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A Continuing Bibliography with Indexes

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Accession numbers cited in this Supplement fall within the following ranges:

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NASA SP-7043(30)

ENERGY

A Continuing Bibliography

With Indexes

Issue 30

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced from April 1 through June 30, 1981 in

- *Scientific and Technical Aerospace Reports (STAR)*
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INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(30)) lists 1546 reports, journal articles, and other documents announced between April 1, 1981 and June 30, 1981 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of this continuing bibliography was published in May 1974 and succeeding issues are published quarterly.

The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The entries are arranged in eight major categories, with *IAA Entries* preceding *STAR Entries* in each category. The citation, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR* including the original accession numbers from the respective announcement journals. This procedure, which saves time and money accounts for the slight variation in citation appearances.

Five indexes -- subject, personal author, corporate source, contract number, and report number -- are included.

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All publications abstracted in this bibliography are available to the public through the sources as indicated in the *STAR Entries* and *IAA Entries* sections It is suggested that the bibliography user contact his own library or other local libraries prior to ordering any publication inasmuch as many of the documents have been widely distributed by the issuing agencies, especially NASA A listing of public collections of NASA documents is included on the inside back cover

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N81-11450*# Virginia Polytechnic Inst and State Univ., Blacksburg. Dept of Materials Engineering
IDENTIFICATION AND ANALYSIS OF FACTORS AFFECTING THERMAL SHOCK RESISTANCE OF CERAMIC MATERIALS IN SOLAR RECEIVERS Final Report
D. P. H Hasselman, J. P Singh, and K Satyamurthy 15 Jul. 1980 150 p refs
(Contracts NAS7-100, JPL-955629)
(NASA-CR-163727, JPL-9950430) Avail NTIS HC A07/MF A01 CSCL 10A

An analysis was conducted of the possible modes of thermal stress failure of brittle ceramics for potential use in point-focussing solar receivers. The pertinent materials properties which control thermal stress resistance were identified for conditions of steady-state and transient heat flow, convective and radiative heat transfer, thermal buckling and thermal fatigue as well as catastrophic crack propagation. Selection rules for materials with optimum thermal stress resistance for a particular thermal environment were identified. Recommendations for materials for particular components were made. The general requirements for a thermal shock testing program quantitatively meaningful for point-focussing solar receivers were outlined. Recommendations for follow-on theoretical analyses were made. Author

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A81-18714 * # **Sodium heat pipe use in solar Stirling power conversion systems.** W. F. Zimmerman (General Electric Co., Advanced Energy Dept., Cincinnati, Ohio), S. M. Divakaruni (General Electric Co., Advanced Reactor Systems Dept., Sunnyvale, Calif.), and Y. S. Won (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *American Society of Mechanical Engineers, Century 2 Solar Energy Conference, San Francisco, Calif., Aug. 19-21, 1980, Paper 80-C2/Sol-13.* 5 p. 6 refs. Members, $1.50; nonmembers, $3.00. Contract No. JPL-955018.

Sodium heat pipes were selected for use as a thermal transport method in a focus-mounted, distributed concentrator solar Stirling power conversion system intended to produce 15-20 kWe per unit. Heat pipes were used both to receive thermal power in the solar receiver and to transmit it to a secondary heat pipe containing both latent heat salt (for up to 1.25 hours of thermal storage) and the heat exchanger of the Stirling engine. Experimental tests were performed on five solar receiver heat pipes with various internal wicking configurations. The performance of the heat pipes at various power levels and operating attitudes was investigated at temperatures near 1550 F, the unidirectional heat transfer in these heat pipes was demonstrated in normal operating attitudes and particularly in the inverted position required during overnight stowage of the concentrator. (Author)

A Listing of Energy Bibliographies Contained In This Publication:

ENERGY

A Continuing Bibliography (Issue 30)

JULY 1981

01
ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

Includes energy requirements, energy conservation, and environmental impacts of energy systems

A81-19848 **Energy analysis of four geothermal technologies.** R. A. Herendeen and R. L. Plant (Illinois, University, Urbana, Ill.). *Energy* (UK), vol. 6, Jan. 1981, p. 73-82. 31 refs. Contract No. ET-78-S-02-5085.

Standard energy analysis was applied to liquid-dominated, hot dry rock, geopressure, and vapor-dominated geothermal-electric technologies. It was shown that the four processes are net energy producers, so that the ratios of net electric energy produced over lifetime to primary nonrenewable energy inputs over lifetime exceed unity. The highest energy ratio of 13 + or - 4 is characteristic of vapor-dominated (dry-stream) technology, which is the only method used commercially to produce electricity in the U.S. It is concluded that the energy ratios computed are similar to those of other authors; however, the estimates for liquid-dominated systems are significantly lower due to the inclusion of environmental control costs. A.T.

A81-20465 **Operational energy conservation strategies in commercial aviation.** R R Covey, G. J. Mascetti, W. U Roessler (Aerospace Corp., El Segundo, Calif.), and R. L. Bowles (U.S Department of Energy, Washington, D.C) In. Conference on Decision and Control, and Symposium on Adaptive Processes, 18th, Fort Lauderdale, Fla, December 12-14, 1979, Proceedings. Volume 1 Piscataway, N J, Institute of Electrical and Electronics Engineers, Inc, 1979, p. 408-414. 12 refs.

Various fuel conservation strategies that are applicable to commercial aviation and that lend themselves to real-time decision and control techniques are discussed It is noted that these 12 strategies could potentially save 12 percent of current fuel usage The strategies are as follows: optimized takeoff procedures, optimized cruise Mach number selection, optimized altitude selection, optimized descent procedures, reduced/delayed flap approaches, flow control, linear holding, gate holding, profile descent, reduced final approach spacing, area navigation/direct routing, and airborne performance computer systems. It is concluded that since the costs incurred and benefits derived in implementing these techniques and strategies are intimately related to fuel prices, comprehensive parametric analyses are needed to clearly identify those strategies for which automatic decision and control can provide the highest energy conservation returns on investment. C.R

A81-20468 **Integration of fuel conservative procedures in the high density terminal area.** R. G Dear (California State University, Fullerton, Calif). In: Conference on Decision and Control, and Symposium on Adaptive Processes, 18th, Fort Lauderdale, Fla., December 12-14, 1979, Proceedings. Volume 1 Piscataway, N.J, Institute of Electrical and Electronics Engineers, Inc., 1979, p 427-431. 8 refs.

Fuel conservative procedures reduce fuel consumption in high density thermal areas if properly planned, but their effectiveness is affected by air traffic controls. Real-time pilot-and-control-in-the-loop simulations showed that fuel savings can be made under moderately heavy traffic conditions; in heavy traffic, high controller workload and lower fuel savings indicate that time-controlled aircraft guidance and computer scheduling may be required to realize the possibilities of fuel conservative procedures. A.T.

A81-20695 # **Environmental assessment for the satellite power system concept development and evaluation program.** M. M. Abromavage (Illinois Institute of Technology, Chicago, Ill.) and A. R. Valentino (Argonne National Laboratory, Argonne, Ill.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St. Louis, Mo., Jan. 12-15, 1981, Paper 81-0244.* 9 p. 8 refs. Research supported by the U.S. Department of Energy.

A 3-year environmental assessment of the satellite power system energy concept has been completed. Potential environmental effects and candidate mitigating strategies have been identified. The important effects which depend upon satellite and energy transmission design are: Low-level long-term microwave exposure to the public; ionizing radiation exposure to workers in space; space transportation exhaust effluent effects in the atmosphere; and electromagnetic compatibility impacts at geostationary earth orbit locations, in the ionosphere, and on earth. These potential effects would influence any further development of the satellite energy concept, including design preferences, energy transmission principles, and system construction, operating and maintenance scenarios. (Author)

A81-21022 **An energy used model of the residential sector.** D. L. O'Neal and E. Hirst (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *IEEE Transactions on Systems, Man, and Cybernetics,* vol. SMC-10, Nov 1980, p. 749-755. 19 refs. Contract No W-7405-eng-26.

An energy simulation model for residential energy uses and costs from 1970 through 2000 estimates annual consumption of four fuels, eight end uses, and three housing types The model also evaluates annual equipment installation, ownership, and equipment costs including charges for improving thermal performance of new and existing housing. An example of the model application is given by estimating the energy and economic factors of alternate water heating conservation options, they show the advantages of heat pump water heaters over conventional and solar units. A.T.

A81-21063 # **Prospective energy sources and their comparison with current supplies (Perspektivnye istochniki energii i ikh sravnenie s ispol'zuemymi).** B V. Voitsekhovskii. *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki,* Sept.-Oct. 1980, p. 118-125. 17 refs. In Russian

The comparative physical-technical and economic characteristics of renewable energy sources are analyzed. The significant advantages of wind energy for future use over oil, gas, and coal are demonstrated. Costs of wind electrical energy are compared in the U.S., Denmark, and the U.S.S.R. A.T.

A81-21101 * # **Response of the global climate to changes in atmospheric chemical composition due to fossil fuel burning.** R. D. Cess, S. Hameed, and J. S. Hogan (New York, State University, Stony Brook, N.Y.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/HT-3.* 3 p. 7 refs. Members, $2.00; nonmembers, $4.00. NSF Grant No. CME-79-09065; Grant No. NCC5-7.

Tropospheric ozone and methane might increase in the future as the result of increasing anthropogenic emissions of CO, NOx and CH4 due to fossil fuel burning. Since O3 and CH4 are both greenhouse gases, increases in their concentrations could augment global warming due to larger future amounts of atmospheric CO2. To test this possible climatic impact, a zonal energy-balance climate model has been combined with a vertically-averaged tropospheric chemical model. The latter model includes all relevant chemical reactions which affect species derived from H2O, O2, CH4 and NOx. The climate model correspondingly incorporates changes in the infrared heating of the surface-troposphere system resulting from chemically induced changes in tropospheric ozone and methane. This coupled climate-chemical model indicates that global climate is sensitive to changes in emissions of CO, NOx and CH4, and that future increases in these emissions could enhance global warming due to increasing atmospheric CO2. (Author)

A81-22548 **Preliminary environmental assessment for the satellite power system /SPS/.** *Journal of Environmental Sciences,* vol. 24, Jan.-Feb. 1981, p. 16-22, 31, 32.

The collection of solar energy via SPS for conversion to microwave energy and subsequent conversion to electricity is examined in light of potential health hazards, effect on ecosystems, and interaction of electromagnetic systems. Research exploring the immunologic, teratologic, and behavioral effects of a frequency of 2.45 gigahertz is discussed. Tropospheric effects of rocket effluents are documented in terms of the modification of weather conditions. Rectenna waste heat may result in alterations in the chemical composition of the stratosphere and mesosphere affecting ozone concentrations. Microwave energy transmitted might be sufficient to heat the ionosphere resulting in increased electron temperatures, irregularities in electron densities, focusing of electromagnetic waves and absorption or scattering of radio waves. Principal nonmicrowave effects catalogued are pollution and exposure of the general public and space workers to explosives and toxins. L.S.

A81-23073 **Characterization of sulfate emissions from nonutility boilers firing low-S residual oils in New York City.** J. B. Homolya (U.S. Environmental Protection Agency, Environmental Sciences Research Laboratory, Research Triangle Park, N.C.) and S. Lambert (Engineering-Science, Inc., McLean, Va.). *Air Pollution Control Association, Journal,* vol. 31, Feb. 1981, p. 139-143. 27 refs.

A81-23416 **Utilization of cascade impactors in hot waste gas from an oil firing installation (Kaskadenimpaktoreinsatz im heissen Abgas einer Ölfeuerung).** H. Franzen and H.-J. Fissan (Duisburg, Gesamthochschule, Duisburg, West Germany) *Staub - Reinhaltung der Luft,* vol. 41, Jan. 1981, p. 22-26. 8 refs. In German.

Andersen cascade impactors were used in an oil firing plant to characterize particulate emissions. Methods of eliminating possible errors in the fractionation and subsequent gravimetric analysis are described. The relation between soot index and particle parameters, including total particle mass concentration and particle mass distribution, is examined in relation to the value of the soot index for the assessment of particulate emissions. B.J.

A81-23555 # **Evaluating the environmental effects of past and present surface mining - A remote sensing applied research review.** A. T. Anderson (U.S. Department of the Interior, Office of Surface Mining, Washington, D.C.). In: International Symposium on Remote Sensing of Environment, 14th, San Jose, Costa Rica, April 23-30, 1980, Proceedings. Volume 1 Ann Arbor, Mich., Environmental Research Institute of Michigan, 1980, p. 275-278.

The objectives of the Office of Surface Mining Reclamation and Enforcement (OSM) of the U.S. Department of Interior are outlined, with a view to its applied research program on remote sensing projects. The projects discussed include the development of a coal surface mine monitoring capability, the aerial photography of the Appalachian coal regions, contributions to the national high-altitude aerial photography data base and western surface mine aerial coverage. Remote sensing is also being used as a supplementary tool in five project and program areas dealing with mine evaluation. L.S.

A81-24622 **Sulfur pollution from coal combustion - Effect of the mineral components of coal on the thermal stabilities of sulfated ash and calcium sulfate.** D. C. Baker and A. Attar (Houston, University, Houston, Tex.) *Environmental Science and Technology,* vol. 15, Mar. 1981, p. 288-293. 33 refs. Research supported by the Texas Energy Advisory Council and Dow Chemical Co.

A81-24991 **Energy storage technology - Environmental implications of large scale utilization.** M. C. Krupka, J. E. Moore, W. E. Keller (California, University, Los Alamos, N. Mex.), G. A. Baca, R. I. Brasier, and W. S. Bennett (Los Alamos Technical Associates, Inc., Los Alamos, N. Mex.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1.
Washington, D.C., Hemisphere Publishing Corp., 1981, p. 265-284. 33 refs.

Environmental effects are identified for several energy storage technologies including advanced lead-acid battery, compressed air, underground pumped hydroelectric, flywheel, superconducting magnet, and various thermal systems. A preliminary study on fuel cell technology is also reported. New applications for energy storage technologies and the additional costs of controls to be used for mitigation of specific impacts are briefly discussed. V.L.

A81-25020 **The series solar heat pump and energy conservation.** E. A. Kush (Brookhaven National Laboratory, Upton, N.Y.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 665-676. 17 refs. Research sponsored by the U.S. Department of Energy.

An overview is given of the series solar heat pump concept and the reasons why it can serve an important role in energy conservation in space heating. These are highlighted by elevated Coefficients of Performance (COP's) and the use of low-temperature potentially inexpensive solar collectors. The characteristics required of the subsystems and integrated system are detailed. Particular emphasis is given to the performance of the heat pump itself at high temperature source conditions corresponding to those of solar input, and recent laboratory results which demonstrate very high COP's using practical components are shown. The reasons why the high COP's are a necessary but not sufficient condition for competitive overall system performance are detailed and methods for applying the high COP's to an effective Solar Assisted Heat Pump (SAHP) system are discussed. Ongoing development work in the field is summarized. (Author)

A81-25036 **A non-conventional reversible total energy system.** S. Arosio (Milano, Politecnico, Milan, Italy) In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 865-887. 20 refs.

The possibility of producing electricity and heat for residential use by a heat-pumped, freon working fluid-cycle thermogravimetric method is explored. The plant structure matches that of apartment buildings, and its operational characteristics react positively to insolation-incidence fluctuations. The system is made up entirely of conventional, safe and highly reliable components and with the choice of a suitable user, it is possible to obtain a system producing 100% of required heat and 30% of required electricity with operating costs lower than present energy prices and high efficiencies at even off-design conditions. O.C.

A81-25053 **An assessment of the atmospheric effects of a Satellite Power System.** D. M. Rote, K. L. Brubaker, J. Lee, and A. R. Valentino (Argonne National Laboratory, Argonne, Ill.). In: *Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3.* Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1163-1191. 36 refs.

Assuming the elements of a reference Satellite Power System (SPS) created by NASA, the general environmental consequences and specific atmospheric effects of the Heavy Lift Launch Vehicle needed for its construction are assessed. Beginning with the troposphere, potential atmospheric effects such as weather modification, and the present understanding of them, are summarized as a function of altitude. Although all levels of the atmosphere will be affected, it is thought that its progressive rarefication with increasing altitude will attenuate the rocket effluent and acoustical energy impacts of the HLLV's two daily flights over a period of 30 years and the rectenna waste heat release of the microwave power transmission system. O.C.

A81-25061 **Residential passive solar systems - Regional sensitivity to system performance costs, and alternative prices.** C. Kirschner, S. Ben-David (New Mexico, University, Albuquerque, N. Mex.), and F. Roach (California, University, Los Alamos, N. Mex.). In: *Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3.* Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1371-1401. 6 refs. Research supported by the U.S. Department of Energy.

The economic potential of two passive space heating configurations with night insulation - a masonry thermal storage wall (Trombe) and a direct gain system - is assessed. Use is made throughout the analysis of a standard tract home design for each of the two passive systems in order to allow interregional comparisons. The performance of the two systems is evaluated from an economic standpoint on a regional basis (223 locations) throughout the U.S. For each of the two conventional energy types considered (electricity and natural gas), sensitivity analysis is carried out to determine the impact of alternative fuel price escalation rates and solar costs upon feasibility of the two solar systems. Cost goals for solar system prices are fixed under one set of future fuel prices and stated economic conditions. Alternatively, future fuel price requirements (given solar feasibility) are examined under stated add-on cost expenditures. C.R.

A81-25088 **Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 5 - Geothermal power/energy program.** Conference supported by the International Association for Hydrogen Energy, IAEA, ISES, Florida International University, and University of Miami. Edited by T. N. Veziroglu (Miami, University, Coral Gables, Fla.). Washington, D.C., Hemisphere Publishing Corp., 1981. 409 p. *Price of nine volumes, $595.*

This volume examines the geothermal resource and geothermal energy utilization, and surveys regional energy programs worldwide. The particular papers presented on geothermal energy include those on the temperature indicators for geothermal use, geothermal drilling research in the United States, and geothermal energy and biofuel production in agriculture. Energy programs from India, Egypt, Turkey, Greece and Puerto Rico are reviewed. L.S.

A81-25098 **Indian energy sources in 1980's.** A. C. Chaturvedi (Minor Irrigation Department, Lucknow, India). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 5. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 2173-2196. 23 refs.

Indian energy sources for electrical power generation are surveyed with a view to the development of the available hydroelectric resources. The capital-intensive nature of hydroelectric projects and their long gestation periods have impeded the rapid exploitation of the hydroelectric resources in the country, which are expected to provide 37% of the 16,200 MW capacity anticipated by 2001. Alternative sources of power such as solar and wind energy, biogas conversion and the use of industrial waste heat to produce electricity are discussed with case studies presented. L.S.

A81-25161 **Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 9 - Conservation, economics, and policy; Index.** Conference supported by the International Association for Hydrogen Energy, IAEA, ISES, Florida International University, and University of Miami. Edited by T. N. Veziroglu (Miami, University, Coral Gables, Fla.). Washington, D.C., Hemisphere Publishing Corp., 1981. 560 p. *Price of nine volumes, $595.*

The book examines the topics of waste utilization, conservation, and energy economics and policy. Energy supply and demand, energy economics and planning, and energy strategies and policies are reviewed. Papers are presented on the contributions to the energy supply of the industrialized countries from nuclear energy and regenerative energy flows, a method for estimating escalation and interest during construction, and a comparison of the incentives used to stimulate energy production between the United States and Japan. L.S.

A81-25800 **Energy efficiency of electrified passenger railway in the Canadian context.** A. M. Khan (Carleton University, Ottawa, Canada) *Journal of Advanced Transportation*, vol 14, Fall 1980, p. 237-254. 17 refs. Research sponsored by the Science Council of Canada and Transport Canada

Energy requirements of electrified passenger trains have not been adequately addressed in the technical literature. This paper examines in the Canadian context (1) the energy implications of passenger railway electrification in terms of propulsion energy requirements (from primary energy source to final consumption) as well as the indirect energy needed for rolling stock and infrastructure, and (2) the relative energy efficiencies of electric and diesel-electric railway traction systems (Author)

A81-26196 **An environmental appraisal of tidal power stations: With particular reference to the Severn barrage.** Edited by T. L. Shaw (Bristol, University, Bristol, England) London and Marshfield, Mass., Pitman Publishing, Ltd. (Current Reports in Civil and Environmental Engineering 1), 1980. 932 p. $18.95.

The book evaluates the changes in natural environment of the Severn Estuary whose tidal conditions are most favorable for power stations. Topics covered include physics of water movements in the Severn Estuary, sediment dynamics, drainage and land quality, and biological effects. In addition, ecosystem models and predictions, pollution, impact on wading birds, effects on wildfowl, fisheries, civil engineering problems, and the use of china clay sand in construction are discussed. A.T.

A81-26371 **Wind energy - A utility perspective.** K. T. Fung, R. L. Scheffler, and J Stolpe (Southern California Edison Co, Rosemead, Calif.) *(Institute of Electrical and Electronics Engineers, Summer Meeting, Minneapolis, Minn, July 13-18, 1980) IEEE Transactions on Power Apparatus and Systems,* vol. PAS-100, Mar 1981, p. 1176-1182. 6 refs.

Broad consideration is given to the siting, demand, capital and operating cost and wind turbine design factors involved in a utility company's incorporation of wind powered electrical generation into existing grids With the requirements of the Southern California Edison service region in mind, it is concluded that although the economic and legal climate for major investments in windpower are favorable, the continued development of large only wind turbine machines (on the scale of NASA's 2 5 MW Mod 2 design) is imperative in order to reduce manpower and maintenance costs. Stress is also put on the use of demonstration projects for both vertical and horizontal axis devices, in order to build up operational experience and confidence O.C.

A81-27212 # **The U.S. National Photovoltaic Program.** L. M. Magid and P. D. Maycock (U.S. Department of Energy, Div. of Distributed Solar Technology, Washington, D.C.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 887-892.

The Photovoltaic Energy System Program proposed by the United States Department of Energy is discussed with reference to the program strategy and goals, major elements, and management. A key element in this program is the expectation that photovoltaic residences will begin to be cost effective within the Southwestern United States when modules are priced at 70 cents/peak watt and the total installed system costs from $1.6 to $2.20 per peak watt (in 1980 dollars). The program anticipates this occurring in 1986. V.L.

A81-28478 # **Cloud modification by man-made pollutants - Effects of a coal-fired power plant on cloud drop spectra.** R. F. Pueschel, E. W. Barrett, D. L. Wellman, and J. A. McGuire (NOAA, Air Resources Laboratories, Boulder, Colo.). *Geophysical Research Letters*, vol. 8, Mar. 1981, p. 221-224. 11 refs. Research supported by the U.S. Environmental Protection Agency.

A81-28549 **Pacific Northwest geothermal - Review and outlook.** W. Youngquist. *Geothermal Energy*, vol 8, Oct.-Nov. 1980, p. 3-11.

Activities associated with geothermal exploration and development in the states of Idaho, Oregon, and Washington are reviewed. A geothermal electric plant on the Raft River is almost operational Tests for space heating projects at Rexburg and in the City of Boise continue The State of Oregon conducts its regional temperature gradient drilling program, and a number of shallow wells were drilled in 1979 and 1980 Deep well drilling (projected to 5,000 to 7,000 ft.) is pursued at Mount Hood The eruption of Mount St. Helens has increased interest in the geothermal resources in Washington A study of the warm and hot water potential on the northwest flank of Mount Ranier is negotiated Possible space heating sources in 22 cities, towns, and hamlets in the Columbia Basin have been identified. Deleterious environmental impact on the forest regions of the Pacific Northwest is one reason for the Federal leasing problems. The electric power situation will be critical in the Northwest in 1983, as no additional power will probably be available to utilities from the Bonneville Power Administration Indigenous U S energy sources can be developed and exploration activity can be increased if federal lease processing is greatly expedited K S

A81-28993 **Sulphur removal potential of American coals as a determinant of sulphur dioxide emissions from coal-fired power plants.** S. Ergun (California, University, Berkeley, Calif.) *(Royal Society, Discussion on New Coal Chemistry, London, England, May 21, 22, 1980.) Royal Society (London), Philosophical Transactions, Series A*, vol 300, no. 1453, Mar 20, 1981, p. 89-97, Discussion, p. 97, 98. 13 refs

The presence of sulphur in coals is a major obstacle to their use in coal-fired power plants because of the restrictions placed on sulphur dioxide emitted from such plants In this study, it has been found that the recently imposed sulphur dioxide emission standards in the United States are unrealistic because they are not consonant with the reserve base of U S. coals by total and pyritic sulphur contents, and with factors influencing the removal of pyrite by physical methods. Since cleaning of coal by physical means is inexpensive compared with converting coals into clean-burning fuels before burning them in the boilers or reverting to stack-gas clean-up, and since direct firing of coal conserves the coal if the end product is electricity, it is recommended that the standards to be imposed should be consonant with the reverse base and the potential of physical methods. (Author)

A81-29195 **Oil substitution and energy saving - A research and development strategy of the International Energy Agency /IEA/ (Ölsubstitution und Energieeinsparung - Eine Forschungs- und Entwicklungsstrategie der Internationalen Energieagentur /IEA/).** S. Rath-Nagel (Kernforschungsanlage Julich GmbH, Julich, West Germany). *Brennstoff-Wärme-Kraft*, vol 33, Mar. 1981, p. 85-89 18 refs In German.

Systems analyses were carried out by the International Energy Agency for the participating 15 countries in order to work out strategies and scenarios for lessening the dependence on imported oil and for developing new energy technologies. MARKAL model computations show the technology and energy mixes necessary for achieving a reduction of oil imports by two thirds over the next 40 years. The scenario 'high social security' examines the projected rise in energy consumption, the development of oil substitutes, the increase in alternative heating sources, the development of markets for liquid energy products, the demand for gas, and the relative usage of various energy generation methods. The recommended strategy involves as the most important points an increase in coal consumption, greater nuclear energy reliance and development of alternative technologies D.K.

A81-29681 **Private sector initiatives - A case history.** H Homeyer (Texas Eastern Synfuels, Inc., Houston, Tex.). In: Synfuels industry opportunities, Proceedings of the Seminar, Washington, D.C., November 6, 7, 1980. Seminar sponsored by the Government Institutes. Washington, D.C., Government Institutes, Inc., 1981, p. 95-126.

The overall development of the synfuel industry in the United States is reviewed with reference to types of synfuels, synfuel production goals, expected structure of industry, characteristics of projects, and government involvement. In particular, the role of private energy companies in the synfuels area is discussed using as an example the projects pursued by Texas Eastern. V.L

A81-30056 * # **Evaluation of concepts for controlling exhaust emissions from minimally processed petroleum and synthetic fuels.** P L. Russell, G W. Beal (United Technologies Corp., Government Products Div., West Palm Beach, Fla), R. A Sederquist (United Technologies Corp., Power Systems Div., South Windsor, Conn.), and D. Shultz (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-157* 8 p Members, $2 00, nonmembers, $4 00. Research supported by the U.S Department of Energy and NASA

Rich-lean combustor concepts designed to enhance rich combustion chemistry and increase combustor flexibility for NO(x) reduction with minimally processed fuels are examined. Processes such as rich product recirculation in the rich chamber, rich-lean annihilation, and graduated air addition or staged rich combustion to release bound nitrogen in steps of reduced equivalence ratio are discussed Variations to the baseline rapid quench section are considered, and the effect of residence time in the rich zone is investigated The feasibility of using uncooled non-metallic materials for the rich zone combustion construction is also addressed The preliminary results indicate that rich primary zone staged combustion provides environmentally acceptable operation with residual and/or synthetic coal derived liquid fuels L S

A81-30111 # **Energy conservation through process modification and control.** S. C. Agarwal and M A Keyes (Bailey Controls Co., Wickliffe, Ohio) *American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, Houston, Tex , Jan. 18-22, 1981, Paper 81-PID 2* 13 p 9 refs. Members, $2 00, nonmembers, $4.00

Application of the second law of thermodynamics for identification of energy conservation opportunities in process plants is briefly reviewed Energy conservation by process modification and control in process and petrochemical plants is presented via examples Also, a generalized algorithm, minimizing incremental cost, for load allocation to multiple units (functionally similar, e g , boilers, process heaters, pumps, compressors, etc.) operating in parallel has been developed (Author)

A81-30113 # Making windpower an important part of a national energy plan. A. N. Finlayson (A. Neil Finlayson, Ltd., Broomall, Pa.) *American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, Houston, Tex., Jan. 18-22, 1981, Paper 81-Pet-11* 5 p. Members, $2.00; nonmembers, $4.00.

The design characteristics of the Finlayson Windcatcher wind turbine are outlined. The unit geometry consists of two vertical axis cylindrical vane arrays mounted very close to each other and rotating in opposite directions. The two rotors are supported top and bottom by anti-friction bearings mounted at the ends of arms which are attached to a single support pillar. Because the rotor axes are downwind of the support pillar axis, they are free to swing in the horizontal plane, remaining automatically downwind without the need for a separate guide vane. There is not gyroscopic effect of the rotors to hinder rotation in wind direction. A 1-2 kW net electrical output in a 30 mph wind is estimated. L.S.

A81-30118 # Overview of unconventional energy projects in the public power sector. R. E Leber (American Public Power Association, Washington, D.C.) *American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, Houston, Tex., Jan. 18-22, 1981, Paper 81-DGP-1.* 8 p. Members, $2.00; nonmembers, $4.00.

The alternative energy programs sponsored by publically owned utilities across the country are reviewed. Biomass conversion, diesels, combustion turbines, fuel cells, solar heating units, wind power, cogeneration, and load management are discussed in the context of the individual projects The emphasis of the programs is on providing the services required by consumers, such as water heating, space conditioning, and insulation, rather than on the marketing of electricity as a single product L.S

N81-16311# Committee on Energy and Natural Resources (U.S Senate)
OCTOBER REPORT ON THE CURRENT FUEL SITUATION FROM THE ENERGY INFORMATION ADMINISTRATION
Washington GPO 1980 220 p refs Hearing before the Subcomm on Energy Regulation of the Comm. on Energy and Nat. Resources, 96th Congr, 1st Sess., 22 Oct 1979
(GPO-60-871, Publ-96-101) Avail: Subcommittee on Energy Regulation

The energy situation is assessed with emphasis on the near term supply of petroleum fuels and prevailing prices. The effect of immediate decontrol of gasoline prices is considered as well as the profits of refineries since price controls were life lifted from heating oil and diesel fuels. A.R.H

N81-16314# Oak Ridge National Lab., Tenn. Environmental Sciences Div.
ENVIRONMETRICS OF SYNFUELS. 1: PROCESSING THE AUTOMATED PDP-11 DATA COMPONENTS FOR THE UMD GASIFIER FACILITY
R. H. Strand, M P. Farrell, C W. Gudmundson, T K. Birchfield, S. S. Casada, and M. E. Vansuch 1980 19 p
(Contract W-7405-eng-26)
(CONF-8010106-7; Publ-1564) Avail. NTIS HC A02/MF A01

Techniques and procedures used to handle automated data collected at the University of Minnesota-Duluth campus coal gasification facility are described This facility is evaluated for its potential health and environmental effects. Automatic and manually collected data and sample results data are used for this assessment. The procedures developed within the data management project for handling two categories of automated data are described: (1) process; and (2) environmental. The examples use data from the first one and a half years of gasifier operation. S.F.

N81-16316# Mid-American Solar Energy Complex, Minneapolis, Minn.
ON-FARM PRODUCTION OF FUEL-ALCOHOL IN MID-AMERICA TECHNICAL AND ECONOMIC POTENTIAL
Michael A Hohmann Mar 1980 22 p refs Presented at the 12th Ann. Meeting of the Mid-Continent Regional Sci Assoc, Lincoln, Nebr., 24-26 Apr 1980
(Contract DE-AC02-79CS-30150)
(MASEC-TP-80-009, CONF-8004124-1) Avail NTIS HC A02/MF A01

The agricultural energy consumption for the central part of the United States was examined. Fermentation alcohol production and co product usage rates were predicted Theoretical ethanol yields from raw materials are presented Suggestions for further research and development in farm fuel production are presented. T M

N81-16510 Michigan State Univ., East Lansing
THE INDIAN LANDS STUDY: AN EXAMPLE OF THE APPLICATION OF GEOGRAPHIC RESEARCH TO THE ANALYSIS OF COMPLEX ENERGY AND ENVIRONMENTAL POLICY ISSUES Ph.D. Thesis
Douglas Burton Richardson 1980 397 p
Avail: Univ. Microfilms Order No. 8101157

Numerous policy and land use planning issues related to controlling the environmental impacts and changes which accompany large scale surface mining on Indian lands were analyzed. The spatial area encompassed by the project includes all twenty-five Indian reservation in the United States which are known to contain coal resources. The subject matter of the study ranged from the physical landscapes of those areas to their political and cultural environments to their interaction with the larger, national region in two key areas--the quest for an expanded energy supply, and the need to prevent environmental damage and degradation The Study's final report, entitled The Control and Reclamation of Surface Mining on Indian Lands, brings together a comprehensive set of data on the contemporary North American Indian setting, and in so doing addresses an important range of the key energy related issues confronting tribes in their modern environment. Dissert Abstr

N81-16513*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
REGIONAL PRICE TARGETS APPROPRIATE FOR ADVANCED COAL EXTRACTION
Katsuaki L. Terasawa and David M Whipple 1 Dec. 1980 74 p refs
(Contracts NAS7-100; DE-AI01-76ET-12548)
(NASA-CR-163896; JPL-Pub-80-91) Avail: NTIS HC A04/MF A01 CSCL 08I

A methodology is presented for predicting coal prices in regional markets for the target time frames 1985 and 2000 that could subsequently be used to guide the development of an advanced coal extraction system. The model constructed is a supply and demand model that focuses on underground mining since the advanced technology is expected to be developed for these reserves by the target years. Coal reserve data and the cost of operating a mine are used to obtain the minimum acceptable selling price that would induce the producer to bring the mine into production. Based on this information, market supply curves can be generated. Demand by region is calculated based on an EEA methodology that emphasizes demand by electric utilities and demand by industry. The demand and supply curves are then used to obtain the price targets The results show a growth in the size of the markets for compliance and low sulphur coal regions. A significant rise in the real price of coal is not expected even by the year 2000. The model predicts heavy reliance on mines with thick seams, larger block size and deep overburden. A R H

N81-16524# Committee on Science and Technology (U S. House).
NATIONAL ACADEMY OF SCIENCES REPORT: ENERGY IN TRANSITION, 1985-2010
Washington GPO 1980 150 p refs Hearing before the

Comm on Sci and Technol., 96th Congr., 2nd Sess., no. 119, 25 Jan. 1980
(GPO-61-647) Avail. Committee on Science and Technology
The results of the report of the Committee on Nuclear and Alternative Energy Systems, known as the CONAES report, were reviewed The economic, social and technical aspects of energy policy options during the remainder of the 20th century and early in the 21st century were examined. The results are used as one of many guidelines in energy policy making. T.M

N81-16525# Committee of Conference (U. S Congress)
WIND ENERGY SYSTEMS ACT OF 1980
Washington GPO 1980 17 p Conf Rept to accompany H R 5892 presented by the Comm of Conf at the 96th Congr., 2nd Sess., 1 Aug 1980
(H-Rept-96-1217) Avail. US Capitol, House Document Room
A compromise set of findings and purpose was adopted which is based on parts of both the House and Senate bills. By the end of 1988, the Act seeks (1) to reduce the average cost of electricity produced by installed wind energy systems; (2) to reach a total megawatt capacity in the U.S from wind energy systems of at least 800 megawatts, of which at least 100 megawatts are provided by small wind energy systems, and (3) to accelerate the growth of a commercially viable and competitive industry to make wind energy systems available to the general public as an option It is recommended that the House recede from disagreement to the Senate amendment to test the bill and agree on a compromise title. A.R.H.

N81-16527# Committee on Science and Technology (U. S. House)
FORESIGHT. VOLUME 2: ENERGY CONSERVATION IN CITIES
Washington GPO 1979 123 p refs Presented to the Subcomm. on Advan Energy Technol and Energy Conserv Res., Develop. and Demonstration of the Comm on Sci and Technol., 95th Congr., 2nd Sess, Dec 1978 Prepared by Congressional Research Service, Library of Congress
(GPO-47-454) Avail: SOD
A review of the development of cities is presented along with demographic patterns and imperatives that affect energy conservation Public reactions to energy conservation were surveyed and planning strategies and policies were developed Social and institutional barriers to energy conservation were examined Problems that cities have with federal energy conservation programs were reviewed Urban planning with emphasis on energy conservation was discussed T.M.

N81-16530*# National Aeronautics and Space Administration, Washington, D C
SOLAR POWER SATELLITE SYSTEM Patent Application
George L Sarver, III, inventor (to NASA) (MIT, Cambridge) Filed 29 Sep. 1980 11 p Sponsored by NASA
(NASA-Case-HQN-10949-1, US-Patent-Appl-SN-191747) Avail: NTIS HC A02/MF A01 CSCL 10A
A solar power satellite system is provided which includes a power satellite and at least one reflector satellite. The power satellite, which constitutes the great mass of the system, has a geosynchronous, gravity gradient stabilized orbit. The power satellite comprises a planar array of solar cells, with the plane of the satellite being oriented so as to be parallel with the plane of its orbit. An antenna or antennas mounted on the power satellite are powered by the solar cells and serve to transmit microwave energy back to earth. The shape and orbit of the reflector satellite are controlled so that solar radiation is focused by the reflector satellite onto the solar array of the power satellite. NASA

N81-16531# Comptroller General of the United States, Washington, D C.
A FRAMEWORK FOR DEVELOPING A NATIONAL ENERGY CONSERVATION PROGRAM
31 Jul 1979 60 p refs
(EMD-79-76) Avail. NTIS HC A04/MF A01
A decision making framework is discussed which is intended as one approach for considering the wide range of alternatives available to the Government for achieving more energy conservation in the Nation. The framework provides for evaluating energy conservation strategies ranging from voluntary initiatives to mandatory actions. It also provides for selecting specific policies and programs based on an evaluation of expected energy savings and costs and on environmental, economic, and social impacts. A.R.H.

N81-16532# Comptroller General of the United States, Washington, D C
HOW THE PETROLEUM REFINING INDUSTRY APPROACHES ENERGY CONSERVATION. A CASE STUDY
13 Jun 1980 70 p refs
(EMD-80-55) Avail: NTIS HC A04/MF A01
The U.S. petroleum refining industry accounts for about 4 percent of total domestic energy consumption and over 10 percent of all energy consumed by the industrial sector. The refining industry has achieved significant improvements in efficiency in the past and expects continued improvements Conservation achievements are examined and the impact of existing Federal energy conservation programs in furthering conservation gains are assessed. The definition of 'conservation' used includes both increased energy efficiency and fuel substitution A R.H.

N81-16569*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md
HOUSING AUTHORITY OF BALTIMORE CITY-PUBLIC HOUSING ENERGY WORKSHOP
Thomas S. Golden, ed. 1980 49 p Workshop held at Easton, Md, 21-23 Sep. 1980
(NASA-TM-82050) Avail: NTIS HC A03/MF A01 CSCL 10B
The NASA/Baltimore Applications Project operating at the Goddard Space Flight Center was called upon by the Housing Authority of Baltimore City to consider the problems of providing low cost public housing because of increased energy costs and suggest methods for correction and alleviation The first step chosen was to elicit as many different options for solution as possible through means of a Public Housing Energy Workshop held in Easton, Md. in September 1980. A final role for the Workshop was a listing and qualifying of each alternative as to its suitability and cost. Specific areas were examined by three panels: (1) Systems, (2) Conservation and Motivation, and (3) Fuels Each panel was made up of persons from differing but appropriate backgrounds; membership was not restricted to housing people alone. A summary of their deliberations is given - it will be used as a stepping stone to further selection and implementation of alternatives Author

N81-16585# Committee on Energy and Natural Resources (U S Senate)
ENERGY IN TRANSITION, 1985-2010
Washington GPO 1980 64 p refs Hearing before the Comm. on Energy and Nat. Resources, 96th Congr. 2nd Sess, 18 Apr 1980
(GPO-63-171, Publ-96-110) Avail. Committee on Energy and Natural Resources
Highlights of the Committee on Nuclear and Alternative Energy Systems' (CONAES) report are summarized A variety of energy futures are discussed with respect to their political desirability and feasibility. The social acceptability attached to the risks involved in each of the possible energy futures was examined. Policies were determined with regard for the flexibility to change the direction of growth and research in the future T M

N81-16587# Air Force Inst of Tech, Wright-Patterson AFB, Ohio. School of Meteorology
ENVIRONMENTAL INFLUENCES IN THE SIMULATION OF A SOLAR SPACE HEATING SYSTEM M.S. Thesis - Oklahoma Univ.
Douglas M. Brooks 1980 132 p refs
(AD-A092436; AFIT-CI-80-20T) Avail NTIS HC A07/MF A01 CSCL 13/1
The objective of this thesis was to determine whether hourly

departures in building heat loss given by a simplified degree day approach has a significant effect on the selection of an optimum collector size for the solar system A numerical model was to do simulation studies Using the results from this simulation an optimum collector size was determined from the energy requirements given by each model and a comparison made between the simulations and the degree day approaches GRA

N81-16603# Houston Univ., Tex
ENERGY SUPPLY AND DEMAND PROPERTIES FROM ENGINEERING PROCESS MODELS Final Report
R G Thompson, S Muthukrishnan, F D Singleton, Jr, and J C Stone Jan 1980 171 p refs
(EPRI Proj 1055-1)
(EPRI-EA-1568) Avail: NTIS HC A08/MF A01

Energy supplies and demands are studied by use of process models A process mode represents a synthesis of engineering and economic principles into a mathematical model of production. The mathematical procedure employed is linear programming The distinguishing features of this method are: (1) the representation of specific processes by vectors of fixed coefficients which describe the inputs, outputs and costs of each process: and (2) the mathematical structuring of these process representations in such a way as to impose relevant economic, engineering, and policy constraints on the choice of process alternatives Solution of the linear programming model for its minimum cost solution gives the economically efficient way to produce the required outputs within the limitations of externally imposed economic and regulatory constraints. S F

N81-16604# Los Alamos Scientific Lab, N. Mex
CONSTRAINTS TO BIO-ENERGY DEVELOPMENT
Virginia Barber Parsons 1980 9 p refs Presented at the 3rd Intern. Conf on Alternative Energy Sources, Miami Beach, Fla., 15-17 Dec. 1980
(Contract W-7405-eng-36)
(LA-UR-80-3387; CONF-801210-7) Avail: NTIS HC A02/MF A01

The energy crisis has prompted research and development of renewable, domestic, cost effective, and publicly acceptable energy alternatives Among these are the bioconversion technologies To date bioenergy research has been directed toward the mechanics of the conversion processes and technical assessment of the environmental impacts However, there are other obstacles to overcome before biomass can be converted to more useful forms of energy that fit existing need Barriers to bioenergy resource application are identified In addition, examples from several agricultural regions serve to illustrate site specific resource problems. E D.K.

N81-16605# Los Alamos Scientific Lab., N. Mex.
ENERGY, HELIUM, AND THE FUTURE, 2
Milton C Krupka and Edward F Hammel 1980 23 p refs Presented at Third Intern Conf on Alternative Energy Sources, Miami Beach, Fla, 15-17 Dec 1980
(Contract W-7405-eng-36)
(LA-UR-80-3342; CONF-801210-6) Avail. NTIS HC A02/MF A01

Potential supplies of helium from both conventional and unconventional natural gas resources, projected supply/demand relationships to the year 2030 based upon a given power generation scenario, projected helium demand for specific energy related technologies and the supply options available to meet that demand are discussed. An updated review is given of the energy requirements for the extraction of helium from natural gas as they relate to the concentration of helium. The technical and economic feasibility of several methods available both now and conceptually possible to extract helium from helium lean natural gas, the atmosphere and outer space is discussed. A brief review is given of the 1980 congressional activities with respect to the introduction and possible passage of helium conservation legislation E D.K.

N81-16611# National Inst. of Building Sciences, Washington, D C.
RESIDENTIAL ENERGY EFFICIENCY STANDARDS STUDY: TECHNICAL ANALYSIS
Jun. 1980 370 p refs
(Contract HUD-HC-5040)
(PB81-106981, HUD-0001671) Avail NTIS HC A16/MF A01 CSCL 13A

The need for, the feasibility of, and the problems of requiring, by mandatory federal action, that all residential dwelling units meet applicable, energy efficiency standards was determined The potential requirements of mandatory energy efficiency standards was identified. The incremental energy savings and investment cost of mandatory standards for 1981 through 1990 was estimated. The impact of estimated, maximum incremental energy savings and investment cost of standards on the entire economy was assessed. GRA

N81-16612# National Bureau of Standards, Washington, D C. National Engineering Lab
THE NBS ENERGY MODEL ASSESSMENT PROJECT: SUMMARY AND OVERVIEW
S. I. Gass, K L Hoffman, R H F. Jackson, L S. Joel, and P B Saunders Sep. 1980 43 p refs Sponsored in part by DOE
(PB81-105082, NBSIR-80-2128) Avail NTIS HC A03/MF A01 CSCL 10A

The activities and technical reports for the project are summarized The reports cover assessment of the documentation of Midterm Oil and Gas Supply Modeling System, analysis of the model methodology characteristics of the input and other supporting data, statistical procedures undergirding construction of the model and sensitivity of the outputs to variations in input, as well as guidelines and recommendations for the role of these in model building and developing procedures for their evaluation GRA

N81-16614# Gamze-Korobkin-Caloger, Inc, Washington, D C
ANALYSIS OF RESIDENTIAL DUCT LOSSES Final Report, Mar. 1979 - Apr. 1980
Joseph A Orlando, Maurie G Gamze, N Malik, R Crews, G. Michaels, and J. Christie Aug 1980 219 p refs Sponsored by Gas Research Inst
(PB80-228000, Rept-9240-2, GRI-79/0037) Avail NTIS HC A10/MF A01 CSCL 08M

To assess the impact of measured duct losses on energy consumption, it is necessary to consider the duct system as but one element in the residential environmental control system that includes both the building frame and the furnace Based on data collected in this effort, it was concluded that duct systems should include return registers in each room and balancing dampers in all supply branches This will increase occupant comfort and decrease heating costs. It may also improve the performance of a central air conditioning system It was also found that taping and insulating duct-work can produce meaningful energy savings, while the use of outside air for combustion was of minor consequence GRA

N81-16626# Committee on Energy and Natural Resources (U S Senate)
EFFECTS OF CARBON DIOXIDE BUILDUP IN THE ATMOSPHERE
Washington GPO 1980 344 p Hearing before the Comm on Energy and Nat. Resources, 96th Congr, 2nd Sess, 3 Apr 1980
(GPO-62-841, Publ-96-107) Avail Committee on Energy and Natural Resources

The extent to which the burning of fossil fuels contributes to the greenhouse effect is examined as well as other sources of carbon dioxide in the atmosphere and the effects on climate, environment and society Physical processes important for climate and climate modeling and the validity of the models is assessed. Particular attention is given to atmospheric warming and the snow-ice effects. The need for international efforts to consider the global effects of carbon dioxide and the possibilities for avoiding or reducing them is expressed A.R H.

N81-16631# Brookhaven National Lab, Upton, N Y Process Sciences Div
THE VALUE OF FORESTATION IN ABSORBING CARBON DIOXIDE SURROUNDING A COAL FIRED POWER PLANT
V D. Dang and M Steinberg Aug 1980 25 p refs
(Contract DE-AC02-76CH-00016)
(BNL-51279) Avail NTIS HC A02/MF A01

The dispersion of carbon dioxide emitted from a 1000 MW(e) coal fired power plant is investigated Forestation is examined as a means for removal and control of atmospheric carbon dioxide at a distance of 5 to 10 km away from the power plant stack An equilibrium and a dynamic approach are considered For an average temperate zone forest growth rate (7 42 mg/sqdm hr), the overall reduction in forested land area required to remove the equivalent of all of the CO2 from a 1000 MW(e) power plant would be less than 3 3% compared to removing the equivalent amount of CO2 by planting forests remotely from the plant If faster growing tropical plants or trees having up to four times the temperature plant growth rate were used, there would be a maximum savings of 15% in forested land area compared to a remote planting This magnitude of reduction in cultivated forest area is insufficient to recommend planting forested areas adjacent to central power stations as a means of controlling CO2 emission Rather it is suggested to provide sufficient increased regional forest areas on a global scale M G

N81-16635# California Univ, Livermore Lawrence Livermore Lab
ECOLOGY PROBLEMS ASSOCIATED WITH GEOTHERMAL DEVELOPMENT IN CALIFORNIA
J H Shinn and R R Ireland 4 Aug 1980 14 p refs Submitted for publication Sponsored by DOE
(UCRL-83941-Rev-1, CONF-800867-1-Rev-1) Avail NTIS HC A02/MF A01

Geothermal power plants have the potential for supplying about 5 percent of the U S electrical generating needs by 1985 and are even now supplying about one third of San Francisco's electricity. Our investigations have shown that the typical geothermal field, such as the hot water resource of Imperial Valley, can be developed in an environmentally sound manner when proper considerations are made for ecosystem problems Experimental evidence is presented, both pro and con for potential impacts due to habitat disturbance, powerline corridors, noise effects, trace element emissions from cooling towers, accidental brine discharges into aquatic or soil systems, competition for water and H2S effects on vegetation A mitigation and control strategy is recommended for each ecological issue and it is shown where effects are likely to be irreversible E D K.

N81-16956# Committee on Science and Technology (U S House).
MUNICIPAL SOLID WASTE TO ENERGY ACT OF 1979
Washington GPO 1980 220 p refs Hearings on S 1934 before the Subcomm. on Energy Conserv. and Supply of the Comm on Energy and Nat. Resources, 96th Congr., 2nd Sess 27-28 Feb. 1980
(GPO-60-684; Publ-96-99) Avail Subcommittee on Energy Conservation and Supply

A bill is discussed which is designed to promote the construction and operation of facilities for solid waste utilization. Among its provisions is a price support loan program for municipal solid waste to energy systems Grants in the amount of $12 million are authorized for states and local subdivisions, to evaluate the feasibility of various resource recovery alternatives in given communities. A R H.

N81-16958# Argonne National Lab, Ill Transportation Energy Systems Sect.
TECHNOLOGY ASSESSMENTS IN TRANSPORTATION: SURVEY OF RECENT LITERATURE
Sarah J LaBelle Mar 1980 245 p refs
(Contract W-31-109-eng-38)
(ANL/CNSV-TM-44) Avail NTIS HC A11/MF A01

A survey and an evaluation of recent studies of transportation systems done in a technology assessment framework were undertaken as the basis for a detailed statement for a technology assessment of transportation energy conservation strategies Several bibliographies were searched and numerous professionals in the field of technology assessment were contacted regarding current work Detailed abstracts were prepared for studies judged to be sufficiently broad in coverage of impacts assessed, yet detailed in coverage of all or part of the nation's transportation systems Some studies were rich in data but not comprehensive in their analytical approach, brief abstracts were prepared for these An explanation of the criteria used to screen the studies, as well as abstracts of 37 reports, are provided in this compendium of transportation technology assessment literature Author

N81-17285# Oak Ridge National Lab, Tenn
LIFE SCIENCES SYNTHETIC FUELS PROGRAM AT OAK RIDGE NATIONAL LAB.
K E Cowser and C R Richmond 1980 27 p refs Presented at 20th Ann Hanford Life Sci Symp, Richland, Wash, 10 Oct 1980
(Contract W-7405-eng-26)
(CONF-801039-3) Avail. NTIS HC A03/MF A01

The health and environmental issues of synthetic fuels technologies is summarized The program objectives are discussed Investigations underway on the chemical, physical, and biological properties of potentially hazardous products derived from coal conversion or shale oil and on the environmental aspects of these products are described DOE

N81-17394# National Water Well Association, Worthington, Ohio.
GROUND-WATER HEAT PUMPS: AN EXAMINATION OF HYDROGEOLOGIC, ENVIRONMENTAL, LEGAL, AND ECONOMIC FACTORS AFFECTING THEIR USE. VOLUME 1: MAIN TEXT, APPENDICES A, B, AND C
D. M. Armitage, Douglas J Bacon, John T Massey-Norton, and James M. Miller 12 Nov 1980 280 p refs
(Contract DE-AC01-78CS-20060)
(DOE/CS-20060/5120-Vol-1) Avail: NTIS HC A13/MF A01

Groundwater is attractive as a potential low temperature energy source in residential space conditioning applications When used in conjunction with a heat pump, ground water can serve as both a heat source and a heat sink. Major hydrogeologic aspects that affect system use include groundwater temperature and availability at shallow depths as these factors influence operational efficiency Ground water quality is considered as it affects the performance and life expectancy of the water side heat exchanger. Environmental impacts related to groundwater heat pump system use are most influenced by water use and disposal methods In general, recharge to the subsurface is recommended. Legal restrictions on system use are often stricter at the municipal and county levels than at state and federal levels. Computer simulations indicate that under a variety of climatologic conditions, groundwater heat pumps use less energy than conventional heating and cooling equipment. Life cycle cost comparisons with conventional equipment depend on alternative system choices and well cost options included in the groundwater heat pump system. DOE

N81-17410# Oak Ridge National Lab, Tenn Presented at Ind. Hygiene and Occupational Med in Coal Conversion Project Workshop, Washington, D.C., 7 Nov 1980
BIOLOGICAL EXPOSURE SENSORS IN COAL CONVERSION TECHNOLOGIES
A. S. Garrett, Jr. 1980 9 p refs
(Contract W-7405-eng-26)
(CONF-801143-1) Avail. NTIS HC A02/MF A01

A surveillance package appropriate to the special needs for those exposed to effects of coal conversion technologies was proposed. The monitoring program to evaluate the health of the population exposed to the chemical constituents of conversion products, effluents, process stream contents or wastes is described. Particular attention is paid to polycyclic aromatic hydrocarbons. DOE

N81-17445# Automated Sciences Group, Inc., Silver Spring, Md

SUPPORT FOR THE ANALYTICAL TOOLS FOR AUTOMOTIVE FUEL ECONOMY ACTIVITIES Final Report, 30 Nov. 1977 - 1 Jul. 1980
William E. Hatch Jun 1980 78 p refs
(Contract DOT-HS-7-01708)
(PB81-109555; ASG-TR-80-31; DOT-HS-805-518) Avail: NTIS HC A05/MF A01 CSCL 13F

Vehicle certification reports issued by EPA in September and February of each year contain individual emissions tests results. Data on vehicle test weight, engine displacement, dynamometer horsepower setting and fuel economy as computed from the emissions values are included. The certification data were extracted on magnetic tape. GRA

N81-17520*# Meridian Corp., Falls Church, Va.
CENTRAL STATION MARKET DEVELOPMENT STRATEGIES FOR PHOTOVOLTAICS Final Report
7 Nov. 1980 70 p refs Sponsored by DOE Prepared for JPL
(Contract JPL-955820)
(NASA-CR-163947; DOE/JPL-955820-80) Avail: NTIS HC A04/MF A01 CSCL 10A

Federal market development strategies designed to accelerate the market penetration of central station applications of photovoltaic energy system are analyzed. Since no specific goals were set for the commercialization of central station applications, strategic principles are explored which, when coupled with specific objectives for central stations, can produce a market development implementation plan. The study includes (1) background information on the National Photovoltaic Program, photovoltaic technology, and central stations; (2) a brief market assessment; (3) a discussion of the viewpoints of the electric utility industry with respect to solar energy; (4) a discussion of commercialization issues; and (5) strategy principles. It is recommended that a set of specific goals and objectives be defined for the photovoltaic central station program, and that these goals and objectives evolve into an implementation plan that identifies the appropriate federal role. Author

N81-17526*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
THE DEVELOPMENT AND UTILIZATION OF SOLAR PHOTOVOLTAIC CELLS: AN ASSESSMENT OF THE POTENTIAL FOR A NEW ENERGY TECHNOLOGY
Kelley J. Cyr Jan 1981 45 p refs
(NASA-TM-58229) Avail: NTIS HC A03/MF A01 CSCL 10A

The Government set the goal of accelerating the adaptation of photovoltaics by reducing system costs to a competitive level and overcoming the technical, institutional, legal, environmental, and social barriers impeding the diffusion of photovoltaic technology. The technology of silicon solar arrays was examined and the status of development efforts are reviewed. The political, legal, economic, social, and environmental issues are discussed, and several methods for selecting development projects are described. A number of market forecasting techniques, including time trend, judgemental, and econometric methods, were reviewed, and the results of these models are presented. T.M.

N81-17578# Aerospace Corp., Germantown, Md. Environment and Energy Conservation Directorate
MILITARY WASTES-TO-ENERGY APPLICATIONS
Keith E. Kawaoka Nov. 1980 199 p refs
(AD-A093042; ATR-80(8374)-1) Avail: NTIS HC A09/MF A01 CSCL 13/2

This analysis focuses on the military waste material and byproduct stream and the potential for energy recovery and utilization. Feedstock material includes municipal-type solid waste, selected installation hazardous waste, and biomass residue. The study objectives are to (1) analyze the characteristics of the military waste stream; (2) identify potential energy recovery options; and (3) examine and assess the technical and economic feasibility and environmental and institutional impacts of various energy recovery approaches. Total energy recoverable from DOD solid waste could provide about 2 percent of DOD's facility energy demand. The energy potential available to DOD from biomass and hazardous waste was not available. Available waste-to-energy systems are thermal conversion processes such as incineration with heat recovery. The significance of this recoverable energy from military wastes is put in proper perspective when the benefits and barriers in using waste-derived energy are considered. Some of the benefits of waste-to-energy conversion are as follows: waste energy is a readily available and inexhaustible resource that greatly reduces dependence on imported energy. GRA

N81-17582# Friends of the Earth, San Francisco, Calif
DECENTRALIZED ENERGY STUDIES: COMPENDIUM OF INTERNATIONAL STUDIES AND RESEARCH
Cissy Wallace Mar. 1980 73 p refs Prepared in cooperation with Midwest Research Inst., Golden, Colo.
(Contract EG-77-C-01-4042)
(SERI/RR-744-451) Avail. NTIS HC A04/MF A01

With efficient use of energy, renewable energy sources can supply the majority, if not the totality, of energy supplies in developed nations at real energy prices that double or triple by 2025 (1975 prices) This appears true even in harsh climates with oil dependent industrial economies. Large increases in end-use energy efficiency are cost effective at present prices. Some reports show that cost effective end-use efficiency improvements can reduce energy consumption (per capita, per unit of amenity, or per unit of output) to as much as 90 percent. This was demonstrated by highly disaggregated analyses of end-uses. Such analyses consistently show larger potential for efficiency improvements than can be detected from conventional analyses of more aggregated data. As energy use demands decline due to end use efficiency improvements, energy supply problems subsequently decrease Lifestyle changes, influenced by social factors, and rising energy prices can substantially reduce demands for energy Such changes are already discernible in end-use energy studies When energy efficient capital stock is in place, many end-users of energy will be able to provide a substantial portion of their own energy needs from renewable energy sources that are directly available to them. E.D K

N81-17583# Oak Ridge Associated Universities, Tenn Inst. for Energy Analysis.
COST-ENERGY DYNAMICS: AN ENGINEERING-ECONOMIC BASIS FOR INDUSTRIAL ENERGY CONSERVATION POLICIES
Doan L Phung and Willem vanGool (Rijksuniversiteit Utrecht, The Netherlands) Oct. 1980 41 p refs
(Contract DE-AC05-76OR-00033)
(ORAU/IEA-80-12(M)) Avail: NTIS HC A03/MF A01

A theory of cost energy dynamics that can be used to shape policies for industrial energy conservation is developed The theory is built on two relationships commonly observed in process engineering: cost varies as a positive power function of system size and complexity, whereas energy consumption varies as a negative power function of the same attributes These functions, rooted in thermodynamics, may be combined to yield a technological parameter (denoted c) that can be determined for each unit process. The lower the value of c, the greater the energy savings may be for a given expenditure. Cost energy dynamics ranks energy conservation potentials of industrial processes by the technology parameter c, aggregates energy consumption by unit processes, accounts for energy embodied in the investments, considers the tradeoffs between cost and energy and distinguishes bases for decision making in the public and private sectors. E.D.K.

N81-17588# Argonne National Lab., Ill.
COMMUNITY ENERGY AUDITING: EXPERIENCE WITH THE COMPREHENSIVE COMMUNITY ENERGY MANAGEMENT PROGRAM
J. L Moore, D. A. Berger, C B Rubin, P. A. Hutchinson, Sr., and H. M. Griggs Sep 1980 107 p refs
(Contract W-31-109-eng-38)
(ANL/CNSV/TM-43) Avail: NTIS HC A06/MF A01

The evaluation issues and key findings based on the communities' experiences from Spring of 1979 to approximately March of 1980 are presented An organized review of experience of communities in applying the detailed audit methodology for estimating current community energy consumption and projecting future consumption and supply is presented. A preliminary assessment of how audit information is being used in other CCEMP tasks is provided DOE

N81-17597# Battelle Inst., Frankfurt am Main (West Germany).
ENERGY: ECONOMIC ACTIVITY AND ENERGY DEMAND; LINK TO ENERGY FLOW. EXAMPLE: FRANCE
1980 112 p Sponsored by Commission of the European Communities
(EUR-6773-EN) Avail: NTIS (US Sales Only) HC A06/MF A01: DOE Depository Libraries

The data derived from the EXPLOR and EPOM, Energy Flow Optimization Model are described. The core of the EXPLOR model is a circular system of relations involving consumer's demand, producer's outputs, and market prices. The solution of this system of relations is obtained by successive iterations; the final output is a coherent system of economic accounts. The computer program for this transition is described. The work conducted by comparing different energy demand models is summarized. The procedure is illustrated by a numerical projection to 1980 and 1985 using the existing version of the EXPLOR France model. DOE

N81-17598# Yale Univ., New Haven, Conn. Dept. of Political Science.
US SOLAR ENERGY POLICY FOR LESS DEVELOPED COUNTRIES
B. Russett Oct. 1980 55 p refs
(Contract DE-AC02-79CS-10048)
(DOE/CS-10048/T1) Avail: NTIS HC A04/MF A01

While remaining sensitive to engineering and economic considerations, concentration is on some political and sociological issues which will have great affect on decisions whether and how to make use of solar energy technology in less developed countries (LDCs). Only with an understanding of these issues and with answers to some of the questions raised can there be any serious effort to devise a satisfactory United States government policy for the promotion of solar energy applications abroad. Tentative propositions outlining issues about which further information is required are based on the results of interviews in the United States, India and the Middle East, and an analysis of various reports by private individuals, national and transnational organizations, and government agencies. DOE

N81-17610# Oak Ridge National Lab., Tenn. Data Management Analysis Group.
END USE ENERGY CONSUMPTION DATA BASE: TRANSPORTATION SECTOR
John N Hooker, Axel B. Rose, and David L. Greene Feb. 1980 461 p refs
(Contract W-7405-eng-26)
(PB81-112203, DOE/DF-81/002A) Avail: NTIS HC A20/MF A01 CSCL 10A

The transportation fuel and energy use estimates developed at Oak Ridge National Laboratory (ORNL) for the end use energy consumption data base are documented The transportation data generally cover each of the ten years 1967 to 76, with omissions in some modes The estimates are broken down by mode of transport, by fuel, by region and state, by the sector of the economy providing the transportation and by the use to which it is put, and in the case of automobile and bus travel by the income of the traveler The mode, fuel, sector, and use categories themselves subname one, two, or three levels of subcategories, resulting in a very detailed categorization of energy use. GRA

N81-17611# TRW, Inc, McLean, Va. Energy System Planning Div.
ENERGY/ECONOMIC MODEL ANALYSIS. VOLUME 1: GAS TECHNOLOGY ASSESSMENTS USING THREE ENERGY SUPPLY/DEMAND INTEGRATING MODELS Final Report
Stanley Cohen Jun 1980 109 p refs Sponsored by Gas Research Inst 2 Vol.
(PB81-114225, GRI-79/0052.1) Avail. NTIS HC A06/MF A01 CSCL 10A

The main outputs of the three models are forecasts of the energy (in Btu's) supplied or converted by various technologies and the prices associated with such supply or conversion. Forecasts are made at points in time during the period of 1980-2025. GRA

N81-17612# TRW, Inc, McLean, Va. Energy Systems Planning Div.
ENERGY/ECONOMIC MODEL ANALYSIS. VOLUME 2: EVALUATION OF ENERGY SUPPLY/DEMAND INTEGRATING MODELS Final Report
Stanley Cohen Jun. 1980 86 p refs Sponsored by Gas Research Inst 2 Vol.
(PB81-114233; GRI-79/0052.2) Avail. NTIS HC A05/MF A01 CSCL 10A

The main objective of this evaluation is to give GRI and its advisors insight into how useful each model is in meeting the objectives of a particular GRI activity. A second major objective is to furnish insight on the similarities and differences of the numerical output associated with the R&D assessment project. GRA

N81-17613# Jorgenson (Dale W.) Associates, Cambridge, Mass
ENERGY/ECONOMIC MODEL ANALYSIS. MACROECONOMIC IMPACTS OF RESEARCH AND DEVELOPMENT IN GAS SUPPLY AND END USE TECHNOLOGIES Final Report
Richard J Goettle, IV and Edward A Hudson Jun. 1980 73 p Sponsored by Gas Research Inst. Prepared for TRW, Inc., McLean, Va.
(PB81-114258, GRI-79/0052 4) Avail NTIS HC A04/MF A01 CSCL 10A

The Gas Research Institute (GRI) needs to consider the economic impact of the various technologies whose research and development is supported by GRI funding Three energy-economic models are useful for such a technology assessment These models are: Energy Economic Modeling System, Energy Policy Model, and Time Stepped Energy System Optimization/Long Term Inter-Industry Transaction Model. These three models were used to help in the economic impact evaluation of various GRI research and development programs GRA

N81-17614# Decision Focus, Inc, Palo Alto, Calif
ENERGY/ECONOMIC MODEL ANALYSIS. ENERGY ECONOMIC MODELING SYSTEM Final Report
Dale M Nesbitt and Donna B Oman Jun 1980 329 p refs Sponsored by Gas Research Inst. Prepared for TRW, Inc, McLean, Va.
(PB81-114274, GRI-79/0052 6) Avail NTIS HC A15/MF A01 CSCL 10A

The Decision Focus Incorporated (DFI) Energy-Economy Model is an integrating model designed in part to focus on two budget-related decisions Specifically, the DFI model provides a robust but simply way of computing the benefits of successful R&D both in the aggregate and at the level of individual R&D projects GRA

N81-17615# Brookhaven National Lab., Upton, N Y
ENERGY/ECONOMIC MODEL ANALYSIS. TIME-STEPPED ENERGY SYSTEM OPTIMIZATION MODEL Final Report
A S Kydes and J Rabinowitz Jun 1980 137 p refs Sponsored by Gas Research Inst. Prepared for TRW, Inc, McLean, Va
(PB81-114241, GRI-79/0052 3) Avail NTIS HC A07/MF A01 CSCL 10A

The energy results from the Brookhaven National Laboratory/Dale W Jorgenson Associates energy-economy system as executed under GRI specifications are presented It is intended to serve as a complement to the DJA report on the macroeconomic consequences of these specifications GRA

N81-17616# California Univ, Livermore Lawrence Livermore Lab
ENERGY/ECONOMIC MODEL ANALYSIS. LIVERMORE

ENERGY POLICY MODEL Final Report
Robert B. Bell Jun 1980 135 p Sponsored by Gas Research Inst Prepared for TRW, Inc., Mclean, Va.
(PB81-114266. GRI-79/0052.5) Avail. NTIS HC A07/MF A01 CSCL 10A

The results of a study done by the Energy and Resources Planning Group of the Lawrence Livermore Laboratory (LLL) for the Gas Research Institute (GRI) using the LLL Economic Modeling System (EMS) are described The purpose was to allow GRI to evaluate the appropriateness of their continued use of an energy model and, at the same time, for them to gain a better understanding of the consequences of current or proposed GRI supported research and development. GRA

N81-17620# National Technical Information Service, Springfield, Va
ENERGY POLICY AND RESEARCH PLANNING. CITATIONS FROM THE NTIS DATA BASE Progress Report, Oct. 1977 - Sep. 1980
Audrey S Hundemann Sep. 1980 260 p Supersedes NTIS/PS-79/1069 and NTIS/PS-78/0962
(PB81-800112, NTIS/PS-79/1069, NTIS/PS-78/0962) Avail: NTIS HC $30 00/MF $30 00 CSCL 10A

Citations relative to planning for future U.S energy needs on both national and state government levels are presented The history and development of national and state legislation and regulations, Project Independence studies, and assessment of the effects of deregulation are included Technical, economic, and environmental considerations in energy planning are also covered This updated bibliography contains 254 citations, 77 of which are new entries to the previous edition. T.M

N81-17630# National Oceanic and Atmospheric Administration, Washington, D C.
REPORT TO THE CONGRESS ON OCEAN POLLUTION AND OFFSHORE DEVELOPMENT Annual Report, Oct. 1977 - Sep. 1978
May 1980 94 p
(PB81-118333, NOAA-80093001; AR-6) Avail: NTIS HC A05/MF A01 CSCL 08J

The sixth annual report on NOAA's research activities presents the highlights that contributed to a better understanding of the marine environment and the effect of human activities upon it. Four principal areas of concern were addressed. petroleum hydrocarbons, chlorinated (manmade) hydrocarbons, metals, and biological hazards. GRA

N81-17635# Wapora, Inc., Washington, D. C.
ENVIRONMENTAL IMPACT ASSESSMENT GUIDELINES FOR NEW SOURCE COAL GASIFICATION FACILITIES Final Interim Report
Robert N. Rickles and D. Keith Whitenight Aug. 1980 108 p refs
(Contract EPA-68-01-4157)
(PB81-114555; EPA-130/6-80-001) Avail: NTIS HC A06/MF A01 CSCL 13B

Guidance on identification of potential wastewater effluents, air emissions and solid wastes from coal gasification facilities, assessment of the impacts of such residuals on the quality of the environment, state of the art technology for in process and end of process control waste streams, evaluation of alternatives; and environmental regulations that apply to industry are included. In addition, the guidelines include an 'overview' chapter that gives a general description of the coal gasification industry, significant problems associated with it, and recent trends in location, raw materials, processes, pollution control, and the demand for industry output. GRA

N81-17636# Coordinating Research Council, Inc, Atlanta, Ga
INFORMATIONAL REPORT: 1979 PROGRESS OF THE CHEMICAL CHARACTERIZATION PANEL OF THE COMPOSITION OF DIESEL EXHAUST PROJECT AND RESULTS OF PARTICULATE EXTRACTION ROUND-ROBIN Progress Report, 1979
Mar. 1980 75 p refs
(CRC Proj. CAPI-1-64)
(PB81-114670; CRC-516; CRC-APRAC-CAPI-1-64-516) Avail: NTIS HC A04/MF A01 CSCL 13B

Chemical characterization methods for unregulated diesel emissions are described. Chemical analysis methods to measure unregulated emissions are validated. The extraction of particle bound material is discussed as well. GRA

N81-17641# Tetra Tech, Inc, Lafayette, Calif
METHODOLOGY TO EVALUATE THE POTENTIAL FOR GROUND WATER CONTAMINATION FROM GEOTHERMAL FLUID RELEASES Final Report
Karen Summers, Steve Gheirini, and Carl Chen Aug 1980 178 p refs
(Contract EPA-68-03-2671)
(PB81-111114; EPA-600/7-80-117) Avail: NTIS HC A09/MF A01 CSCL 13B

Analytical methods and graphical techniques are presented for predicting potential ground water contamination from geothermal energy development. Overflows and leaks from ponds, pipe leaks, well blowouts, leaks from well casing, and migration from injection zones can be handled by the methodology. General characteristics of geothermal systems and fluids and probable modes of release are included to provide typical data. GRA

N81-17644# Foster Associates, Inc., Washington, D.C.
A STATISTICAL STUDY OF COAL SULFUR VARIABILITY AND RELATED FACTORS Final Report
George R. Warholic, John E. Morton, Yimin Ngan, James E. Spearman, and Yvonne Harris May 1980 265 p refs
(Contract EPA-68-02-2592)
(PB81-111585; EPA-450/5-80-008A) Avail: NTIS HC A12/MF A01 CSCL 13B

Coal analysis data and power plant continuous monitoring data were gathered, reviewed and analyzed to assess the impact of fuel coal characteristics on compliance strategies and emission regulations. Analyses indicated that the heat content (Btu/lb) was best approximated by the normal distribution, of which the sulfur content and pounds sulfur/MMBtu were best represented by the inverted gamma distribution which was slightly superior to the lognormal distribution Analysis of available continuous monitoring data supported the inverse relationship between coal sulfur variability and lot size, i e., significant reductions in relative variability of emissions occur as the averaging time increases. The various analyses of coal sulfur variability identified no reliable method for coal suppliers or consumers to predict variability which may be critical for compliance by some coal-fired boilers to existing sulfur emission-limiting regulations GRA

N81-17645# Hittman Associates, Inc., Columbia, Md.
PROCEEDINGS: EPA/INDUSTRY FORUM ON COAL-LIQUEFACTION
Dorothy G. Weatherby Sep. 1980 179 p Forum held at Chicago, 23-24 Oct. 1979
(Contract EPA-68-02-3147)
(PB81-113052, HIT-C1005/402-80-938; EPA-600/9-80-054, IERL-RTP-1112) Avail: NTIS HC A09/MF A01 CSCL 13B

Representatives of government and industry met with the goal of sharing information and increasing cooperation between the two groups. Synthetic fuels, standards-setting procedures, activities, and plans relating to coal liquefaction were discussed for air emissions, solid wastes, and liquid effluents. Permit procedures were summarized for coal liquefaction plants State government participation in coal liquefaction development was discussed for Kentucky and Illinois. Industry plans in the area of coal liquefaction were presented by representatives of several firms actively involved in development and use of the technology. GRA

N81-17959# National Highway Traffic Safety Administration, Washington, D C
AUTOMOTIVE FUEL ECONOMY PROGRAM Annual Report
Jan. 1980 79 p
(DOT-HS-805-279, ARTTC-4) Avail: NTIS HC A05/MF A01

An energy outlook is presented that focuses on petroleum demand and supply, and the effects of fuel economy standards on petroleum savings Passenger car and light truck fuel economy activities are summarized including sales patterns and trends Other fuel economy related activities are discussed and include compliance activities, the gas guzzler tax, legislative recommendations, and voluntary fuel economy programs T.M.

N81-18050# Information Spectrum, Inc, Warminster, Pa
COMPILATION OF ENERGY EFFICIENT CONCEPTS IN ADVANCED AIRCRAFT DESIGN AND OPERATIONS. VOLUME 2: ABSTRACT DATA BASE Final Report, 10 Mar. - 5 Nov. 1980
Milton Clyman, Sheldon J Einhorn, and Richard S Schultz 5 Nov 1980 435 p refs
(Contract N62269-80-C-0200)
(AD-A094226, NADC-79239-60-Vol-2) Avail NTIS HC A19/MF A01 CSCL 01/3

The technologies necessary to support next generation (I 1990+) air vehicle design and operation concepts that will reduce the requirements for natural petroleum derived energy are considered in the Advanced Concepts Data Base which consists of 599 abstracts listed as 948 entries. The data base abstracts are arranged into 11 areas of R&D effort as follows. synthetic fuels, liquid hydrogen fuels, other fuels, gas turbines, nuclear propulsion, advanced propulsion, aerodynamics; structures and materials, flight performance management, advanced and unconventional systems, and energy efficient operation A R H

N81-18051# Information Spectrum, Inc, Warminster, Pa
COMPILATION OF ENERGY EFFICIENT CONCEPTS IN ADVANCED AIRCRAFT DESIGN AND OPERATIONS. VOLUME 1: TECHNICAL REPORT Final Report, 10 Mar. - 5 Nov. 1980
Milton Clyman, Sheldon J Einhorn, and Richard S Shultz 5 Nov 1980 101 p refs
(Contract N62269-80-C-0200)
(AD-A094225, NADC-79239-60-Vol-1) Avail NTIS HC A06/MF A01 CSCL 01/3

This final report (contained in two volumes) presents the results of research into published literature The search addressed the technologies necessary to support next generation (1990+) vehicle design and operation concepts that will reduce the requirement for natural petroleum-derived energy The Advanced Concepts Evaluation (ACE) Data Base consists of 599 unique abstracts listed as 948 entries The ACE Data Base is arranged into eleven areas of R D effort, each subdivided into Navy and non-Navy funded programs Volume 1 includes introduction, Data Bases searched, research methodology for creation of the ACE Data Base, summary of search results, conclusions and recommendations This volume contains an appendix of search strategies utilized GRA

N81-18510# Oak Ridge National Lab, Tenn
US DEPARTMENT OF ENERGY THERMAL ENERGY STORAGE PROGRAM
James F Martin 12 Nov 1980 16 p refs Presented at the Intern Conf on Thermal Storage in Buildings, Toronto, 12 Nov 1980
(Contract W-7405-eng-26)
(CONF-801154-1) Avail NTIS HC A02/MF A01

The overall DOE program for energy conservation in space heating and cooling, in industrial waste heat utilization, and in power generation through the use of thermal energy storage (TES) and the ORNL activities for building heating and cooling uses and industrial uses of TES are discussed It is concluded that the DOE TES program is both comprehensive and of significant size and that demonstration projects within the program will show a favorable commercialization potential for TES DOE

N81-18512# Centro Informazioni Studi Esperienze, Milan (Italy)
OPTIMIZED DESIGN OF TOTAL ENERGY SYSTEMS: THE RETE PROJECT
P Alia, F Dallavalle, C deNard, F Sanson, S Veneziani (Azienda Gas Acqua Consorziale, Reggio Emilia), and G Spagni (Azienda Gas Acqua Consorziale, Reggio Emilia) 12 May 1980 40 p refs Presented at the 4th Intern Conf of Urban Heating, Sirmione, Italy, 12-15 May 1980
(CISE-1606; CONF-8005120-1) Avail NTIS HC A03/MF A01

The RETE (Reggio Emilia Total Energy) project is discussed The total energy system (TES) was developed to achieve the maximum quality matching on the thermal energy side between plant and user and perform an open scheme on the electrical energy side by connection with the Italian electrical network The most significant qualitative considerations at the basis of the plant economic energy optimization and the selection of the operating criterion most fitting the user consumption characteristics and the external system constraints are reported The design methodology described results in a TES that in energy terms achieves a total efficiency evaluated on a yearly basis to be equal to about 78 percent and a fuel saving of about 28 percent and in economic terms allows a recovery of the investment required as to conventional solutions, in about seven years DOE

N81-18514# Land (Peter), Chicago, Ill
DEVELOPMENT OF ECONOMIC HOUSE TYPE BASED UPON PASSIVE SOLAR ENERGY UTILIZATION AND ENERGY CONSERVATION FOR HIGH DENSITY URBAN PLANNING
1980 16 p
(Contract DE-FG02-79R5-10104)
(DOE/R5-10104/1) Avail NTIS HC A02/MF A01

House types and their corresponding nesting patterns for high density, low rise urban neighborhoods are described which have the following characteristics utilize the Sun for warming in winter, self cool in summer, conserve energy, low building cost and ingracture costs, and efficiently use land Implementing these criteria produces a range of about 25 designs and proposals for neighborhoods using them Designs included are one story, two story, and split level Basic house forms are determined A precision model of one complete 800 unit neighborhood proposal is discussed DOE

N81-18524# Department of Energy, Washington, D C
REDUCING US OIL VULNERABILITY: ENERGY POLICY FOR THE 1980'S
10 Nov 1980 40 p
(DOE/PE-0021) Avail NTIS HC A03/MF A01

Current Federal energy policies and programs are asked in light of recent events and in light of what are believed to be the most reliable available projections of the future Additional steps are outlined that could reduce our vulnerability to an oil import disruption during the next decade Specifically, the study seeks to answer three questions as a base case, what levels of US energy consumption, production, and imports might we anticipate for 1985 and 1990 under existing statutes, policies, and programs, considering both our own and our allies dependence on oil imports, how vulnerable does this leave the United States to foreign supply disruptions, considering the likely effects of government policies and programs which already exist to reduce our vulnerability (through reduction of US oil imports or by any other means), are there additional initiatives that could be undertaken to give us greater protection - especially between now and 1990 DOE

N81-18528# Oak Ridge National Lab Tenn Metals and Ceramics Div
ECONOMIC APPLICATION, DESIGN ANALYSIS, AND MATERIAL AVAILABILITY FOR CERAMIC HEAT EXCHANGERS
V J Tennergy Jan 1981 74 p refs
(Contract W-7405-eng-26)
(ORNL/TM-7580) Avail NTIS HC A04/MF A01

Fuel consumption in an industrial process can be reduced by 40% or more by using recuperation or regeneration to heat air for the burners compared with use of ambient temperature air for fuel combustion with furnace gases in the range of 1300 C and air preheat temperatures above 800 C Alloy temperature limitations and corrosion of the alloys severely limit the use of metal recuperators to preheat air above about 600 C Structural ceramics, such as silicon carbide, offer promise for use in high-temperature HXs for recovering waste heat from hot flue gases An assessment was made of industrial attitudes toward advanced high-temperature ceramic recuperators Three promising industrial processes are identified where these recuperators could be applied Conceptual designs of ceramic recuperators are given consistent with the furnace requirements for these processes The annual national fuel saving possible for the three applications of these recuperators was estimated DOE

N81-18549# California Univ., Berkeley Lawrence Berkeley Lab Energy and Environment Div.

THIN FILM ELECTROCHROMIC MATERIALS FOR ENERGY EFFICIENT WINDOWS

Carl M Lampert Oct. 1980 47 p refs
(Contract W-7405-eng-48)
(LBL-10862; EEB-W-80-10) Avail NTIS HC A03/MF A01

By use of electrochromic thin films, it is possible electronically to control transmission or reflection properties of a window, thus allowing it to be optically and thermally managed, thereby reducing space heating and cooling load. The properties of transition metal oxides, such as WO3, MoO3, Ir2O3, and V2O5 are detailed. Organic systems such as Heptyl Viologen, Polytungsten anion are reviewed. Also, intercalated structures are discussed. The designs of working devices are outlined. From this quantification, materials, devices, and appropriate deposition technology are selected for window applications. DOE

N81-18563# National Academy of Sciences - National Research Council, Washington, D C Committee on Nuclear and Alternative Energy Systems.

ENERGY CHOICES IN A DEMOCRATIC SOCIETY

Laura Nader Apr. 1980 156 p refs
(PB81-114852; ISBN-0-309-03045-5; LC-80-81335) Avail. NTIS HC A08/MF A01 CSCL 10A

Four views of the future involving widely varying levels of energy consumption and life styles are presented. The futurists' descriptions of life in the imagined societies, loosely termed superindustrial, plentitude, small is beautiful, and minimum feasible are explored according to predictions about twelve cultural dimensions, including natural environment, settlement patterns, occupations, leisure, dispersion of decision making power, and pluralism vs. homogeneity These descriptions demonstrate some possible results of alternatives to be considered by scientists, policymakers, and citizens concerned about the direction of energy policy. GRA

N81-18571*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THE ENVIORNMENTAL ASSESSMENT OF A CONTEMPORARY COAL MINING SYSTEM

Elisabeth J. Dutzi, Patrick J. Sullivan, Charles F. Hutchinson, and Christopher M. Stevens 15 Dec 1980 55 p refs
(Contracts NAS7-100, DE-AI01-76ET-12548)
(NASA-CR-163974, JPL-Pub-80-99) Avail: NTIS HC A04/MF A01 CSCL 13B

A contemporary underground coal mine in eastern Kentucky was assessed in order to determine potential off-site and on-site environmental impacts associated with the mining system in the given environmental setting. A 4 section, continuous room and pillor mine plan was developed for an appropriate site in eastern Kentucky. Potential environmental impacts were identified, and mitigation costs determined. The major potential environmental impacts were determined to be acid water drainage from the mine and refuse site, uneven subsidence of the surface as a result of mining activity, and alteration of ground water aquifers in the subsidence zone. In the specific case examined, the costs of environmental impact mitigation to levels prescribed by regulations would not exceed $1/ton of coal mined, and post mining land values would not be affected T.M.

N81-18573# PEDCo-Environmental, Inc, Cincinnati, Ohio.

ACID RAIN: THE IMPACT OF LOCAL SOURCES

P. Spaite (Paul W. Spaite Co.), M. P. Esposito, M. F. Szabo, and T. W. Devitt 24 Nov 1980 28 p refs
(Contract DE-AC21-80MC-14787)
(DOE/METC-14787/103) Avail. NTIS HC A03/MF A01

Acid rain is predominantly a problem of long range transport of pollutants from large fossil fuel combustion sources, namely coal-fired utilities However, close examination of fuel use information and source emission charrctenstics in the Adirondacks, Florida, and California suggests that local oil burning and automotive sources may be major contributors to the occurrence of acid rain in these areas. The possible role of local combustion sources in the production of acid rain, the implications of the findings, and their relevance to alternative control strategies for acid rain are discussed Oil-fired boilers, especially the smaller commercial, industrial, and residential units, produce at least 3 to 10 times as much primary sulfate per unit of sulfur content as coal-fired units. Oil-fired units emit comparatively large quantities of catalytic compounds capable of rapidly converting still more sulfur oxide to sulfate in the atmosphere DOE

N81-18575# California Univ, Livermore Lawrence Livermore Lab Environmental Sciences Div

ENVIRONMENT, HEALTH, SOCIOECONOMIC AND ENVIRONMENTAL CONTROL TECHNOLOGY EXECUTIVE SUMMARY

David W Layton Oct 1980 38 p refs
(Contract W-7405-eng-48)
(DOE/TIC-11308) Avail. NTIS HC A03/MF A01

The important findings of a two volume report that deals with the potential impacts and environmental controls associated with the operation of geothermal power plants in California's Imperial Valley are summarized The valley contains nearly a third of the nation's total energy potential for identified hot water resources. Possible impacts of developing those resources include violation of air quality standards if emissions of hydrogen sulfide are not abated, negative ecological effects resulting from increases in the salinity of the Salton Sea, and damage to irrigation systems caused by land subsidence induced by the extraction of geothermal fluids Other minor impacts concern occupational health and safety, socioeconomics, and hazardous wastes. Analyses of environmental impacts and the control measures for minimizing negative impacts are based primarily on a projected production of 3000 MW of electrical power by the year 2010 DOE

N81-18576# California Univ., Los Angeles Lab. of Nuclear Medicine and Radiation Biology.

MICROENVIRONMENTAL CHANGES AND PLANT RESPONSES DUE TO SHADING AND WIND DEFLECTION BY SOLAR COLLECTORS: A SIMULATION STUDY

Duncan T Patten and S D Smith Nov 1980 71 p refs
(Contract DE-AC03-76SF-00012)
(UCLA-12/1268) Avail NTIS HC A04/MF A01

The potential changes were investigated in a Sonoran Desert The simulated array consisted of twelve panels designed to exhibit a similar shape, tilt, and spacing as is expected to occur in heliostat fields of solar thermal facilities or in arrays of photovoltaic collectors The experimental design was based on comparing two microsites in the simulated array versus the open desert Presence of the panels results in up to a 90% reduction in solar radiance during the midday period, with microsites beneath each panel receiving about 14% of the open desert irradiance over the whole day The array of panels also effected a 14% to 60% reduction in monthly accumulated wind flow in the center of the array The combination of reduced radiant energy input and wind deflection resulted in significantly reduced surface and soil temperatures in the heavily shaded sites, and moderately reduced surface and soil temperatures in the sunny microsites DOE

N81-18577# Oak Ridge National Lab, Tenn

A COMPARISON OF ENVIRONMENTAL ISSUES RELATED TO DEVELOPMENT OF SMALL HYDROPOWER RESOURCES AT NEW VERSUS EXISTING SITES

J. M Loar and S. G. Hildebrand 1980 20 p refs Presented at 3rd Miami Intern Conf. on Alternative Energy Sources, Miami Beach, Fla, 15 Dec 1980
(Contract W-7405-eng-26)

(CONF-801210-13) Avail NTIS HC A02/MF A01

Many of the ecological issues associated with the development of small hydropower resources are similar at both new (undeveloped) sites and those with existing dams that will be retrofitted for hydroelectric generation Issues that could occur with both types of development are blockage of fish migration routes, water level fluctuations, instream flows, water quality, dredging and dredged material disposal, and threatened or endangered species However, new site development projects require the alteration of existing aquatic and terrestrial ecosystems that will be, in most cases, significantly greater than the environmental changes associated with the retrofitting of existing dams. Although project design and operation are important factors controlling the nature and magnitude of the environmental impacts of small hydropower resource development, the mitigation of adverse impacts (and the optimization of beneficial effects) is dependent, in large measure, on our ability to accuratly predict physical, chemical, and biological changes DOE

N81-18578# Oak Ridge National Lab, Tenn Environmental Sciences Div

STRATEGIES FOR ECOLOGICAL EFFECTS ASSESSMENT AT DOE ENERGY ACTIVITY SITES

F S Sanders, S M Adams, L W Barnhouse, J M Giddings, E E Huber, K D Kumar, D Lee, B Murphy, G W Suter, and W VanWinkle Dec 1980 389 p refs

(Contract W-7405-eng-26)

(ORNL/TM-6783) Avail NTIS HC A17/MF A01

Guidance for the monitoring and assessment of ecological impacts resulting from DOE energy production activities was developed to improve the accuracy of analysis under the National Environmental Policy Act Basic concepts in monitoring and assessment that can be adapted to site specific circumstances are stressed Four major areas of activity that should be integrated into a comprehensive interdisciplinary assessment program are, field monitoring, laboratory studies, experimental field perturbation studies, and mathematical modeling, both statistical and ecological Each of these areas is discussed with respect to terrestrial, marine, and freshwater environments Appendices are included that provide references to sampling methodologies DOE

N81-18580# National Academy of Sciences - National Research Council, Washington, D C

LONG-RANGE ENVIRONMENTAL OUTLOOK

May 1980 210 p refs Workshop held at Washington, D C, 15-16 Nov 1979

(PB81-114977, ISBN-0-309-03038-2, LC-80-16190) Avail NTIS HC A10/MF A01 CSCL 13B

Proceedings of a workshop to address a long range environmental outlook are reported Task groups were established to discuss future trends in energy, agriculture, toxic substances, and hazards of facility siting and the potential environmental problems that may develop The charge to each group was to identify specific future problems, establish the priority of importance and recommend research GRA

N81-18620 Oklahoma State Univ., Stillwater

DEVELOPMENT OF AN IMPROVED DEGREE-DAY CONCEPT BY ANALYSIS OF HISTORICAL WEATHER DATA FOR PREDICTING ENERGY REQUIREMENTS OF BUILDINGS Ph.D. Thesis

Nader Sharabianlou 1980 161 p

Avail Univ Microfilms Order No 8103331

Computational experiments were conducted to determine the effects of weather parameters on thermal response of buildings and to identify the significant environmental parameters The significant environmental parameters were utilized in development of an improved degree day concept A methodology was developed estimating energy demand of commercial structures via simple expressions which require evaluation of the product of two terms These terms are distinct functions of the significant building and weather parameters A procedure for estimating seasonal heating and cooling efficiency parameters was developed for estimating energy consumption The significant environmental parameters identified by sensitivity analysis of the thermal response of buildings to perturbations in the climate were bulb temperature, solar insolation, humidity ratio difference of indoor and outdoor air, and the daily temperature range Dissert Abstr

N81-18931# Policy and Management Associates, Inc, Boston, Mass

THE EFFECT OF ECONOMIC REGULATION ON FUELUSE EFFICIENCY IN PRIVATE TRUCKING-OPERATIONS Final Report

Apr. 1980 105 p refs

(Contract DOT-OS-90023)

(PB81-114753; DOT-P-50-37) Avail. NTIS HC A06/MF A01 CSCL 05C

Private trucking operations are a substantial component of the motor carrier industry. The description of private carriage covers magnitude and growth, reasons for use, traffic characteristics, fleet operations, relations with other modes; and the effect of the regulatory system on private trucking operations An analysis of how regulations affect private trucking fuel use efficiency and an attempt to forecast the effects of regulatory change are included GRA

N81-18935*# Mechanical Technology, Inc, Latham, N Y

ADVANCED PROPULSION SYSTEM CONCEPT FOR HYBRID VEHICLES

Suresh Bhate, Hsin Chen, and George Dochat Dec 1980 169 p refs

(Contracts DEN3-92, EC-77-A-31-1044)

(NASA-CR-159772, DOE/NASA/0092-80/1; MTI-80TR25) Avail NTIS HC A08/MF A01 CSCL 13F

A series hybrid system, utilizing a free piston Stirling engine with a linear alternator, and a parallel hybrid system, incorporating a kinematic Stirling engine, are analyzed for various specified reference missions/vehicles ranging from a small two passenger commuter vehicle to a van Parametric studies for each configuration, detail tradeoff studies to determine engine, battery and system definition, short term energy storage evaluation, and detail life cycle cost studies were performed Results indicate that the selection of a parallel Stirling engine/electric, hybrid propulsion system can significantly reduce petroleum consumption by 70 percent over present conventional vehicles J M S

N81-18951# Societe Nationale Industrielle Aerospatiale, Les Mureaux (France) Div Systemes Balistiques et Spatiaux

EXAMPLE OF A FAVORABLE POLICY FOR SPACE TECHNOLOGY TRANSFER TO OTHER FIELDS [EXEMPLE D'UNE POLITIQUE DE VALORIZATION DE RETOMBEES TECHNOLOGIQUES SPATIALES DANS D'AUTRES DOMAINES]

Didier G Compard *In* ESA Econ. Effects of Space and Other Adv. Technol. Sep 1980 p 153-168 In FRENCH

Avail. NTIS HC A12/MF A01

The technology transfer policy of an aerospace industry is described. Several examples, including kinetic energy storage, the SOPHOCLE program for solar energy conversion, the SYSCOMORAM medical data acquisition and data processing system, industrial safety programs, and new materials applications are cited The benefits of planning for technology transfer include diversification of risks, faster response to changing markets, establishment of new clients, and improving the public image of the company Author (ESA)

N81-19110*# National Academy of Sciences - National Research Council, Washington, D C Ad Hoc Committee on Aircraft Energy

AN EVALUATION OF NASA'S PROGRAM FOR IMPROVING AIRCRAFT FUEL EFFICIENCY Final Report

1980 25 p refs

(Contract NASw-2342)

(NASA-CR-164015, PB81-116790) Avail: NTIS HC A02/MF A01 CSCL 01C

The report provides commentary and recommendations where appropriate on each of the major elements of the program. Key findings of the committee included a recommendation that closer ties be established between NASA and the FAA to expedite the use and acceptance of the new technology The committee also cited the potential for fuel savings through an imporved air traffic control system and recommended that the management of NASA and the FAA discuss ways and means to work together to exploit more effectively the capabilities and responsibilities of each to develop air traffic control GRA

N81-19329# Los Alamos Scientific Lab, N Mex Energy Programs Office
USE OF NON-PETROLEUM FUELS TO REDUCE MILITARY ENERGY VULNERABILITIES: SELF-SUFFICIENT BASES AND NEW WEAPON PROPULSION SYSTEMS
David A Freiwald 1980 19 p refs Presented at the 46th Mil Operations Res Soc Meeting, Newport, R I, 2-4 Dec 1980
(Contract W-7405-eng-36)
(LA-UR-80-3445, CONF-801239-1) Avail NTIS HC A02/MF A01
An approach is outlined which is directed towards moving the U S military in the direction of energy self-sufficiency without having to rely on frequent deliveries of military fuels from off-base sources The various pathways and options of this approach are considered It is shown that the nuclear and hydrogen pathway is most likely to yield the best possibility for ultimate self-sufficiency RCT

N81-19353# Battelle Pacific Northwest Labs., Richland, Wash
ANALYSIS OF ALTERNATIVE STRATEGIES FOR ENERGY CONSERVATION IN NEW BUILDINGS
Jeffrey M Fang and Jack Tawil, J Dec 1980 89 p refs
(Contract DE-AC06-76RL-01830)
(PNL-3309) Avail NTIS HC A05/MF A01
The policy instruments considered include: greater reliance on market forces, research and development, information, education and demonstration programs, tax incentives and sanctions, mortgage and finance programs, and regulations and standards. The analysis starts with an explanation of the barriers to energy conservation in the residential and commercial sectors Individual policy instruments are described and evaluated with respect to energy conservation, economic efficiency, equity, political impacts, and implementation and other transitional impacts Five possible strategies are identified. (1) increased reliance on the market place, (2) energy consumption tax and supply subsidies (3) Building Energy Performance Standards (BEPS) with no sanctions and no incentives, (4) BEPS with sanctions and incentives (price control); and (5) BEPS with sanctions and incentives (no price controls) A comparative analysis is performed Elements are proposed for inclusion in a comprehensive strategy for conservation in new buildings DOE

N81-19404# Cyclomatic Industries, Inc, San Diego, Calif
HIGHLY EFFICIENT WELDING POWER SUPPLY Final Report, 1 May 1978 - 30 Sep. 1980
J M Thommes Sep 1980 103 p refs
(Contract DE-AC03-78CS-40023)
(DOE/CS-40023/T2) Avail NTIS HC A06/MF A01
The results and findings of an energy efficient welding power development project are presented The power source developed is to be used for electric arc welding processes in which 3 5 trillion Btu of energy can be saved annually The power source developed incorporates the use of switch mode power supply techniques in order to convert industrial supply mains to appropriate welding voltages and currents A series capacitor switch mode power circuit was the circuit technique chosen in order to optimize energy efficiency, costs, reliability, size/weight, and welding performance Test results demonstrated an effective efficiency (taking into account idle power consumption) of 80 to 91 percent for the energy efficient power source while the conventional types of power sources tested ranged from 41 to 74 percent efficiency Line power factor was also improved for the energy efficient power source Field tests indicated additional refinements of weld process performance and power source audible noise emission reduction could be beneficial DOE

N81-19463# Argonne National Lab, Ill Energy and Environmental Systems Div
CLASSIFICATION AND EVALUATION OF ELECTRIC MOTORS AND PUMPS
Sep 1980 267 p refs Prepared in cooperation with Little (Arthur D.), Inc, Cambridge, Mass and Energy and Environmental Analysis, Inc., Arlington, Va.
(Contract W-31-109-eng-38)
(DOE/TIC-11339) Avail NTIS HC A12/MF A01
Electric motors and pumps are evaluated to determine standard classifications with respect to size, function, type of energy used, method of manufacture, and the practicability and effects of requiring all or part of such classes of electric motors and pumps to meet performance standards establishing minimum levels of energy efficiency. Two specific conservation strategies for improving the energy efficiency of standardized electric motors and pumps are analyzed: labeling rules, and energy efficiency standards DOE

N81-19576# Air Force Engineering and Services Center, Tyndall AFB, Fla. Engineering and Services Lab
THE US AIR FORCE ACADEMY SOLAR ENERGY RESEARCH PROJECT SUMMARY REPORT Progress Report, Apr. 1975 - Jan. 1980
Kenneth A. Cornelius Jul 1980 103 p refs
(AF Proj. 2054)
(AD-A094802; AFESC/ESL-TR-80-35) Avail NTIS HC A06/MF A01 CSCL 13/1
This report summarizes the solar energy research which was conducted by the U.S Air Force Academy from April 1975 to January 1980. This research consisted of investigations on a retrofit space heating system which was installed on a typical Military Family Housing (MFH) unit. This summary uses a lessons learned and designer tips approach in its discussion of the solar system's operation. This discussion is organized around the many areas of solar technology which were investigated during the course of this project. Those major areas were energy conservation effects, solar collectors, thermal storage, control systems, Thermography studies, performance comparison to a design model, and homeowner and maintenance manual development A thermal performance summary of the solar system is also presented The report concludes with numerous recommendations regarding policy initiatives which the Air Force should take to foster conversion to solar technology. GRA

N81-19584# Harbridge House, Inc, Washington, D.C Office of Environmental Assessments.
GROUND WATER AND ENERGY: PROCEEDINGS OF THE US DEPARTMENT OF ENERGY'S NATIONAL WORKSHOP
Nov. 1980 213 p refs Workshop held in Albuquerque, N Mex., 29-31 Jan. 1980
(Contract W-7405-eng-36)
(CONF-800137) Avail NTIS HC A10/MF A01
This national workshop on ground water and energy was conceived by the US Department of Energy's Office of Environmental Assessments Generally, OEA needed to know what data are available on ground water, what information is still needed, and how DOE can best utilize what has already been learned The workshop focussed on three areas: (1) ground water supply, (2) conflicts and barriers to ground water use, and (3) alternatives or solutions to the various issues relating to ground water. DOE

N81-19589# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.
DEVELOPMENT OF A PROTOTYPE HEAT ENGINE FOR ENERGY CONSERVATION Progress Report, Oct. - Dec. 1979
W. S. Ginell Jan. 1980 9 p
(Contracts DE-AC05-78OR-06028; ET-78-C-05-6028)
(DOE/OR-06028/T6) Avail: NTIS HC A02/MF A01
The goals of this program are to produce a 1 hp Nitinol heat engine, to obtain a set of performance measurements over a range of operating conditions, and to establish design relations between performance and hardware configurature, engine dimensions, and Nitinol characteristics The principal efforts were directed toward completion and initial operation of the Nitinol

Engine Module (MOD) Diagnostic instrumentation was completed and a computerized data acquisition system was installed Nitinol elements for MOD were conditioned and installed and the MOD was operated briefly. The first samples of Nitinol manufactured and processed at ORNL (Type 3) were characterized, and a second sample (Type 5) was received. DOE

N81-19590# Computer Sciences Corp, Vienna, Va.
REVIEW OF ACTIVITIES AND PLANS FOR SOLAR ENERGY IN FEDERAL BUILDINGS
Oct 1980 35 p refs
(Contract DE-AC01-79CR-10001)
(DOE/CR-10001/T2) Avail· NTIS HC A03/MF A01

Federal Buildings Program and plans regarding the use of solar energy are reported. Recommendations concerning the solar Federal Buildings Program's plan are given, specifically an analysis of agencies' Ten Year Buildings construction, leasing and retrofit plans to provide visibility for and detailed knowledge of Federal agencies planning regarding solar and other renewable resources. Statistical information regarding planned solar projects, and recommendations concerning the SFBP plans are presented. DOE

N81-19596# Los Alamos Scientific Lab., N. Mex.
SOME LONG-TERM ENERGY OPTIONS
J. R. Bartlit and F J. Edeskuty Dec. 1980 8 p refs
(Contract W-7405-eng-36)
(LA-8628-MS) Avail. NTIS HC A02/MF A01

Some energy options, although of little immediate use, still offer advantages which make them worthy of continued investigation to determine their feasibility and their potential These technologies include, the possibility of recovering vast amounts of methane from naturally occurring methane hydrates and the use of hydrogen as a fuel. The inherently high risk of these technologies for short term payoff makes them a particularly appropriate concern for national laboratories DOE

N81-19599# Oak Ridge National Lab., Tenn Energy Div
DESIGN OPTIMIZATION OF CONVENTIONAL HEAT PUMPS: APPLICATION TO STEADY STATE HEATING EFFICIENCY
C. K Rice, S. K Fischer, R D. Ellison, and W. L. Jackson 1981 28 p refs Presented at the ASHRAE Meeting, Chicago, 25 Jan. 1981
(Contract W-7405-eng-26)
(CONF-810101-5) Avail. NTIS HC A03/MF A01

A physically based heat pump model was connected to an optimization program to form a computer code for use in the design of high efficiency heat pumps The method used allows for the simultaneous optimization of selected design variables, taking proper account of their interactions, while constraining other parameters to chosen limits or fixed values. For optimization of the steady state heating efficiency of conventional heat pumps, ten variables were optimized while heating capacity was fixed; the results may, however, be scaled to other capacities. Calculations were made for a range of component efficiencies and heat exchanger sizes The results predict substantial improvement in heating performance due to both optimal system configuration and the use of improved components Sensitivity analyses show that there is considerable latitude for deviating from the optimum design to make use of available component sizes and for accomodating the compromises needed for good cooling performance DOE

N81-19603# Rice Univ, Houston, Tex. Dept. of Sociology.
SOCIAL ACCEPTABILITY OF SATELLITE POWER SYSTEMS (SPS). THE NEAR TERM OUTLOOK
S L Klineberg May 1980 61 p refs
(Contract DE-AS05-79ER-10072)
(DOE/ER-10072/1) Avail: NTIS HC A04/MF A01

Current public attitudes make it appear unlikely that a consensus will evolve during the 1980s favoring costly efforts to develop vast new supplies of conventional energy. Opinion polls reveal a pervasive worry over inflation, a broadening of aspirations to encompass quality of life concerns, a growing distrust of central governments, large corporations, big science and technology, and a continuing commitment to environmental protection - all of which suggests a social environment that is likely to resist the development of a major new high technology energy system such as the SPS DOE

N81-19608# National Association of Home Builders (NAHB) Research Foundation, Inc, Rockville, Md
APPLIANCE ENERGY EFFICIENCY IN NEW HOME CONSTRUCTION Final Report
30 Nov 1980 31 p
(Contract DE-AC01-80CS-23999)
(DOE/CS-23999/T1) Avail. NTIS HC A03/MF A01

A survey of 224 builders was conducted to which 160 builders responded. Each respondent completed between one and seven separate questionnaires. Each of the seven questionnaires were designed to collect information about one type of equipment or major appliance These are heat pump, heating system, air conditioner; domestic water heater, dishwasher, range, and refrigerator. Analyses of the resulting 406 questionnaires indicated that builders were primarily responsible for brand selection. These choices were made primarily without regard for the secondary efficiency of the product A similar apparent lack of consideration of energy efficiency during brand and model selection was found among home buyers and specialized subcontractors. DOE

N81-19620# Illinois Univ, Urbana Dept of Agricultural Engineering
SURFACE-HEATING GREENHOUSES WITH WASTE HEATED WATER Final Report
P. N. Walker Dec 1980 13 p refs Prepared in cooperation with Illinois Power Co, Decatur
(Contract DE-FG02-79R5-10107)
(DOE/R5-10107/T1) Avail· NTIS HC A02/MF A01

An aluminum framed glass greenhouse was constructed The outside surface of this greenhouse was heated by flowing power plant cooling water over it The water was applied at the ridge and allowed to run over the roof and sidewalls and into gutters where it was returned to the power plant's discharge canal One season's heating performance data and resulting conclusions are presented These results show that surface heating reduced conventional heat requirements by one third on the test greenhouse. However, when these results are projected to a commercial greenhouse the heating energy costs can be reduced by 67 percent. These cost savings would be 28 percent if 5 C cooler water were used and 90 percent if 5 C warmer water were used. DOE

N81-19641# National Bureau of Standards, Washington, D C
LIFE-CYCLE COST MANUAL FOR THE FEDERAL ENERGY MANAGEMENT PROGRAM Final Report
Rosalie T. Ruegg Dec. 1980 240 p refs Sponsored in part by DOE
(PB81-136269; NBS-HB-135) Avail. NTIS HC A11/MF A01 CSCL 05C

The manual is a guide to understanding the life cycle costing method and an aid to calculating the measures required for evaluating energy conservation and renewable energy investments in all Federal buildings. It expands upon life cycle costing criteria contained in the Program Rules of the Federal Energy Management Program (Subpart A of Part 436, Title 10, U S Code of Federal Regulations) and is consistent with those criteria Its purpose is to facilitate the implementation of the Program Rules by explaining the life cycle costing method defining the measures, describing the assumptions and procedures to follow in performing evaluations, and giving examples. GRA

N81-19645# Applied Physics Lab., Johns Hopkins Univ, Laurel, Md.
GEOTHERMAL ENERGY MARKET STUDY ON THE ATLANTIC COASTAL PLAIN. DEFINITION OF MARKETS FOR GEOTHERMAL ENERGY IN THE NORTHERN ATLANTIC COASTAL PLAIN
William J. Toth May 1980 218 p refs
(Contract EX-76-A-36-1008)

(PB81-123861, JHU/APL/GEMS-002, JHU/APL/QM-80-075) Avail: NTIS HC A10/MF A01 CSCL 05C

The cost and revenue streams for each year in the lifetime of a geothermal energy conversion project are calculated by the Geothermal Resource Interactive Temporal Simulation (GRITS) computer program. The program gives preliminary economic evaluations of projects under a wide range of resource, demand, and financial conditions. T.M.

N81-19646# Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.

GEOTHERMAL ENERGY MARKET STUDY ON THE ATLANTIC COASTAL PLAIN. GRITS: A COMPUTER PROGRAM FOR THE ECONOMIC EVALUATION OF DIRECT-USE APPLICATIONS OF GEOTHERMAL ENERGY

William Barron, Peter Kroll, Richard Weissbrod, and William J. Toth Jun 1980 84 p refs

(Contract EX-76-A-36-1008)

(PB81-119786, JHU/APL/QM-80-077; JHU/APL/GEMS-008; MCGER-80-002) Avail: NTIS HC A05/MF A01 CSCL 05C

The Geothermal Resource Interactive Temporal Simulation (GRITS) model calculates the cost and revenue streams for each year in the lifetime of a project that utilizes low to moderate temperature geothermal resources. With these two estimates, the net present value of the project can be determined for each year. The GRITS model allows preliminary economic evaluations of direct use applications of geothermal energy under a wide range of resource, demand, and financial conditions, some of which change over the lifetime of the project. GRA

N81-19652# National Academy of Sciences - National Research Council, Washington, D. C. Committee on Offshore Energy Technology.

ENVIRONMENTAL EXPOSURE AND DESIGN CRITERIA FOR OFFSHORE AND GAS STRUCTURES

May 1980 230 p refs

(Contract N00014-76-C-0309)

(AD-A094651) Avail: NTIS HC A11/MF A01 CSCL 08/9

One of the tasks of the Committee on Offshore Energy Technology was to review the availability of engineering field data, methods, and procedures for adequately describing and interpreting the environmental conditions that go into criteria for the design, verification, and inspection of offshore oil and gas structures Accordingly, the committee examined how industry obtains environmental data, how it uses the data to evaluate environmental exposures, and how it uses environmental exposures to establish criteria to design, build, install, and operate offshore platforms. The committee examined all three phases of developing offshore petroleum reserves. pre-lease, exploration, and production The purpose was to find where and what types of data were needed by government and industry. GRA

N81-19653# Argonne National Lab., Ill. Energy and Environmental Systems Div.

LOCAL AIR QUALITY CONSTRAINTS ON ENERGY GROWTH, 1985-1990

D G Streets Mar. 1980 65 p refs

(Contract W-31-109-eng-38)

(ANL/EES-TM-114) Avail. NTIS HC A04/MF A01

This report examined the potential future conflict between energy growth and environmental protection from the perspective of siting constraints imposed by requirements of the Clean Air Act Amendments of 1977 County-level projections of additional utility powerplant capacity and increases in industrial coal, oil, and gas consumption were derived for the period 1985 to 1990. Emissions of sulfur dioxide and particulate matter, after the application of appropriate control systems, were converted to changes in ambient air quality using a proportional modeling approach These changes were then compared with Nonattainment and Prevention of Significant Deterioration requirements, and the energy activity is considered to be constrained if a violation is projected Total percentages of constrained energy activity were developed for the nation, and the geographical patterns of significant impacts are presented Author

N81-19655# Ames Lab., Iowa.

AIR POLLUTION CONTROL TECHNOLOGY FOR MUNICIPAL SOLID WASTE-TO-ENERGY CONVERSION FACILITIES: CAPABILITIES AND RESEARCH NEEDS

Joseph F. Lynch and James C. Young Sep. 1980 53 p refs

(Contract W-7405-eng-82)

(DOE/EV-0115) Avail: NTIS HC A04/MF A01

Three major categories of waste to energy conversion processes in full scale operation or advanced demonstration stages in the US are co-combustion, mass incineration, and pyrolysis. These methods are described and some information on US conversion facilities was tabulated. Conclusions and recommendations dealing with the operation, performance, and research needs for these facilities are given. Research needs concerning air pollution aspects of the waste to energy processes were identified and significant operating and research findings for the co-combustion, mass incineration, and pyrolysis waste to energy systems were reviewed. DOE

N81-19674# Calspan Advanced Technology Center, Buffalo, N.Y.

AEROSOL FORMATION FROM DIESEL EXHAUST AND SO2. A CHAMBER STUDY Final Report, Sep. 1978 - Mar. 1980

R. J Anderson and J T Hanley Dec 1980 110 p refs

(Contract EPA-68-02-2987)

(PB81-121147; EPA-600/3-80-095) Avail. NTIS HC A06/MF A01 CSCL 13B

Dilute diesel emission systems were studied in a 600 cu m indoor smog chamber under various conditions likely to be encountered in an urban environment Aerosol formation and growth in an irradiated diesel emission/SO2/propylene system was primarily attributed to sulfate formation During irradiated experiments, the rate of SO2 oxidation experienced a maximum of about 5 percent/hr in the period when the O3 concentration was increasing rapidly Following the peak in the O3 concentration, the rate of SO2 oxidation decreased to about 1 percent/hr.GRA

N81-19972# Sheffield Univ. (England). Dept. of Control Engineering

AN OPTIMAL CONTROL APPROACH TO ENERGY MINIMIZATION IN ELECTRIC VEHICLES

J. B. Edwards and K. Pacey (Chloride Legg Ltd) Apr. 1980 23 p refs Presented at Inst. of Mech Engr. Conf. on System Eng. in Land Transport, Sussex, England, 24-25 Sep 1980

(Rept-109) Avail NTIS HC A02/MF A01

An optimal control strategy designed to minimize the energy losses incurred by an electric vehicle in making a journey of prespecified time and distance was analyzed. A boundary value iteration method was successfully applied to a series-motordriven vehicle on undulating gradient profiles. A significant influence of drive characteristics on the optimal driving strategy was found. The need for continuing investigation into the optimal control of a wide range of drives is emphasized. Author (ESA)

N81-20077 General Accounting Office, Washington, D. C.

A LOOK AT NASA'S AIRCRAFT ENERGY EFFICIENCY PROGRAM

General Accounting Office 28 Jul. 1980 4 p

(PSAD-80-50) Avail. NTIS HC A02/MF A01

The status of the Aircraft Energy Efficiency (ACEE) program the coordination effectiveness between NASA and the Department of Defense (DOD), the need for periodic reporting to the Congress on efforts as ACEE, and NASA's role in aeronautical R&D are examined. The ACEE program accounted for over one third of NASA's aeronautical budget for fiscal year 1980 and will decrease to 29 percent in fiscal year 1981. Details on ACEE costs and funding for NASA's aeronautical research and technology program are appended. E A K.

N81-20318# National Bureau of Standards, Washington, D.C Center for Building Technology

A REFERENCE BUILDING APPROACH TO BUILDING ENERGY PERFORMANCE STANDARDS FOR SINGLE-FAMILY RESIDENCES Final Report

Stephen R Petersen and Jim L Heldenbrand Oct 1980 40 p

refs
(Contract EA-77-A-01-6010)
(PB81-135642, NBSIR-80-2161) Avail NTIS HC A03/MF A01 CSCL 13A

A reference building approach to building energy performance standards is described. Each proposed building design would be compared with a reference building design and operating profile. In order to comply with the standard, the design energy requirements of the new building would not be allowed to exceed those of the reference building when evaluated by a parallel modeling process GRA

N81-20441# Cyclomatic Industries, Inc., San Diego, Calif.
HIGHLY EFFICIENT WELDING POWER SUPPLY Final Report, 1 May 1978 - 30 Sep. 1980
James M. Thommes Sep. 1980 99 p refs
(Contracts DE-AC03-78CS-40023; EM-78-C-03-1837)
(DOE/CS-40023/T1) Avail. NTIS HC A05/MF A01

The results and findings of an energy efficient welding power source development project are reported. The power source developed is to be used for electric arc welding processes in which 3.5 trillion Btu of energy can be saved annually. The power source development incorporates the use of switch mode power supply techniques in order to convert industrial supply mains (230/460 VAC 3 phi 60 Hz) to appropriate welding voltages and currents (up to 32 volts/up to 300 amps). A series capacitor switch mode power circuit was the circuit technique chosen in order to optimize energy efficiency, costs, reliability, size/weight, and welding performance. Test results demonstrated an effective efficiency of 80% to 91% for the energy efficient power source while the conventional types of power sources tested ranged 41% to 74% efficiency. DOE

N81-20538*# General Electric Co., St. Petersburg, Fla. Corporate Research and Development.
MONITORING AND CONTROL REQUIREMENT DEFINITION STUDY FOR DISPERSED STORAGE AND GENERATION (DSG), VOLUME 1 Final Report
Oct. 1980 330 p refs Sponsored by NASA and New York State Energy Research and Development Authority Prepared for JPL 5 Vol.
(Contract JPL-955456)
(NASA-CR-164051; SRD-80-042-I-Vol-1; DOE/JPL-955456-1; JPL-9950-419) Avail. NTIS HC A15/MF A01 CSCL 10A

Twenty-four functional requirements were prepared under six categories and serve to indicate how to integrate dispersed storage generation (DSG) systems with the distribution and other portions of the electric utility system. Results indicate that there are no fundamental technical obstacles to prevent the connection of dispersed storage and generation to the distribution system. However, a communication system of some sophistication is required to integrate the distribution system and the dispersed generation sources for effective control. The large-size span of generators from 10 KW to 30 MW means that a variety of remote monitoring and control may be required. Increased effort is required to develop demonstration equipment to perform the DSG monitoring and control functions and to acquire experience with this equipment in the utility distribution environment. A.R.H.

N81-20539*# General Electric Co., St. Petersburg, Fla. Corporate Research and Development.
MONITORING AND CONTROL REQUIREMENT DEFINITION STUDY FOR DISPERSED STORAGE AND GENERATION (DSG). VOLUME 2, APPENDIX A: SELECTED DSG TECHNOLOGIES AND THEIR GENERAL CONTROL REQUIREMENTS Final Report
Oct. 1980 168 p refs Sponsored by NASA and New York State Energy Research and Development Authority Prepared for JPL 5 Vol
(Contract JPL-955456)
(NASA-CR-164052, SRD-80-042-II-Vol-2; DOE/JPL-955456-1, JPL-9950-419) Avail. NTIS HC A08/MF A01 CSCL 10A

A consistent approach was sought for both hardware and software which will handle the monitoring and control necessary to integrate a number of different DSG technologies into a common distribution dispatch network. It appears that the control of each of the DSG technologies is compatible with a supervisory control method of operation that lends itself to remote control from a distribution dispatch center. T.M.

N81-20540*# General Electric Co., St. Petersburg, Fla. Corporate Research and Development.
MONITORING AND CONTROL REQUIREMENT DEFINITION STUDY FOR DISPERSED STORAGE AND GENERATION (DSG). VOLUME 3, APPENDIX B: STATE OF THE ART, TRENDS, AND POTENTIAL GROWTH OF SELECTED DSG TECHNOLOGIES Final Report
Oct. 1980 46 p refs Sponsored by NASA and New York State Energy Research and Development Authority Prepared for JPL 5 Vol.
(Contract JPL-955456)
(NASA-CR-164054; SRD-80-042-III-Vol-3, DOE/JPL-955456-1, JPL-9950-419) Avail. NTIS HC A03/MF A01 CSCL 10A

Present and future relatively small (<30 MW) energy systems, such as solar thermal electric, photovoltaic, wind, fuel cell, storage battery, hydro, and cogeneration can help achieve national energy goals and can be dispersed throughout the distribution portion of an electric utility system. Based on current projections, it appears that dispersed storage and generation (DSG) electrical energy will comprise only a small portion, from 4 to 10 percent, of the national total by the end of this century. In general, the growth potential for DSG seems favorable in the long term because of finite fossil energy resources and increasing fuel prices. Recent trends, especially in the institutional and regulatory fields, favor greater use of the DSGs for the future A.R.H.

N81-20541*# General Electric Co., St. Petersburg, Fla. Corporate Research and Development
MONITORING AND CONTROL REQUIREMENT DEFINITION STUDY FOR DISPERSED STORAGE AND GENERATION (DSG). VOLUME 4, APPENDIX C: IDENTIFICATION FROM UTILITY VISITS OF PRESENT AND FUTURE APPROACHES TO INTEGRATION OF DSG INTO DISTRIBUTION NETWORKS Final Report
Oct. 1980 77 p Sponsored by NASA and New York State Energy Research and Development Authority Prepared for JPL 5 Vol.
(Contract JPL-955456)
(NASA-CR-164055, SRD-80-042-IV-Vol-4, DOE/JPL-955456-1, JPL-9950-419) Avail. NTIS HC A05/MF A01 CSCL 10A

Visits to four utilities concerned with the use of DSG power sources on their distribution networks yielded useful impressions of present and future approaches to the integration of DSGs into electrical distribution network. Different approaches to future utility systems with DSG are beginning to take shape. The new DSG sources will be in decentralized locations with some measure of centralized control. The utilities have yet to establish firmly the communication and control means or their organization. For the present, the means for integrating the DSGs and their associated monitoring and control equipment into a unified system have not been decided A.R.H.

N81-20542*# General Electric Co., St. Petersburg, Fla. Corporate Research and Development.
MONITORING AND CONTROL REQUIREMENT DEFINITION STUDY FOR DISPERSED STORAGE AND GENERATION (DSG). VOLUME 5, APPENDIX D: COST-BENEFIT CONSIDERATIONS FOR PROVIDING DISPERSED STORAGE AND GENERATION FOR ELECTRIC UTILITIES Final Report
Oct. 1980 42 p Sponsored by NASA and New York State Energy Research and Development Authority Prepared for JPL 5 Vol.
(Contract JPL-955456)
(NASA-CR-164053; DOE/JPL-955456-1; JPL-9950-419; SRD-80-042-V-Vol-5) Avail: NTIS HC A03/MF A01 CSCL 10A

Cost benefit considerations are extremely important in obtaining the acceptance of dispersed storage and generation

(DSG) by the electric utilities. These considerations involved somewhat different economic analyses depending on whether the generation is utility, customer, or combined ownership. It is necessary to get acceptance of more easily understood methods for evaluating the economics of DSG because much of the benefits of DSG may accrue in the generation and transmission portions of the utility system while the costs tend to be centered in the distribution portion of that system. The influence of factors, such as reliability, capital costs, and other economic measures were also investigated. T.M.

N81-20563# Acres Shawinigan Ltd., Toronto (Ontario).
STUDY OF THE POTENTIAL FOR COGENERATION IN CANADA: INDUSTRIAL STEAM TURBINES. VOLUME 1: MAIN REPORT
Dec. 1979 176 p refs
(NP-25187-Vol-1) Avail. NTIS (US Sales Only) HC A09/MF A01, DOE Depository Libraries

Results of a study to determine the potential for cogeneration in Canada are presented. National, provincial, and industrial potentials for cogeneration based on responses to a questionnaire from 211 plants operating boiler plants are developed. Each of the 211 plants were subjected to a common analysis procedure to determine cogeneration capability and cost. The study defined cogeneration, and addressed the technical potential for cogeneration, the economic implications of cogeneration, and the institutional barriers which have to be overcome before cogeneration is fully accepted as an energy supply option in Canada. DOE

N81-20573# Volvo Flygmotor A.B., Trollhaettan (Sweden).
DEVELOPMENT OF METHOD AND EQUIPMENT FOR ENERGY RECOVERY FROM THE EXHAUST GASES OF THE OIL-FUELED SMELTING AND HOLDING FURNACES
Ake Holm Mar. 1980 14 p In SWEDISH
(STU-78-6895) Avail: NTIS (US Sales Only) HC A02/MF A01

A heat recovery system was tested. The system consists of a flat ceramic heat exchanger and a high temperature burner for preheated combustion air. The fuel saving tests were made with a smelting furnace for aluminum. The furnace can be used as a holding furnace and for a combination of smelting and holding. When the modified furnace is used for holding only, there is 50 percent reduction of fuel consumption. Combined use renders 30 to 35 percent saving of fuel. The yearly savings are about 75,000 Skr in this case. Long time tests (about 5000 h) show no change. The equipment can be adapted to various types of oil fueled furnaces for smelting, forging, and in the glass industry. DOE

N81-20598# Argonne National Lab., Ill.
ENVIRONMENTAL ASSESSMENT FOR THE SATELLITE POWER SYSTEM CONCEPT DEVELOPMENT AND EVALUATION PROGRAM. ATMOSPHERE EFFECTS
D. M. Rote, K. L. Brubacker, and J. L. Lee Nov 1980 128 p refs
(Contract W-31-109-eng-38)
(DOE/ER-0090) Avail NTIS HC A07/MF A01

The issues associated with SPS activities in the troposphere were examined. These include tropospheric weather modification related to rectenna operations and rocket launches, and air quality impacts related to rocket launch ground clouds. Then progressing upward through the various levels of the atmosphere, the principal middle and upper atmospheric effects associated with rocket effluents were analyzed. Finally, all of the potential SPS atmospheric effects are summarized. DOE

N81-20604# Ford, Bacon and Davis, Inc., New York
ENERGY EMERGENCY CONTINGENCY PLAN
Nov 1980 179 p refs Prepared in cooperation with Tri-State Regional Planning Sponsored in part by DOT Commission, New York
(PB81-128704, UMTA-NY-09-0054-80-1) Avail. NTIS HC A09/MF A01 CSCL 08L

The feasibility of implementing certain contingency measures to relieve or eliminate capacity shortfalls on subsidized bus transportation under the auspices of the New Jersey Transit Corporation is detailed. The primary purpose is to evaluate effective short range strategies to expand existing transit services, capable of being implemented within two weeks, should a reduction of fuel supplies curtail travel by automobile. The study area is in the nine northern counties of New Jersey under Tri-State jurisdiction. GRA

N81-20620# Environmental Protection Agency, Ann Arbor, Mich Control Technology Assessment and Characterization Branch
COMPARISON OF GAS PHASE HYDROCARBON EMISSIONS FROM LIGHT-DUTY GASOLINE VEHICLES AND LIGHT-DUTY VEHICLES EQUIPPED WITH DIESEL ENGINES
Penny Carey and Janet Cohen Sep 1980 31 p refs
(PB81-122996; EPA-AA-CTAB/PA-80-5) Avail: NTIS HC A03/MF A01 CSCL 13F

Existing data on gas phase hydrocarbon exhaust emissions from both gasoline vehicles and vehicles equipped with diesel engines are consolidated. Recent studies show that diesel emissions contain compounds of high molecular weight. This high molecular weight component is dominated by particle bound hydrocarbons; however, the potential health risk associated with heavy hydrocarbons merits examination of the gas phase as well. Particular emphasis is placed on the comparison of emissions and their potential carcinogenicity. Other areas discussed include evaporative hydrocarbon emissions and the effect of fuel composition on gasoline gaseous hydrocarbon emissions. GRA

N81-21161# Argonne National Lab., Ill. Energy and Environmental Systems Div
ENERGY AND MATERIALS FLOWS IN THE PRODUCTION OF OLEFINS AND THEIR DERIVATIVES
L. L. Gaines and S. Y. Shen Aug 1980 184 p refs
(Contract W-31-109-eng-38)
(ANL/CNSV-9) Avail NTIS HC A09/MF A01

Production of olefins and their derivatives uses almost 3.5% of the oil and gas consumed annually in the United States. It is estimated that their production requires an input energy of 2 Q, which is 50% of the energy used in the production of all petrochemicals. Substantial amounts of this energy could be recovered through recycling. For example, recycling of a single plastic product, polyester soft drink bottles, could have recovered about 0.014 Q in 1979. Petrochemical processes use fuels as feedstocks, as well as for process energy, and a portion of this energy is not foregone and can be recovered through combustion of the products. The energy foregone in the production of ethylene is estimated to be 7800 Btu/lb. The energy foregone in plastics production ranges from 12,100 Btu/lb for the linear low density polyethylene to 77,200 Btu/lb for nylon 66, which is about 60% of the total energy input for that product. DOE

N81-21216# Tennessee Valley Authority, Muscle Shoals, Ala Div. of Chemical Development
ENVIRONMENTAL CONSIDERATION FOR TVA'S AMMONIA FROM COAL PROJECT
P. C. Williamson and D. A. Waitzman 1980 18 p Presented at the Fertilizer Inst. Environ. Symp., New Orleans, 7-10 Apr 1980
(CONF-8004137-1) Avail: NTIS HC A02/MF A01

The project involves retrofitting a coal gasification process to the front end of its existing 225 ton-per-day ammonia plant. The purpose of the project is to develop design and operating data to assess the technological, economic, and environmental aspects of substituting coal for natural gas in the manufacture of ammonia. The gasification plant and process are described. Solid wastes are to be disposed of in a sanitary landfill. Precautionary measures are described. Environmental study areas are outlined. These include: gaseous, liquid, and solid waste monitoring and characterization; radiological characterization, medical surveillance; and basic industrial hygiene. Possible hazardous agents are described. DOE

N81-21371# Environmental Protection Agency, Ann Arbor, Mich Test and Evaluation Branch
EMISSIONS AND FUEL ECONOMY OF A COMPREX PRESSURE WAVE SUPERCHARGED DIESEL
Edward Anthony Barth and Richard N Burgenson Oct. 1980 10 p refs
(PB81-133399, EPA-AA-TEB-81-1) Avail NTIS HC A02/MF A01 CSCL 21E

In order to increase public interest in vehicles equipped with diesel engines, methods of improving diesel fueled engine performance, as compared to current gasoline fueled counterparts, are investigated One method to increase performance is to supercharge or turbocharge the engine An EPA assessment of a supercharging technique previously evaluated is described GRA

N81-21467# Oak Ridge National Lab., Tenn. Chemical Technology Div
FUTURE US ENERGY SUPPLY: CONSTRAINTS BY NONFUEL MINERAL RESOURCES
H E Goeller Dec 1980 114 p refs
(Contract W-7405-eng-26)
(ORNL-5656) Avail. NTIS HC A06/MF A01

Current energy-related requirements for the various elements and mineral products are established Domestic and world reserves and resources for each nonrenewable resource are assessed and a ranking made of impending domestic scarcities by using resource-to-demand ratios Special problems on by-products production are noted, followed by a discussion on import dependency The roles of recycle and substitution are assessed, and the possibilities for synthesis of nonelement commodities are reviewed Detailed requirements for the more widely used materials in a large number of energy supply systems are provided, followed by newer future requirements for more advanced energy systems anticipated to be in widespread use in the next century. Finally, the various problems associated with 16 elements deemed most likely to become scarce within the next 50 years are resummarized, and general conclusions are provided DOE

N81-21490# International Institute for Applied Systems Analysis, Laxenburg (Austria)
EFFECTS OF ACCOUNTING RULES ON UTILITY CHOICES OF ENERGY TECHNOLOGIES IN THE UNITED STATES
Bernard I Spinrad Jul 1980 35 p refs
(IIASA-RR-80-27) Avail Issuing Activity

Comparisons of the costs of power systems, specifically the cost of nuclear versus other power systems, are discussed The effects of inconsistent accounting are examined Five systems that supply electrical power are cost analyzed (1) light water reactors, (2) liquid metal fast breeder reactors, (3) coal plants, with scrubbers, burning low sulfur or processed high sulfur coal, (4) coal plants with fluidized bed combustion of high sulfur coal, and (5) solar power plants with sufficient storage for baseload use Cost estimates for the system are made and justified Cost comparison results show that, contrary to currently accepted conclusions, light water reactors have a decisive cost advantage over coal, if assumed target costs are met, after development, liquid metal fast breeder reactor would be the cheapest system, and if postdevelopment target costs are met, solar power plants are almost competitive with the nuclear systems and are much cheaper than coal Author (ESA)

N81-21559# Princeton Univ, N J Center for Environmental Studies
ALTERNATIVE ENERGY FACILITY SITING POLICIES FOR URBAN COASTAL AREAS: EXECUTIVE SUMMARY OF FINDINGS AND POLICY RECOMMENDATIONS
David Morell and Grace Singer Nov 1980 29 p refs
(Contract DE-AS03-77EV-01528)
(DOE/EV-01528/T1) Avail. NTIS HC A03/MF A01

An analysis was made of siting issues in the coastal zone, one of the nation's most critical natural resource areas and one which is often the target for energy development proposals The analysis addressed the changing perceptions of citizens toward energy development in the coastal zone, emphasizing urban communities where access to the waterfront and revitalization of waterfront property are of interest to the citizen. The case studies demonstrate the significance of local attitudes and regional cooperation in the siting process. DOE

N81-21560# Los Alamos Scientific Lab., N Mex.
WATER SUPPLY AND DEMAND IN AN ENERGY SUPPLY MODEL
David Abbey and Verne Loose Dec. 1980 61 p refs
(Contract DE-AC04-80EV-10180)
(DOE/EV-10180/2) Avail: NTIS HC A04/MF A01

The model allows adjustments in the input mix and plant siting in response to water scarcity Thus, on the demand side energy conversion facilities can substitute more costly dry cooling systems for conventional evaporative systems. On the supply side groundwater and water purchased from irrigators are available as more costly alternatives to unappropriated surface water. Water supply data is developed for 30 regions in 10 western states. Preliminary results for a 1990 energy demand scenario suggest that, at this level of spatial analysis, water availability plays a minor role in plant siting Future policy applications of the modeling system are discussed including the evaluation of alternative patterns of synthetic fuels development DOE

N81-21561# Battelle Columbus Labs, Ohio
ANALYSIS OF FIELD TEST DATA ON RESIDENTIAL HEATING AND COOLING Final Report
S G Talbert Dec 1980 129 p refs Sponsored by Electric Power Research Inst
(EPRI Proj 1364-1)
(EPRI-EA-1649) Avail. NTIS HC A07/MF A01

The computer program using field site data collected on 48 homes located in six cities in different climatic regions of the United States is discussed In addition, a User's Guide was prepared for the computer program which is contained in a separate two-volume document entitled User's Guide for REAP Residential Energy Analysis Program Feasibility studies were conducted pertaining to potential improvements for REAP, including the addition of an oil-furnace model, improving the infiltration subroutine, adding active and/or passive solar subroutines, incorporating a thermal energy storage model, and providing dual HVAC systems (e g, heat pump-gas furnace) The purpose of REAP is to enable building designers and energy analysts to evaluate how such factors as building design, weather conditions, internal heat loads, and HVAC equipment performance, influence the energy requirements of residential buildings DOE

N81-21565# California Univ, Livermore Lawrence Livermore Lab
US ENERGY CONSUMPTION AND SUPPLY
C. M VanAtta 13 Jan 1981 44 p refs
(Contract W-7405-eng-48)
(UCID-18856) Avail NTIS HC A03/MF A01

Energy consumption and cost in 1978 and 1979 are discussed with emphasis on the effect of imported oil on the economy of the United States Some of the international aspects of energy supply are described, and actions to meet the probability of a cutoff of oil imports from the Persian Gulf area are suggested. Short and long range strategies for ensuring energy self sufficiency are discussed A rationale for major, long range dependence on fission and fusion power is given, and the possible advantages of a nearly all electric energy system are mentioned. Projection of energy consumption and supply to the year 2020 based upon economic and demographic models is discussed DOE

N81-21576# Midwest Research Inst, Golden, Colo Solar Energy Research Inst
SOLAR ENERGY IN ITALY: A PROFILE OF RENEWABLE ENERGY ACTIVITY IN ITS NATIONAL CONTEXT
Carol A Shea Dec 1980 76 p refs
(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042)
(SERI/SP-763-718) Avail NTIS HC A05/MF A01

The energy profile includes imported energy sources, solar research and development, solar energy organizations, solar energy related legislation and administration policies, and international agreements, contacts, manufacturers, and projects. The country overview includes: Italian Republic geopolitical analysis, economic analysis; and cultural aspects T.M.

N81-21590*# PRC Energy Analysis Co., Los Angeles, Calif.
SATELLITE POWER SYSTEM (SPS) SOCIETAL ASSESSMENT
Dec 1980 57 p refs Sponsored by NASA
(Contract DE-AC01-79ER-10041)
(NASA-CR-164153; DOE/ER-10041/T12) Avail: NTIS HC A04/MF A01 CSCL 10A

Construction and operation of a 60-unit (300 GW) domestic SPS over the period 2000 to 2030 would stress many segments of U.S. society. A significant commitment of resources (land, energy, materials) would be required, and a substantial proportion of them would have to be committed prior to the production of any SPS electricity. Forty-four concerns about the SPS were identified via a public outreach experiment involving 9000 individuals from three special interest organizations. The concerns focused on environmental impacts (particularly the effects of microwave radiation) and the centralizing tendency of the SPS on society. DOE

N81-21593# Bonneville Power Administration, Portland, Oreg. Div. of Power Resources.
WIND ENERGY INTEGRATION STUDY
Aug. 1980 77 p
(Contract DE-AC79-79BP-10552)
(DOE/BP-10552/17) Avail: NTIS HC A05/MF A01

The feasibility of integrating a simulated 3000 megawatt (MW) wind energy conversion network into the Pacific Northwest hydro-thermal generation system was investigated. The following areas were identified for preliminary analysis: seasonal power planning (regulation); secondary energy (surplus); energy reserve planning; peak reserves; and hourly planning. DOE

N81-21595# Alaska State Div. of Energy and Power Development, Anchorage.
ALASKA REGIONAL ENERGY RESOURCES PLANNING PROJECT. PHASE 2: COAL, HYDROELECTRIC AND ENERGY ALTERNATIVES. VOLUME 1: BELUGA COAL DISTRICT ANALYSIS
Gene Rutledge, Darlene Lane, and Greg Edblom 1980 452 p refs 3 Vol.
(Contract DE-AT06-77EV-73002)
(DOE/EV-73002/1-Vol-1, DEPD-81-001-1-Vol-1) Avail: NTIS HC A20/MF A01

Socio-economic implications of the development and management alternatives are discussed. A review of permits and approvals necessary for the initial development of Beluga Coal Field is presented. Major land tenure issues in the Beluga Coal District as well as existing transportation routes and proposed routes and sites are discussed. The various coal technologies which might be employed at Beluga are described. Transportation options and associated costs of transporting coal from the mine site area to a connecting point with a major, longer distance transportation mode and of transporting coal both within and outside (exportation) the state are discussed. DOE

N81-21596# Alaska State Div. of Energy and Power Development, Anchorage.
ALASKA REGIONAL ENERGY RESOURCES PLANNING PROJECT. PHASE 2: COAL, HYDROELECTRONIC AND ENERGY ALTERNATIVES. VOLUME 2: HYDROELECTRIC DEVELOPMENT
Gene Rutledge, Darlene Lane, and Greg Edblom 1980 177 p refs
(DOE/EV-73002/1-Vol-2; DEPD-81-001-2-Vol-2) Avail: NTIS HC A09/MF A01

More than 600 sites for possible hydroelectric power development were identified in Alaska. The power potential of these sites is 200 times as great as the currently developed hydroelectric capacity of 131 MW. Information is presented on the location and characteristics of Alaska's hydropower sites, licensing and cost requirements for site development, the environmental impact of hydroelectric development, and a review of hydroelectric technology including low head, ocean wave, and tidal hydropower and the equipment for hydropower conversion DOE

N81-21597# Alaska State Div of Energy and Power Development, Anchorage
ALASKA REGIONAL ENERGY RESOURCES PLANNING PROJECT. PHASE 2: COAL, HYDROELECTRIC AND ENERGY ALTERNATIVES. VOLUME 3: ALASKA'S ALTERNATIVE ENERGIES AND REGIONAL ASSESSMENT INVENTORY UPDATE
Gene Rutledge, Darlene Lane, and Greg Edblom 1980 300 p refs
(Contract DE-AT06-77EV-73002)
(DOE/EV-73002/1-Vol-3; DEPD-81-001-3-Vol-3) Avail: NTIS HC A13/MF A01

Topics include the utilization of windpower and geothermal resources, the utilization of very small hydropower systems, and the use of fuel cells Waste energy utilization is also discussed and emphasis is placed on the use of wood residues and waste heat for energy conversion Siting criteria for each of the alternate energy systems is presented T.M

N81-21606# Oak Ridge National Lab., Tenn Engineering Technology Div.
FUEL CYCLE ANALYSIS FOR FOSSIL ENERGY SYSTEMS: COAL COMBUSTION
W. L. Greenstreet and R. L. Carmichael Feb 1981 392 p refs Submitted for publication
(Contract W-7405-eng-26)
(ORNL-5661) Avail NTIS HC A17/MF A01

Elements of the fuel cycle for coal combustion in power generation are examined; and information on economics, technological status, energy efficiencies, and environmental issues is reviewed. Overall background information is provided for guidance in identifying issues and establishing needs and priorities for engineering research, development, and demonstration. The elements treated include mining, transportation, coal preparation, direct combustion, and environmental control technology. The treatment used differs from that of usual compendiums in its emphasis on integrated examination and presentation directed primarily toward providing bases for general assessment and for guidance in program development Emphasis is on program identification as opposed to advocacy. DOE

N81-21611# Los Alamos Scientific Lab., N. Mex.
CERAMIC HEAT PIPE DEVELOPMENT Annual Report, 1 Oct. 1979 - 30 Sep. 1980
M. Merrigan Dec. 1980 30 p refs
(Contract W-7405-eng-36)
(DOE/TIC-11389) Avail. NTIS HC A03/MF A01

Progress in developing ceramic heat pipe recuperators for recovering heat from industrial processing furnaces is reported. Information is included on the design, materials procurement, fabrication, materials testing, performance testing, performance and cost of ceramic heat pipes, especially tungsten-coated silicon carbide and Sic-W-Mo heat pipes. DOE

N81-21613# California Univ., Berkeley. Lawrence Berkeley Lab.
ENVIRONMENTAL ASSESSMENT FOR THE SATELLITE POWER SYSTEM CONCEPT DEVELOPMENT AND EVALUATION PROGRAM: NONMICROWAVE HEALTH AND ECOLOGICAL EFFECTS
Margaret R. White Nov. 1980 89 p refs
(Contract W-7405-eng-48)
(DOE/ER-0089) Avail: NTIS HC A05/MF A01

A preliminary reference system was developed. The assessment is summarized as to scope, methodology, impacts of terrestrial development, launch and recovery of spacecraft, space activities (including health effects of the space environment, ionizing radiation, electromagnetic exposure, spacecraft charging and environmental interactions, occupational hazards, etc.) and construction and operation of rectenna (ground receiving station). DOE

N81-21618# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.
CURRENT AND FUTURE INDUSTRIAL ENERGY SERVICE CHARACTERIZATIONS, VOLUME 1
Frank Krawiec, Tom Thomas, Frederick Jackson, Dilip R. Limaye, Steve Isser, Ken Karnofsky, and Todd D. Davis Oct. 1980 243 p refs *Prepared in cooperation with Synergetic Resources Corp.*
(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042)
(SERI/TR-733-790-Vol-1) Avail: NTIS HC A11/MF A01

Current and future energy demands, end uses, and cost used to characterize typical applications and resultant services in the industrial sector of the United States are examined. A review and evaluation of existing industrial energy data bases was undertaken to assess their potential for supporting SERI research on: (1) market suitability analysis; (2) market development; (3) end use matching; (4) industrial applications case studies; and (5) identification of cost and performance goals for solar systems and typical information requirements for industrial energy end use. The focus was on fuels and electric energy used for heat and power purchased by the manufacturing subsector and listed by 2, 3, and 4 digit SIC, primary fuel, and end use. The effects of federal and state industrial energy conservation programs on future industrial sector demands were assessed. DOE

N81-21622# Sandia Labs., Albuquerque, N Mex Energy Systems Studies Div
SURVEY OF US INDUSTRIAL PROCESS HEAT USAGE DISTRIBUTIONS
J J Iannucci 1981 30 p refs Sponsored by DOE
(SAND-80-8234) Avail: NTIS HC 03/MF A01

The energy use characteristics of industry are examined in terms of the potential for penetration of solar thermal energy into the industrial process heat market. Data on 1972 United States industrial energy consumption (grouped by standard industrial classifications) were used along with the number of energy consuming establishments to generate estimates of the average consumption rate (megawatts) of energy at any site. Known temperature requirements for those industrial types were incorporated to calculate the power ratings required at various temperatures These data were combined to yield distributions of energy consumption facility sizes at various temperatures In terms of number of facilities, the small, lower temperature end users dominate However, in terms of total energy consumed, the larger users (> 10 MW) and higher temperatures dominate J.M.S

N81-21624# Battelle Pacific Northwest Labs., Richland, Wash.
THE ECONOMICS OF RESIDENTIAL ENERGY EFFICIENCY
Richard P Mazzucchi and Wally J Hopp Jun 1980 16 p refs
(Contract DE-AC06-76RL-01830)
(PNL-SA-8696; CONF-800828-3) Avail. NTIS HC A02/MF A01

The building thermal analysis program is utilized to analyze various measures for reducing energy consumption in single-family dwellings in northeastern Oregon. The results from the program are combined with energy price data and other economic assumptions to produce a ranking of the conservation measures according to their economic attractiveness An evaluation is given of the utility and cost-effectiveness of the program as a tool for the design of energy efficient housing for specific climatic locations S.F.

N81-21630# General Accounting Office, Washington, D. C. Energy and Minerals Div.
IMPROVED DATA AND PROCEDURES NEEDED FOR DEVELOPMENT AND IMPLEMENTATION OF BUILDING ENERGY PERFORMANCE STANDARDS
23 Dec. 1980 38 p
(PB81-138422; EMD-81-2) Avail: NTIS HC A03/MF A01 CSCL 13A

Energy conservation standards for new buildings being developed by the Department of Energy are discussed. Specifically, it addresses: what still needs to be done before sound standards can be issued; the need to transfer implementation responsibility for the standards from the Department of Housing and Urban Development to the Department of Energy; and the inappropriateness of the proposed sanction for noncompliance in view of the large decrease in expected energy savings. GRA

N81-21631# Resource Planning Associates, Inc., Washington, D. C.
REGIONAL ANALYSIS OF RESIDENTIAL/COMMERCIAL GAS DEMAND Final Report
Dec. 1980 93 p
(Contract GRI-5014-310-0238)
(PB81-134496; RPA-RA-80-0429(2); GRI-80/0011) Avail: NTIS HC A05/MF A01 CSCL 13A

The market for the following systems for space conditioning is analyzed; deluxe gas furnace/central air-conditioner; oil furnace/central air-conditioner; electronic furnace/central air-conditioner, gas pulse-combination furnace/central air-conditioner, gas absorption heat pump; gas mechanical heat pump; advanced electric heat pump The methodology used forecasting regional characteristics affecting regional gas demand; forecasting regional gas demand; and analyzing the economics of and developing market shares for each of the above systems regionally. GRA

N81-21639# New Mexico State Univ., Las Cruces. New Mexico Energy Inst.
ENVIRONMENTAL OVERVIEW FOR THE DEVELOPMENT OF GEOTHERMAL RESOURCES IN THE STATE OF NEW MEXICO Final Report
M. Bryant, Arlene H. Starkey, and William A Dick-Peddie Jun. 1980 268 p refs Prepared for California Univ., Livermore. Lawrence Livermore Lab
(Contract W-7405-eng-48)
(UCRL-15317) Avail. NTIS HC A12/MF A01

Technologies and environmental impacts are considered at all points on the pathway of development resource exploration; well field, plant and transmission line construction; and plant operation. The technologies for electrical generation direct, dry steam conversion; separated steam conversion; single flash conversion, separated steam/single flash conversion and binary cycle conversion and the heat exchanger, down the hole heat exchanger and heat pump are described. A summary of the geothermal technologies planned or in operation within New Mexico geothermal areas is provided. A review of regulations that affect geothermal development and its related environmental impact in New Mexico is presented DOE

N81-21640# California Univ., Livermore Lawrence Livermore Lab.
MANAGEMENT PLAN FOR FISCAL YEAR 1981: ENVIRONMENTAL CONTROL TECHNOLOGY PROJECT GEOTHERMAL DEVELOPMENT
W. F. Morris and F. B. Stephens 14 Oct. 1980 31 p refs
(Contract W-7405-eng-48)
(UCID-18903) Avail. NTIS HC A03/MF A01

The management of four assessment tasks are discussed The tasks were: current progress in H2S abatement technology; solid wastes from geothermal power production operations, characterization, handling, and disposal; problems associated with the use of agricultural drainage water for geothermal power plant cooling in the Imperial Valley; and liquid dominated, low total dissolved solids geothermal resources; characterization and evaluation of potential problems due to composition. DOE

N81-21641# Department of Energy, Washington, D. C. Office of Fossil Energy.
ENVIRONMENTAL DEVELOPMENT PLAN: COAL LIQUEFACTION
Aug. 1980 78 p
(DOE/EDP-0044) Avail: NTIS HC A05/MF A01

This Environmental Development plan (EDP) examines environmental concerns being evaluated for the technologies in DOE's Coal Liquefaction Program. It identifies the actions that are planned or underway to resolve these concerns while the technologies are developed. Research is scheduled on the evaluation and mitigation of potential environmental impacts The major unresolved environmental concerns associated with the coal liquefaction subactivities and projects are summarized. DOE

N81-21642# Battelle Pacific Northwest Labs., Richland, Wash
ENVIRONMENTAL ASSESSMENT FOR THE SATELLITE POWER SYSTEM CONCEPT DEVELOPMENT AND EVALUATION PROGRAM-ELECTROMAGNETIC
K A Davis, W. B. Grant, E. L. Morrison, and J. R. Juroshek
Jan. 1981 93 p refs Prepared in cooperation with Institute for Telecommunication Sciences
(Contract DE-AC06-76RL-01830)
(DOE/ER-0096) Avail: NTIS HC A05/MF A01

An initial quantitative indication of the scope of potential electromagnetic compatibility (EMC) problems is provided and the importance of EMC considerations in rectenna site selection are indicated The effects of satellite power system (SPS) microwave emissions on important categories of electronic systems and equipment are summarized, with many examples of test results and demonstrated techniques for mitigation of problems encountered The SPS effects on other satellite systems are presented Astronomical research frequently involves measurement of extremely low levels of electromagnetic radiation and is thus very susceptible to interference The concerns of both radio astronomy with microwave emissions from SPS and optical astronomy with sunlight scattered from SPS spacecraft are discussed. Summaries of mitigation techniques, cost estimates, and conclusions are presented DOE

N81-21646# Texas Univ., Austin. Bureau of Economic Geology
ENVIRONMENTAL ANALYSIS OF GEOPRESSURED-GEOTHERMAL PROSPECT AREAS, DEWITT AND COLORADO COUNTIES, TEXAS Final Report, 1 Mar. - 31 Aug. 1979
Thomas C Gustavson, Florette S Reeder, and Elizabeth A. Badger
Feb. 1980 282 p refs
(Contract DE-AS05-79ET-27127)
(DOE/ET-27127/1) Avail: NTIS HC A13/MF A01

Information collected and analyzed for a preliminary environmental analysis of geopressured geothermal prospect areas in Colorado and DeWitt Counties, Texas is presented Specific environmental concerns for each geopressured geothermal prospect area are identified to: (1) conduct an environmental analysis to identify more and less suited areas for geopressured test wells; and (2) provide an environmental data base for development of geopressured geothermal energy resources. A series of maps and tables are included to illustrate environmental characteristics including geology; water resources, soils; current land use; vegetation, wildlife, and meteorological characteristics, and additional relevant information on cultural resources, power and pipelines, and regulatory agencies. DOE

02

SOLAR ENERGY

Includes solar collectors, solar cells, solar heating and cooling systems, and solar generators.

A81-19698 **Diffusion length measurements in CdS and CdSe Schottky barrier junctions.** S. Mora, N. Romeo, and L. Tarricone (Parma, Università, CNR, Gruppo Nazionale di Struttura della Materia, Parma, Italy). *Nuovo Cimento B, Serie 11,* vol 60B, Nov. 11, 1980, p. 97-105. 16 refs.

The minority carrier diffusion length has been measured on CdS and CdSe single crystals by means of the surface photovoltage method. By illuminating the samples through semitransparent metal semiconductor Schottky barriers and for a given photovoltage signal, a linear relation was found between the intensity of light and the absorption length By extrapolating to zero light intensity such a straight line, the diffusion length was obtained as the intercept with the x-axis. For good accuracy, a least-square fit method was employed to calculate the diffusion length values The agreement of measurements performed on some Schottky diodes prepared in different ways and displaying different spectral responses confirmed a near independence of the SPV technique on some material parameters and experimental conditions. (Author)

A81-19766 * **Titanium dioxide antireflection coating for silicon solar cells by spray deposition.** W. Kern and E. Tracy (RCA Laboratories, Princeton, N.J.). *RCA Review,* vol. 41, June 1980, p. 133-180. 66 refs. Research sponsored by the U.S. Department of Energy; Contract No. JPL-954868.

A high-speed production process is described for depositing a single-layer, quarter-wavelength thick antireflection coating of titanium dioxide on metal-patterned single-crystal silicon solar cells for terrestrial applications. Controlled atomization spraying of an organotitanium solution was selected as the most cost-effective method of film deposition using commercial automated equipment. The optimal composition consists of titanium isopropoxide as the titanium source, n-butyl acetate as the diluent solvent, sec-butanol as the leveling agent, and 2-ethyl-1-hexanol to render the material uniformly depositable. Application of the process to the coating of circular, large-diameter solar cells with either screen-printed silver metallization or with vacuum-evaporated Ti/Pd/Ag metallization showed increases of over 40% in the electrical conversion efficiency. Optical characteristics, corrosion resistance, and several other important properties of the spray-deposited film are reported. Experimental evidence indicates a wide tolerance in the coating thickness upon the overall efficiency of the cell. Considerations pertaining to the optimization of AR coatings in general are discussed, and a comprehensive critical survey of the literature is presented. (Author)

A81-19813 **On the possible use of MHD generators in solar energy systems.** H. Branover, I. Borde, A. El-Boher, and A. Leitner (Negev, University, Beersheba, Israel). In: MHD-flows and turbulence. II. Jerusalem, Israel Universities Press, 1980, p. 197-205. 5 refs.

It is shown that electric power can be obtained as a by-product of solar water heating using flat-plate collectors with maximum temperatures of only 80-90 C. An MHD system using solar energy heats liquid metal in the heat exchanger which receives heat from a flat collector, a solar pond, or a concentrator; the thermodynamic cycle consists of an upper basic Rankine cycle and a bottom Rankine cycle with isothermal expansion. The efficiencies of the MHD generator, pumps, heat exchanger, and solar collector are determined, with the total efficiency of 5.6% at 105 C for liquid metal collectors. A.T.

A81-19849 **Optimization of fin and tube parameters in a flat-plate collector.** H. P. Garg, U. Rani, and R. Chandra (Indian Institute of Technology, New Delhi, India). *Energy* (UK), vol. 6, Jan. 1981, p. 83-92. 16 refs.

A theoretical investigation for optimizing collector-cost effectiveness is carried out by considering various tube diameters, materials, tube spacing, fin materials, and thicknesses for black and other paints. The bond conductance is taken into account for various joining techniques. Various tube geometries are considered and the convective heat-transfer coefficients are calculated. The pressure drops are calculated with allowance for the friction factor due to the skin effect. Since the friction factor for bends and fittings is negligibly small in the laminar flow regime, the pressure drop is calculated for skin friction alone. Efficiency and costs are computed to determine an optimal system. (Author)

A81-19951 **New method for maximum power consideration in solar cells with and without resistive losses.** K. K. Govil and K. K. Aggarwal (Regional Engineering College, Kurukshetra, India). *Electronics Letters,* vol. 17, Jan. 8, 1981, p. 5, 6.

A81-20007 **The controlling influence of the Cu2S optical absorption coefficient on the short-circuit currents of Cu2S/CdS solar cells.** A. Rothwarf (Drexel University, Philadelphia, Pa.) and H. Windawi (Delaware, University, Newark, Del.). *IEEE Transactions on Electron Devices,* vol. ED-28, Jan. 1981, p 64-69. 33 refs. Research supported by the Solar Energy Research Institute; Contract No. EG-77-C-01-4042.

A81-20008 **Effect of anodic-oxide layer thickness on the performance of GaAs MOS solar cells.** P. C. Mathur, J. D. Arora (Delhi, University, Delhi, India), and H L. Hartnagel. *IEEE Transactions on Electron Devices,* vol. ED-28, Jan. 1981, p. 69-71. 18 refs.

A81-20010 * **The properties of polycrystalline silicon solar cells with controlled titanium additions.** A. Rohatgi, R. H. Hopkins, and J. R. Davis, Jr. (Westinghouse Research and Development Center, Pittsburgh, Pa.). *IEEE Transactions on Electron Devices,* vol. ED-28, Jan. 1981, p. 103-108. 18 refs. Research sponsored by the Department of Energy and NASA

By coupling the results of electrical measurements, such as spectral response, lighted and dark I-V determinations, and deep-level-transient spectroscopy with optical and laser scan photomicroscopy, the effects of grain boundaries and impurities on silicon solar cells were evaluated. Titanium, which produces two deep levels in silicon, degrades cell performance by reducing bulk lifetime and thus cell short-circuit current. Electrically active grain boundaries induce carrier recombination in the bulk and depletion regions of the solar cell. Experimental data imply a small but measurable segregation of titanium into some grain boundaries of the polycrystalline silicon containing high Ti concentration. However, for the titanium-contaminated polycrystalline material used in this study, solar cell performance is dominated by the electrically active titanium concentration in the grains. Microstructural impacts on the devices are of secondary importance. (Author)

A81-20011 * **Determination of lifetimes and recombination currents in p-n junction solar cells, diodes, and transistors.** A. Neugroschel (Florida, University, Gainesville, Fla.). *IEEE Transactions on Electron Devices,* vol. ED-28, Jan. 1981, p. 108-115. 22 refs. Research supported by the University of Florida; Grant No. NsG-3018.

New methods are presented and illustrated that enable the accurate determination of the diffusion length of minority carriers in the narrow regions of a solar cell or a diode. Other methods now available are inaccurate for the desired case in which the width of the region is less than the diffusion length. Once the diffusion length is determined by the new methods, this result can be combined with measured dark I-V characteristics and with small-signal admittance characteristics to enable determination of the recombination currents in each quasi-neutral region of the cell - for example, in the emitter, low-doped base, and high-doped base regions of the BSF (back-surface-field) cell. This approach leads to values for the effective surface recombination velocity of the high-low junction forming the back-surface field of BSF cells or the high-low emitter junction of HLE cells. These methods are also applicable for measuring the minority-carrier lifetime in thin epitaxial layers grown on substrates with opposite conductivity type (Author)

A81-20295 * Interactions of efficiency and material requirements for terrestrial silicon solar cells. D. L. Bowler and M. Wolf (Pennsylvania, University, Philadelphia, Pa.). *(Institute of Electrical and Electronics Engineers and Electronic Industries Association, Electronic Components Conference, 30th, San Francisco, Calif, May 11-13, 1980.) IEEE Transactions on Components, Hybrids, and Manufacturing Technology*, vol. CHMT-3, Dec. 1980, p. 464-472. 17 refs. Research supported by the U.S. Department of Energy and NASA.

The transport velocity transformation method was used to analyze solar cell designs to determine optimum cell structures. It was found that low resistivity materials should be used up to the onset of Auger recombination; a properly designed three-layer structure permits base region approaching an ideal device in performance, and that higher resistivity front regions will need more sophisticated grid metallization structures than those used now. It was concluded that new features will provide idealized silicon cell structures yielding airmass 1 efficiencies in the 24-26.5% range, with real efficiencies near 22%. A.T.

A81-20490 A review of the application of modern control theory to solar energy systems. P. Dorato (New Mexico, University, Albuquerque, N. Mex.). In: Conference on Decision and Control, and Symposium on Adaptive Processes, 18th, Fort Lauderdale, Fla., December 12-14, 1979, Proceedings. Volume 2. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 907-910. 34 refs.

The application of modern control theory to the problem of solar energy temperature control is discussed. Attention is given to classical temperature control and to some of the basic model components required for solar systems. A number of optimization techniques that have been proposed in the literature for solar systems, including linear-quadratic optimization, optimal on-off control, singular control, periodic optimization, optimal-adaptive control, and stochastic optimization, are discussed. Attention is also given to the role to be played by microprocessors. The need for commonly accepted criteria for evaluating control systems is stressed. C.R.

A81-20492 Solar Energy Management System. R. L. Moen (Honeywell Energy Resources Center, Minneapolis, Minn.). In Conference on Decision and Control, and Symposium on Adaptive Processes, 18th, Fort Lauderdale, Fla, December 12-14, 1979, Proceedings. Volume 2. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 917-919. Research supported by the U S. Department of Energy.

The Solar Energy Management System (SEMS), a general-purpose, flexible system for the residential solar energy market based on microprocessors, is analyzed. The modes resident in the SEMS controller are enumerated, for example, purge excess energy and charge heat storage tank, and the system's ability to assign priority to modes is described. The controller examines analog temperature sensor inputs and thermostat demands first to arrive at preliminary mode requests for each mode. The resulting requests are then processed in order of priority to determine the state of each relay. As each requested mode is processed, conflicting relay states in the mode/relay table may lead the latest mode to be precluded. When all requested modes have been processed, any relays that are not explicitly commanded to be energized or de-energized will be commanded to their default state C.R.

A81-20493 Capacity modulation of solar-fired absorption chillers with single and multi-temperature energizing sources. A. Davis (Rho Sigma, Inc., North Hollywood, Calif.) and A. B. Newton. In: Conference on Decision and Control, and Symposium on Adaptive Processes, 18th, Fort Lauderdale, Fla., December 12-14, 1979, Proceedings. Volume 2. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc, 1979, p. 920, 921.

This paper discusses two approaches to improve performance of solar-energized absorption systems. The first approach improves part-load performance of the absorption chiller by modulating the energizing temperature to track the load and the cooling tower water temperature. The second approach improves the heat collection of the solar array by using solar storage tanks at different temperatures, and selecting the storage tank which is most appropriate to drive the absorption chiller to meet the load. (Author)

A81-20600 * # Solar-pumped gas laser development. J. W. Wilson (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo., Jan. 12-15, 1981, Paper 81-0098.* 15 p 33 refs.

The direct conversion of solar radiation into an inverted population for extraction in an optical cavity holds promise as a relatively simple system design. Broad-band photoabsorption in the visible or near-UV range is required to excite large volumes of gas and to ensure good solar absorption efficiency. The state excited must be a metastable state which is not quenched by the parent gas. The emission bandwidth must be less than approximately 10 A. The system should show chemical reversibility and an insensitivity to increasing temperature. Other properties such as good quantum efficiency and kinetic efficiency are also implied A search of electronic-vibrational transitions in diatomic molecules satisfying these conditions is now in progress A photodissociation-pumped atomic iodine laser is now being tested under solar pumping conditions Photodissociation studies for thallium spin-flip metastable formation will begin in the near future. (Author)

A81-20787 # Temperature stratification in hot water solar thermal storage tanks. S M Koldhekar (ITT General Controls, Glendale, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo, Jan. 12-15, 1981, Paper 81-0368* 10 p. 5 refs. Research supported by the Arizona Solar Energy Research Commission.

The overall efficiency of solar domestic hot water systems using liquid sensible heat storage can be enhanced by temperature stratification in the storage tank. An experimental apparatus was designed to study how the storage tank stratified for three different hot water load schedules (morning peak, evening peak and distributed), three solar-inputs (clear day, cloudy day and intermittent), three flow rates (1.6, 1 0 and 0.5 gpm) and two inlet configurations (vertical pipe and horizontal diffuser). Criteria were developed to evaluate the effect of these variables on temperature stratification in the preheat tank. A hot water load schedule and the ratio of flow rates in the collector-heat exchanger and heat exchanger-storage loops were selected using these criteria Finally a novel hot water load schedule was designed which will provide the greatest degree of temperature stratification. (Author)

A81-20906 Interaction in Si3N4-C and BN-C systems under conditions of radiation heating. A. A. Korol, V S Dverniakov, and G. S. Elicheva (Akademiia Nauk Ukrainskoi SSR, Institut Problem Materialovedeniia, Kiev, Ukrainian SSR) *(Geliotekhnika*, vol. 16, no 2, 1980, p. 11-14.) *Applied Solar Energy*, vol 16, no 2, 1980, p 9-12 7 refs Translation.

The physicochemical, thermophysical, and operating properties of high-temperature materials are changed when the nonmetallic nitrides and carbon they contain interact during exposure to powerful thermal fluxes Specimens of Si3N4-C and BN-C were irradiated by a solar-energy concentrator which provided a radiant flux density of 0.07-1400 W/sq cm in a focal spot 8 mm in diameter Weight loss of the specimens was measured against the magnitude of incident radiant flux, the regenerated layer then subjected to phase and macrostructural analyses. Silicon carbide first appeared in the Si3N4-C at 210 W/sq cm, with a 10% weight loss Sintering occurred at 420 W/sq cm. The critical value for the BN-C system - that is, the point at which B4C was first detected - was 1050 W/sq cm; there was no accompanying loss of weight. Optimum thermal flux for this system was determined to be 1430 W/sq cm. R.S

A81-20907 **Method of calculating shading of heliostats in tower-type solar power plants.** R. R. Aparisi (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *(Geliotekhnika,* vol. 16, no. 2, 1980, p. 22-27.) *Applied Solar Energy,* vol. 16, no. 2, 1980, p. 20-25. Translation.

A81-20908 **Heliostats and concentrators with variable reflecting-surface geometry.** V. K. Baranov. *(Geliotekhnika,* vol. 16, no. 2, 1980, p. 28-33.) *Applied Solar Energy,* vol. 16, no. 2, 1980, p. 26-30. Translation.

A81-20910 **Solar electric propulsion systems - A survey.** V. A. Grilikhes, G. M. Zav'ialova, and L. B. Popov. *(Geliotekhnika,* vol. 16, no. 2, 1980, p. 65-72.) *Applied Solar Energy,* vol. 16, no. 2, 1980, p. 62-68. 10 refs. Translation.

The Solar Electric Propulsion System (SEPS) currently under development in the United States offers several advantages as a third-stage power system for interplanetary and inter-earth-orbit flights. Its electric propulsion motors (EPM), with the relatively large specific impulse of 30,000 m/sec each, consume less propellant than do chemical rocket motors or compressed-gas engines, and constitute, with the solar batteries, 50% of the SEPS dry mass. Outfitted with 8-10 energy converters with attainable efficiency of 92%, SEPS is being considered for missions that range from the transport of payloads to geosynchronous orbit to an interplanetary rendezvous with Halley's Comet. The paper also presents configuration options and subsystem parameters. R.S.

A81-20973 **Coatings with induced transmission.** P. H. Lissberger (Belfast, Queen's University, Belfast, Northern Ireland). *Applied Optics,* vol. 20, Jan. 1, 1981, p. 95-104. 14 refs.

A brief review is given of how fundamental concepts of thin film optics (potential transmittance, the two-effective-interfaces theorem, the principle of equivalent layers, matching conditions and absentee layers) are used to design optical coatings with controlled absorptance. The general principles are illustrated by a discussion of interference filters containing both dielectric and metallic layers, including the design and preparation of induced transmission filters. Reference is also made to coatings for optimizing the photon efficiencies of photodetectors. Further insight into how coatings with absorbing layers function is provided by consideration of the electric field distribution of radiation within the coatings. (Author)

A81-21029 **Optimal and suboptimal control policies for a solar collector system.** C. Rorres, R. Fischl (Drexel University, Philadelphia, Pa.), and A. Orbach (J. Deere and Co., Waterloo, Iowa). *IEEE Transactions on Automatic Control,* vol. AC-25, Dec. 1980, p. 1085-1091. 8 refs. Contract No. E-8-77-5-02-4512.

An optimal control policy to maximize the net energy gathered by a flat-plate solar collector by controlling the fluid flow rate is formulated in terms of a distributed parameter system solved by the method of characteristics. The optimal control policy instantly switches between the zero and maximum rates if the pump of the collector loop has power which is greater than the linear function of the fluid velocity. The switching function can be decomposed into a portion which depends on the state of the system and a suboptimal policy which can be implemented by an on/off feedback controller. The two policies are identical on a clear day with sufficient solar insulation; under other weather conditions, the suboptimal controller will keep the pump off for a slightly shorter time period. A.T.

A81-21030 **Design of self-calibrating controllers for heliostats in a solar power plant.** R. S. Baheti and P. F. Scott (General Electric Co., Schenectady, N.Y.). *IEEE Transactions on Automatic Control,* vol. AC-25, Dec. 1980, p. 1091-1097.

A self-calibrating controller is developed for reducing installation and drive errors in a heliostat (steerable mirror used in solar/electric energy conversion). In this scheme, the heliostat periodically tracks the sun, which serves as a precision position reference. The difference between commanded and actual drive angles is used to estimate the coefficients of a model representing installation and drive errors. The calibrated model is then used to correct the drive actuator commands for these error sources when the heliostat is in a tracking mode (its principle mode of operation). Simulation results are given for a typical heliostat configuration with realistic errors. The algorithm is very effective in reducing beam steering errors. The concept is demonstrated using a prototype test apparatus and is shown to achieve an error reduction of more than 5.1. (Author)

A81-21113 # **Analysis and design of hybrid double-absorption cooling systems for low grade thermal energy applications.** C. S P Peng and J. R. Howell (Texas, University, Austin, Tex.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/HT-44.* 10 p. 16 refs. Members, $2.00; nonmembers, $4.00.

A hybrid double-absorption system using LiCl-H2O solution as a working fluid is proposed in this paper. This system can operate at low source temperature (55 C-80 C), requires lower blower power than a desiccant system, and has a higher system C.O.P. A modification of this system, a double absorption-evaporation system that provides even higher C.O.P. is also proposed. Both closed and open regeneration of the working fluid are considered in the system design. Performance equations for these hybrid systems are presented. A computer code HYBRID is written to do parametric analysis for these systems under steady state conditions. The operating range and optimum design conditions are determined through both theoretical analysis and computer simulation. It is shown that these hybrid absorption systems have definite advantages over conventional absorption and desiccant systems for low grade thermal energy applications. (Author)

A81-21129 # **Performance of solar collectors - An evaluation of standard ratings.** D. Jones, L. Shaw, and G O G. Lof (Solaron Corp., Englewood, Colo.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/Sol-1* 7 p. 7 refs. Members, $2.00, nonmembers, $4 00.

This paper is a critique of the Solar Energy Industry Association (SEIA) Collector Rating Method and Directory. Yearly average collector output values calculated using the FCHART method for a domestic water heating system with two collectors rated by SEIA are compared to calculated values for a domestic water heating application using SEIA certified data and recommended procedures. Results indicate that both collector energy output and relative output vary substantially from FCHART predictions and vary with location and system size. It is concluded that use of the SEIA rating method in its present form is a very poor method of selecting a solar collector, suggestions for improving the rating method are included (Author)

A81-21130 # **Temperature variation in the absorber plate of an air heating flat plate solar collector.** L A. Diaz and N. V. Suryanarayana (Michigan Technological University, Houghton, Mich) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-2.* 7 p. 11 refs. Members, $2 00, nonmembers, $4 00. Research supported by the Michigan Technological University.

A flat plate solar collector is modelled as a rectangular channel of high width to gap ratio with air entering the collector with a fully developed turbulent velocity profile. One plate of the collector is subjected to a uniform heat flux with the other plate heavily insulated. Experimental values of friction factor and heated plate temperature in the thermal entrance region are presented and compared with analytical predictions. It is shown that there will be significant plate temperature variation in the thermal entrance region particularly at low flow rates. It is also shown that neglecting conduction effects in the absorber plate will not lead to any significant errors in estimating absorber plate temperature variation.

Tabulated values of dimensionless plate temperature for different values of the dimensionless distance from the leading edge for several Reynolds number are presented. (Author)

A81-21131 # **Analytical predictions of liquid and air photovoltaic/thermal flat-plate collector performance.** P. Raghuraman and S D. Hendrie (MIT, Lexington, Mass.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov. 16-21, 1980, Paper 80-WA/Sol-3.* 8 p 12 refs. Members, $2.00, nonmembers, $4 00. Research sponsored by the U.S Department of Energy

Two separate one-dimensional analyses have been developed for the prediction of the thermal and electrical performance of both liquid and air flat-plate photovoltaic/thermal (PV/T) collectors. The analyses account for the temperature difference between the primary insolation absorber (the photovoltaic cells) and the secondary absorber (a thermal absorber flat plate). The results of the analyses are compared with test measurements, and therefrom design recommendations are made to maximize the total energy extracted from the collectors. (Author)

A81-21132 # **Modeling and analysis of an all-fiberglass flat plate solar collector.** L. D Russell (Mississippi State University, Mississippi State, Miss) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov. 16-21, 1980, Paper 80-WA/Sol-4* 5 p 5 refs Members, $2 00, nonmembers, $4.00.

The concept of an all-fiberglass liquid flat plate solar collector was studied. Such a collector eliminates the need for coatings, metals, and all other materials except fiberglass The concept appears to offer possibilities for the mass production of a low-cost lightweight solar collector which is reasonably efficient. Mathematical models were developed for study of this concept Convection and nonlinear radiation between the covers was computed in all of the models In addition, absorptance and conduction in the cover(s) and the fluid cover plate were studied in order to determine their effects on the panel performance. A model panel was fabricated, and computer results were compared with test data for the efficiency of the panel. (Author)

A81-21133 # **Design and evaluation of a computer controlled solar collector simulator.** J F Kotas and B. D. Wood (Arizona State University, Tempe, Ariz.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-6* 7 p. 13 refs Members, $2.00, nonmembers, $4 00. Contract No DE-AC03-79CS-30203

A computer-controlled system has been developed to simulate the thermal processes of a flat-plate solar collector. The simulator is based on four water heaters of capacities of 1.5, 2.5, 5.0 and 5 0 kW providing a maximum design output of 14 0 kW which are controlled by a Nova 3 minicomputer, which also monitors temperatures in the fluid stream. Measurements have been obtained of the steady-state operating values and time constants of the individual heaters at different flow rates in order to utilize effectively their thermal outputs. Software was designed to control the heater system so the total thermal output closely approximates that of an actual heater array, utilizing steady-state or dynamic control modes. Simulation of the heat output of a previously tested collector has resulted in simulated values differing from actual output by a maximum of 3% under identical operating conditions, thus indicating that the simulator represents a viable alternative to the testing of a large field of collectors. A.L.W.

A81-21134 # **Radiation and free convection shield for passive thermal control.** J K E Ortega (Solar Energy Research Institute, Golden, Colo). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov. 16-21, 1980, Paper 80-WA/Sol-7.* 6 p. 5 refs. Members, $2.00; nonmembers, $4.00.

A radiation and free convection shield (RFS), when used with a thermal storage wall, can enhance the thermal performance of the storage wall and provide passive thermal control. In order to optimize the performance of the RFS, it is desirable to know how the impedance provided by the use of an RFS varies with the thermophysical properties of materials used to construct it A numerical nodal thermal model was constructed to evaluate the impedance as a function of the thermophysical properties of the RFS Two RFS thermophysical properties are identified as the most important in controlling the impedance from the storage wall to the room thermal conductivity and total surface emissivity. A decrease in the RFS surface-to-surface thermal conductance, a decrease in the RFS total surface emissivity, or both, substantially increases the impedance from the storage wall to the room. (Author)

A81-21135 # **Design procedure and application of solar-assisted series heat pump systems.** C. D Svard, J. W. Mitchell, and W. A. Beckman (Wisconsin, University, Madison, Wis.) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov 16-21, 1980, Paper 80-WA/Sol-9.* 10 p. 9 refs Members, $2.00, nonmembers, $4.00 Research supported by the U S. Department of Energy.

A general design procedure is presented for solar assisted series heat pump systems for space heating and process water heating. The procedure accounts for the variable efficiency and rate of energy delivery by the heat pump The performance results from this design procedure are compared against detailed computer simulations on a monthly and seasonal basis For low temperature space heating applications, the maximum difference between the design procedure and computer simulations is 3% on a seasonal basis while for high temperature process water heating systems, the maximum differences are 3-6%. This design procedure is then used to investigate high temperature series heat pump systems for providing hot water for industrial processes Recommendations are given for high temperature series heat pump system design. (Author)

A81-21136 # **Thermal and economic assessment of ground-coupled storage for residential solar heat pump systems.** M K Choi and J. H. Morehouse (Science Applications, Inc, McLean, Va.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/Sol-10* 10 p. 9 refs. Members, $2.00, nonmembers, $4.00 Research supported by the U.S. Department of Energy.

This study performed an analysis of ground-coupled stand-alone and series configured solar-assisted liquid-to-air heat pump systems for residences The year-round thermal performance of these systems for space heating, space cooling, and water heating were determined by simulation and compared against non-ground-coupled solar heat pump systems as well as conventional heating and cooling systems in three geographic locations· Washington, D.C., Fort Worth, Tex., and Madison, Wis. The results indicate that without tax credits a combined solar/ground-coupled heat pump system for space heating and cooling is not cost competitive with conventional systems. Its thermal performance is considerably better than non-ground-coupled solar heat pumps in Forth Worth. Though the ground-coupled stand-alone heat pump provides 51% of the heating and cooling load with non-purchased energy in Forth Worth, its thermal performance in Washington and Madison is poor. (Author)

A81-21137 # **Economic analysis and optimization of solar residential space heating.** C. L. Buck, R. I Vachon (Minnesota, University, Minneapolis, Minn.), and J. S. Goodling (Auburn University, Auburn, Ala.) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov 16-21, 1980, Paper 80-WA/Sol-11.* 9 p 18 refs Members, $2.00, nonmembers, $4.00

Current economic analyses for residential solar heating and hot water systems have numerous problems and are cumbersome for users as decision making aids. By development of the concept of a utilization factor and a correlation for it, the economic analyses can be expressed in dimensionless forms. These dimensionless expressions are more easily used and make the economic analyses independent of the system design, system size, the relative contribution of the solar energy system, and the geographic location of the system. This study should facilitate the use of such economic information in the decision making process. (Author)

A81-21139 # **Dynamic modeling and experimental simulation of active solar energy systems for the evaluation of control strategies.** S. R Schiller, M. L. Warren, and M. Wahlig (California, University, Berkeley, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-14* 8 p 15 refs. Members, $2 00, nonmembers, $4.00. Contract No. W-7405-eng-48

Dynamic modeling and experimental simulation are used to evaluate control strategies for active solar energy systems Performance of proportional and on/off collector loop controllers are evaluated and compared using a theoretical dynamic collector model. Use of the experimental test facility at Lawrence Berkeley Laboratory for evaluating the effect of controls and control strategies on hydronic space heating system performance is also discussed Both the computer model and the test facility allow evaluation of control strategies using various flow rates, controller set points, insolation patterns, ambient temperature conditions, and collector types. The test facility also allows comparison of collector and load loop flow strategies based on various system configurations and building load demands. (Author)

A81-21140 # **Frequency response analysis of fluid control systems for parabolic-trough solar collectors.** R Schindwolf (Sandia Laboratories, Albuquerque, N Mex.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-15.* 8 p. 6 refs. Members, $2.00, nonmembers, $4.00.

Previous studies of solar-collector fluid-control systems have used computer simulations of collector and piping dynamics to evaluate stability and response characteristics To obtain reasonable simulation accuracy requires substantial computer memory and time, and is well beyond the capability of small desk-top computers. This paper derives a linearized steady-state frequency response for parabolic-trough collectors and for connecting piping that can be used in standard gain-phase analyses to evaluate system stability and closed-loop frequency response. The frequency-response characteristics of a typical collector string and piping are used in a gain-phase analysis to get some insight into the effect on system stability of various system parameters such as controller gain, sensor and controller-time constants, and sensor location (Author)

A81-21144 * # **High temperature solar thermal technology.** L P Leibowitz, E. J. Hanseth, and M. L. Peelgren (California Institute of Technology, Jet Propulsion Laboratory, Solar Thermal Technology Group, Pasadena, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov 16-21, 1980, Paper 80-WA/Sol-20* 8 p 6 refs Members, $2 00, nonmembers, $4.00. Research sponsored by the U.S. Department of Energy and NASA

Some advanced technology concepts under development for high-temperature solar thermal energy systems to achieve significant energy cost reductions and performance gains and thus promote the application of solar thermal power technology are presented. Consideration is given to the objectives, current efforts and recent test and analysis results in the development of high-temperature (950-1650 C) ceramic receivers, thermal storage module checker stoves, and the use of reversible chemical reactions to transport collected solar energy. It is pointed out that the analysis and testing of such components will accelerate the commercial deployment of solar energy A L.W.

A81-21145 * # **Thermal storage requirements for parabolic dish solar power plants.** L. Wen and H. Steele (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-21* 10 p 12 refs. Members, $2 00, nonmembers, $4 00. Research sponsored by the U.S. Department of Energy and NASA.

The cost effectiveness of a high temperature thermal storage system is investigated for a representative parabolic dish solar power plant The plant supplies electrical power in accordance with a specific, seasonally varying demand profile. The solar power received by the plant is supplemented by power from fuel combustion The cost of electricity generated by the solar power plant is calculated, using the cost of mass-producible subsystems (specifically, parabolic dishes, receivers, and power conversion units) now being designed for this type of solar plant The trade-off between fuel and thermal storage is derived in terms of storage effectiveness, the cost of storage devices, and the cost of fuel Thermal storage requirements, such as storage capacity, storage effectiveness, and storage cost are established based on the cost of fuel and the overall objective of minimizing the cost of the electricity produced by the system. As the cost of fuel increases at a rate faster than general inflation, thermal storage systems in the $40 to $70/kWthr range could become cost effective in the near future. (Author)

A81-21148 # **The Solar-Meteorological Research Program for the South-Central U.S.** J E. Rudzki, G. Clark (Trinity University, San Antonio, Tex.), F Loxsom, and L. Micek. *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-24.* 12 p 11 refs. Members, $2 00; nonmembers, $4 00. Research supported by the U.S. Department of Energy.

In assessing a six-state region comprising Texas, Oklahoma, Arkansas, Kansas, Louisiana, and Missouri, the Solar-Meteorological Research Program for the South-Central U.S. hopes to assemble a data base that will predict the performance of various solar systems and enable the development of design tools for both active and passive systems. Data sources include the long-term record accumulated at the National Climatic Center of the National Weather Service as well as new airborne and ground-based measurements of meteorological and radiation parameters of the region. Administered by the Solar Data Center at Trinity University in San Antonio, Texas, the program conducts workshops on insolation measurements and modelling. R.S.

A81-21150 # **Diffuse sky measurements and determination of corrected shadow band multiplication factors.** A. Mujahid and W D. Turner (Arkansas, University, Fayetteville, Ark). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-26* 7 p. 15 refs. Members, $2.00; nonmembers, $4.00. Contract No. EG-77-05-5565

A meteorological monitoring station has been in operation at Blytheville, Arkansas, from April 1978 to April 1980 Direct normal, global, and diffuse sky radiation have been monitored From these data, models have been developed for the prediction of solar radiation, and discussions of several diffuse solar radiation models are included herein Comparisons are made with these current diffuse models, and the correlation is quite good In addition, instantaneous shadow band correction factors are presented which will allow a more accurate correction to be applied to the measured diffuse sky reading. The instantaneous correction factors are keyed to the global radiation measurement. Therefore, instead of applying a fixed correction factor to the diffuse measurement, regardless of sky condition, a variable factor can be applied This will solve some of the current errors observed in diffuse measurements, because the current factors overpredict the diffuse radiation on cloudy days and underpredict the diffuse on clear days (Author)

A81-21152 # **Comparison of several models for long term monthly average daily insolation on horizontal surfaces and the estimation of horizontal surface insolation for 16 U. S. locations.** T K. Goswami (Continental Oil Co., Ponca City, Okla) and D. E Klett (North Carolina Agricultural and Technical State University, Greensboro, N C.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/Sol-28* 9 p 15 refs. Members, $2 00, nonmembers, $4 00.

Six models for estimating monthly average daily total insolation were compared with rehabilitated measured data for seven U.S. locations The models compared are those of Bennett, Barbaro, et al., Sabbagh, et al , Reddy, Danashyar, and Swartman and Ogunlade. As a result of the comparison, the Barbaro model was chosen to estimate the insolation for U.S locations for which the required climatological input data exists but for which no insolation data is available The model was modified by a constant multiplier and used to generate average daily insolation values for the 16 locations The results are tabulated for use by solar system designers (Author)

A81-21153 # **Analysis of two-phase flow solar collectors with application to heat pumps.** K Chaturvedi, Y. F Chiang, and A. S. Roberts, Jr (Old Dominion University, Norfolk, Va) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-32* 12 p. 14 refs Members, $2.00, nonmembers, $4.00

A thermodynamic model is developed to analyze the thermal performance of two phase solar collectors. The well-known equilibrium homogeneous theory is used to model the two phase flow in the solar collectors The resultant set of coupled ordinary differential equations for saturated pressure and quality of working fluids in the collector tubes are solved by an iterative procedure using a fourth order Runge-Kutta method. The results are then applied to determine the thermal performance of a solar assisted heat pump which uses two phase flow collectors as the evaporator The results indicate that even with the use of less expensive bare solar collectors as evaporator for the heat pump, the heating coefficient of performance (COPH) as high as 6, can be obtained under realistic ambient conditions provided a proper matching exists between the collector's evaporative capacity and the compressor's pumping capacity (Author)

A81-21155 # **Nocturnal radiation from a solar collector.** H. F. Wang and C. W. Chiang (South Dakota School of Mines and Technology, Rapid City, S. Dak). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-35.* 6 p. 10 refs. Members, $2.00, nonmembers, $4.00.

As the sky temperature during the night is relatively low compared to the ambient temperature, the temperature of the absorber plate in a solar collector can be lower than the ambient temperature due to nocturnal radiation. Measurements have been made for Lennox Solar Collectors installed in a solar heating and cooling project, a same collector in Rapid City and a simple home-made collector in the laboratory. The home-made collector consists of a brass-copper plate sprayed with flat-black paint, covered with glass sheets and boxed with two inch thick styrofoam insulation. A cooling as much as 10 C in winter has been observed. It is expected to be appreciably more in summer This suggests a potential utilization of nocturnal radiation for air conditioning. Theoretical analysis is presented. (Author)

A81-21156 # **Comparison of liquid solar thermal storage subsystems in the national solar data network.** M. J. Kennedy, S. J. Sersen, and S. M. Rossi (Automation Industries, Inc., Vitro Laboratories, Silver Spring, Md.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/Sol-36.* 11 p 16 refs Members, $2.00, nonmembers, $4.00.

A performance comparison is presented of liquid solar thermal storage subsystems whose design is determined by architectural and retrofit constraints. Several models proposed for simulating water solar thermal storage are based on assumptions regarding mixing, inlet pipe Reynolds numbers, and stratification and load profiles. Analysis by the National Solar Data Network found that well mixed tanks will be common during and at the end of a charge cycle despite initial stratified temperature profiles, the inlet Reynolds number from the collector heat exchanger has a significant effect in vertical inlet storage tanks; and solar assisted pumps have large demand flow rates which will keep storage tanks well mixed during demand intervals. A.T.

A81-21157 # **Design of solar cells for use in photovoltaic/thermal collectors.** C H. Cox, III (MIT, Lexington, Mass.). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-37* 7 p. 7 refs. Members, $2 00, nonmembers, $4 00 Research sponsored by the U S Department of Energy

A promising design development for combined photovoltaic/thermal (PV/T) collectors is one in which the photovoltaic (PV) cell is both the conversion device for electrical energy and the absorber of thermal energy To accomplish this, the PV cell design is modified to utilize the approximately 25% of the AM 1 spectrum at 1 1 microns which is currently rejected by the cell The parameters investigated are cell back metallization, back surface field, texture etching, and AR coating A model indicating the increase in absorptance as a function of these parameters is presented, together with the results of experimental measurements A PV/T collector design which incorporates the improved cells, has 10% greater thermal output than current PV/T collectors, and exhibits no degradation in electrical output is discussed (Author)

A81-21158 # **Parametric analysis of louvered air-heating solar collectors.** D M. Christopher and J T Pearson (Purdue University, West Lafayette, Ind). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/Sol-38* 13 p. 13 refs Members, $2.00, nonmembers, $4 00. Contract No EM-78-C-04-5366

A family of air-heating collectors having inclined louvered absorber surfaces has been studied using an analysis which accounts for conduction, forced convection, and thermal radiation exchange A two-band radiation exchange model describes the surface and material properties for the solar and thermal radiation bands After calculating the steady-state temperature distribution, the pressure drop across the collector is determined by a model accounting for viscous, thermal, and gravitational effects A parametric study is performed to determine the effects of collector and louver geometry, solar angle, and operational parameters. The results are presented graphically for normal ranges of the parameters influencing the collector performance. When combined with manufacturing, installation, and energy cost information, these results can aid in the design of louvered solar collectors according to regional, environmental, and economic situations (Author)

A81-21159 # **Operational characterization of the solar-thermal power system near Willard, New Mexico.** G. A Krivokapich, D. L. Fenton, G. H. Abernathy (New Mexico State University, Las Cruces, N Mex.), and J. V. Otts (Sandia Laboratories, Albuquerque, N. Mex). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-39.* 7 p 6 refs. Members, $2.00; nonmembers, $4 00. Research supported by the U.S. Department of Energy.

The output capacity of the solar-thermal power system located near Willard, N Mex., is 19 kW (25 hp) where the primary application is irrigation pumping. Solar radiation is collected with east/west tracking parabolic trough collectors with a total aperture area of 1275 sq m. Thermal storage is adequate for 20 hr of power system operation utilizing a reaction-type turbine in conjunction with an organic Rankine cycle engine. Operating efficiencies for the turbine component, organic Rankine cycle engine, and the complete power system are 65-80, 10-16, and 4-6%, respectively. Examples of component operation under transient environmental conditions are presented for the winter season. Maintenance experience with the Willard system is also given. (Author)

A81-21160 # **The parallel heat pump and photovoltaic heating and cooling - Phase II.** G. Darkazalli (Texas, University, Arlington, Tex.) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov 16-21, 1980, Paper 80-WA/Sol-40.* 5 p. Members, $2 00, nonmembers, $4.00.

Results are presented from Phase II experimental evaluation of the Photovoltaic/Thermal Solar experiment. The facility consists of a 145 sq m single family residence with a passive design, an 8-kW peak flat-plate photovoltaic array, and a 55 sq m flat-plate thermal collector array. The heating and cooling system utilizes a 'parallel' air-to-air heat pump. The thermal system operation includes direct solar heating, heat pump heating, direct heat pump cooling, and off-peak heat pump cooling of a low temperature thermal storage. The photovoltaic electricity generated is used directly by the residence. Excess photovoltaic energy is either thermally stored or fed back to the electric company lines. (Author)

A81-21161 # **Heat transfer and the future of solar energy utilization.** F. Kreith (Solar Energy Research Institute, Golden, Colo). *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov. 16-21, 1980, Paper 80-WA/Sol-41.* 10 p. 14 refs Members, $2.00; nonmembers, $4.00.

Research tasks in the field of heat transfer to accelerate the development of large scale commercial solar energy conversion systems are examined Projects are investigated in relation to basic research, applied research, and exploratory development, and evaluated according to a system of priorities by Jadyadev and Roessner (1980). An active solar heating and cooling program to provide domestic hot water, heating, and cooling to buildings is discussed along with passive solar heating and cooling systems to make full use of natural terrain and available sunshine in architectural designs Biomass and alcohol systems, and methods to extract energy from the ocean are also examined R.C.

A81-21584 **Convection in side-by-side open and closed vertical rectangular channels in thermal interaction with the ambient medium (Convection dans des canaux rectangulaires verticaux ouvert et fermé juxtaposés en interaction thermique avec le milieu ambiant).** H. Mouton, J. C Couanon, and M Roiland (Nantes, Université, Nantes, France). *Letters in Heat and Mass Transfer,* vol. 7, Nov -Dec. 1980, p. 447-456 12 refs. In French Research supported by the Ministère de l'Environnement et du Cadre de Vie.

Convection in contiguous open and closed vertical channels with slightly insulating walls is considered for application to solar energy collection with three glass covers. A method for wall temperatures distributions and convective efficiency prediction is developed. (Author)

A81-21674 # **Electrochemical semiconductor solar energy converters (Poluprovodnikovye elektrokhimicheskie preobrazovateli solnechnoi energii).** A. T Vas'ko, P P. Pogoretskii, and S K. Kovach (Akademiia Nauk Ukrainskoi SSR, Institut Obshchei i Neorganicheskoi Khimii, Kiev, Ukrainian SSR) In Electrode processes in aqueous solutions (Elektrodnye protsessy v vodnykh rastvorakh). Kiev, Izdatel'stvo Naukova Dumka, 1979, p 20-44. 30 refs. In Russian.

The present paper deals with the design and properties of solar energy converters employing photoelectrolysis and converters employing electrochemical photolysis of water at a semiconductor electrode. The conversion efficiency is calculated, and the photoelectrochemical behavior of coated and uncoated semiconductor electrodes is examined The stability aspects of such electrodes are discussed. V.P

A81-21939 **Transparent heat mirrors - Influence of the materials on the optical characteristics.** J. A. Pracchia and J. M. Simon (Buenos Aires, Universidad, Buenos Aires, Argentina). *Applied Optics,* vol. 20, Jan. 15, 1981, p. 251-258. 10 refs Research supported by the Comisión Nacional de Investigaciones Espaciales

Transparent heat mirrors of the antireflecting metal type with a dielectric/metal/dielectric structure are studied. It is found that dielectrics of lower refractive index give a higher cutoff wavelength, but the transition becomes more gradual The angular behavior of these mirrors is also analyzed. The optimum mechanical efficiency obtainable with a plain collector and a Carnot engine is given for different concentrations and refractive indices Moreover it appears that using Al instead of Ag introduces appreciable absorption losses (approximately 25-35 percent). (Author)

A81-21954 # **Development of a high efficiency 2 arcsec silicon solar cell for concentrator systems.** M. Conti and A. Modelli (SGS-ATES Componenti Elettronici S.p.A., Milan, Italy). *Alta Frequenza,* vol. 49, Nov.-Dec. 1980, p 419-423. 6 refs. Research supported by the Consiglio Nazionale delle Ricerche, European Economic Communities Contract No. 456-78-1.

The design, fabrication and performance of a high efficiency 2-arcsec silicon solar cell are described. This cell is based on the n(+)p structure which was optimized to deliver the maximum power under concentrated sunlight, typically 20-50 X The cell is soldered on a metal base which provides a quick and reliable mounting and interconnection Its reliability, as ascertained by a test program which includes a humidity test, salt spray and thermal fatigue, allows the prediction of a satisfactory life performance for a long period of time. (Author)

A81-21956 **A comparison of thermal performance of austenitic stainless steel solar absorber plates coloured by chemical and thermal oxidation techniques.** V. C. Sharma (Benin, University, Benin City, Nigeria). *Energy,* (UK), vol. 6, Feb. 1981, p 133-138. 13 refs.

A81-21957 **Performance study of air-heated packed-bed solar-energy collectors.** C. B. Mishra and S. P. Sharma (Birla Institute of Technology, Mesra, India). *Energy,* (UK), vol. 6, Feb. 1981, p. 153-157. 6 refs.

A performance study of three packed-bed solar collectors for air-heating is presented. Iron chips, aluminum chips, and pebbles have been used as packing materials. It is observed that the performance of plane collectors improves appreciably by packing with blackened metallic materials Moreover, the packed-bed collector also works nicely as a thermal storage system. Iron-chips packed-bed collectors show the best performance (Author)

A81-21958 **Frameworks for modeling learning on the supply side of solar technology market penetration studies.** J H. Herbert. *Energy* (UK), vol. 6, Feb 1981, p. 159-166 14 refs

We have previously suggested that the concept of learning is critical for determining the expected future market penetrations of solar technologies This article presents economic frameworks suitable for analytic examinations of learning Learning is considered within the context of economic production and supply functions for solar technology firms. Such functions are important for economic analysis of such issues as the expected future price of solar technology products and the expected future demand for capital and labor inputs by solar technology firms (Author)

A81-22148 **Surface charge and specific ion adsorption effects in photoelectrochemical devices.** P. Singh, R. Singh, R Gate, K. Rajeshwar, and J. DuBow (Colorado State University, Fort Collins, Colo.). *Journal of Applied Physics,* vol. 51, Dec. 1980, p 6286-6291. 29 refs Contract No XP-9-8002-9

The importance of specific ion adsorption and surface charge effects in the design and operation of PEC devices is demonstrated by experimental data on the n-GaAs/electrolyte and n-Si/electrolyte interface A direct correlation between the extent of specific adsorption of Cl(-) ions and photovoltaic output parameters is established for the n-GaAs/AlC3-BPC, ferrocene/ferricenium ion couple/C PEC cell. Anomalous PEC behavior is observed at the n-Si/AlC13-BPC interface brought about by modification of the electrode/electrolyte interface either by specific adsorption of Cl(-) ions or by electrodeposition of a thin layer of aluminum on the n-Si electrode surface. Model calculations show that considerable voltage drops may occur across the interphasial region in the case of high surface-state densities (greater than 10 to the 12th per sq cm) and for thick Helmholtz layers (5-10 A). B.J.

A81-22155 **The operation of the semiconductor-insulator-semiconductor solar cell - Barrier height lowering through interface states.**- M. Spitzer (Spire Corp., Bedford, Mass.), J. Shewchun (Syracuse University, Syracuse, N.Y.), and D Burk (Florida, University, Gainesville, Fla.) *Journal of Applied Physics,* vol 51, Dec 1980, p. 6399-6404. 17 refs. Contract No E(04-3)-1203.

Previous studies have shown that the characteristics of the semiconductor-insulator-semiconductor (SIS) solar cell can be controlled by the thin interfacial layer. In this paper, the results of a theoretical investigation of the role of interface states at the SiO2-Si interface in the ITO-SiO2-Si SIS solar cell are presented A numerical solution of the governing transport equations yields the dependence of efficiency, short-circuit current, and open-circuit voltage on interface state density. It is shown theoretically that occupied acceptorlike interface states lower the barrier height and thus raise the dark saturation current while lowering the open-circuit voltage. Experimental results are presented which relate the saturation current to the process step which forms the interfacial layer and which support the model. (Author)

A81-22197 **Two-dimensional analysis of the interdigited back-contact solar cell.** D. J. Chin and D H. Navon (Massachusetts, University, Amherst, Mass). *Solid-State Electronics,* vol 24, Feb. 1981, p. 109-114. 17 refs

The behavior of the interdigited back-contact solar cell (IBC) under high illuminating levels has been analyzed by two-dimensional numerical techniques. The effects of cell geometry and surface recombination on efficiency are examined. The IBC cell with a doping gradient at the front surface is also considered. V L.

A81-22198 * **Effect of short wavelength illumination on the characteristic bulk diffusion length in ribbon silicon solar cells.** C. T Ho and J D Mathias (Mobil Tyco Solar Energy Corp., Waltham, Mass.). *Solid-State Electronics,* vol. 24, Feb 1981, p. 115-120. 10 refs Research supported by the U S. Department of Energy, Contracts No. NAS7-100, No. JPL-954355.

The influence of short wavelength light on the characteristic bulk minority carrier diffusion length of the ribbon silicon photovoltaic cell has been investigated. We have measured the intensity and wavelength dependence of the diffusion length in an EFG ribbon cell, and compared it with a standard Czochralski grown silicon cell While the various short wavelength illuminations have shown no influence on the diffusion length in the CZ cell, the diffusion lengths in the ribbon cell exhibit a strong dependence on the volume generation rate as well as on the wavelength of the superimposed lights. We have concluded that the trap-filling phenomenon at various depths in the bulk neutral region of the cell is consistent with the experimental observation (Author)

A81-22200 **Theory of photo induced open circuit voltage decay in a solar cell.** S. C. Jain (Solid State Physics Laboratory, Delhi, India). *Solid-State Electronics,* vol. 24, Feb. 1981, p. 179-183. 13 refs.

A81-22212 **FREHEAT - A passive solar system simulation program.** J. C Chapman, P. J. Burns, and C B Winn (Colorado State University, Fort Collins, Colo.). In Winter Simulation Conference, San Diego, Calif, December 3-5, 1979, Proceedings Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc , 1979, p. 107-115 10 refs.

FREHEAT is a finite-difference nodal computer simulation developed to handle various passive solar components and systems Mass wall and direct gain systems can be analyzed Various overhang geometries, thermocirculation heat transfer, variable thermal mass, secondary lumped thermal mass, heat pipes, selective surfaces, night insulation, and thermosyphon systems are options available in the two versions of FREHEAT. Various auxiliary heating, venting, and cooling options are available with low and high thermostat set temperatures. B J

A81-22349 **Solar energy conversion by chloroplast photoelectrochemical cells.** R. Bhardwaj, R. L. Pan, and E. L Gross (Ohio State University, Columbus, Ohio). *Nature,* vol. 289, Jan. 29, 1981, p. 396-398. 17 refs. Contract No. DE-FG02-79ER-10538.

A photoelectrochemical cell based on chloroplasts which generates large photovoltages and photocurrents from solar energy is presented. The cell contains broken Type C chloroplasts placed on a filter separating compartments containing an electron acceptor and electron donor with platinum electrodes in each. Photovoltages were observed across a load resistance of 3000 ohms with either flavin mononucleotide or anthroquinone 2-sulphonate as the electron acceptor and dichlorophenol indophenol as the donor, and persisted for 1-2 hr after the light was turned off. The powers and short circuit currents obtained in the chloroplast cells are nearly equal to those obtained in cells based on isolated photosystem I particles. Finally, an efficiency of 2.3% has been measured for the chloroplast contribution to the total power in flavin mononucleotide cells. A L.W.

A81-22695 **Analysis by real-time holographic interferometry of heat transfer at the surface of cold solar collectors.** J Guerry, J P. Hot, and C Durou (Toulouse III, Université, Toulouse, France). In: European Congress on Optics Applied to Metrology (METROP), 2nd, Strasbourg, France, November 26-30, 1979, Proceedings Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1980, p 178-185 8 refs. Research supported by the Ministère de l'Environnement et du Cadre de Vie

The rate of convective heat transfer at the surface of a solar collector is measured by means of a real-time holographic interferometry system as part of a study of the suitability of cold solar collectors Holograms were recorded in rapid sequence on photographic plates and continuously on magnetic by the use of a video system for both surfaces of a flat rectangular collector which was heated and cooled to temperatures 20 C above and 10 C below ambient and tilted at various angles of inclination A zone of laminar flow with a heat transfer coefficient decreasing from 5 to 3.5 W/K per min with distance from the edge of the vertical plate is found, followed by a transition into a turbulent regime in which the heat transfer coefficients remain nearly constant at 3 W/K per min As the plate is tilted, the heat transfer coefficient on the upper face is observed to exceed that of the lower face, accompanied by greater turbulence on the upper face Results thus indicate that a 1-sq m collector inclined at 45 deg and maintained at 2 C in a still 12-C atmosphere will collect 70 W of ambient energy by free convection, in addition to the 200 W recoverable from diffuse solar radiation S.C S

A81-22763 * # **Utility of and technology for a space central power station.** P. F. Holloway and L. B Garrett (NASA, Langley Research Center, Hampton, Va) *American Institute of Aeronautics and Astronautics, Conference on Large Space Platforms Toward Permanent Manned Occupancy of Space, 2nd, San Diego, Calif, Feb 2-4, 1981, Paper 81-0449* 23 p. 31 refs

The technological and economic impact of a large central power station in earth orbit on the cost and performance of future spacecraft and their orbital-transfer systems are examined. The three systems considered for the space central power station are a photovoltaic array, a direct nuclear-pumped laser and a direct solar-pumped laser. It is noted that laser transmitters/receivers will be required to make central power stations feasible. While the remote transmission of power solely to meet the needs of earth orbiting satellites will not be cost-effective in the near future, the remote-power transmission for propulsion of orbital-transfer vehicles promises many cost benefits. L.S.

A81-22838 # **Effects of a satellite power system on ground-based radio and radar astronomy.** A R. Thompson (National Radio Astronomy Observatory, Socorro, N Mex.) *Radio Science,* vol 16, Jan.-Feb 1981, p. 35-45 22 refs.

It is noted that when the satellite power system (SPS) is in operation, the power signal and its harmonics, which fall close to radio astronomy bands, may cause overloading of input stages. Mitigation will require the development of cryogenically cooled filters Radiation within radio astronomy bands can arise from transmitter-generated noise, thermal noise from the large solar cell arrays, and possibly from intermodulation, component failures, and turn-on transients. It is noted that noise and harmonics can also be generated by the power-collecting rectennas, and that there may be propagation effects resulting from ionospheric heating It is concluded that for any radio telescope, a zone of sky will be centered on the arc of satellites and observations here with high sensitivity will be precluded. It is estimated that the width of the zone, as determined by thermal radiation, will vary from about 30 deg for single-antenna telescopes to a few degrees for high-resolution arrays and interferometers. It is noted that since there will be some degradation in performance in bands close to the power signal and its second harmonic, adequate shielding by terrain between radio observatories and power receiving sites will be necessary. C.R.

A81-22861 **Comparison of solar cell performance to calculations using different energy band-gap narrowing models.** H. T. Weaver (Sandia Laboratories, Albuquerque, N. Mex.). *Applied Physics Letters*, vol 37, Dec. 1, 1980, p. 1009-1011. 11 refs. Research supported by the U.S. Department of Energy.

Three different energy band-gap narrowing models were used for exact numerical calculations of silicon solar cell performance. The results are compared to data from high-efficiency cells. Two of the gap narrowing models are derived empirically from other types of devices, and the third is theoretical. The applicability of the models to these cells is demonstrated. (Author)

A81-22872 **Electrostatic effects in inversion-layer metal-insulator-semiconductor solar cells.** Y. W. Lam, M. A. Green, and L. W. Davies (New South Wales, University, Kensington, Australia). *Applied Physics Letters*, vol. 37, Dec. 1980, p. 1087-1089. 10 refs. Research supported by the Australian Research Grants Committee.

Several newer solar cell structures rely on charges in antireflection coatings to induce a charge layer along the surface of the semiconductor region of the cell The present letter describes experimental results for time-dependent electrostatic effects in such devices, with particular reference to inversion-layer metal-insulator-semiconductor solar cells. It is shown experimentally that, over a period of several weeks, a charge layer builds up on the outside of the antireflection coating, which reduces its effectiveness as a charge inducer. Although devices can be designed to accommodate this effect, a preferable approach is to prevent this layer from building up. (Author)

A81-22874 **Molecular beam epitaxial GaAs heteroface solar cell grown on Ge.** D. L Miller and J. S. Harris, Jr. (Rockwell International Electronics Research Center, Thousand Oaks, Calif.). *Applied Physics Letters*, vol. 37, Dec. 15, 1980, p. 1104-1106. 8 refs. Research supported by the Solar Energy Research Institute; Contract No. F33615-78-C-2036.

GaAs/AlGaAs heteroface solar cells having AM1 efficiencies up to 17% have been grown by molecular beam epitaxy (MBE) directly on Ge(100) substrates These cells on Ge have efficiencies identical to cells grown simultaneously on GaAs. The cells reported here are the highest efficiency MBE solar cells reported to date and are the first high-efficiency GaAs solar cells grown directly on Ge by MBE. (Author)

A81-22897 * **A dish-Stirling solar-thermal power system.** R. L. Pons and T. B. Clark (Ford Aerospace and Communications Corp., Newport Beach, Calif.). *International Journal of Ambient Energy*, vol. 1, July 1980, p. 133-148. 14 refs. Contract No. JPL-955115.

This paper presents results of a preliminary design/economic study of a first-generation point focusing distributed receiver solar-thermal electric system optimized for application to industrial and small community power plants at power levels up to 10 MWe. Power conversion is provided by small Stirling cycle engines mounted at the focus of paraboloidal solar concentrators. The output of multiple power modules (concentrator, receiver, engine, and electric generator) is collected by means of a conventional electrical system and interfaced with a utility grid. Based on the United Stirling P-75 engine, a 1 MWe system employing mass-produced components (100,000 modules/year) could produce electricity at costs competitive with those projected for electricity generated by more conventional means, e.g. with fossil fuels. (Author)

A81-22898 **The potential for solar space heating in Scotland.** A. W. K. MacGregor (Napier College of Commerce and Technology, Edinburgh, Scotland). *International Journal of Ambient Energy*, vol. 1, July 1980, p. 149-153. 9 refs.

This paper investigates the relative effectiveness of passive-type solar-assisted space heating systems at various latitudes within the British Isles. A comparison is made of the useful solar gain of the same system linked to the same house at four different locations. Month-by-month energy balances indicate that the annual useful solar contribution at the highest latitude (Lerwick, 60 deg N) is about 35% higher than at the lowest latitude (Kew, 53 deg N). The main reason for this difference is the higher heating loads in the north, particularly outside the winter months. The estimated available irradiation on south-facing vertical surfaces was almost the same at all four locations. Previous work in the UK indicates that, contrary to the conclusions in this paper, more southerly latitudes were the most favorable for solar space heating. The reasons for the disparity are discussed. It is recommended that research and development of passive solar-assisted space heating systems should be most vigorously pursued in the more northerly latitudes of the British Isles, where both the potential benefit and the need are greatest. (Author)

A81-23007 **Mapping of solar radiation for use in the Sudanese-Sahelian region of Africa (Contribution à la cartographie du rayonnement solaire utilisable en Afrique soudano-sahélienne).** J. Amado, C. Delorme, C. Delorme, and Y. Vuillaume (Groupement pour le Développement de la Télédétection Aérospatiale, Toulouse, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1980, p. 11-14. In French. Research supported by the Commissariat à l'Energie Solaire.

Two complementary methods to evaluate the variation of the available solar energy for a system of conversion are presented. The first one, based on data available in meteorological station describes the evolution of energy versus time, the second method yields the instantaneous evolution versus geographical location from Meteosat digital imagery. (Author)

A81-23008 **Solar input and solar energy resources (Intrant solaire et gisement solaire).** L. Aiache, M. Bachir-Rao, J.-P. David, and J. Guèrin (Aix-Marseille III, Université, Aix-en-Provence, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester 1980, p. 15-20. 11 refs. In French.

Systems theory is applied to the determination of the absolute solar energy input at a given location. A method is proposed for absolute input determination based on the measurement of state variables of solar radiation, so that measurements may be applicable to any type of solar energy conversion system. Solar input is treated as a stochastic signal, with processing designed to evaluate the instantaneous and mean luminances, their variance and correlations, which take into account parameters such as mean cloud size and prevailing wind. Shape classification and recognition methods are used to provide a framework within which different types of measurements may be compared. Experimental results have been obtained for the Saint-Jérôme station. A.L.W.

A81-23009 **A simplified non-linear model leading to full range valid calibration test of thermal solar collectors through simple experimental procedure.** G. Y. Saunier (Asian Institute of Technology, Bangkok, Thailand). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1980, p. 21-29.

This semiphenomenological model provides designers of solar energy power plant with a powerful tool for evaluating the performances of flat-plate or semiconcentrating type solar collectors under specific working conditions. The main feature of the model is that once a set of parameters is given by the manufacturer, the performances of a solar collector could be accurately evaluated by means of a very simple analytic expression. This performance evaluation is accurate, regardless of the outlet temperature of the heat carrier fluid which could be as close as desired to the stagnation temperature, as well as the solar flux, the wind speed, and the ambient thermal conditions Comparison of the results of the actual model with those given by a much more sophisticated computer simulation program have shown that the actual model can accurately predict the performance of thermal solar collectors for the whole range of the outlet temperature, under wind of any speed and under solar flux values ranging from 1000 W/sq m to values as low as 400 W/sq m. (Author)

A81-23010 **Energy collected by flat-plate collectors, not oriented toward the south (Energie recueillié par les capteurs plans non orientés vers le sud).** R Bernard (Lyon I, Université, Villeurbanne, Rhône, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique,* 2nd Semester, 1980, p. 34, 35. In French

The global irradiance received by the absorbing material of a flat-plate collector has been evaluated for a given district (Lyon, France) and various periods of the year. Equal energy curves have been plotted for different azimuths and tilts of the collector. It appears that the collector azimuth can be fairly different from the optimum value without losing much of the energy collected. (Author)

A81-23011 **Experimental apparatus for cooling of photovoltaic cells at high concentration.** C. Casarosa, B. Consorti, E. Latrofa, and L. Martorano (Pisa, Università, Pisa, Italy). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique,* 2nd Semester, 1980, p. 36-41. 5 refs. Research supported by the Consiglio Nazionale delle Ricerche.

The efficiency of solar cells generally drops sharply at high levels of energy concentration as a result of the temperature rise at the junction This paper studies the use and performance of a passive cooling device which keeps the temperature of the cell at the desired value. Analysis is presented for the thermal behavior and the general criteria governing a passive system consisting of a heat pipe which is gravity-assisted only and has no capillary structure A first set of experiments was performed on a suitable prototype, whose characteristics are reported for different working fluids - water, ethyl alcohol, Freon 11, Freon 113 - and in various working conditions A second set of experiments was performed using a newly designed heat pipe forming part of a specially designed dual mirror system The conclusions of this investigation, and the aims of further research, are reported. (Author)

A81-23012 **Identification of a solar pumping installation (Identification d'une installation de pompage solaire).** M Annabi, N B. Slama, M. Kachoukh, M. Ksouri (Ecole Normale Supérieure de l'Enseignement Technique, Tunis, Tunisia), and J Perard (Grenoble I, Université, Grenoble, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique,* 2nd Semester, 1980, p 42-46 6 refs In French.

The process identification of a solar pumping facility is discussed in view of its importance to pump power supply optimization. A method for process identification based on the measurement of the short circuit current, open circuit voltage and in-charge current and voltage of the photovoltaic cell in order to determine the cell illumination and junction temperature is presented, and the determination of pump efficiency from measurements of generator power and actual pumping power is indicated. An application of the method to the identification of the parameters of the Hendi Zitoun pumping station is presented The optimization of generator power on the basis of the information gained from process identification is then illustrated by the use of a chopper-type static converter installed between the solar panel and the load to optimize the power supplied by providing a constant voltage at a constant junction temperature, and varying the voltage with the temperature A L W.

A81-23013 **The photovoltaic-aeolian plant at Passo Mandrioli /Italy/.** P U Calzolari (CNR, Istituto LAMEL, Bologna, Università, Bologna, Italy), A Garulli, D. Nobili, and A Sardo (CNR, Istituto LAMEL, Bologna, Italy) *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique,* 2nd Semester, 1980, p 47-49

The use of aeolian-photovoltaic power generation to supply the needs of an isolated farm house in Northern Italy is presented, noting the experimental character of the project Estimated energy consumption is 1650 kWh for lighting and various appliances The system includes two power generators (aeolian and photovoltaic) connected in parallel, battery storage, regulation and control circuit, inverter, supplementary generator and a complete data acquisition subsystem Design characteristics such as the tower height, electrical output and lightning protection are given, together with the parameters to be continuously monitored including meteorological data, wind speed and the angular speed of the propeller L.S

A81-23015 **A solar biotechnology based on microalgae (Pour une biotechnologie solaire basée sur les microalgues).** C Gudin, D Chaumont, O Desanti, and D Pioline (Laboratoire d'Héliosynthèse, Martigues-Lavéra, Bouches-du-Rhône, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique,* 2nd Semester, 1980, p 55-62 35 refs In French Research supported by the Communaute Economique Européenne and Commissariat à l'Energie Solaire

The use of controlled cultures of microalgae in the production of biomass from solar energy is investigated Algae cultures were grown continuously in tubular chambers with an area of 1 sq m exposed to sunlight near Marseilles Productivities of up to 21 g/sq m/day of dry biomass were obtained, corresponding to an average solar conversion efficiency of 4 percent out of a theoretical maximum of 6 6 percent Although biomass yields are greater for microalgae than for other species investigated, the energy required to grow the algae was found to be greater than that produced in biomass, indicating a need for improved growth techniques The potential of extracellular biomass production, in which microalgae are immobilized on a fixed bed and polysaccharides or hydrocarbons excreted by the cells are collected, is also noted A L W

A81-23026 * **Solar energy market penetration models - Science or number mysticism.** E. H Warren, Jr. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif). *Technological Forecasting and Social Change,* vol 16, 1980, p. 105-118 20 refs Research sponsored by the U.S. Department of Energy and NASA.

The forecast market potential of a solar technology is an important factor determining its R&D funding. Since solar energy market penetration models are the method used to forecast market potential, they have a pivotal role in a solar technology's development. This paper critiques the applicability of the most common solar energy market penetration models. It is argued that the assumptions underlying the foundations of rigorously developed models, or the absence of a reasonable foundation for the remaining models, restrict their applicability (Author)

A81-23497 **A Fresnel-Winston tandem concentrator system.** T. C. Kandpal, S. S. Mathur, and R. N. Singh (Indian Institute of Technology, New Delhi, India) *International Journal of Energy Research,* vol. 5, Jan.-Mar. 1981, p. 77-82 8 refs.

The geometrical performance of a solar concentration system employing a Fresnel reflector concentrator and a compound parabolic concentrator (CPC) in tandem is discussed. The concentration of the Fresnel reflector with and without the CPC in tandem is calculated concluding that a significant increase in concentration occurs by using a CPC as a secondary concentrator The number of reflecting mirrors does not affect the overall concentration of the two stage system. D.K.

A81-23498 **Simple transient thermal model for solar collector/storage water heaters.** M. S. Sodha, P K. Bansal, and S. C Kaushik (Indian Institute of Technology, New Delhi, India) *Interna-*

tional Journal of Energy Research, vol. 5, Jan.-Mar. 1981, p. 95-100. 7 refs.

A simple transient model predicting the thermal performance of novel solar water heaters combining both collection and storage of solar energy is presented. These heaters consist of either an insulated rectangular tank whose top surface is suitably blackened and glazed or an insulated open shallow tank with black bottom/inner sides and a top glass cover (shallow solar pond). Heat losses are reduced by adequately covering the heaters with insulation during the night. The proposed model is based on different characteristic equations during sunshine and off-sunshine hours. It is seen that the model predicts the water temperature in close agreement with the experimental observations and earlier theoretical investigations. An extension of the model can include the demand pattern of hot water. D.K.

A81-23701 **The solar pond - A collector and store of solar energy.** M. N. A. Hawlader (University College, Cardiff, Wales). *Sun at Work in Britain*, no. 10, 1980, p. 12-18. 23 refs. Research supported by the Science Research Council.

Experiments on solar ponds in Britain have used highly soluble salts (magnesium chloride being better than sodium chloride) to stop convection effects and heat loss due to evaporation. Findings are that the salinity concentration should be greatest at the bottom and least at the top; the necessary mixed zone at the bottom should not be exceeded beyond the limit set by Nielsen's equation. A density difference of 340 kg/cu m between top and bottom is found to be necessary for a 1 m deep $MgCl_2$ pond to maintain stability at around 100 C. The daily average efficiency of a typical pond in terms of the absorption of solar radiation is found to be about 25-30%. The solar pond is found to be cost effective for process heating, especially for processes involving low temperatures such as crop drying. D.K.

A81-23702 **Thermochemical storage for solar heating and cooling.** C. J. Swet. *Sun at Work in Britain*, no. 10, 1980, p. 20-25. 9 refs.

Thermochemical heat pump storage systems can combine the functions of heat amplification, cooling, and long duration storage. They are being developed primarily for solar space heating and cooling, but the concept is adaptable to solar cooking and other applications. The concept is explained and ultimate performance limits are delineated. Four versions are described, all of which involve two reversible reactions coupled by a common carrier gas. Advantages and limitations of each are discussed, and paths to the solution of some problem areas are indicated. (Author)

A81-23703 **Solar energy research and applications in China.** L. Wei De (Peking Solar Energy Research Institute, Peking, Communist China). *Sun at Work in Britain*, no. 10, 1980, p. 27-29.

Solar collectors and silicon solar cells are being used by a dozen or so provinces and municipalities in China, in barbershops, hotels, restaurants and public bath houses, and solar radiation is being used for distillation and power generation. Vacuum-glass tube solar collectors, solar air driers, solar cookers, solar houses, solar welding devices and solar thermal power installations are some of the projects that are being developed D.K.

A81-23704 **Comparison of commercial and do-it-yourself solar collectors.** R. Roy (Open University, Milton Keynes, Bucks., England). *Sun at Work in Britain*, no. 10, 1980, p. 41-50 19 refs. Research supported by the Open University.

Cost benefits and operating efficiency of commercial versus do-it-yourself solar collectors are analyzed in a 2 5-year comparison experiment. The do-it-yourself collector is found to be identical in thermal performance to the commercial collector, by 1 to 9 years shorter in durability, and about twice as cost-effective unless the commercial collector were to last longer than 15 years. Advantages of self-sufficiency and job-creation benefits of do-it-yourself systems are also discussed. D.K.

A81-23724 **Solar satellites - The trillion dollar question.** J. K. Beatty. *Science 80*, vol. 1, Dec. 1980, p. 28-33.

The obstacles facing the solar power satellite system (SPS) are discussed with a view toward the NASA-DOE reference system. The problems identified include the research and environmental issues surrounding the transmission of microwave energy from orbit to the system rectennas and the cost factor. The cost optimistically aims at one trillion dollars for the total, 60 satellite system. The cost per installed kilowatt may fall anywhere from 3100 up to 16,000 dollars. L.S

A81-23803 # **Concentration dependences of the parameters of high-voltage silicon photocells under high levels of illumination (Kontsentratsionnye zavisimosti parametrov vysokovol'tnykh fotopreobrazovatelei iz kremniia pri vysokoi osveshchennosti).** G. N Galkin, V. M. Evdokimov, O I Koval', L. P. Kudeshova, A. F Milovanov, D. S. Strebkov, and V. A Unishkov *Radiotekhnika i Elektronika*, vol 26, Jan. 1981, p. 190-194. 5 refs In Russian.

The paper presents an experimental study of the properties of high-voltage silicon photocells with specific resistances of 0.01, 0.1, 1.0, and 7 5 ohm-cm under radiation intensities of 0 01-3.5 kW/sq cm. Particular attention is given to the concentration dependence of the diffusion length of the minority carriers. The volt-ampere characteristics are determined, and short-circuit current, emf, and power and efficiency are studied as a function of radiation intensity. B J

A81-23861 **Energy from space - A survey of activities for power generation using space technology.** D. Kassing and G Seibert (ESA, Paris, France). *Advances in Earth Oriented Applications of Space Technology*, vol. 1, no. 1, 1981, p. 19-31 17 refs.

A comprehensive review is presented of solar satellite power systems' conceptual development over the last decade, their current status, possible development schedule, economic viability, and social and environmental impacts It is suggested that further development and testing of selected system elements may supply the key to greater economy and more rapid implementation. O C.

A81-24056 **A solar-pond power plant.** Y. L. Bronicki (Ormat Turbines, Ltd., Yavne, Israel). *IEEE Spectrum*, vol. 18, Feb. 1981, p. 56-59. 5 refs.

Solar pond power plants are discussed in light of the construction and operation of an experimental 150-kW installation in Ein Bokek, Israel. The principle of the collection and storage of solar energy in salt ponds where the salinity increases with depth is introduced, and the six polar ponds constructed by Israel since 1960 to test the theory of solar pond energy conversion are indicated. The facilities and operation of the Ein Bokek plant, which utilizes a 75,000 sq m, 2.5-m deep pond in which the bottom temperature reaches 93 C, are presented, and the design of a basic nonconvecting solar pond for a 20 MW electric power plant is examined, with attention given to the water layers, pumps, evaporator, organic vapor turbogenerator and condenser. The performance characteristics of solar pond power plants, which can be started up in a few minutes and deliver up to ten times or more of their rated output power, are pointed out as the basis for the suggestion that they can be used initially as peaking plants in the power grid. The future plans of the Israeli solar pond program, which expects to be supplying up to 2000 MW by the year 2000, are outlined, and potential sites for solar pond installations in other countries are indicated S.C.S.

A81-24332 **Optical analysis of point focus parabolic radiation concentrators.** P. Bendt and A. Rabl. *Applied Optics*, vol. 20, Feb. 15, 1981, p. 674-683. 15 refs.

A simple formalism is developed for analyzing the optical performance of point focus parabolic radiation concentrators. To account for off-axis aberrations of the parabola, an angular acceptance function is defined as that fraction of a beam of parallel radiation incident on the aperture that would reach the receiver if the optics were perfect. The radiation intercepted by the receiver of a real concentrator is obtained as a convolution of angular acceptance function, of optical error distribution, and of angular brightness distribution of the radiation source. For numerical calculations this method is more accurate and less time-consuming than the ray-tracing method. (Author)

A81-24414 **Polycrystalline Zn3P2 Schottky barrier solar cells.** M. Bhushan and A. Catalano (Delaware, University, Newark, Del.). *Applied Physics Letters,* vol. 38, Jan 1, 1981, p 39-41. 8 refs. Research supported by the U.S Department of Energy.

Energy conversion efficiencies as high as 5.96% are reported on polycrystalline transparent magnesium Zn3P2 diodes, 0.7 sq cm in area, tested under simulated AM1 illumination. The transparent Mg films with low sheet resistivities are obtained by dc sputtering. The effective minority-carrier diffusion length in Zn3P2 is estimated from spectral response measurements and correlates well with the measured short-circuit current. Loss analysis of the present cells shows a practical upper limit of 9% in conversion efficiency. (Author)

A81-24426 **A consideration of possible receiver designs for solar tower plants.** F. K. Boese, A Merkel, D. Stahl, and H. Stehle (Interatom Internationale Atomreaktorbau GmbH, Bergisch Gladbach, West Germany) *Solar Energy,* vol 26, no. 1, 1981, p. 1-7 Research supported by the Bundesministerium fur Forschung und Technologie.

The 500-kW Solar Tower Plant in Almeria, Spain, will be provided with a sodium primary circuit. In the present paper detailed information is given on the basic investigations and on the design of the solar receiver of this circuit Considerations concerning the optimum geometry as well as thermodynamic behavior are described Different design possibilities and the respective behavior of the receiver with respect to short term transients due to cloud passage, heliostat field or mass flow failure, as well as with respect to optimum operational conditions are discussed. Special stress is placed upon a comparison between receivers with or without a large thermal mass. (Author)

A81-24428 **Solar radiation estimates in Malaysia.** D G. S. Chuah and S. L. Lee (University of Science, Penang, Federation of Malaysia). *Solar Energy,* vol 26, no 1, 1981, p. 33-40. 8 refs.

A81-24429 **An assessment of solar energy availability in different regions of the solar spectrum.** M. Munroe and W Shepherd (Bradford, University, Bradford, Yorks., England) *Solar Energy,* vol. 26, no. 1, 1981, p. 41-47.

A81-24430 **Solar energy breeders.** D. P Grimmer (California, University, Los Alamos, N. Mex) *Solar Energy,* vol 26, no. 1, 1981, p. 49-53. 15 refs. Research sponsored by the U.S. Department of Energy.

An energy breeder can be defined as a device which creates capacity to generate useful energy without consuming energy stocks. Any solar conversion device (SCD) that delivers in its life-time more energy than needed to maintain and rebuild itself is a solar energy breeder, since some of the surplus energy can be used to build more such SCDs. A breeding SCD must necessarily produce energy of sufficiently high intrinsic quality (e g. electricity) or high temperature to provide energy at the various temperatures needed for its fabrication and maintenance Thus, the amount of energy produced by an SCD breeder at various temperatures must be examined, in addition to the simple energy quantity produced over a solar collector lifetime. Capacity breeding rates are calculated for both SCDs producing electricity intrinsically (e.g. photovoltaics) and for SCDs producing both electricity and a significant amount of thermal energy (e g. total solar energy systems) (Author)

A81-24431 **Availability modeling methodology applied to solar power systems.** A Unione, E. Burns, and A Husseiny (Science Applications, Inc., Palo Alto, Calif.). *Solar Energy,* vol. 26, no. 1, 1981, p. 55-64. 32 refs

Availability is discussed as a measure for estimating the expected performance for solar- and wind-powered generation systems and for identifying causes of performance loss Applicable analysis techniques, ranging from simple system models to probabilistic fault tree analysis, are reviewed. A methodology incorporating typical availability models is developed for estimating reliable plant capacity. Examples illustrating the impact of design and configurational differences on the expected capacity of a solar-thermal power plant with a fossil-fired backup unit are given. (Author)

A81-24432 **Optimum performance of thermal trap collectors.** T. D. M. A. Samuel (Peradeniya, University, Peradeniya, Sri Lanka) and N. E. Wijeysundera (Drexel University, Philadelphia, Pa , Peradeniya, University, Peradeniya, Sri Lanka). *Solar Energy,* vol. 26, no. 1, 1981, p. 65-76. 8 refs. Research supported by the University of Sri Lanka.

A steady-state analysis neglecting internal reflections and body radiation shows optimum performance for single-layer, semitransparent-slab thermal trap collectors and its dependence on thickness. The model is extended to multilayer collectors of two kinds, methylmethacrylate and 'glass', with two layers of the former yielding better performance than corresponding one, three or four layer systems. The results show that the number of slabs, in addition to their thickness, is an important parameter in the performance of thermal trap collectors. O.C.

A81-24434 **Irradiance estimates for Zambia.** G Lewis (University of Zambia, Lusaka, Zambia). *Solar Energy,* vol. 26, no. 1, 1981, p. 81-85 27 refs.

A81-24444 **Merocyanine-dye photovoltaic cell on a plastic film.** T. Morizumi and K. Kudo (Tokyo Institute of Technology, Tokyo, Japan). *Applied Physics Letters,* vol 38, Jan. 15, 1981, p. 85, 86 6 refs.

A flexible photovoltaic cell was produced by depositing a merocyanine-dye layer on a transparent electro-conducting film, which is a polyester film coated with ITO (indium-tin oxide) Two kinds of the layered structures on the films were examined, i e., Al/merocyanine/ITO and Ag/merocyanine/ZnO/ITO structures It was found that the latter structure was more promising for a solar cell because of a considerably better output stability and a higher conversion efficiency (Author)

A81-24448 **Sede Boqer shallow pond project.** A Kudish (Negev, University, Beersheba, Israel). *Energy* (UK), vol 6, Mar. 1981, p 277-292 16 refs Research supported by the Ministry of Commerce, Industry and Tourism.

The use of shallow solar ponds for the conversion of solar energy into low grade thermal energy is examined at Sede Boqer, Israel with an emphasis placed upon the utilization of locally manufactured components The daily performance of four small-module shallow solar ponds was monitored almost continuously between Aug 1978 and May 1979. The ponds all used PVC lower film but differed in the type of transparent upper film, glazing material or glazing angle The daily performance is characterized by the maximum daily water temperature achieved, the total daily thermal energy collected, and the daily efficiency The results indicate that the SSP system can supply approximately 3 GJ per square meter of thermal energy a year under semi-arid climatic conditions. The economic feasibility of the system is analyzed in comparison with oil (heavy fraction), natural gas, and electrical sources of energy L S

A81-24616 **Fluids for energy transport and conversion in solar power stations (Fluide fur den Energietransport und die Energiewandlung in Solarkraftwerken).** G Schmidt (Messerschmidt-Bolkow-Blohm GmbH, Munich, West Germany) *Brennstoff-Warme-Kraft,* vol 33, Feb 1981, p 49-54. In German

A solar power station can be optimized with regard to internal losses by the proper choice of heat-carrying fluids Attention is given to the choice of optimal fluids for heat transmission from the absorber to the engine cycle, as well as within the engine cycle It is shown how a preliminary choice can be made in a simple way from the material data of the various fluids without detailed design calculations. B.J.

A81-24618 * **Modeling of a solar-pumped iodine laser.** J. W. Wilson (NASA, Langley Research Center, Hampton, Va.) and J. H. Lee (Vanderbilt University, Nashville, Tenn.). *Virginia Journal of Science,* vol. 31, Fall 1980, p. 34-38. 5 refs.

The direct conversion in space of solar radiation into laser radiation for power transmission to earth, satellites, or deep space probes shows promise as a reasonably simple technology and may have cost advantage in deployment and greater reliability compared to other methods of space power generation and transmission The main candidates for solar pumping are the gas dynamic, photochemical, and direct photoexcited lasers. Here consideration is given to the photochemical reaction of alkyliodides which predominantly excite the I(2P1/2) state which then lases at 1.315 microns. The iodine ground state is eventually lost to reconstituting the gas or in the formation of molecular iodine. The rates at which the gas is required to be recycled through the laser system are modest. The side exposure at 100-fold solar concentration of a 100-m long tube with a 1 sq m cross section is estimated to provide 20 kW of continuous laser output. Scaling laws and optimum operating conditions of this system are discussed (Author)

A81-24801 **Theoretical efficiency of S/p+ -n/IS solar cells.** K. Sen, B. K. Jain (Dayanand Brijendra Swaroop College, Dehradun, India), and V. K Srivastava (Roorkee, University, Roorkee, India). *Solar Cells,* vol. 3, Feb. 1981, p. 1-8. 15 refs.

A new S(p+ -n)IS solar cell structure is investigated theoretically. It is noted that this structure helps to increase the open-circuit voltage, the short-circuit current, and ultimately the efficiency. The calculated efficiency is found to be of the order of 36%, far greater than the previously reported maximum (20%) theoretical efficiency for similar S(n+)IS solar cells. C.R.

A81-24802 **Optimum cell size for concentrated-sunlight silicon solar cells.** C M Singal (Roorkee, University, Roorkee, India) *Solar Cells,* vol 3, Feb 1981, p 9-16. 7 refs. Research supported by the Indian National Science Academy.

The photovoltaic power conversion efficiency of a silicon solar cell varies with the concentration of sunlight on the solar cell. It is shown that, for a given grid structure and cell design, the variation in cell efficiency with sunlight concentration depends on the size of the solar cell and that for a given sunlight concentration there is an upper limit to the solar cell size required to obtain a given cell efficiency. (Author)

A81-24803 **Loss mechanism analysis in single-crystal and polycrystalline silicon MIS solar cells to produce 13% efficiency.** K. Rajkanan, W A Anderson, and G Rajeswaran (New York, State University, Amherst, N.Y) *Solar Cells,* vol. 3, Feb 1981, p. 17-25 10 refs. Contract No DE-AC03-79ET-23044

A81-24804 **Method for evaluation of antireflection coatings.** D. Redfield (RCA Laboratories, Princeton, N.J.). *Solar Cells,* vol. 3, Feb. 1981, p. 27-33. Research supported by the RCA Corp.; Contract No. DE-AC01-79ET-23108.

A method for quantitatively evaluating the overall effectiveness of antireflection coatings on optical detectors and solar cells in terms of a single parameter is described. This parameter is the weighted average reflectance of the device, the weighting factor being the product of the incident light flux density and the internal quantum efficiency of the device. Knowledge of the parameter also makes possible an evaluation of the internal electrical properties of the device, independent of the surface reflectance. A simple procedure is presented for measuring the parameter to a good degree of accuracy. Experiments and calculations are included which confirm the simplicity and accuracy of the method. C.R.

A81-24805 **The effects of intragrain defects on the local photoresponse of polycrystalline silicon solar cells.** N. Inoue, C. W. Wilmsen, and K A. Jones (Colorado State University, Fort Collins, Colo.). *Solar Cells,* vol 3, Feb 1981, p 35-43 11 refs Contract No. XS-9-8232-1

Intragrain defects in Wacker cast and Monsanto zone-refined polycrystalline silicon materials were investigated using the electron-beam-induced current (EBIC) technique. The EBIC response maps were compared with etch pit, local diffusion length and local photoresponse measurements. It was determined that the Wacker polycrystalline silicon has a much lower density of defects than does the Monsanto polycrystalline silicon and that most of the defects in the Wacker material are not active recombination sites A correlation was found between the recombination site density, as determined by EBIC, and the local diffusion length. It is shown that a large density of intragrain recombination sites greatly reduces the minority carrier diffusion length and thus can significantly reduce the photoresponse of solar cells (Author)

A81-24806 **An analytical model for solar cells.** J. P Charles, M. Zaghdoudi, P. Mialhe, and A Marrakchi (Tunis, Ecole Nationale d'Ingénieurs, Tunis, Tunisia) *Solar Cells,* vol 3, Feb. 1981, p. 45-56. 30 refs

In this paper we give an analytical treatment of the electrical conduction through a solar cell By considering both the conductivity and the size of each constituent of a unit cell, an analytical expression for the current I versus voltage V is derived The model is applied to I-V characteristics and proves to be most useful for estimation of the possible effects of grid design, of the properties of the top conducting layer, of the recombination factor and of related power losses. (Author)

A81-24807 **Wide band wide angle reflection-reducing coatings for silicon cells.** S F Pellicori (Santa Barbara Research Center, Goleta, Calif) *Solar Cells,* vol 3, Feb 1981, p 57-63. 5 refs

A81-24808 **Short wavelength spectral response of the tandem junction solar cell.** P L. Swart (Rand Afrikaans University, Johannesburg, Republic of South Africa). *Solar Cells,* vol. 3, Feb 1981, p. 65-71 Research supported by the Rand Afrakaans University, and South African Council for Scientific and Industrial Research.

The effect of surface recombination velocity on the short wavelength response of the tandem junction solar cell is investigated theoretically. The analysis predicts approximately the same dependence of the short-circuit current on surface recombination velocity as for a conventional p-n junction solar cell. It is concluded that the experimentally observed improvement in the blue response of the tandem junction solar cell is probably due to a small surface recombination velocity as a result of the absence of front-surface metallization. (Author)

A81-24809 **Heterojunction solar cells on cuprous oxide.** L Papadimitriou, N. A Economou (Salonika, University, Salonika, Greece), and D. Trivich (Wayne State University, Detroit, Mich.) *Solar Cell,* vol 3, Feb 1981, p 73-80 13 refs. Contracts No. ER-78-S-02-4995; No DE-AC04-79ET-23010.

Heterojunction solar cells were made on Cu2O by sputtering In2O3, SnO2, CdO and mixtures of CdO and SnO2 and by thermal evaporation of ZnSe Photovoltaic effects were observed in most cases. High series resistances were an indication of chemical reactions at the interface. Auger surface analysis showed evidence of copper metal at the interface, arising from chemical reactions For a CdO/Cu2O junction formed at room temperature, no copper metal was found at the interface. The CdO/Cu2O cells showed V sub oc = 0.4 V and I sub sc = 2 mA/sq cm. The properties appear to be dominated by a multiple-step tunneling at the junction, presumably due to dislocations and impurities in the Cu2O samples as prepared. (Author)

A81-24810 **Inclusion of degeneracy in the analysis of heavily doped regions in silicon solar cells and other semiconductor**

devices M A Shibib (Bell Telephone Laboratories, Inc., Reading, Pa). *Solar Cells*, vol 3, Feb. 1981, p 81-85 12 refs.

A simple analytic approximation of Fermi-Dirac integrals of order 1/2 is presented and is used to derive an expression for the square of the effective intrinsic carrier concentration (n sub ie squared) in a semiconductor with energy band gap narrowing and degeneracy of the charge carriers. This expression is useful in the analysis of solar cells and of other semiconductor devices containing regions of heavy doping concentration. (Author)

A81-24823 **Temperature dependence for the power outputs of n-CdSe liquid junction cells.** J. F. McCann, M. S. Kazacos, and D Haneman (New South Wales, University, Kensington, Australia). *Nature*, vol. 289, Feb. 26, 1981, p 780-782. 10 refs. Research supported by the National Energy Research Development and Demonstration Council.

Thin film n-CdSe photoanodes have great potential as efficient and inexpensive electrodes in liquid junction photovoltaics. This stems from the stability of n-CdSe in the S/S(-2) electrolyte, its direct band gap of 1.7 eV and the large barrier height, of approximately S(-2) interface. The recently reported 8% AM1 conversion efficiency for a cadmium chalcogenide thin film based cell suggests that these low cost devices may soon compete favorably with the conversion efficiencies of the more expensive single crystal solid state photovoltaics. In view of the increasing practical importance of this system, the study of any parameter which may affect its performance is relevant. The dramatic effect of temperature on the power outputs on n-CdSe based cells is reported. (Author)

A81-24827 **Extraction of oxygen and metals from lunar ores.** N. Jarrett, S. K. Das, and W. E. Haupin (Alcoa Technical Center, Alcoa Center, Pa.). *Space Solar Power Review*, vol. 1, no. 4, 1980, p. 281-287. 6 refs.

Consideration of the lunar environment suggests modifications of the Bayer-Hall approach leading to a conceptual process for extracting aluminum and oxygen from lunar soil. The process consists of electrowinning aluminum-silicon-iron-titanium alloy and oxygen from unrefined soil in a bipolar fluoride type cell with inert electrodes. Aluminum and other elements would be recovered from the alloy by vacuum fractional distillation. The silicon produced would be used to produce solar cells for additional electrical power. (Author)

A81-24976 **Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1 - Solar energy.** Conference supported by the International Association for Hydrogen Energy, IAEA, ISES, Florida International University, and University of Miami. Edited by T. N. Veziroglu (Miami, University, Coral Gables, Fla.). Washington, D C., Hemisphere Publishing Corp., 1981. 490 p. Price of nine volumes, $595.

The book examines such topics as insolation, flat plate collectors, concentrating collectors, and energy storage. Several papers are presented on the static endo-absorbent flat solar collector, the performance of a flat type solar collector composed of selective transparent and absorbing plates, and the solar image characteristics of concentrators. Thermal storage is discussed in papers on the thermal storage cell for high temperature solar systems, a cycle life tester for the long-term stability of phase change materials for thermal energy storage, and membrane-lined thermal storage systems. L.S.

A81-24977 **Calculation of hourly and daily available solar energy to a flat plate collector inclined by the angle of optimum tilt in Iraq.** H. R. Hamdan and Z. M Majeed (Al-Mustansiriyah University, Baghdad, Iraq). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 37-45. 8 refs

A81-24978 **A simulated comparison of the useful energy gain in fixed and tracking flat plate and evacuated tube collectors.** P. Drago (U.S Maritime Administration, Merchant Marine Academy, Kings Point, Total Energy Corp, Bohemia, N Y) In. Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 1. Washington, D C, Hemisphere Publishing Corp., 1981, p. 47-62. 7 refs

A computer simulation of the thermodynamic efficiency of fixed, tracking flat plate, and evacuated tube solar collectors was made based on 1977 insolation figures for Kings Point, N.Y. It yielded monthly, seasonal and yearly comparisons for the various devices from which collector cost/useful energy gain merit figures can be derived. It is concluded that tracking collectors should be taken advantage of whenever possible. O.C.

A81-24979 **Static endo-absorbent flat solar collector.** L. N. Blanco (Miami, University, Coral Gables, Fla.). In Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 1 Washington, D.C., Hemisphere Publishing Corp, 1981, p. 65-72. 6 refs

The possibility of absorbing solar radiation by means of discrete micro-absorbers completely immersed in a heat transfer fluid is analyzed. This is termed the endo-absorbent concept and does not include designs such as the overlapped-glass plates or the blackened metal screen. The closest realization of this concept is the black liquid collector in which the micro-absorbers are permanently suspended in the heat transfer fluid and travel in it via a closed circuit. As opposed to the above, the static endo-absorbent concept is presented in which the micro-absorbers are not permanently dispersed or suspended in the heat transfer fluid but are instead kept within the limits of the solar radiation absorbing volume while the heat transfer fluid circulates through it. The performance of a collector of this type is studied analytically as well as experimentally It is shown that designs based on this concept allow not only a higher efficiency but also several other advantages when compared to a traditional tube-and-fin collector and to the black liquid concept (Author)

A81-24980 **A figure of merit for solar collectors with several separate absorber segments.** R. P. Patera and H. S. Robertson (Miami, University, Coral Gables, Fla.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 73-87

The proposed general figure of merit, Q, has information about the input distribution, the concentration and the acceptance function built into its definition. In addition, the use of a channel matrix to characterize a collector is proposed. The channel matrix enables the figure of merit to be readily calculated for various input distributions. (Author)

A81-24981 **Performance comparison of flat plate collector absorber coatings utilizing NBS Standard 74-635 and the ASHRAE Collector Performance Method.** H A. Ingley, E. A. Farber, and R Reinhardt (Florida, University, Gainesville, Fla.). In Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D C., Hemisphere Publishing Corp., 1981, p. 89-100. 12 refs.

Mildly selective (Chemglaze Z306 and Solarsorb C-1077 paints) surfaces, along with flat black paint and untreated copper, were evaluated as flat-plate solar collector coatings according to the National Bureau of Standards and the American Society of Heating, Refrigeration and Air Conditioning Engineers procedures for determining solar absorptivity. The moderately selective surfaces proved less efficient than flat black paint for operating temperatures less than 180 F Highly selective (black chrome and copper oxide) surfaces, although tested, were not evaluated. O C.

A81-24982 **Performance of a flat type solar collector composed of the selective transparent and absorbing plates.** K Kanayama, H Baba, and H. Ebina (Kitami Institute of Technology, Kitami, Japan). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 101-110. 6 refs.

Analytical and experimental results are reported for the performance of a flat plate solar collector whose transparent and absorbing plates have selective characteristics. The analysis of thermal properties extends to heat balances among radiative, convective and conductive processes for both plates Good agreement between prediction and performance was obtained for all seasons of a one year period. The effect of the wavelength dependence of various transparent plates on the collector efficiency was checked, showing that the effect of glass was highest and that of the PVC was lowest. O.C.

A81-24983 **Theoretical and experimental investigation of a flat-plate solar collector performance with the use of a solar simulator.** G. B Hanna, M. S. El-Shobokshy, and L. H. Saadi (Riyadh, University, Riyadh, Saudi Arabia). In. Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 111-132. 8 refs.

A solar illumination simulator and computerized temperature monitoring are used to investigate the thermal performance of a flat plate solar collector in indoor tests. Predicted values for overall heat loss coefficients and effective transmittance absorption products show good agreement with experimental results. O.C.

A81-24984 **Solar collector performance without flow measurement.** P. C. Lobo (Paraiba, Universidade Federal, João Pessoa, Brazil). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 133-143.

A81-24985 **Effects of dust on the performance of thermal and photovoltaic flat plate collectors in Saudi Arabia - Preliminary results.** B. Nimmo and S. A. M. Said (Petroleum and Minerals University, Dhahran, Saudi Arabia). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 145-152. 10 refs.

One photovoltaic and two thermal panels were tested, and the degradation in performance due to surface dust was determined. The thermal panels showed a decrease in efficiency of about 26 percent as a result of dust accumulated over several months of outdoor exposure. The photovoltaic panel efficiency decreased by 40 percent over a period of about six months. (Author)

A81-24986 **Solar image characteristics of concentrators.** P. Phillips (I. A. Naman and Associates, Inc., Houston, Tex.) and Y. Bayazitoglu (Rice University, Houston, Tex). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 155-172. 5 refs. Research supported by Rice University and I. A. Naman and Associates, Inc.

A model is developed to study solar image characteristics of solar concentrators. The reflecting and absorbing surfaces of the concentrator are represented by finite elements. Each element is considered to have nine nodes. A piecewise ray tracing method is studied such that, instead of representing the reflected beam from an element with one ray, nine rays are used. At each node the solar beam is assumed to be reflected with the same solid angle of the solar disk, which provides a diverging reflected image of the element. This model accommodates the size of the solar disk; can study complex reflector and absorber geometries and can consider ill-defined or broad incident fields. The computer implementation of the present model is used to study a conical reflector with its base as an absorber. The reflector is chosen such that a ray reflected from the top edge strikes the outer edge of the absorber on the opposite side. (Author)

A81-24987 * **Analysis of a high-performance tubular solar collector.** F. L. Lansing and C S. Yung (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 1. Washington, D.C , Hemisphere Publishing Corp., 1981, p. 173-216. 9 refs.

This article analyzes the thermal performance of a new vacuum tube solar collector The assumptions and mathematical modeling are presented. The problem is reduced to the formulation of two simultaneous linear differential equations characterizing the collector thermal behavior. After applying the boundary conditions, a general solution is obtained which is found similar to the general Hottel, Whillier and Bliss form, but with a complex flow factor. The details of the two-dimensional thermal model of the solar collector at steady state is also presented to include the computer simulation and the performance parameterization. Comparison of the simulated performance with the manufacturer's test data showed good agreement at wide ranges of operating conditions. (Author)

A81-24988 **Development and study of a flat mirror multivalent concentrator.** L M Schwartz, R. Louat, and G. Menguy (Lyon I, Université, Villeurbanne, Rhône, France). In Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 1 Washington, D.C , Hemisphere Publishing Corp., 1981, p. 217-224.

A solar concentrator has been designed which is made up of 25 x 25 cm flat mirrors and has a total reflecting area of 4 sq m The theoretical concentration ratio is 60, so that the temperature reaches 300 C when the intensity of solar radiation is 850 W/sq m. The concentrator could be useful in studies involving the use of direct solar radiation, particularly in poorly insolated areas V.L.

A81-24989 **Investigations on the prediction of thermal performance of compound parabolic concentrators.** C R Hariprasad, R Natarajan, and M. C Gupta (Indian Institute of Technology, Madras, India) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C , Hemisphere Publishing Corp., 1981, p 225-238

An iterative mathematical model is presented for predicting the thermodynamic efficiency of compound parabolic concentrators, for different values of both insolation and collector medium mass flow rate, under steady-state conditions. Collector efficiency for different concentration ratios is computed by subtracting convective and radiative losses from the collector elements' predicted temperatures O C

A81-24990 **Dynamic response analysis of a solar powered heliotropic fluid-mechanical drive system.** N A. Cope, H. A Ingley, E. A. Farber, and C. A. Morrison (Florida, University, Gainesville, Fla.). In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp , 1981, p. 249-261.

This paper provides a summary of work performed during the design, construction, and subsequent analysis of a solar powered tracking mechanism. The mechanism utilizes basic mechanical and thermodynamic principles in its construction and operation Data taken during the course of the research and reported in this paper reveal that with a particular combination of system components and working fluid, a high degree of accuracy and wind stability can be achieved with this device when used to drive large concentrating solar collectors. The tracking mechanism was found to be fully self-correcting during normal daily operation and to reorient itself to the morning sun. (Author)

A81-24992 **Thermal energy storage in aquifers for a solar power plant.** W. J. Schaetzle, C E. Breet (Alabama, University, University, Ala.), and J. M. Ansari (Petroleum and Minerals University, Dhahran, Saudi Arabia). In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 285-298. 16 refs.

Thermal energy storage in confined aquifers for the direct heating and cooling of community buildings in conjunction with a solar power plant is investigated with emphasis on its thermodynamic efficiency and economic feasibility. The per kilowatt plant capacity cost is estimated at $10,000/kw. The storage system is only $40/kw or 0.4% of the capital cost. V.L.

A81-24993 **Thermal storage cell for high temperature solar systems.** L. Fellows (U.S. Department of the Interior, National Park Service, Titusville, Fla.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1 Washington, D.C., Hemisphere Publishing Corp., 1981, p. 313-320.

Large scale solar thermal electric power generation is practical at present if higher temperatures can be developed. This has been proven in the United States and other countries with the use of large concentrating collector systems which attain tremendous temperatures and high thermal flux. The concept of solar power as a sole source of power, rather than a supplementary supply, is feasible also, and though further research is needed in this area, a simple, and relatively inexpensive storage method is currently being examined, utilizing high temperature steel alloys. (Author)

A81-24994 * **Advanced solar thermal storage medium test data and analysis.** H Saha (Alabama Agricultural and Mechanical University, Normal, Ala). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 321-339. 10 refs. Grant No. NsG-8041.

A comparative study has been made of experimentally obtained heat transfer and heat storage characteristics of a solar thermal energy storage bed utilizing containerized water or phase change material (PCM) and rock or brick. It is shown that (1) containers with an L/D ratio of 0.80 and a mass/surface area ratio of 2.74 in a random stacking arrangement have the optimum heat transfer characteristics; and (2) vertical stacking has the least pressure drop across the test bed. It is also found that standard bricks with appropriate holes make an excellent storage medium. V.L.

A81-24998 **Sensitivity analysis of a community solar system using annual cycle thermal energy storage.** F Baylin, R. Monte, and S. Sillman (Solar Energy Research Institute, Golden, Colo.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C, Hemisphere Publishing Corp., 1981, p 389-398. 12 refs.

The objective of this research is to assess the sensitivity of design parameters for a community solar heating system having annual thermal energy storage to factors including climate, building type, community size and collector type and inclination. The system under consideration uses a large, water-filled, concrete-constructed tank for providing space heating and domestic hot water (DHW). This presentation outlines results and conclusions about system sizing; a system design study and economic analysis are underway. (Author)

A81-24999 **The use of concrete block directly under a concrete slab as a heat storage system in a passive solar heated building.** R. Mitchell (Solar Systems Design, Inc., Selkirk, N Y.) and J. E. Giansante. In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C, Hemisphere Publishing Corp., 1981, p 399-411.

A81-25000 **Membrane-lined thermal storage systems.** R. C. Bourne (Nebraska, University, Lincoln, Neb.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 1. Washington, D.C., Hemisphere Publishing Corp, 1981, p. 413-446.

Background and advantages of membrane-lined liquid thermal storage are presented. Surveys of existing projects and potential liner materials are reviewed. Alternate structural enclosure designs are discussed for basement, crawl space, and slab-on-grade foundation types, and optimal-cost designs are identified. Improved heat transfer methods are investigated. Design and laboratory test results are presented for several concepts providing forced air heating via an air jacket around the storage surface Test results and cost-effectiveness studies are presented for four types of free-convection domestic water preheaters immersed in the storage container. Preferred storage inlet/outlet designs, and techniques for auxiliary heating of storage, are also discussed. (Author)

A81-25001 **Solar-powered saline sorbent-solution heat pump/storage system.** H. Robison and S. Houston (South Carolina, University, Conway, S.C.). In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 1. Washington, D.C, Hemisphere Publishing Corp., 1981, p. 447-451. 6 refs. Research supported by the Coastal Educational Foundation and Horry County Higher Education Commission.

Coastal Energy Laboratory Chemical Heat Pump (CEL-CHEAP) is a redesigned open-cycle liquid desiccant air conditioner. Heat is discharged to shallow-well water by dehumidification-humidification for cooling and extracted by humidification-dehumidification for heating. Direct solar radiation concentrates the desiccant For continuous operation, a small uninsulated tank stores concentrated solution. This chemical heat pump needs no mechanical compressor, condenser, vacuum system, or pressure system. The collector-regenerators are inexpensive The refrigerant is water and the desiccant is calcium chloride. First cost and operating expenses are very low. (Author)

A81-25005 **Numerical resolution of the heat transfer equations in a latent heat solar energy storage system.** D Gobin (CNRS, Châtenay-Malabry, Hauts-de-Seine, France), D. Levesque (CNRS, Laboratoire de Physique Théorique, Orsay, Essonne, France), and C Benard (CNRS, Gif-sur-Yvette, Essonne, France) In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 477-485. 7 refs.

A81-25006 **Heat transfer through a paraffin wax solar energy storage characterized by a temperature dependent specific heat.** D. Gobin, J. C. Gory (Ecole Centrale des Arts et Manufactures, Châtenay-Malabry, Hauts-de-Seine, France), C Benard (CNRS, Gif-sur-Yvette, Essonne, France), and D. Levesque (CNRS, Laboratoire de Physique Théorique, Orsay, Essonne, France). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 487-492.

A81-25007 **Trombe-Michel wall using phase change materials.** B. Farouk and S. I. Guceri (Delaware, University, Newark, Del). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 493-502. 15 refs.

A one dimensional numerical model is used to predict the performance of a Trombe-Michel wall using phase change materials (PCM). The usefulness of the PCM wall installed in a building for night-time home heating is investigated by considering the data for Glauber's salt mixture (Na2SO4 10H2O) and Sunoco P-116 wax. The weather information for a mid-February day along with data for the Solar One house were used for the system simulation. It is observed that if the PCM wall is designed properly, it eliminates some of the undesirable features of the masonry walls with comparable results. (Author)

A81-25009 Experimental results from the first year of operation of the solar ground coupling research facility of Brookhaven National Laboratory. P. D. Metz (Brookhaven National Laboratory, Upton, N.Y.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 527-540. 6 refs Research sponsored by the U.S. Department of Energy.

A81-25010 A new formal graphic language for the representation of complex energy distribution systems. E. Benes and F. P. Viehboeck (Wien, Technische Universitat, Vienna, Austria). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 541-552.

A schematic notation system for the representation in design and analysis of multi-component heating systems is presented. This graphic language is clear and rigorous and allows quick changes between two basic levels of abstraction, as shown by two examples: a swimming pool with combined solar/electric heating system and the low temperature heating system of the Institute of Molecular Biology in Salzburg, Austria. The notation's 'energy path graphs' are more adequate for judging the relative merits of alternative system configurations than commonly used simplified installation schemes. O.C.

A81-25013 Solar water heating demonstration program for public schools in New Mexico. J. T. Pytlinski, E. Lumsdaine, and J. Cherng (New Mexico State University, Las Cruces, N. Mex.). In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 2. Washington, D C., Hemisphere Publishing Corp , 1981, p. 581-587.

A81-25014 Method of on site testing for performance rating of solar water heating systems. J. T. Pytlinski (New Mexico State University, Las Cruces, N. Mex.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 589-602. 5 refs.

A81-25015 Preliminary evaluation of overall thermal performance of solar water heating systems using air and liquid flat-plate collectors. J. Cherng, E Lumsdaine, J. T. Pytlinski, and B. Blevins (New Mexico State University, Las Cruces, N. Mex.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 603-617. Research supported by the New Mexico Department of Energy and Minerals.

A81-25016 The development of a freeze-tolerant solar water heater using crosslinked polyethylene as a material of construction. J. M. Bradley (Polyset, Inc., Manchester, Mass.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 619-626.

The development of a freeze-tolerant solar water heater with tubes of black cross-linked polyethylene is discussed. This material can withstand repeated freezing and thawing without rupture and also handle the pressure of domestic hot water. The tests demonstrate an absorptivity for sunlight equal to the conventional solar absorber surfaces. (Author)

A81-25018 Enhancement of low grade heat via the HYCSOS chemical heat pump. D. M. Gruen, I. Sheft, and G. J. Lamich (Argonne National Laboratory, Argonne, Ill.). In Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C , Hemisphere Publishing Corp., 1981, p. 641-649. 20 refs. Research sponsored by the U.S. Department of Energy

The Argonne HYCSOS demonstration system is a thermally driven chemical heat pump based on two metal hydrides with different free energies of formation that functions in heating, cooling and energy conversion modes. Thermodynamics of hydrides are discussed, and it is shown that a continuous supply of high pressure hydrogen can be generated by the system for doing useful work in an expansion engine-dynamo unit supplying electricity and then be absorbed on the alloy at a lower temperature The ability of the system to enhance low grade solar energy, obtained from inexpensive flat plate collectors to provide domestic hot water, is also discussed. Using the LaNi5 and CaNi5 currently in the HYCSOS system, 34 kcal of thermal energy raised the temperature of water from 39 to 66 C. D.K.

A81-25021 Analysis of solar-powered absorption cycle heat pumps with internal/external energy storages. A. W. Harris (General Electric Co., Schenectady, N.Y.) and C. N. Shen (Rensselaer Polytechnic Institute, Troy, N.Y.). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 677-700. 12 refs.

System diagrams and performance equations are presented for solar-powered water-lithium bromide absorption cycle heat pump systems utilizing two different modes of energy storage. In the ETS system the collector is coupled to the absorption cycle generator through a thermal energy storage external to the other elements of the system. In the ILES system the collector is coupled directly to the absorption cycle generator with latent energy storage internal to the cycle itself. Discrete-time computer models of the systems are constructed to enable operational and parameter studies to be carried out. Generalized weather functions are used to represent insolation and building load demands to the systems Operating strategies to minimize auxiliary energy requirements and to maximize the utilization of solar energy are described for each system. Parameter studies were carried out in terms of system cost and solar energy supply fraction versus storage size and insolation to load ratio (collector area). Comparisons between the ETS and ILES systems show that the greater capital cost of the ILES system is offset by higher solar energy utilization. (Author)

A81-25022 Direct solar air heating in Denmark /56 deg N/ - Heating strategies in theory and practice. F. Bason and E. Fogh (Silkeborg Amtsgymnasium, Silkeborg, Denmark). In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 703-712. 9 refs.

The use of solar energy in Denmark is discussed with reference to three types of solar heating systems: (1) a solar water heater, (2) a direct air space heating system, and (3) a complementary water-air heating system. It is shown that well loaded water heating systems with average daily loads in the range 1.5-2.0 kWh/sq m per day are already economically feasible and can supply about 50% or more of the yearly hot water requirements in typical situations. V.L.

A81-25023 **Bi-coolant flat plate solar collector.** W. Y. Chon (New York, State University, Buffalo, N Y.) and L. L. Green (Johns Hopkins University, Baltimore, Md.). In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 713-725

The feasibility study of a flat plate solar collector which heats air and water concurrently or separately was carried out. Air flows above the collector absorber plate, while water flows in tubes soldered or brazed beneath the plate. The collector efficiencies computed for the flow of both air and water are compared with those for the flow of a single coolant. The results show that the bi-coolant collector efficiency computed for the entire year in Buffalo, New York is higher than the single-coolant collector efficiency, although the efficiency of the water collector is higher during the warmer months. (Author)

A81-25025 **Solar air conditioning with solid absorbents and earth cooling.** E. Mayer (Universidad Simón Bolívar, Caracas, Venezuela). In Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp, 1981, p. 741-748. 12 refs.

An experimental design is described for an efficient desiccant cooling system using natural cold sink to reduce the moisture content of the ambient air Used in a warm, humid, tropical climate, the unit is shown to provide up to 0 77 ton of refrigeration under extreme conditions with an average daily coefficient of performance of 0.5 Solar heat is applied to regenerate the silica gel D.K.

A81-25027 **Solar air conditioning in a hot arid climate.** A. A M. Sayigh (Riyadh, University, Riyadh, Saudi Arabia). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C, Hemisphere Publishing Corp., 1981, p. 761-773. 9 refs.

Performance comparisons for a hot, arid climate like that of Riyadh, Saudi Arabia are made for four solar air conditioning systems: Rankine engine-powered, flat-plate solar collector-powered thermochemical absorption, lithium-bromine absorption; and passive convection tower. A typical case is studied for each system and recommendations are made as to most viable size, application, and optimal relationships for system elements. O.C.

A81-25028 **Analytical and experimental evaluation of solar absorption and vapor compression residential cooling systems.** G. Darkazalli and T. J. Lawley (Texas, University, Arlington, Tex). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C, Hemisphere Publishing Corp, 1981, p 775-783.

Results from the University of Texas at Arlington/Solar Energy Research Facility (UTA/SERF) analytical and experimental study on residential solar heating and cooling systems are given. A description of the 145-sq m solar residence, its basic components, operation, and controls of various combinations of system components is presented. A comparison of solar-powered absorption cooling and solar-assisted electric-powered heat pump cooling for a single family residence is also presented Solar domestic hot water and space heating systems, with heat pump, are also evaluated. (Author)

A81-25029 **A simple method for computing the dynamic response of passive solar buildings to design weather conditions.** D. B. Goldstein and M. Lokmanhekim (California, University, Berkeley, Calif.). In. Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 2 Washington, D.C., Hemisphere Publishing Corp, 1981, p. 797-808 10 refs. Contract No W-7405-eng-48

In contrast to the lengthy computations required to simulate hour-by-hour building performance using response-factor or thermal network models, design-day performance can be analyzed simply by using a method developed based on Fourier transforms. This paper describes how Fourier response functions are derived from the building's thermal properties and shows how approximations can be made which allow the results to be expressed as algebraic formulas which can be computed rapidly using a hand-calculator. A program written for a hand-calculator which can perform this analysis requires as inputs building design parameters such as 'UA' products (conductances), specific heats of materials, and weather parameters. Since similar materials (e g frame walls and ceilings) can be lumped together, data for only a few different construction types are needed. Weather parameters are daily solar gains for sunny and cloudy design days, length of cloudy design weather cycle, average ambient temperature of the design day and typical diurnal temperature fluctuation. Output from the program is hourly room temperatures for each of the design days. (Author)

A81-25031 **Convertible, tri-mode solar conversion system.** D. A. Kelly (Technidyne Associates, Maspeth, N.Y.) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D C., Hemisphere Publishing Corp., 1981, p. 815-820.

A convertible, tri-mode solar collection system has been developed to provide year-round operation in the Northeastern U S. Employing a plastic hot air duct-box in addition to conventional linear parabolic concentrators and thermal storage units, the system is able to provide wintertime hot air for residential heating and summertime steam for electrical power generation. Because of its superior utilization factor, it is expected that the device will pay back for an initial investment in a significantly shorter time than present alternatives. O.C

A81-25032 **Report on the measuring data evaluation of the first large-scale solar heated building in Austria.** F P Viehboeck, E. Benes, and L Wimmer (Wien, Technische Universitat, Vienna, Austria) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2 Washington, D C, Hemisphere Publishing Corp., 1981, p 821-830. 8 refs. Research supported by the Bundesministerium fur Wissenschaft und Forschung

Results of an 18-month testing period are presented for the low temperature solar heating system of the Institute of Molecular Biology in Salzburg, Austria. The system is equipped with a microprocessor-controlled data acquisition and recording system, which collects the readings of 80 meteorological, temperature-sensing and flow-metering transducers Computer-plotted energy balance diagrams show heat losses for the flat-plate solar collectors' various elements. It was found that long-term mean values of the solar collector efficiency are lower than would be expected from steady-state efficiency specifications. O.C.

A81-25033 **Performance of a solar heating system on the LSU Field House determined from test data.** D. Maples and G. D Whitehouse (Louisiana State University, Baton Rouge, La.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 2 Washington, D C, Hemisphere Publishing Corp, 1981, p. 831-839

A81-25034 **Domestic utilization of solar energy in the Michigan area.** K. S. Varde (Michigan, University, Dearborn, Mich). In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 2. Washington, D C, Hemisphere Publishing Corp., 1981, p. 841-850. 8 refs.

A model has been constructed to determine the heating loads in a typical residential building in the Michigan area and the efficiency of a solar energy collection system using flat plate collectors. It is found that solar energy when combined wih a heat pump, could be an attractive option during the heating season provided that (1) the life of the collector and associated equipment is over 15 years, and (2) the cost of electrical energy more than doubles over the life of the system. V.L.

A81-25037 **Solar energy assisted fluidized bed fruit drying.** B. Kilkis (Middle East Technical University, Ankara, Turkey). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 903-918. 14 refs.

The possibility of using the fluidized-bed principle for solar drying of fruits economically and simply is explored. With the aid of computerized design methods, an optimized fluidized bed/packed bed combination was achieved, that in addition functions as a solar air heater. Based on this configuration, a novel aparatus was designed in Turkey for drying Turkish grapes. Comparisons with comparable systems are made. O.C.

A81-25038 **Solar installation for process steam generation for a refinery.** L. D. Clark, S. Hudson (Monument Solar Corp., Dallas, Tex.), J. T. Pytlinski, E. Lumsdaine (New Mexico State University, Las Cruces, N. Mex.), and F. Bridgers (Bridgers and Paxton, Albuquerque, N. Mex.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 961-967. 7 refs.

A solar thermal system for steam generation in a refinery is presented. The system is installed in the Southern Union Refinery in Hobbs, New Mexico, U.S.A. The refinery processes 36,000 BPSD of crude oil (42 U.S. gallon barrels of product fuels per steam day). The solar system is a two loop system. A heat transfer oil (Therminol T-55) circulates through an array of parabolic collectors of 936 sq m area while saturated steam at 190 C/12 kg/sq m is generated in the steam generator loop. The steam flow is 658 kg/hr. A data acquisition system (ODAS) was designed and assembled to evaluate the solar system's thermal performance. It is expected that on an annual basis the solar system will provide a thermal process heat equivalent to 93,400 cu m of natural gas. (Author)

A81-25039 **Heat generation for multipurpose utilization systems by heat of dilution converted from solar energy.** T. Tanaka, T. Tani, S. Sawata, M. Kamimoto, K. Sakuta, and T. Hirogome (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tokyo, Japan). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 969-978.

A solar energy system that converts sunlight into both heat and electricity by thermochemical means is analyzed. Two liquids that produce heat of dilution, such as sulfuric acid and water, are mixed in multistage vessels and the recovered heat used for domestic and industrial water heating. Steam generated at the final mixing stage was used to run a turbogenerator. A performance analysis of the system was made under various temperature conditions and the effectiveness of heat removal considered by numerical calculation. It is concluded that while space and process heating requirements are met, turbogenerator steam production is insufficient. O.C.

A81-25041 **Solar energy in the field of distillation - Design parameters and thermodynamic analysis of solar stills.** G. Kamaraj, V. Ganesan, and K. N. Seetharamu (Indian Institute of Technology, Madras, India). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 991-999. 11 refs.

A81-25042 **New solar still /the wiping spherical still/ - Design and experimentation.** G. Menguy, M. Benoit, R. Louat, A Makki, and M. Schwartz (Lyon I, Université, Villeurbanne, Rhône, France). In Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1001-1007

A novel solar still design is described, whose solar collection/vapor distillation surface is spherical and employs a motor-turned conformal internal wiper to accelerate distillate collection and prevent efficiency loss due to re-evaporation The performance of the new device was compared to that of a conventional still, and performance gains of over 30 percent were determined. O.C

A81-25043 **Solar desalination by freezing and distillation.** G. Kvajic (Miami, University, Coral Gables, Fla.). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1009-1046. 13 refs.

It is noted that among seawater desalination processes the absorption-freeze vapor compression processes based on the thermal heat pump, although untested commercially and still in the development stage, appears technically and economically an attractive application of low-grade (exergy) solar heat. The distillation processes proposed here may be conveniently powered by low-grade solar heat (from flat plate solar collectors). It is expected that the scaling problem will be insignificant in comparison with that encountered in the conventional multistage flash process. The novel feature here is the use of enlarged capacity for heat exchange between distillate and brine via latent heat of solid-liquid phase change of a suitable hydrophobic intermediate heat transfer material. C.R.

A81-25044 **High temperature solar power tower plants - Concept considerations and operational criteria.** C. Cefaratti (Ente Nazionale per l'Energia Elettrica, Pisa, Italy) and J. Gretz (Commission of the European Communities, Joint Research Centre, Ispra, Italy). In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C, Hemisphere Publishing Corp., 1981, p. 1049-1064. 5 refs.

Conceptual considerations and operational criteria are described for central receiver/distributed heliostat reflector solar power plants, based on experience gained to date with Eurelios, a European Economic Community 1 MW powerplant now under construction in Italy. This installation is described with respect to economic, material, operational and performance requirements, which indicate that there are as yet few grounds for optimism regarding the large-scale implementation of such technology. O.C.

A81-25045 **More on duel purpose solar-electric power plants.** F. F. Hall (Stanford University, Stanford, Calif.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1065-1083. 6 refs.

Rationale for such plants is reviewed and plant elements are listed. Dual purpose solar-electric plants would generate both electricity and hydrogen gas for conversion to ammonia or methanol or direct use as a fuel of unsurpassed specific power and cleanliness. By-product oxygen would also be sold to owners of hydrogen age equipment. Evolved gasses at high pressure could be fired in compressorless gas turbines, boilerless steam-turbines or fuel-cell-inverter hydrogen-electric power drives of high thermal efficiency as well as in conventional internal combustion engines. (Author)

A81-25046 **Solar power generation by ground thermal energy conversion.** P. I. Chen (Portland State University, Portland, Ore.) and W. J. Lehr (Petroleum and Minerals University, Dhahran, Saudi Arabia). In: Alternative energy sources II; Proceedings of the

Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1085-1092. 5 refs.

It is known that the earth temperature beneath a certain depth in the ground is generally kept at constant due to thermal insulation of the ground, while on the surface the temperature varies from high in the summer to low in the winter. The variation of the ground thermal gradient can be used to drive a Rankine cycle for power generation. This paper describes the design of a power plant by means of the ground thermal energy conversion (GTEC). The power plant design is centered on the solar energy application in the arid zone. (Author)

A81-25047 **A solar-powered organic vapour power cycle with electricity generation.** A. Kenkare (Hatfield Polytechnic, Hatfield, Herts., England). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C, Hemisphere Publishing Corp., 1981, p. 1093-1112. 13 refs.

An economic and technological assessment is made of Rankine-cycle solar power plants employing an organic working fluid such as Freon 12. Consideration extends to global and seasonal patterns of insolation, and the design and performance of flat-plate collector, turbine, and Freon boiler and condenser elements of a system such as the medium-sized house tested at Hatfield, England. O.C.

A81-25049 **Prospects for developing an efficient photoemissive solar cell.** M. Tavel (Vassar College, Poughkeepsie, N.Y.) and J. Regunberg (Regunberg Corp., Poughkeepsie, N.Y.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1133-1138. 15 refs.

The photoemissive solar cell (PEC) is no longer considered a viable device for direct conversion of solar energy to electrical energy because of extremely low efficiencies as compared to the photovoltaic solar cell (PVC). We shall derive a simple phenomenological expression for the efficiency of a PEC and, by identifying the important parameters, show that new, 'negative electron affinity photoemissive materials offer the possibility of making the PEC competitive with the PVC. We briefly discuss the operation of a PEC. (Author)

A81-25050 **The effects of junction depth and impurity concentration on diffused junction solar cells.** R. C. Neville (Northern Arizona University, Flagstaff, Ariz.) and R. Ginsburg (Drain's Solar Distribution Co., Summerland, Calif.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1139-1146. 8 refs.

A81-25051 **Development trends for the mass production of low cost conductor-insulator-semiconductor /CIS/ solar cells.** R. Singh, J. B. DuBow (Colorado State University, Fort Collins, Colo.), and K. Rajkanan (General Instrument Corp., Hicksville, N.Y.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1147-1156. 31 refs. Research supported by the U.S. Department of Energy.

A81-25054 **Thin film photovoltaic solar energy conversion.** L. C. Burton, L. R. Ijaz, and M. A. Ijaz (Virginia Polytechnic Institute and State University, Blacksburg, Va.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1205-1213. 23 refs.

The current status of thin film solar cells is reviewed. The Cu2S/Zn(x)Cd(1-x)S heterojunction is discussed, especially its potential advantages and present limitations. Some of the anomalous measurements for this junction can be attributed to lateral and vertical nonuniformities in composition caused by the kinetics of ion-exchange. These measurements are reviewed, and an improved energy band model is presented. (Author)

A81-25055 * **The DOE photovoltaic program - An overview.** R. R. Ferber and R. G. Forney (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1215-1228. Research sponsored by the U.S. Department of Energy and NASA.

A81-25056 **Design of a 100 kW photovoltaic flat panel system at a Washington, D.C. area waste treatment plant.** J. C. Belote, P. A. Borgo, M. R. Hamilton, H. A. Yingst, and S. K. Young (BDM Corp., McLean, Va.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1229-1242.

A81-25057 **Solar thermionic power plant. II.** F. Abou-Elfotouh, M. Almassary, and H. Fatmi (Riyadh University, Riyadh, Saudi Arabia). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1243-1251. 7 refs.

It has been shown that the geometric configuration of a central receiver solar electric power plant SEPP can be optimized for the high power density and concentration required for the operation of a thermionic converter. The working period of a TDC constructed on the top of a SEPP in Riyadh area is 5 to 6 hours per day in winter and 6 to 8 hours in summer. At the 25 percent conversion efficiency achieved by a laboratory test model, a reduction in the cost per unit power of 8-12 per cent is expected. The spectral behavior and work functions of the working surface of the thermionic electrodes were investigated. (Author)

A81-25058 **Solar energy power generators with advanced thermionic converters for spacecraft applications.** S Sahin (Lausanne, Ecole Polytechnique Fédérale, Lausanne, Switzerland). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 3. Washington, D.C, Hemisphere Publishing Corp., 1981, p. 1253-1266. 25 refs.

Space solar energy power generators (SEPGs) using a proposed solar energy advanced thermionic converter (SEATC) are discussed, with detailed attention given to a 50 kWel solar energy generator in a geostationary orbit for direct TV-broadcasting and a 10 GWel space power plant Basic engineering outlines are presented for both projects, each using a SEATC whose optimal operating temperatures range from 1100 to 1600 K with parabolic Fresnel mirrors as solar energy concentrators The mirror concentration ratios may reach up to 10,000 with temperatures up to 4000 K SEPGs with ordinary converters and those with SEATCs are compared A comparison of the SEATC with the spacecraft thermionic reactor is also presented. D.K.

A81-25059 **Study of combined /photovoltaic-thermal/ solar energy systems.** R. C. Neville (Northern Arizona University, Flagstaff, Ariz.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1267-1280. 16 refs.

A theoretical analysis of a combined photovoltaic-thermal energy system for converting solar energy is presented. Optical concentration is employed to intensify the available solar energy density. The thermal energy extraction works both to cool the solar cells and to provide heat energy. Overall system efficiencies (total output energy, both thermal and electrical, divided by the available insolation) are shown to reach values close to 40%, with predicted capital costs less than 0.1 cent per kWh. C.R.

A81-25060 **An analysis of macroeconomic effects of increased market penetration by solar energy technologies.** C. J. Pleatsikas (Urban Systems Research and Engineering, Inc., Washington, D.C.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1333-1344. 5 refs.

A81-25062 **The construction cost of thermal storage for solar systems.** T. A. King, J. B. Carlock, and J. G. Shingleton (Mueller Associates, Inc., Baltimore, Md.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1403-1415.

Storage construction costs are presented for 29 completed solar energy systems for commercial buildings which comprise a variety of geographic locations, storage vessel types, and mixtures of new and retrofit designs. It was shown that the storage subsystems represented 8.4% of the total cost; storage costs ranged from 3 to 26% of the system cost; and the type of the storage vessel was the major factor affecting costs. The geographic location was not significant, but the physical placement of the storage vessel was important, with interior tanks proving to be the most expensive. A.T.

A81-25063 **Solar energy for multi-residential water heating - An economic approach.** A. Melnik (York University, Downsview, Ontario, Canada). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1427-1442.

This study deals with multiresidence buildings and several size buildings. A general discussion of the economic evaluation of solar systems for residential buildings is given. An approach for evaluating the economic efficiency of a solar system is outlined. The impact on cost of two major variables, level of consumption and building size are considered. (Author)

A81-25064 **Domestic solar water preheating versus solar water heating - An economic evaluation.** A. F. Orlando, A. V. Carvalho, Jr., and N. Lassner (Centro de Tecnologia Promon, Rio de Janeiro, Brazil). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 1443-1455.

A81-25096 **Solar standards and testing activities in developed and developing countries.** J. T. Pytlinski and H. L. Connell (New Mexico State University, Las Cruces, N. Mex.). In: Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 5. Washington, D.C., Hemisphere Publishing Corp., 1981, p. 2091-2123. 43 refs.

Solar standards and testing activities in developed and developing countries are described in detail. The process of setting up solar standards in the United States is presented. Testing activities in the United States in the areas of flat-plate solar collectors, photovoltaic cells, solar materials and equipment, solar systems and wind machines are discussed and technical details concerning some of the testing facilities are provided. Solar standards and related testing activities in other countries are also discussed. The importance of solar standards and testing in setting up a healthy international solar market and in establishing a uniform base for solar technology transfer from developed to developing countries is pointed out. (Author)

A81-25873 **Efficient Si solar cells by laser photochemical doping.** T. F. Deutsch, J. C. C. Fan, G. W. Turner, R. L. Chapman, D. J. Ehrlich, and R. M. Osgood, Jr. (MIT, Lexington, Mass.) *Applied Physics Letters,* vol. 38, Feb. 1, 1981, p. 144-146. 8 refs. DARPA-USAF-sponsored research.

An ArF excimer laser has been used to form p-n junctions in Si. The laser produces dopant molecules by gas-phase photolysis of an organometallic molecule and simultaneously heats the substrate to allow incorporation of the dopant. Solar cells having conversion efficiencies of 9.6% at AM1 without the use of antireflection coatings have been fabricated from these junctions. (Author)

A81-26355 **Cu/x/S/Cd/y/Zn/1-y/S and Cu/x/S/Cd/y/Zn/1-y/S, CdS thin film solar cells using chemically sprayed films.** L. W. Chow and H. L. Kwok (Chinese University of Hong Kong, Shatin, Hong Kong). *Journal of Physics D - Applied Physics,* vol. 14, Mar. 14, 1981, p. 463-469. 10 refs.

This work studies the effects of adding Zn to CdS films and solar cells. It was observed that the film surface structures were quite similar to CdS films although the electronic properties showed a marked difference as the film resistivity increased considerably with increasing Zn concentration. Measurements on uniformly doped Cu(x)S/Cd(y)Zn(1-y)S solar cells showed no significant improvements in the photovoltaic response for concentrations up to 10% of Zn. Similar measurements on a Cu(x)S/Cd(0.9)Zn(0.1)S, CdS solar cell, however, showed a significant increase in the open-circuit voltage, suggesting that the high series resistance in Zn-added films could be a cause for the observed low photovoltage. (Author)

A81-26372 **On the dynamic optimal coupling of a solar cell array to a load and storage batteries.** A. Braunstein and Z. Zinger (Tel Aviv University, Tel Aviv, Israel). *(Institute of Electrical and Electronics Engineers, Summer Meeting, Minneapolis, Minn., July 13-18, 1980.) IEEE Transactions on Power Apparatus and Systems,* vol. PAS-100, Mar. 1981, p. 1183-1188. 13 refs.

A new and more accurate approach to the design of solar cell arrays is presented, based on the analysis of solar cell connections within the array. The method of determining the optimum point is based on the coupling of the load to the solar cell array by means of a two-port with DC transformer characteristics, and in addition defines the optimum way of charging the batteries, given varying load characteristics, radiation levels, and other operational conditions. O.C.

A81-26373 **Dynamic matching of a solar-electrical /photovoltaic/ system - An estimation of the minimum requirements on the matching system.** Z. Zinger and A. Braunstein (Tel Aviv University, Tel Aviv, Israel). *(Institute of Electrical and Electronics Engineers, Summer Meeting, Minneapolis, Minn., July 13-18, 1980.) IEEE Transactions on Power Apparatus and Systems,* vol. PAS-100, Mar. 1981, p. 1189-1192.

The power losses due to poor matching of a solar cell array and its electrical system are determined. It is shown that by means of a two-state direct current transformer, efficiency gains of between 5 and 10% can be achieved over a single-state solar array system. Although it was assumed that only insolation varies, changes occur in both storage battery charge and load characteristics. It was also determined that use of a three-state direct current converter did not yield proportionate efficiency gains, and that the proper dynamic matching of array, load and battery variations may result in efficiency gains of as much as 15%. O.C.

A81-26374 **Optimum operation of a combined system of a solar cell array and a dc motor.** Z. Zinger and A. Braunstein (Tel Aviv University, Tel Aviv, Israel). *(Institute of Electrical and Electronics Engineers, Summer Meeting, Minneapolis, Minn., July 13-18, 1980.) IEEE Transactions on Power Apparatus and Systems,* vol. PAS-100, Mar. 1981, p. 1193-1197.

A novel method for the optimum matching of an electric motor with varying mechanical loads to a solar cell array is presented. This method enables designers, by means of switching procedures of the array together with flux changes, to ensure maximum mechanical energy supply to the load The use of a direct current transformer, moroever, overcomes the problem posed by relatively large starting current requirements of the motor The method for finding the optimum mechanical operation point of the system is simple and relatively short, and should make possible more effective and efficient use of solar power packs. O.C.

A81-26401 **The Total Solar House.** L. Starobin (Total Solar, Inc, Blue Bell, Pa). *Sunworld,* vol 4, no. 5, 1980, p. 154-159.

A detailed thermodynamic performance report is presented for the Total Solar House, a demonstration facility located in Blue Bell, Pennsylvania All the energy for house heating, domestic hot water and air conditioning is derived from the sun in this 5000 degree-day climate. The system incorporates roof-mounted flat panel solar collectors, basement rockpile heat/cold storage, domestic water heater and heat exchangers. It is concluded that in light of last winter's carefully monitored performance, the system has sufficient excess capacity to serve well even during unusually severe years O.C.

A81-26402 **Solar perspectives - Solar pond power, the Israel-California connection.** S. Winsberg *Sunworld,* vol 4, no. 5, 1980, p 170-173

The performance to date, and the future potential, of solar saline pond electrical generation systems on the Israeli shores of the Dead Sea, and the Salton Sea in California, are assessed. The environmental cleanliness and low capital costs of saline pond solar energy collection (and inherent thermal storage) is stressed, as well as the near-term impact of such projects due to their use of existing, natural bodies of water. The possibility of incorporating water desalination operations is mentioned as a crucial consideration in many potential areas of use, such as Israel and the American Southwest A rough estimate suggests that the Great Salt Lake in Utah could yield a maximum 10,000 MW of electrical power. O.C.

A81-26473 # **Performance test of a non-parabolic asymmetrical solar concentrator.** C. T. Leung (University of Hong Kong, Hong Kong) and Y B. Ng (Hong Kong Polytechnic, Hong Kong) *Regional Journal of Energy, Heat and Mass Transfer,* vol 2, Oct 1980, p. 229-233 12 refs

This paper reviews the geometrical optics for constructing the reflector of a nonparabolic asymmetrical solar concentrator A prototype concentrator of this kind has been constructed with a concentration ratio of 4 07 and a theoretical optical efficiency of 0 67 Standard performance tests on such a concentrator indicate a heat loss coefficient relative to the collector aperture area of 4.35 and a heat extraction efficiency factor of 0.92. (Author)

A81-27010 **Collection efficiency of low-mobility solar cells.** J. Reichman (Grumman Aerospace Corp., Bethpage, N.Y.). *Applied Physics Letters,* vol. 38, Feb. 15, 1981, p. 251-253. 8 refs.

An equation for the collection efficiency (i.e., internal quantum efficiency) is derived that can be used for Schottky barrier, metal-insulator-semiconductor, or semiconductor-electrolyte junction solar cells. It is obtained from an exact solution of the transport equation in the space-charge region and includes the effects of photogenerated majority carriers. It is shown that these carriers can diffuse to the interface and thereby oppose the minority-carrier photocurrent by recombination or emission. This effect is shown to be quite significant in reducing the collection efficiency when the majority-carrier mobility is low and at short wavelengths where the absorption coefficient becomes large. (Author)

A81-27014 **11.5% solar conversion efficiency in the photocathodically protected p-InP/V/3+/-V/2+/-HCl/C semiconductor liquid junction cell.** A Heller, B. Miller, and F. A. Thiel (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). *Applied Physics Letters,* vol 38, Feb. 15, 1981, p. 282-284. 18 refs.

The oxidation of the surface of p-InP with alkaline peroxide and treatment with dilute potassium cyanide increase the efficiency of the p-InP/V(2+) -V(3+)-HCl/C cell to 11.5%. The open circuit voltage of the cell follows the redox potential of the solution over a 0 5 V range. The lack of voltage pinning is consistent with photoemission studies of Spicer et al. (1979, 1980), showing that adsorption of oxygen on p-InP raises the surface Fermi level from a position near the valence band maximum to one near the conduction band minimum. (Author)

A81-27076 **Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record.** Conference sponsored by the Institute of Electrical and Electronics Engineers New York, Institute of Electrical and Electronics Engineers, Inc, 1980 1454 p. Members $75, nonmembers, $100

Papers are presented on developments in thin film solar cells, high-efficiency solar cells and systems and applications of photovoltaics. Specific topics include the ultrahigh speed growth of silicon ribbons, an MIS inversion layer solar cell, the performance of a photovoltaically-powered air conditioning system, high-efficiency wraparound contact solar cells, grain orientations and boundaries in polycrystalline silicon solar cells, the economics of photovoltaics in the commercial, institutional and industrial sectors, CuCdS thin film solar cells, dendritic web silicon in solar cells and modules, progress in cascade solar cells, ion-implanted grating-type silicon solar cells, and the effects of nonuniform illumination on silicon concentrator solar cell performance Attention is also given to the theoretical efficiency limit of direct gap solar cells, ZnO films and ZnO/CdTe heterojunction preparation, a high-efficiency, radiation damage-resistance space solar cell, low-cost ion implantation and annealing for solar cells, a simulation of a hybrid solar photovoltaic thermal electric power system, a proposed design of a-Si H solar cells, GaAs shallow homojunction solar cells, and BSR solar cells for space solar arrays A.L W

A81-27077 # **Overview - Cost goals in the LSA project.** P D. Maycock (U S Department of Energy, Washington, D C.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 6-12

The federal goals and strategy for assisting the U S. industry in reducing the costs of photovoltaic systems are described As an example of the process the technical progress in reducing the price of creating silicon sheet from pure silicon is summarized for silicon ribbon growth, dendrite films, silicon on ceramics and heat exchanger crystallization In conclusion, it appears that the probability of obtaining the price reduction required for broad use of PV systems by the mid-80's is high. (Author)

A81-27078 * **Progress in the growth of wide silicon ribbons by the EFG technique at high speed using multiple growth stations.** J. P Kalejs, B. H. Mackintosh, E. M. Sachs, and F. V. Wald (Mobil Tyco Solar Energy Corp., Waltham, Mass.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 13-18 9 refs. Research supported by the U.S. Department of Energy, Contract No. JPL-954355.

We report here progress in a program designed to examine the feasibility of large scale production of low-cost silicon sheet substrates for solar cells by the EFG process. A multiple-ribbon EFG station, containing five single-ribbon cartridges, has been continuously operated for a period of 15 hours at a duty cycle of 94%. The average width of the ribbon grown was 5 cm, and the average growth speed was 3.4 cm/min. The cartridge concept of ribbon growth has been extended to successfully grow 10 cm wide ribbon at speeds up to 4 cm/min. Large area (approximately 50 sq cm) solar cells with efficiencies in the range from 8% to 11% (AM1) have been made from ribbon grown in the cartridge systems. (Author)

A81-27079 **Low cost production of terrestrial solar arrays utilizing EFG silicon ribbon crystals.** K Kimura, S. Koyama, and H. Watanabe (Japan Solar Energy Co., Ltd., Kyoto, Japan). In:

Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 19-24. 11 refs

A81-27080 * **Development of processes for the production of low cost silicon dendritic web for solar cells.** C. S. Duncan, R. G. Seidensticker, J. P. McHugh, R. H. Hopkins, M. E. Skutch, J. M. Driggers, and F. E. Hill (Westinghouse Research and Development Center, Pittsburgh, Pa.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 25-30. 10 refs. Research sponsored by the U.S. Department of Energy and NASA.

High area output rates and continuous, automated growth are two key technical requirements for the growth of low-cost silicon ribbons for solar cells By means of computer-aided furnace design, silicon dendritic web output rates as high as 27 sq cm/min have been achieved, a value in excess of that projected to meet a $0 50 per peak watt solar array manufacturing cost. The feasibility of simultaneous web growth while the melt is replenished with pelletized silicon has also been demonstrated. This step is an important precursor to the development of an automated growth system. Solar cells made on the replenished material were just as efficient as devices fabricated on typical webs grown without replenishment Moreover, web cells made on a less-refined, pelletized polycrystalline silicon synthesized by the Battelle process yielded efficiencies up to 13% (AM1). (Author)

A81-27081 **Ultra high speed growth of silicon ribbons for solar cells.** K. I. Arai, N. Tsuya, and T. Takeuchi (Tohoku University, Sendai, Japan) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 31-35. 6 refs

P-type silicon ribbons with and without p-n junction and n-type silicon ribbons were prepared directly by rapid quenching methods at ultra high speed about 20 m/s. The average grain size was 20 to 30 microns, and the columnar grain structure perpendicular to the ribbon plane was observed By means of DC conductivity and Hall measurements of ribbons, it was found that the active carrier concentration of the ribbons was nearly the same as the doped carrier concentration from 10 to the 14th to 10 to the 20th/cu cm, and the Hall mobility perpendicular to the ribbon plane was 700 sq cm/V per sec Solar cells using the present ribbon were made by means of a CVD and a paint on diffusion method, and conversion efficiencies of about 5% were obtained for both cells (Author)

A81-27082 * **A silicon sheet casting experiment.** D. B. Bickler, L. E. Sanchez (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), and W. J. Sampson (Applied Solar Energy Corp., City of Industry, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 36-38 Research sponsored by the U.S. Department of Energy and NASA.

The casting of silicon blanks for solar cells directly without slicing is an exciting concept. An experiment was performed to investigate the feasibility of developing a machine that casts wafers directly. A Czochralski furnace was modified to accept a graphite ingot-simulating fixture. Silicon was melted in the middle of the ingot simulator in a boron nitride mold. Sample castings showed reasonable crystal size. Solar cells were made from the cast blanks. The performance is reported. (Author)

A81-27083 * **Continuous coating of silicon-on-ceramic.** J. D. Heaps, S. B. Schuldt, B. L. Grung, J. D. Zook, and C. D. Butter (Honeywell Corporate Technology Center, Bloomington, Minn.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 39-48. 15 refs Research sponsored by the U.S. Department of Energy and NASA.

Growth of sheet silicon on low-cost substrates has been demonstrated by the silicon coating with inverted meniscus (SCIM) technique. A mullite-based ceramic substrate is coated with carbon and then passed over a trough of molten silicon with a raised meniscus. Solidification occurs at the trailing edge of the downstream meniscus, producing a silicon-on-ceramic (SOC) layer. Meniscus shape and stability are controlled by varying the level of molten silicon in a reservoir connected to the trough. The thermal conditions for growth and the crystallographic texture of the SOC layers are similar to those produced by dip-coating, the original technique of meniscus-controlled growth. The thermal conditions for growth have been analyzed in some detail. The analysis correctly predicts the velocity-thickness relationship and the liquid-solid interface shape for dip-coating, and appears to be equally applicable to SCIM-coating. Solar cells made from dip-coated SOC material have demonstrated efficiencies of 10% on 4-sq cm cells and 9.9% on 10-sq cm cells. (Author)

A81-27084 **Substrate related problems in RAD solar cells.** C. Belouet, J Schneider, C. Belin, C. Texier, and R. Martres (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 49-53 11 refs Research supported by the Commission of the European Communities

A81-27085 * **Epitaxial solar cells on metallurgical grade silicon substrates.** P. H. Robinson, R. V D'Aiello, and D. Richman (RCA Laboratories, Princeton, N.J.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 54-57. 7 refs. Research supported by RCA; Contracts No. JPL-954817; No. XS-9-8274.

A81-27086 * **Behavior of interdigitated back-contact solar cells.** L. J. Cheng and D. C Leung (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif) In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 72-75. 6 refs. Research sponsored by the U.S. Department of Energy and NASA.

This paper presents experimental data concerning operation mechanisms of two versions of interdigitated back-contact solar cells the tandem junction cell and the front-surface field cell. It is shown that a photogenerated forward bias at the front junction of a tandem junction cell is a critical parameter for cell performance which not only causes photogenerated carriers to migrate to the back junction, but also eliminates the reduction in photoresponse over back p(+) metallization regions However, no similar light effects are observed in the performance of front-surface field cells Finally, a discussion on mechanisms concerning the performance of front-surface field and tandem junction cells along with their merits is given. (Author)

A81-27087 **Performance study of p/+//n and n/+//p solar cell structures on polycrystalline material.** P. Lester, S J. Fonash, and S Ashok (Pennsylvania State University, University Park, Pa.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 82-85.

In this paper, the possibility of obtaining an analytical solution for the minority carrier distribution in a grain under illumination is explored. The goal is to be able to analytically undertake a performance study of p(+)/n and n(+)/p solar cell structures on polycrystalline material. It is shown that an analytical solution can be obtained in terms of Fourier and Fourier-Bessel series for a columnar grain under very general conditions. These conditions allow for grain boundary penetration from the top of a variable depth, grain boundary penetration from the bottom of a variable depth, and an arbitrary degree of passivation in the remainder of the grain boundary. (Author)

A81-27088 *A two-dimensional model of an MIS inversion layer solar cell.* P De Visschere. In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 86-92. 11 refs.

A computer model is proposed which calculates the IV-characteristic of an MIS inversion layer solar cell. The model takes into account the two-dimensional current flow in the device. The general ideas underlying the model are described and calculated efficiencies are presented for an Al-SiO2-pSi cell. It is investigated in which way the efficiency is influenced by the fingerspacing, the oxide charge density, the doping density, the insulator thickness and the illumination level. (Author)

A81-27089 * **Silicon solar cells with high open-circuit voltage.** J A Minnucci, K. W. Matthei, A. R. Kirkpatrick, and A. McCrosky (Spire Corp, Bedford, Mass.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 93-96. Contract No. NAS3-20823.

Open-circuit voltages as high as 0.645 V (AM0-25 C) have been obtained by a new process developed for low-resistivity silicon. The method utilizes high-dose phosphorus implantation, followed by furnace annealing and simultaneous oxide growth to form high-efficiency, shallow junctions. The effect of the thermally grown oxide is a reduction of surface recombination velocity, the oxide also acts as a moderately efficient AR coating. Boron doped silicon with resistivities from 0.1 to 0.3 ohm-cm has been processed according to this sequence, results show highest open-circuit voltage is attained with 0 1-ohm-cm starting material. The effects of bandgap narrowing, caused by high doping concentrations in the junction, were also investigated by implanting phosphorus over a wide range of dose levels. (Author)

A81-27090 **Design and performance characteristics of a solar photovoltaic power system at the Oklahoma Center for Science and Arts.** V. P. Gupta (Science Applications, Inc., McLean, Va.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 109-114. Contract No. DE-AC04-78ET-23063.

A81-27091 **The 25 kW Fresnel lens/photovoltaic concentrator application experiment at Dallas-Fort Worth Airport.** M. J. O'Neill (E-Systems, Inc., Energy Technology Center, Dallas, Tex.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 125-130. Contract No. DE-AC04-78ET-20539.

A81-27092 * **High efficiency ultrathin coplanar back contact cells.** G Storti, C. Wrigley, J. Wohlgemuth, D. Whitehouse, and A. Scheinine (Solarex Corp., Rockville, Md.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 137-140. Contract No. NAS3-21250.

Efforts to fabricate high efficiency, ultrathin coplanar back contact cells are described. Included is a description of design considerations, cell fabrication, and theoretical and experimental analyses of loss mechanisms The results of these efforts has been the fabrication of a 11.8% AM0 efficient, 50 micron cell when measured at 25 C. Design and process changes required to increase the efficiency are indicated. (Author)

A81-27093 **Compatibility of BSR and BSF solar cell technology.** K.-D Rasch, K. Roy, R. Schilling, and H Fischer (Telefunken AG, Heilbronn, West Germany). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 141-145. 5 refs. Research supported by the Bundesministerium fur Forschung und Technologie.

A81-27094 * **High efficiency wraparound contact solar cells /HEWACS/.** M Gillanders and R Opjorden (Spectrolab, Inc, Sylmar, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 146-150. Contracts No. NAS3-20065; No. NAS3-21270.

A cell technology, producing high efficiency wrap-around contact solar cells (HEWACS), with both electrical contacts on the back and AMO conversion efficiencies of almost 15%, is presented. A flow chart indicating the baseline process sequence along with the process changes is given. Tests checking for coating delamination and contact integrity, those measuring contact strength, and thermal cycle tests, successfully demonstrated that this cell technology is ready to be moved to the pilot production stage. K.S.

A81-27095 **New developments in vertical junction silicon solar cells.** J Wohlgemuth and A. Scheinine (Solarex Corp., Rockville, Md.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 151-155 5 refs Contract No. F33615-78-C-2039.

A report on the development of improved vertical junction cells, with AM0 efficiencies greater than 15%, and a high yield manufacture of large numbers of 2 cm x 2 cm, 2 cm x 4 cm, and 2 cm x 6 cm cells, is presented. Materials, structural parameters, and performance parameters of the cells are summarized in table form. Results of the development of thinning techniques indicate that thinner VJ cells, with almost the same power levels as the standard 10 to 12 mil thickness, can be made. New cell geometry has alleviated thermal degradation: covered cells have been subjected to thermal cycles (-120 C to +100 C) without measurable effects. Thinner substrate cells are more radiation resistant, with the effect saturating below a 5-mil thickness. Deep groove cells have better radiation resistance than shallow groove cells. Two-dimensional computer modeling helps in the development of higher efficiency, radiation resistant VJ structures. K.S.

A81-27097 * **Thin n-i-p silicon solar cell.** A. Meulenberg, Jr, J. F. Allison, and R. A. Arndt (COMSAT Laboratories, Clarksburg, Md.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 161-165. Research sponsored by the Communications Satellite Corp.; Contract No. NAS3-21280.

A space solar cell concept which combines high cell output with low diffusion length damage coefficients is presented for the purpose of reducing solar cell susceptibility to degradation from the radiation environment. High resistivity n-i-p silicon solar cells ranging from upward of 83 micron-cm were exposed to AM0 ultraviolet illumination. It is shown that high resistivity cells act as extrinsic devices under dark conditions and as intrinsic devices under AM0 illumination. Resistive losses in thin n-i-p cells are found to be comparable to those in low resistivity cells. Present voltage limitations appear to be due to generation and recombination in the diffused regions. D.K.

A81-27099 * **Theoretical results on the tandem junction solar cell based on its Ebers-Moll transistor model.** C. Goradia, J. Vaughn (Cleveland State University, Cleveland, Ohio), and C. R Baraona (NASA, Lewis Research Center, Cleveland, Ohio). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January

7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 172-177. 12 refs.

A one-dimensional theoretical model of the tandem junction solar cell (TJC) with base resistivity greater than about 1 ohm-cm and under low level injection has been derived. This model extends a previously published conceptual model which treats the TJC as an npn transistor. The model gives theoretical expressions for each of the Ebers-Moll type currents of the illuminated TJC and allows for the calculation of the spectral response, I(sc), V(oc), FF and eta under variation of one or more of the geometrical and material parameters and 1MeV electron fluence. Results of computer calculations based on this model are presented and discussed. These results indicate that for space applications, both a high beginning of life efficiency, greater than 15% AM0, and a high radiation tolerance can be achieved only with thin (less than 50 microns) TJC's with high base resistivity (greater than 10 ohm-cm) (Author)

A81-27100 **Improved performance from thin film dielectric wraparound solar cells.** D. K. Zemmrich (Applied Solar Energy Corp., City of Industry, Calif.) and D. Lott (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 178-183. 12 refs.

The production of film dielectric wraparound (DWA) solar cells, which offer process, performance, and cost advantages, by depositing a dielectric layer by chemical vapor deposition, is presented. A comparison of the DWA and the junction wraparound (JWA) processes is given. The performance of the wraparound cells exceeds 14.5% AM0 for backsurface field (BSF) and backsurface reflector (BSR) structures. The dollar per watt ratio for large area wraparound solar cells (approximately 36 sq cm) is 22% below that of smaller area (2 x 4 cm) wraparound solar cells. K.S.

A81-27101 **The influence of grains and grain boundaries on the device characteristics of polycrystalline silicon solar cells.** G. M. Storti, S. M. Johnson (Solarex Corp., Rockville, Md.), H. C. Lin, and C. D. Wang (Maryland, University, College Park, Md.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 191-195. 10 refs.

A81-27105 **Chemical and structural defects in thin film polycrystalline silicon solar cells.** T. L. Chu, E. D. Stokes, S. S. Chu, and R. Abderrassoul (Southern Methodist University, Dallas, Tex.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 224-227. Contract No. EY-76-C-03-1285.

The deposition of a silicon film containing a p-n junction on a partially purified and recrystallized metallurgical silicon substrate is a promising approach to the fabrication of low cost solar cells. This type of solar cell contains a high concentration of chemical impurities, such as iron, and structural defects, such as grain boundaries. The heat treatment of solar cell structures after the deposition of the active region has been found to be essential for obtaining solar cells of relative high conversion efficiencies. In this paper, the effects of heat treatment on the photoresponse at defects, investigated by laser scan, steady state surface photovoltage, and EBIC techniques, are discussed. (Author)

A81-27106 **Application analysis of photovoltaic systems for service/commercial/institutional and industrial sectors.** R. A. Whisnant and R. D. Alberts (Research Triangle Institute, Research Triangle Park, N.C.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 246-251. 5 refs. Research supported by the U.S. Department of Energy.

The service, commercial, institutional and industrial (SCII) sectors of the economy comprise a set of potential photovoltaic (PV) system applications with very diverse energy use characteristics. A set of basic technical and financial attributes have been defined to characterize establishments in these sectors. Photovoltaic systems designed to maximize utilization of insolation have been designed and the cost and benefits in terms of electric energy produced have been determined. A ranking of the members of these sectors disaggregated by two-digit Standard Industrial Classification (SIC) codes has been made. Members of the service, commercial and institutional sectors rank substantially higher than those of the industrial sector as viable PV applications, although some small, light industrial applications would also be suitable. (Author)

A81-27107 **The economics of photovoltaics in the commercial, institutional, and industrial sectors.** A. J. Cox (MIT, Cambridge, Mass.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 252-258. 8 refs.

This paper describes the application of a model which computes system break-even capital costs, array break-even capital costs and profits from photovoltaic investments in the industrial, commercial and institutional sector. Several tax and accounting combinations are described and utilized in this paper. Results indicate that, at rates of return usually found in the industrial and commercial sectors, photovoltaic investments will not be attractive when the costs of those investments are based on the Department of Energy's cost goals for 1986. (Author)

A81-27108 **Simulation of the performance of a 100-kW-peak photovoltaic system.** B. L. Grossman, B. L. Brench, L. L. Bucciarelli, and F. J. Solman (MIT, Lexington, Mass.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 266-272. Research sponsored by the U.S. Department of Energy.

The performance of a 100-kW-peak photovoltaic power system designed and currently under construction for the Natural Bridges National Monument, located in a remote part of Utah, is analyzed based on the results of a computer simulation. The simulation models a simplified representation of the stand-alone power system consisting of a solar array field, battery storage subsystem, ac generator feeding a battery charger, inverter and power shedding switches, using as inputs the time-varying insolation, lighting, appliance and utility loads and ambient temperature. Useful relationships are found among system operating characteristics, array output, generator power usage, generator control strategy, storage losses and battery charge/discharge cycles. It is shown that system operating voltage can be set to extract maximum power from the array during the winter, and that generator operating strategy can be designed to minimize adverse effects on the batteries. Losses due to storage are also found to be offset by surplus array energy and generator power. A.L.W.

A81-27109 # **An overview of thin-film polycrystalline silicon research and development.** L. L. Kazmerski (Solar Energy Research Institute, Golden, Colo). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 281-286. 36 refs

The status and development of the thin-film polycrystalline silicon solar cell are reviewed The effects of polycrystallinity and thickness upon material and solar cell performance are assessed for the purpose of defining thin film for this semiconductor. The major, existing research problems for this device are discussed, including those relating to material production, growth methodologies, grain boundary passivation, junction formation, contacting, device configurations, technology scale-up, costing and degradation/reliability (Author)

A81-27110 **Cu2S-CdS-thin film solar cells.** W. H Bloss and G. H. Hewig (Stuttgart, Universitat, Stuttgart, West Germany) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 287-290. 8 refs Research supported by the Bundesministerium fur Forschung und Technologie and European Economic Community.

The current state of the art of Cu2S-CdS solar cells is presented The conversion efficiency, which is above nine percent, of the heterojunction device is based on the electronic, optical, chemical, and structural properties of the semiconducting films. The solar cell structure and the heterojunction structure are shown, and production of thin films is discussed. Diagnostic methods, which include EBIC studies, capacitance measurements, and coulometric titration, are used to analyze the correlation of the different methods of film growth and chemical conversion processes. The I-V-characteristic of a 7 x 7 sq cm Cu2S-CdS solar cell, with a conversion efficiency of 7.3%, which has been recently developed, is indicated. An integrated generator, consisting of eight cells, with a 4.3 efficiency, based on the total area of the encapsulating front glass, is shown. An evaluation of the loss mechanisms and real efficiencies, is given. K.S.

A81-27111 **An overview of amorphous silicon solar-cell development.** D. E. Carlson (RCA Laboratories, Princeton, N.J.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 291-297. 36 refs. Contract No. XJ-9-8254.

The history and status of amorphous silicon solar cells are reviewed, and the performance limitations of the material are discussed. The major loss mechanisms that limit the conversion efficiency are considered for several amorphous silicon solar-cell structures. A comparison is made of calculated and observed photovoltaic parameters, and future directions for improving device performance are discussed. (Author)

A81-27113 * **Low cost monocrystalline silicon sheet fabrication for solar cells by advanced ingot technology.** G F. Fiegl and A. C. Bonora (Siltec Corp., Menlo Park, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 303-308. Research sponsored by the U.S. Department of Energy and NASA.

The continuous liquid feed (CLF) Czochralski furnace and the enhanced I D slicing technology for the low-cost production of monocrystalline silicon sheets for solar cells are discussed. The incorporation of the CLF system is shown to improve ingot production rate significantly. As demonstrated in actual runs, higher than average solidification rates (75 to 100 mm/hr for 150 mm 1-0-0 crystals) can be achieved, when the system approaches steady-state conditions The design characteristics of the CLF furnace are detailed, noting that it is capable of precise control of dopant impurity incorporation in the axial direction of the crystal. The crystal add-on cost is computed to be $11.88/sq m, considering a projected 1986 25-slice per cm conversion factor with an 86% crystal growth yield. D.K.

A81-27114 * **Evaluation and optimization of silicon sheet solar cells** H Yoo, P Iles, D Tanner (Applied Solar Energy Corp., City of Industry, Calif.), G. Pollock, and F. Uno (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 312-315. Contract No. JPL-955089.

This paper describes the results and procedures to evaluate and improve the efficiency of solar cells made from various unconventional silicon sheets. The performance parameters included photovoltaic characteristics, spectral response, dark I-V characteristics, and diffusion length. The evaluation techniques used provided accurate and reliable information on sheet performance, and self-consistent results were obtained from the various measurement techniques used. Minority carrier diffusion length (L) was shown to be the ultimate limiting factor for the sheet cell performance (efficiency) and other back-up measurements confirmed this L-dependence. Limited efforts were made to identify defects which influence cell performance, and to use some improved process methods to increase cell efficiency. (Author)

A81-27115 **Transport properties in 100 mm CZ silicon.** N -T. Phuoc, E. Fabre (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France), H Lauvray, and D. Diguet (La Radiotechnique Compelec, Caen, France) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 322-326. 10 refs Research supported by the Commissariat à l'Energie Solaire

The investigation of the minority carrier transport properties, which govern the conversion efficiency of the solar cells, the starting material being 100-mm Czochralski single-crystal silicon, is carried out. HeNe and YAG laser beam scanning makes the determination of the minority carrier diffusion length and the study of its homogeneity across the surface of the wafer possible. A general degradation of the diffusion length with high temperature annealing and the possibility of minimizing this degradation under specific gettering conditions are noted The super-linear dependence of the photocurrent upon the light flux, which partly compensates for the degradation of the diffusion length after annealing, is observed. K.S.

A81-27116 * **Performance of silicon solar cells fabricated from multiple Czochralski ingots grown by using a single crucible.** A H. Kachare, F. M. Uno, T. Miyahira (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), and R. L. Lane (Kayex Corp., Rochester, N.Y.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 327-331. 8 refs Research supported by the U.S. Department of Energy, Contracts No. NAS7-100; No. JPL-954888.

Results on the performance of solar cells fabricated on wafers from multiple silicon ingots of large diameter, grown by using a single crucible and a sequential melt replenishment Czochralski (CZO) technique are presented. Samples were analyzed for resistivity, dislocation density and impurity content. Solar cells were fabricated from the seed, center and tang end of each ingot to evaluate the growth reproducibility and material quality. The cell efficiency within a given wafer varies by no more than plus or minus 5% of the average value. A small but consistent decrease in the cell efficiency is observed from the first to the fourth ingot grown from a single crucible. This decrease may be related to an increase in impurity content or dislocation density or a combination of both The efficiency of the cells fabricated from the tang end of the fourth ingot is about 10% lower than that of the control cell An impurity effects model is employed to correlate this decrease in efficiency with the impurity build-up in the residual melt. D K

A81-27117 * **Solar cells and modules from dentritic web silicon.** R. B. Campbell, A. Rohatgi, E. J. Seman (Westinghouse Electric Corp., Advanced Energy Systems Div., Pittsburgh, Pa), J. R. Davis, P. Rai-Choudhury (Westinghouse Research and Development Center, Pittsburgh, Pa.), and B. D Gallagher (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 332-336 6 refs. Contract No. JPL-954873

Some of the noteworthy features of the processes developed in the fabrication of solar cell modules are the handling of long lengths of web, the use of cost effective dip coating of photoresist and antireflection coatings, selective electroplating of the grid pattern and ultrasonic bonding of the cell interconnect. Data on the cells is obtained by means of dark I-V analysis and deep level transient spectroscopy. A histogram of over 100 dentritic web solar cells fabricated in a number of runs using different web crystals shows an average efficiency of over 13%, with some efficiencies running above 15%. Lower cell efficiency is generally associated with low minority carrier time due to recombination centers sometimes present in the bulk silicon. A cost analysis of the process sequence using a 25 MW production line indicates a selling price of $0.75/peak watt in 1986. It is concluded that the efficiency of dentritic web cells approaches that of float zone silicon cells, reduced somewhat by the lower bulk lifetime of the former. D.K.

A81-27118 **Recent progress in the development of the cascade solar cell.** S. M. Bedair, S. B. Phatak, M. Timmons (Research Triangle Institute, Research Triangle Park, N.C.), J. Chang, and J. R. Hauser (North Carolina State University, Raleigh, N.C.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 337-340. 11 refs. Contracts No. F33615-78-C-2077; No. XM-9-81361.

The problem of the formation of an ohmic connecting junction for such high bandgap materials as that of the two-junction cascade solar cell is solved by the growth of AlGaAs p(+)/n(+) junctions with Liquid Phase Epitaxy (LPE) techniques. LPE-grown junctions have shown tunneling behavior for bandgaps up to 1.9 eV. Spectral response data for component parts of the cascade solar cell and material properties and junction characteristics for individual junctions and entire cells are discussed. O.C.

A81-27119 **Low bandgap /0.7 to 1.1 eV/ solar cells in the GaAlAsSb/GaSb system.** Y. Z. Liu, H. T. Yang, and J. S. Harris, Jr. (Rockwell International Electronics Research Center, Thousand Oaks, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 341-345. 9 refs. Contracts No. F33615-78-C-2036; No. XS-9-8032-1.

Solar cells with and without window layers made from the alloy system GaAlAsSb/GaSb are compared A 65% improvement is noted for cells with a window layer, and window layers with higher aluminum content are suggested. Homojunction and heterojunction solar cells demonstrate different characteristics in spectral response curves· heterojunction cells show higher short circuit density while homojunction cells show higher open circuit voltage. Open circuit voltage increased to 0.41 C at approximately 45 suns (AM0) concentration for an 0.8 eV bandgap cell under incident photon energies less than 1.4 eV, indicating that low bandgap cells can contribute significantly to performance in multiple bandgap concentrator solar cell applications. L.S.

A81-27120 **Performance losses in high-efficiency monolithic multijunction solar cells.** S. W. Zehr, J. A. Cape, and J. S. Harris, Jr. (Rockwell International Electronics Research Center, Thousand Oaks, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 346-350. 12 refs.

The types and magnitudes of a number of practical losses and their role in limiting the conversion efficiency of several candidate designs of the stacked multibandgap solar cells, under conditions of 500 suns AM2 illumination with converters maintained at a 300 K operating temperature, are considered. Types of photon losses, i.e., shadowing, reflection, shunting and incomplete collection, absorption, and useless spectral fraction are calculated. To explore the relative effects of various losses, the performance of several subcell combinations, along with their AR coatings and the intercell ohmic contact design (IOC options) is examined. The best cell combination seems to be the 1.65/0 9 eV pair (Al(.2)GaAs/Al(.15)GaSb). The major conclusion is that all losses must be held to minimum achievable values to realize the 30% efficiency goal under the given conditions. K.S.

A81-27121 **A low-cost manufacturing process for thin-film solar cells.** T. W. F. Russell, A. M. Barnett, B N. Baron, J. V Masi, and R. E. Rocheleau (Delaware, University, Newark, Del.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p 354-359. 13 refs.

A preliminary process design for manufacturing of thin film cadmium sulfide/copper sulfide solar cells is outlined. The total product cost is determined from raw materials, utilities, labor, and capital using engineering economic procedures of the chemical processing industry. Results are given for manufacturing facilities with annual throughput of 100 and 1000 megawatts Batch and continuous modes of operation are compared. Thin film solar cells can be manufactured for less than $0 5 per watt in a continuous production facility. (Author)

A81-27124 **Pigmented tin oxide solar cell.** J Higgins and H T. Tien (Michigan State University, East Lansing, Mich.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p 369-374 12 refs

An important goal of photovoltaic research is the electrolysis of water to produce hydrogen. Energetic requirements make electrolysis cells driven by two-photon processes more efficient in the solar spectrum. This paper reports a new design of this type: n-type SnO2 made light-sensitive by dye VBB on the photoanode and tetraphenylporphyrin on the photocathode Characteristics are photopotential 0.4 V, photocurrent (5-8) x 10 to the -6th A/sq cm, fill-factor 0 3, power 8 x 10 to the -7th W/sq cm white light irradiation 100 mW/sq cm, quantum efficiency 1.0% Absorption is increased by dyes of complementary spectra and by a battery of stacked, nearly transparent cells, which was chemically stable over two months and delivered power close to the theoretical circuit value (Author)

A81-27125 **Ultra high efficiency thin silicon p-n junction solar cells using reflecting surfaces.** M. Spitzer, J. Shewchun (McMaster University, Hamilton, Ontario, Canada, Brown University, Providence, R.I.), E. S. Vera, and J J. Loferski (Brown University, Providence, R.I.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p. 375-380 8 refs. NSF-supported research, Contract No. XS-9-8233-1.

The theoretical upper limit of the efficiency of silicon p/n junction solar cells is calculated for a cell which incorporates minority carrier mirrors and optical mirrors on both the front and back boundaries of the active part of the device. The two optical mirrors provide optical confinement and greatly reduce the thickness of the cell for optimum performance. If the cells are thin enough, the minority carrier mirrors reduce the saturation current and increase the open circuit voltage. The calculations of the efficiency versus cell thickness show that efficiencies of the order of 27% are possible for silicon cells having a thickness of only 15 microns Ways to realize the optical confinement and the minority carrier mirrors are discussed. (Author)

A81-27126 **Ion implanted grating type Si solar cells - Junction depth dependence** H. L Hwang, D. C. Liu, R. S. Tang, Y R. Kao (National Tsinghua University, Hsinchu, Nationalist China), and J. J. Loferski (Brown University, Providence, R.I.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p. 381-385. 9 refs. National Science Council of Nationalist China Grant No. 68E-0404-03(05)-1979

Silicon grating-type solar cells in which the light receiving surface is covered by a finely spaced grating of charge collection barriers were fabricated by ion implantation. The as-fabricated cells exhibited open-circuit voltage of 0.54V, short-circuit current (AM1) of 32 mA/sq cm (without AR coating), a fill factor of 0.68 and a conversion efficiency of 11%. It was found that annealing at 1100 C for a few minutes followed by a slow cooling rate was required to obtain optimized performance For a fixed grating geometry deep junctions resulted in better cells than shallow junctions within the boron implants The paper describes the results of numerical simulation in which the alternating direction implicit method was employed to obtain the collection efficiencies of grating cells with junction depths varied It also describes the computed AM1 I-V characteristics of grating Si cells. (Author)

A81-27127 **Design considerations for high efficiency polycrystalline silicon MIS solar cells.** K Rajkanan (General Instrument Corp, Hicksville, N Y) and W. A Anderson (New York, State University, Amherst, N Y) In. Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 386-390 8 refs Contract No. DE-AC03-79ET-23044

Cr-MIS solar cells have been fabricated on p-type wacker poly-Si substrates Band to band tunneling and tunneling via surface states have been identified in these devices and the role of surface preparation has been determined. Experimentally determined current conduction mechanisms were used in computer simulation of these solar cells. The optimum process parameters and their sensitivity in determining conversion efficiency have been identified. (Author)

A81-27128 **Vacuum deposited polycrystalline silicon solar cells for terrestrial use** C Feldman, N A. Blum, and F. G. Satkiewicz (Johns Hopkins University, Laurel, Md.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 391-396. 9 refs. Contract No. ET-78-A-03-2208.

The paper describes an effort aimed at obtaining low-cost, 10%-efficiency solar cells through the development of an all-vacuum fabrication process incorporating vacuum-deposited thin-film polycrystalline silicon. Experimental devices have been constructed in layers. alumina substrate/TiB2 bottom electrode/p-type polycrystalline silicon film/diffused silicon n-region/Ti-Ag electrode. An important feature of this design is the TiB2 bottom electrode, which remains conducting after the silicon deposition and subsequent processing Grain growth, film composition, interfacial characteristics, and photovoltaic characteristics were studied. B.J.

A81-27129 **Contiguous capillary coating of silicon on porous carbon substrates.** T. F. Ciszek and J L. Hurd (Solar Energy Research Institute, Golden, Colo.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 397-399.

Contiguous coating of silicon on various porous or grid-like forms of carbon has been investigated as a potential low-cost, low-technology thick-film silicon growth technique. Initial experiments were done on rectangular substrates, although the method would readily lend itself to a reel-to-reel semicontinuous mode of operation. Several types of substrates were investigated, including bulk graphite which was machined into thin perforated sheets and porous reticulated vitreous carbon having 6 to 24 pores per cm. When such substrates are dipped into liquid silicon and withdrawn, the holes or pores are filled and the surfaces are coated. Withdrawal rates of up to 6 cm/min were used and grain sizes were typically 0.1 mm (Author)

A81-27130 **Current transport mechanisms of metal-polycrystalline silicon Schottky barrier solar cells.** W Hwang, E. S. Yang, H C. Card, and C. M Wu (Columbia University, New York, N.Y.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 404-409. 16 refs Contract No DE-AC03-79ET-23049.

We describe the results of a theoretical study of the electrical and photovoltaic properties of metal-polycrystalline silicon contacts An analysis of the dark behavior of these structures reveals that the current may be dominated either by majority carrier or by minority carrier transport, depending upon the conditions of Schottky barrier height and parameters which characterize the grain boundaries Experimental verification of this theory is provided by our present results for Al-cast polysilicon contacts and by previously reported characteristics for thin films The implications for solar cell parameters (open-circuit voltage, fill-factor, and conversion efficiency) are also discussed (Author)

A81-27131 **Variation of diffusion length of ribbon-Si solar cells with light intensity.** A. Pogany (IBM East Fishkill Laboratories, Hopewell Junction, N.Y.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 410-413. 8 refs

Variation of minority-carrier diffusion length Ln with illumination has been measured for ribbon-Si cells, and for cells doped with heavy metals. The ribbon cells generally show a gradual increase of Ln, while the metal-doped cells mostly show one or more sharp increases. These effects are attributed to the presence of multilevel centers, and can be used to characterize the recombination properties of the cells. (Author)

A81-27132 **High efficiency silicon concentrator cells.** S. Khemthong, F. F. Ho, and P. A. Iles (Applied Solar Energy Corp., City of Industry, Calif.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 414-418. 6 refs

Silicon concentrator cells of significantly increased efficiency are described, in design, fabrication and measurements. For n(+)pp(+) cells efficiencies above 19% (at 50X), 18% (at 100X) and 16% (at 200X) were achieved for cells of 6-sq-cm area These results are promising for further improved efficiencies at insolation levels above 200X. Within present process limitations, predictions of the computer model show that 20% efficiency can be achieved for the n(+)pp(+) configuration. Further increases must be sought in other structures, or by achieving conductivity modulation. The work also showed that very consistent cells could be made in lots of several hundred, and that there is therefore a good chance of further cost reduction. (Author)

A81-27133 **Characterization of p/+/nn/+/ BSF silicon concentrator solar cells.** R. D. Nasby (Sandia Laboratories, Albuquerque, N. Mex.) and J. G. Fossum (Florida, University, Gainesville, Fla) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 419-422. 8 refs. Research supported by the U.S Department of Energy.

The characteristics of high-efficiency p(+)nn(+) BSF silicon concentrator solar cells are investigated experimentally and theoretically. Current-voltage characteristics and internal quantum efficiency data are used in conjunction with device analysis to characterize cell behavior, to evaluate physical parameters, and to indicate present limitations on cell performance. (Author)

A81-27134 **A low series resistance silicon photovoltaic cell for high intensity applications.** R I Frank, J L. Goodrich (Microwave Associates, Inc., Burlington, Mass), and R. Kaplow (MIT, Cambridge, Mass.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 423-430. 10 refs. Research supported by the U S. Department of Energy.

A silicon photovoltaic cell is described which is particularly suitable for use at concentrations of 500 to 1000 suns (50 to 100 W/sq cm) incident intensity. The main features of the cell are: (1) As there is no current flow within the junction planes, the surface area viable for metallization is large compared with the obscured surface area, (2) it has a very low series resistance, permitting the efficiency to increase with increasing intensity, (3) it is tolerant of extremely non-uniform illumination, (4) the temperature coefficient of efficiency decreases by a factor of about 2 as the intensity is increased from 1 to 1000 suns, (5) p+ and n+ contacts are on opposite sides so that it may be soldered directly to a heat sink for effective cooling, (6) it can be fabricated as a number of cells on a single wafer and then cut into single cells with a negligible effect on performance Efficiencies of the cells range from about 17% at 100 suns for large cells to 20% at 600 suns for small laboratory prototype cells An efficiency of 21 3% at 1000 suns is expected with a nitride AR coating D.K.

A81-27135 **The effects of nonuniform illumination and temperature profiles on silicon solar cells under concentrated sunlight.** R. W. Sanderson, D. T. O'Donnel, and C. E. Backus (Arizona State University, Tempe, Ariz.). In· Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 431-436. 5 refs. Research supported by the U.S. Department of Energy.

The independent effects of either nonuniform illumination or nonuniform temperature distribution on the performance of silicon solar cells under concentrated sunlight are examined. Results from both a theoretical model and experimental observations show that the electrical performance of the concentrator solar cell under nonuniform temperature is dependent on both the magnitude and the location of the nonuniform temperature profile. The model results, however, failed to predict the degree of bending of the open circuit voltage curve which was observed experimentally For nonuniform illumination, experimental and theoretical results show that both the efficiency and the open circuit voltage are decreased compared with the uniform illumination case. The nonillumination profiles included step changes of illuminated to nonilluminated parts of the cell as well as continuously varying profiles across the geometry of the cell. It is found that the efficiency and the overall voltage of the cell can be increased by illuminating the cell closer to the busbar. D.K

A81-27136 **Effects of nonuniform illumination on the performance of silicon concentrator solar cells.** C M. Garner and R. D. Nasby (Sandia Laboratories, Albuquerque, N. Mex.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 437-442. 6 refs. Research supported by the U.S. Department of Energy.

Nonuniform illumination of silicon solar cells can result in degradation of the fill factor and conversion efficiency. In this study, solar cell performance has been computer modeled to account for the intensity distribution incident on the cell. The results from this model have been found to agree well with experimental data obtained on several n(+)-p cells with conventional front grid patterns that were tested under uniform and nonuniform illumination profiles. Voltage drops in the diffused layer were found to produce most of the degradation of performance and the calculations demonstrate that this degradation can be reduced by decreasing the grid line separation and width. (Author)

A81-27137 **Design of metallization for higher-efficiency solar cells.** N. G. Sakiotis (Motorola, Inc., Semiconductor Group, Phoenix, Ariz.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 443-448.

An analytical approach is outlined for the determination of front- and back-surface metallization patterns which provide for optimized overall efficiency under given constraints. Results of numerical calculations for a simple pattern illustrate optimum values of line width and fractional coverage and their dependence upon metal resistivity, substrate thickness and input concentration (Author)

A81-27138 **Effects of temperature variation in concentrator cell series resistance measurements.** J A Cape and S. W Zehr (Rockwell International Electronics Research Center, Thousand Oaks, Calif). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 449-452. 7 refs

A81-27139 **Cuprous oxide MIS solar cells.** E Y Wang, D Trivich, R. J. Komp, I.-F. Huang, and D J. Brinker (Wayne State University, Detroit, Mich.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p. 458-461. 12 refs. Contract No. ER-78-S-02-4995.

Cuprous oxide MIS solar cells were made with SiO2 interfacial layers of thickness ranging from 10 to 100 A, and semitransparent layers of Au, Cu, Ag and Al. Results from current-voltage measurements show that Au/SiO2/Cu2O MIS devices are ohmic in nature and have no photovoltaic effect. Ag/SiO2/Cu2O, Cu/SiO2/Cu2O and Al/SiO2/Cu2O exhibit rectifying and photovoltaic characteristics Capacitance-voltage measurements indicate that the space charge region is approximately 0 5 microns wide The wavelength dependence of the open-circuit photovoltage has a peak at 2.56 eV which can be correlated with reported Cu2O absorption coefficients (Author)

A81-27140 **Investigation of Cu2O solar cells.** L C Olsen, F. W. Addis, and R C Bohara (Joint Center for Graduate Study, Richland, Wash) In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p. 462-467. Research supported by the U.S. Department of Energy.

This paper includes discussion of an approach used for Cu2O substrate fabrication, electrical and optical properties of Cu2O, photocurrent analysis and experimental results for Cu2O solar cells An AM1 photocurrent of 8 5 mA/sq cm and AM1 efficiency of 1.8% has been achieved for Cu-Cu2O MIS cells based on a tentatively identified I-layer of CuBr Studies of MIS cells fabricated with an evaporated SiO2 I-layer are discussed as well as preliminary results for ZnS/Cu2O and ZnO/Cu2O heterojunctions. (Author)

A81-27141 **Characterization of ZnO for the fabrication of conductor-insulator-semiconductor /CIS/ solar cells.** D E Brodie, R Singh, J. H. Morgan, J. D. Leslie, C. J. Moore, and A E. Dixon (Waterloo, University, Waterloo, Ontario, Canada). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 468-471. 16 refs.

A81-27142 **Thin film polycrystalline solar cells prepared by electrodeposition.** Z. Shkedi and R. L. Rod (Monosolar, Inc., Inglewood, Calif). In· Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 472-475. 5 refs Contract No DE-AC04-79ET-23008.

Thin film polycrystalline CdTe photovoltaic cells were prepared by electrodeposition. It is shown that polycrystalline material can be grown at low temperatures. Crystallinity studies of the thin film CdTe material are reported. The first thin film polycrystalline homojunction CdTe cell is reported. I-V characteristics of homojunction and of Schottky barrier cells on electrodeposited CdTe are presented. (Author)

A81-27143 **ZnSe solar spectrum converter for GaAs solar cells.** D. Walsh (McGill University, Montreal, Canada) and Y.-H.

Shing (McGill University, Montreal, Xerox Research Centre of Canada, Mississauga, Ontario, Canada) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. (A81-27076 11-44) New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 476, 477.

A ZnSe solar spectrum converter utilizing the self-activated luminescent property is proposed for improving the efficiency of GaAs solar cells by down-converting the solar photons with energy greater than 2.3 eV. The integrated ZnSe converter and GaAs solar cell assembly can achieve high spectral response, high collection efficiency, low reflection loss, minimum attenuation and low operating temperature. The low-cost ZnSe can also be employed as the substrate for this 'solar matched' GaAs photovoltaic cell (Author)

A81-27145 * **Low-cost conversion of polycrystalline silicon into sheet by HEM and FAST.** C P. Khattak and F. Schmid (Crystal Systems, Inc., Salem, Mass.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 484-487. 10 refs. Research sponsored by the U.S. Department of Energy and NASA.

The conversion of polycrystalline silicon to sheet form (the wafers produced are 10 cm x 10 cm cross section with minimum surface damage) by the Heat Exchanger Method (HEM) and multi-wire Fixed Abrasive Slicing Technique (FAST), as a means of reducing the cost of solar arrays for adaptation of photovoltaic technology for terrestrial applications, is given. A schematic of a HEM furnace, which includes a silica crucible, and developments in the HEM process are presented. A new machine for slicing with wire was designed and fabricated. The high-speed slicer has been used to slice 19 wafers per cm from 10 cm diameter crystals. Both HEM and FAST are low-cost processes and they have the potential of giving one of the lowest add-on costs ($6.24 and $6.48 per square meter of sheet respectively, with the combination add-on cost of $14.87 per square meter) of this conversion. K.S.

A81-27146 * **Flat plate vs. concentrator solar photovoltaic cells - A manufacturing cost analysis.** L A. Granon and M. G Coleman (Motorola, Inc., Semiconductor Group, Phoenix, Ariz.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 488-493 Research supported by the U.S. Department of Energy, Contracts No JPL-954363, No JPL-954847.

The choice of which photovoltaic system (flat plate or concentrator) to use for utilizing solar cells to generate electricity depends mainly on the cost A detailed, comparative manufacturing cost analysis of the two types of systems is presented. Several common assumptions, i.e., cell thickness, interest rate, power rate, factory production life, polysilicon cost, and direct labor rate are utilized in this analysis. Process sequences, cost variables, and sensitivity analyses have been studied, and results of the latter show that the most important parameters which determine manufacturing costs are concentration ratio, manufacturing volume, and cell efficiency. The total cost per watt of the flat plate solar cell is $1.45, and that of the concentrator solar cell is $1.85, the higher cost being due to the increased process complexity and material costs. K.S.

A81-27147 * ***The spectral irradiance of some solar simulators and its effect on cell measurements.*** C H. Seaman, B. E. Anspaugh, R G. Downing, and R. S. Estey (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 494-499.

Moderate resolution spectral irradiance measurements in the range 300 nm to 1100 nm have been made of eight radiant sources which are currently being used as solar simulators. Spectral irradiance data are presented in graphical form. To demonstrate the interplay of source spectral distribution and cell spectral response, measurements of short circuit current of five cells of differing response characteristics have been made with these sources. These results are presented in tabular and graphical form. (Author)

A81-27152 **The energy balance associated with the use of a maximum power tracer in a 100-kW-peak power system** L L Bucciarelli, B. L. Grossman, E. F. Lyon, and N E Rasmussen (MIT, Lexington, Mass.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 523-527 Research sponsored by the U S. Department of Energy.

A81-27153 * **Circuit design considerations for photovoltaic modules and systems.** C. Gonzalez and R. Weaver (California Institute of Technology, Jet Propulsion Laboratory, Applied Mechanics Div., Pasadena, Calif.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 528-535.

A81-27154 **Concepts for GaAs//AlGa/As solar cells with valley-transferred electrons for voltage and efficiency enhancement.** A. G. Milnes (Carnegie-Mellon University, Pittsburgh, Pa.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 536-540. 14 refs.

A81-27155 **Thick film conductive ink contacts for concentrator cells.** I R. Lawrence (Spectrolab, Inc, Sylmar, Calif) In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 541-544. Research supported by the U.S. Department of Energy

A concentrator cell process utilizing thick film conductive ink technology for the front contact offers the premium performance characteristics of an evaporated metal front contact but without costly vacuum processing. Photosensitive resist is used as a mask to form the narrow, thick contact pattern required to reduce the series resistance for concentrator cells This process is integrated with advanced flat plate cell processes to achieve further cost reductions Front contact fingers 35 microns wide on 300 micron centers have been made using this process Techniques for producing sufficient contact thickness with fingers less than 50 microns wide are being developed. (Author)

A81-27156 **Production of high efficiency silicon concentrator solar cells from state-of-the-art design and processing.** L. A Grenon, N. G. Saklotis, and R. A. Pryor (Motorola, Inc., Semiconductor Group, Phoenix, Ariz.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 545-549 5 refs

A manufacturing development program has resulted in the fabrication of silicon concentrator solar cells of efficiency greater than 18% at 50 suns AM1. A number of substrate materials and process parameters were examined to optimize the solar cell for 50 sun concentration applications. This paper reviews the criteria used to determine the resistivity, orientation, thickness and diffusion length of the substrate as well as those for the optimization of junction characteristics, the metallization pattern design, and for the selection of compatible process steps capable of producing a high efficiency cell. (Author)

A81-27157 **Polka Dot Solar Cell.** R. N. Hall and T. J. Soltys (General Electric Co., Schenectady, N.Y.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 550-553.

The Polka Dot Solar Cell has a shallow collecting junction on its front surface and a deeper junction of the same type over most of the back. Photocurrent is collected by both junctions which are connected in parallel by a multiplicity of small-area interconnect paths, formed by patterning the back and etching pyramidal indentations which barely penetrate through the front surface. All of the metallization is applied to the back which is interdigitated to permit ohmic contact to the substrate Experimental results are presented and compared with calculated performance. (Author)

A81-27158 **A monolithic series-connected Al/.93/Ga/.07/As/GaAs solar cell array.** P. G. Borden (Varian Associates, Palo Alto, Calif). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 554-562. 7 refs.

A81-27159 **Designing practical silicon solar cells approaching the 'limit conversion efficiency'.** M. Wolf (Pennsylvania, University, Philadelphia, Pa.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 563-568. 11 refs.

To facilitate rapid low-cost design studies on multilayer solar cells, an analytical method has been developed to replace, for the low-level injection cases, the cumbersome numerical calculations. The method is based on expressing the minority carrier currents as a product of a carrier density and a transport velocity, and on using the superposition principle to the fullest. Each layer can be separately considered as active, i.e., contributing light-generating carriers, or passive, i.e., transporting excess carriers across them. For active layers, the light-generated carrier concentrations at their boundaries are determined. The carrier concentrations and transport velocities are transformed across each passive layer to calculate the total light generated and saturation currents. B.J.

A81-27160 **Theoretical design considerations for back surface field solar cells.** J R. Davis and A. Rohatgi (Westinghouse Research and Development Center, Pittsburgh, Pa.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 569-573. 10 refs.

A simple analytic model of a solar cell is described which provides optimum design rules for back surface field structures. The model provides useful insight into the relative impact of surface and bulk recombination on device performance. Results agree well with experimental data. An optimum back surface field structure is shown to consist of a passivated surface and a thin p(+) region with constant doping in the mid 10 to the 18th/cu cm range. (Author)

A81-27161 **Two modified single diode models for simulating solar cells with distributed series resistance.** R. T. Otterbein and D. L. Evans (Arizona State University, Tempe, Ariz.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 574-579. 9 refs. Research sponsored by the U.S. Department of Energy.

A81-27162 **Theoretical limit efficiency of direct gap solar cells.** M. Spitzer, J. J. Loferski (Brown University, Providence, R.I.), and J. Shewchun (McMaster University, Hamilton, Ontario, Canada). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 585-590. 13 refs. Research supported by the U.S. Department of Energy and NSF.

The theoretical upper limit conversion efficiency is calculated as a function of cell thickness and junction position for a homojunction solar cell made from a direct gap semiconductor in which homogeneously doped n- and p-regions are terminated by surfaces having zero surface recombination velocity and in which an optical mirror is incorporated on the surface opposite that on which light is incident. Most of the calculations are focused on CuInSe2 with a portion of the effort devoted to GaAs. For CuInSe2 cells, the principal conclusion is that the thickness at which optimum AM1 efficiency is obtained is somewhat less than 2 microns and that this efficiency is approximately 26%. The effects of finite values of surface recombination velocity are included. (Author)

A81-27163 **Heterojunction solar cell design and evaluation.** S. J. Fonash and S. Ashok (Pennsylvania State University, University Park, Pa.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 591-595. 10 refs.

A heterojunction solar cell model which explicitly shows the competition among various channels of current flow in these structures is presented. The model gives a general set of criteria for the design and evaluation of p-n window/absorber heterojunction solar cells in terms of a set of dimensionless numbers F(D2), F(I), and F(D1). Other heterojunction models are compared to this very general formulation. Heterojunction solar cell structures are also discussed in the light of this model and the resulting design criteria. (Author)

A81-27164 **A new method of measuring diffusion length and surface recombination velocity.** Y. S Kim, C. I. Drowley, and C. Hu (California, University, Berkeley, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 596-600. 8 refs.

In this novel new method, chopped light that may be broadband and of unknown but constant intensity is incident from the bulk side of the test cell. The photocurrent is measured as a function of the effective bulk thickness of the cell, which is varied by varying the junction reverse bias. The diffusion length and the surface recombination velocity of the bulk material can be deduced from the data directly, without curve fitting. The effective surface recombination velocity at an oxidized silicon surface can be varied by applying a bias voltage to a transparent gate electrode. The recombination velocity can exhibit a maximum when the surface is depleted. (Author)

A81-27165 **Inhomogeneities in silicon solar cells and their influence on cell performance - An experimental study.** B L. Sopori (Motorola, Inc., Semiconductor Group, Phoenix, Ariz.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 606-611.

Inhomogeneities in solar cells fabricated on low cost silicon substrates can be categorized as they give rise to localized variations in cell characteristics (1) lateral (parallel to the junction) and (2) in-depth (normal to the junction). It has been found that the dominant sources of lateral inhomogeneities are localized crystal imperfections in as-grown material, whereas the in-depth inhomogeneities are generally process induced. The influence of either type of nonuniformity on solar cell performance can be represented in terms of an 'effective' minority carrier diffusion length. Techniques for measuring this diffusion length have been developed and it is shown, based on this concept, that cells with each type of nonuniformity can be represented by a simple, phenomenological, lumped equivalent circuit. These large area equivalent circuits can be used to determine the average solar cell performance. (Author)

A81-27166 **Majority carrier conduction effects in ITO/SIS solar cells.** J. DuBow (Colorado State University, Fort Collins, Colo.) and S. Kar (Indian Institute of Technology, Kanpur, India). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 619-622. Research supported by the U.S Department of Energy.

A81-27167 **Progress toward large area amorphous silicon solar cells.** J. J. Hanak (RCA Laboratories, Princeton, N.J.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 623-628. 14 refs. Research sponsored by RCA; Contract No. XJ-9-8254.

Techniques for fabricating a-Si:H solar cells are suitable for areas of several sq m. However, with increasing area, problems with current collection and electrical shorting escalate. This paper reports the development of two significant, large-area structures. One is a series-connected cell, the monolithic solar cell panel (MSCP), which solves the problem of current collection in arbitrarily large cells. Next is a high voltage, stacked (multiple-junction) monolithic solar cell panel (SMSCP), which has the potential of higher efficiency because of more efficient utilization of light. Methods are reported for locating, removing, and preventing electrical shorts. A drastic reduction in shorts is achieved by using a thin, front, Pt-SiO2 cermet; further reduction is achieved with a thick, back cermet such as Ni-SiO2. (Author)

A81-27168 **The CdSe thin-film solar cell.** D. Bonnet and E. Rickus (Battelle Institut, Frankfurt am Main, West Germany). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 629-632. Research sponsored by the Commission of the European Communities and Bundesministerium fur Forschung und Technologie.

The deposition conditions for the 3-micron thick evaporated CdSe films have been optimized with regard to solar cell properties. Some problems posed by the starting material have been solved by synthesizing CdSe from its elements. The best insulating layer consists of ZnSe. Using transparent Au contacts, cells have been prepared which show efficiencies around 6 percent, referring to solar light falling upon the CdSe. The influence which CdSe film orientation and morphology have on the cell performance is illustrated and discussed. (Author)

A81-27169 **ZnO films and ZnO/CdTe heterojunctions prepared using spray pyrolysis.** J. A. Aranovich, A. L. Fahrenbruch, and R. H. Bube (Stanford University, Stanford, Calif.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 633, 634. Research supported by the U.S Department of Energy

Using the essentially low cost technique of spray pyrolysis, highly transparent ZnO films with a resistivity as low as 0.001 ohm-cm have been produced by suitable control of deposition conditions and post-deposition annealing. A detailed structural, optical, electrical and thermoelectrical characterization of these films has been made. The preparation of ZnO/CdTe heterojunctions by spray pyrolysis deposition of ZnO on single crystal p-type CdTe has been systematically investigated, and a consistent model involving control of forward currents by bulk and interface deep traps has been developed. The best cell prepared to date shows V(oc) = 0.54 V, J(sc) = 19 5 mA/sq cm and solar efficiency of 8.8% referred to active area but uncorrected for reflection losses. (Author)

A81-27170 **Thin polycrystalline Zn3P2 films for photovoltaic cells.** A Catalano, M. Bhushan, and N. C Wyeth (Delaware, University, Newark, Del). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 641-646. 14 refs Research supported by the U.S. Department of Energy and Pennsylvania Power and Light Co.

Thin films of zinc phosphide deposited by close space vapor transport onto mica are characterized. The polycrystalline films are highly oriented, and typically have a grain size of 5-10 microns for a 10 micron-thick film. The electrical resistivity of the films is in the range of 100-300 ohm-cm, and the effective minority carrier diffusion length scales with grain size between 0.5-3 6 microns. The barrier height of Schottky diodes fabricated on thin films of zinc phosphide is close to the 0 81 eV found in single crystals The Schottky barrier grid devices manufactured on thin films demonstrate a total area conversion efficiency of 1 58% and an active area conversion efficiency of 4 0% The spectral response of the devices is flat at short wavelength, indicating negligible losses due to surface recombination L S

A81-27173 **Indium phosphide films for photovoltaic devices.** T. L. Chu, S S. Chu (Southern Methodist University, Dallas, Tex), C L Lin, C. T Chang, Y C Tzeng, A B. Kuper (Poly Solar, Inc., Garland, Tex.), L L. Kazmerski, and P. J Ireland (Solar Energy Research Institute, Golden, Colo.) In· Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 661-666 12 refs. Research supported by the Electric Power Research Institute

Indium phosphide films are deposited on coated graphite substrates by the reaction of indium, hydrogen chloride, and phosphine in a gas flow The important process parameters include the temperature of the substrate, and the flow rates of hydrogen, hydrogen chloride, and phosphine. The rate of indium phosphide nucleation decreases with increasing temperature, and continuous films cannot be obtained at very high temperatures. Schottky barriers prepared from these films are found to exhibit low rectification ratios, high dark currents, and poor photovoltaic response due to grain boundary effects Thermal oxidation, ruthenium treatment, and nitridation are found to reduce the grain boundary effects and improve the photovoltaic characteristics of the indium phosphide thin-film Schottky barrier devices L S.

A81-27174 * # **Space solar cells - High efficiency and radiation damage.** H W Brandhorst, Jr. and D. T. Bernatowicz (NASA, Lewis Research Center, Cleveland, Ohio.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 667-673 22 refs

The proceedings of the Third Solar Cell High Efficiency and Radiation Damage Meeting are outlined. The topics covered included high efficiency silicon solar cells, silicon solar cell radiation damage, GaAs solar cell performance, and 30 percent conversion devices. The study of radiation damage from a fundamental defect-centered basis is discussed and evaluated as a focus of future work. 18% AM0 efficiency and 0 7 V open-circuit voltages are designated as achievable goals for silicon solar cells, and the potential for 30% AM0 efficiencies from monolithic tandem cell designs without sunlight concentration is noted. In addition to its potential for 20% AM0 efficiencies, the GaAs cell offers the possibility of a radiation-insensitive power supply when operated at temperatures near 200 C L S.

A81-27175 **High efficiency silicon solar cells.** M Wolf (Pennsylvania, University, Philadelphia, Pa) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7 10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 674-679. 14 refs

The narrow region design approach for obtaining high open circuit and maximum power point voltages in solar cells is discussed The design relies heavily on low effective surface recombination velocities in front and back in conjunction with a textured front surface and an optical internally reflecting back surface. The cell design requires a thin cell in the 50-150 micron range with a thicker front region than conventional designs. The low transport velocities at the back of the narrow base layer are attainable by the addition of two layers with one layer including a drift field or a high/low junction, and the other layer having low resistivity with a thickness on the order of one diffusion length. The front region requires surface passivation by an oxide layer It is noted that high doping effects can be avoided using the proposed design. L.S.

A81-27176 * **Review of physics underlying recent improvements in silicon solar-cell performance.** F A Lindholm and J. G. Fossum (Florida, University, Gainesville, Fla.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 680-683. 20 refs Research sponsored by the U.S. Department of Energy and NASA.

This paper provides a unifying view of the physics of silicon solar cells, and uses it as a basis for explaining how recent improvements in the performance of these cells have been achieved The unification is facilitated by a region-by-region analysis of the solar cell, which is also used to compare several recently proposed cell structures. (Author)

A81-27177 **Laser processing for high-efficiency silicon solar cells.** R. F. Wood and R. T. Young (Oak Ridge National Laboratory, Oak Ridge, Tenn.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 688-693. 12 refs. Contract No W-7405-eng-26.

The experimental and theoretical aspects of the physics of pulsed laser annealing are reviewed with attention to the application of laser processing to solar cell fabrication. The approaches to junction formation discussed include ion implantation followed by laser annealing, laser-induced diffusion of surface-deposited dopants, laser recrystallization of doped amorphous films, and laser annealing after dopant implantation by glow and corona discharge. Cells made from 15 ohm-cm base material with junctions formed by ion-implantation and laser annealing or by laser-induced diffusion of surface-deposited dopants give 15% AM1 efficiencies without back surface fields or front surface passivation. Radiation from Q-switched lasers can also be used to clean up the emitter region in cells made by conventional thermal diffusion and to control grain boundary diffusion in polycrystalline materials L.S.

A81-27178 **An investigation of the Cu/x/S-CdS structure for photovoltaic conversion using an A11 film vacuum deposited process.** T Vanderwel, F Scholz, D. Burk, N. Dalacu (McMaster University, Hamilton, Ontario, Canada), R Clarke (Garrett Manufacturing, Ltd., Toronto, Canada), and J. Shewchun (McMaster University, Hamilton, Ontario, Canada, Brown University, Providence, R.I). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p. 694-699 14 refs. National Research Council Grant No. 05X-78-00091.

An all-evaporation process is used to fabricate good efficiency Cu(x)S-CdS thin film solar cells Isolated Cu(x)S layers are prepared using the resistance heated evaporation of specially prepared chalcocite for the evaluation of the individual materials comprising the solar cell The optical properties of the isolated film are used to determine phase and thickness of the Cu(x)S layer in the cell. The optical diagnostic method is applied to monitor the film depositions and characterize the post-evaporation treatment required to activate the cell The preliminary results of heat treatment studies are provided L.S.

A81-27179 **A microstructural study of the heterojunction materials of the CdS-Cu2S solar cell.** K. H. Norian and J. W. Edington (Delaware, University, Newark, Del.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 700-705. 8 refs. Contract No. XR-9-8063-1.

The grain size, dislocation density, and microscopic defect structure of CdS films used in photovoltaic cells have been determined. In addition, the topography of the CdS-Cu2S interface has been studied. The major features of the Cu2S films and the common features of the interface have been delineated. Moreover the various types of defects that can occur if the material is not grown under ideal conditions are described. Most of these can be avoided by proper control of film growth conditions. The influence of defects on the electrical properties of the cell is discussed. (Author)

A81-27180 **Growth and evaluation of CdS and /CdZn/S films for the fabrication of high performance photovoltaic devices.** R. B Hall, R W. Birkmire, E Eser, T L Hench, and J D. Meakin (Delaware, University, Newark, Del) In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p 706-711. 11 refs Contract No. XR-9-8063-1.

The CdS and (CdZn)S material characteristics required for the fabrication of high performance solar cells are identified. Resistivity, photoluminescence spectral characteristics, and microstructure are examined A quantitative model is used to interpret the relationship between the measured material properties and cell parameters. A high yield of CdS films is achieved which satisfies all criteria, and gives test cells with short circuit currents in excess of 20 mA/sq cm and open circuit voltages in excess of 0.510 volts. By adjusting the growth parameters, low-resistivity (CdZn)S films (less than 20 ohm-cm) having zinc compositions of up to 20% are achieved It is found that post-deposition heat treatments in an H2 atmosphere reduce the resistivity of the (CdZn)S films which initially fail that criterion L.S.

A81-27181 **Cu2S-CdS sprayed solar cells.** M Perotin, J. Bougnot, J Marucchi, O. Maris, R Daures, C Grill, and M. Savelli (Montpellier II, Université, Montpellier, France) In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 712-717. 11 refs.

The properties of spray-deposited CdS layers are discussed with attention to purity and optical characteristics. An apparatus is described for obtaining a homogeneous deposit on a 100 sq cm surface. A rotating driving system permits the nozzle to sweep around the hot plate on which the 25 substrates are placed, and a thermo-couple mounted on a substrate monitor provides control of the substrate heater During the course of the spraying procedure, the maximum variation of the substrate is approximately 5 C. The resulting Cu2-CdS photocells have a conversion efficiency of 6.3 percent. L S

A81-27182 **The role of deep levels in controlling the photovoltaic properties of Cu2S/CdS heterojunction.** W G. Haines and R. H. Bube (Stanford University, Stanford, Calif.). In· Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 718-721. 8 refs. Research supported by the U.S. Department of Energy.

A81-27183 **Optical absorption coefficient changes in Cu2S as the cause of short circuit current changes in Cu2S/CdS solar cells.** A. Rothwarf and H Windawi (Delaware, University, Newark, Del.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 722-727 32 refs. Contracts No. XR-9-8063-1; No EG-77-C-01-4042.

A81-27184 **Cu/x/S growth kinetics and composition analysis by absorbance transient and galvanic electrochemical measurements.** L. F. Donaghey, J. A. Duisman, T. M. Peterson, and P. R. Ryason (Chevron Research Co., Richmond, Calif.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 728-733. 11 refs.

New techniques for characterizing the Cu(x)S layer in the CdS-Cu(x)S thin film solar cell are described. The kinetics of Cu(x)S film growth by the topochemical reaction of CdS with aqueous CuCl are established by a nondestructive optical method using transient optical absorbance of an He-Ne laser beam from which microstructural information can be deduced Different kinetic orders are demonstrated by CdS films prepared by evaporation, spray pyrolysis, and vapor transport The composition profiles in topochemically formed Cu(x)S films are determined by a galvanic electrochemical method with dilute electrolytes. When strong electrolytes are used, substructural information within the Cu(x)S layer can be obtained L S.

A81-27185 **Current-voltage analysis of the Cu2S/CdS solar cell with an interdigitated grid.** J E Phillips (Delaware, University, Newark, Del.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 734-737. 6 refs. Contract No XR-9-8063-1.

A technique is developed for the quantification of the fill factor losses due to the Cu2S layer on an operating CdS-Cu2S solar cell that neither varies with the light intensity nor assumes that deviations from the ideal diode behavior are caused solely by the Cu2S layer The necessary conditions for measuring the Cu2S losses can be met by applying an interdigitated grid consisting of two sets of interleaved parallel grid wires connected to a tab or bus bar at opposite ends of the cell Testing a cell of this type with each tab individually and with both tabs connected together gives a set of current-voltage characteristics that differ only in effective grid spacing This grid structure also modifies the solar cell to give a three-terminal device which permits the measurement of the current-voltage characteristics of the Cu2S layer decoupled from the rest of the cell. L S

A81-27186 **Cells and modules for linear P.V. concentrator systems with forced cooling.** E. Bellafronte, M Giuffrida, S. Pidatella, A Repetto, and P. E Zani (Ansaldo S.p A., Genoa, Italy) In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 738-742 Research supported by the Consiglio Nazionale delle Ricerche

Solar cell and module technology using liquid forced cooling is reviewed The average efficiency of the cell designs under development in Genoa, Italy is over 15% at 30 C. The assembly chosen for the modular element has a total collector area of 47 sq m and a power capacity of 4 5 kW The assembly is bonded to the cooler system with silicon resin preimpregnated tape The cooler is aluminum extruded with a flange for coupling with the photovoltaic receiver and the concentrator. The proposed design is easily transportable and permits eventual substitutions The results of thermal cycling, salt spray and humidity tests are provided. L S.

A81-27187 **Optimization of a photovoltaic receiver for a parabolic trough concentrator.** C. M. Garner and F. Biggs (Sandia Laboratories, Albuquerque, N Mex.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 743-748 Contract No DE-AC04-76DP-00789

The optimum receiver design for two models of parabolic trough is considered. Cell size, cell design, and receiver shape are selected on the basis of the maximum cell power attainable with the least sensitivity to changes in the position of the receiver. A description of the concentrator geometry is given, and the model used to calculate the flux-density pattern on the absorber strip is discussed. A code is described that determines the electrical behavior of the photocells corresponding to the calculated flux-density pattern The best performance of a photovoltaic receiver with a 92 deg rim-angle parabolic trough is achieved at a 30 deg absorber inclination with the Y-axis and 2.5 cm cells for both the Gaussian and wavy-trough models L S

A81-27188 **Parabolic troughs concentrators photovoltaic module.** M Giuffrida, M Bisagni, G P Tornielli, S Pidatella, and A Repetto (AMN, Ansaldo S.p A., Genoa, Italy) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 749-753. 5 refs.

The design characteristics are described of a photovoltaic module with a parabolic trough concentrator under development in Genoa, Italy The rated power capacity of the module is 4 5 kWp, and the initial reflectivity is 0.92 Two trackers control the elevation movement of the two parabolic troughs by means of a shadow-band photodiode couple, and the third tracker controls the azimuthal movement of the turntable by means of a wide angle acquisition system. The solar cells are 33 x 33 mm single crystal silicon cells bonded on an aluminum cooler A photovoltaic plant utilizing two of the modules is presently in operation in Perth, Australia L S

A81-27189 **Low-cost, high-performance, point-focus concentrator array design.** B D Shafer, M W Edenburn, M Garner, and H Togami (Sandia Laboratories, Albuquerque, N. Mex) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 754-759 7 refs Research supported by the U S Department of Energy

The design of a point-focus photovoltaic concentrator array that will meet a goal of $2 80 per peak watt is discussed The optics are high efficiency Fresnel lenses which are parqueted into the lens arrays with five lenses on each side for low cost fabrication The silicon cells are mounted on a solid copper stud which incorporates a solder-bonded alumina wafer for electrical standoff and good thermal conduction between the cell and the stud The 0 15-cm-thick planar heat sink is formed into the box which comprises the module housing, and the modules are mounted on a turntable for two-axis tracking The structure to be used for tracking the modules will vary with the intended application L S

A81-27190 **Efficiency and stability of experimental fluorescent planar concentrators /FPC/.** V Wittwer, K Heidler, A Zastrow, and A Goetzberger (Fraunhofer-Institut fur angewandte Festkorperphysik, Freiburg im Breisgau, West Germany) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 760-764 10 refs. Bundesministerium fur Forschung und Technologie Contract No ET-4190-A

The limiting operating principles of fluorescent solar energy conversion are reviewed The typical electrical AM 1 5 Si efficiency of a single stage fluorescent planar concentrator with a dye emitting at 570 nm is improved to 1 1% The efficiency of a collector stack not yet optimized is 1 7% under AM 1 5 Higher efficiencies are obtained under diffuse weather conditions Outdoor and indoor stability tests demonstrate that the degradation of many of the dyes investigated is due to a decomposition of the dye leading to additional absorption in the fluorescent region L S

A81-27191 **Minimizing end shadowing effects on parabolic concentrator arrays** K Bardwell, T J Lambarski, R M Turfler (BDM Corp, Albuquerque, N Mex), and C B Rogers (Sandia Laboratories, Albuquerque, N Mex) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 765-770

The results are presented of two circuit analyses performed to determine the optimal placement of bypass diodes for a 20-foot long, north-south oriented tracking parabolic collector at 35 deg latitude The modeled collector consisted of four series-connected cell modules containing 22 series-connected cells each, and each of the seven diode configurations studied was chosen to accommodate one 22 cell module Both the HP-9830 and PV-TAP simulations utilized identical input parameters for cell characteristics, insolation data, and receiver tube and shadow geometry. The most cost effective design located the first cell in the southernmost cell module 15 8 in from the collector edge The PV-TAP analysis predicted a 7 8% loss and the HP-9830 analysis predicted an 8.0% loss in the annual array energy output due to end shadowing for the optimized diode configuration. L.S.

A81-27192 **Active and passive cooling for concentrating photovoltaic arrays.** M. W. Edenburn (Sandia Laboratories, Albuquerque, N Mex.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 771-776. Research supported by the U.S. Department of Energy.

Active and passive cooling designs for point-focus Fresnel lens and line-focus parabolic trough concentrating photovoltaic arrays are optimized on the basis of minimum energy cost. Passive cooling is most effective for point-focus lenses smaller than 0.093 sq m and is not cost-effective for larger ones Point-focus arrays using passive heat exchangers designed for minimum energy cost must have a high cell-temperature defocus capability. Passive cooling will not be cost effective for parabolic trough arrays with 1.83 m apertures and concentration ratios above 20 because the high heat flux results in a large temperature difference across the conduction paths between the cell and the heat-exchange surface Heat pipe technology may be used to solve this problem. L.S.

A81-27193 **Design and operation of the Solarex two-axis tracking linear concentrating collector system.** R. C Hamilton, A. S. Levine, J H. Wohlgemuth, and C. Y. Wrigley (Solarex Corp., Rockville, Md.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 777-782. Research supported by the U.S. Department of Energy.

A two-axis tracking photovoltaic collector system is developed based on operating experience with earlier prototype configurations. The collector comprises four east-west tracking mirror troughs on a north-south tracking frame The low-cost frame structure affords good stability under severe wind loading. A trough efficiency of 10.3% at 28 C coolant temperature is demonstrated with a line-focus receiver incorporating textured-surface silicon cells. A series/parallel cell-interconnect scheme is devised to minimize the effect of illumination nonuniformities along the length of the receiver. Test data are presented for a prototype system designed to deliver 1.2 kWe from each of two four-collector arrays. L.S.

A81-27194 * **A reactive plasma process for forming metal grid patterns in solar cell antireflection coatings.** T. G. Sparks and R A. Pryor (Motorola, Inc , Phoenix, Ariz.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 783-786. Contract No. JPL-954847.

A81-27195 * **Screenable silver and base metal solar cell contacts.** B. Ross (Bernd Ross Associates, San Diego, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 787-792. 15 refs. Research sponsored by the U.S. Department of Energy and NASA.

The metallurgical soundness of the all-metal screenable thick film electrode system is established for silver and copper electrodes. Silver fluoride was identified as a successful etchant material and is found most effective in the liquid phase (435-460 C). Best results were achieved with the eutectic alloys of dopants and semiconductors. The air-fired silver inks were strongly adherent, rugged, and solderable, whereas the hydrogen-fired silver inks had very poor adhesion. A two-step firing process was devised in which copper inks containing silver fluoride were activated in a nitrogen atmosphere, with sintering done at the same or higher temperatures in hydrogen. Good solar cells were made using the copper paste back contacts demonstrating that the electrodes are not the limiting factors in efficiency. L.S.

A81-27196 * **A base-metal conductor system for silicon solar cells.** M. G. Coleman, R. A. Pryor, and T. G. Sparks (Motorola, Inc., Phoenix, Ariz.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 793-799. 8 refs Contracts No JPL-954847; No. JPL-954869.

Solder, copper, and silver are evaluated as conductor layer metals for silicon solar cell metallization on the basis of metal price stability and reliability under operating conditions. Due to its properties and cost, copper becomes an attractive candidate for the conductor layer. It is shown that nickel operates as an excellent diffusion barrier between copper and silicon while simultaneously serving as an electrical contact and mechanical contact to silicon. The nickel-copper system may be applied to the silicon by plating techniques utilizing a variety of plating bath compositions. Solar cells having excellent current-voltage characteristics are fabricated to demonstrate the nickel-copper metallization system. L.S.

A81-27197 * **An all-plated, low cost contact system for silicon solar cells.** D. P. Tanner, P. A. Iles (Applied Solar Energy Corp., City of Industry, Calif.), and P. Alexander (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Applied Solar Energy Corp., City of Industry, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p. 800-804. Contract No. JPL-955244.

The plating sequences Pd-Cr-Cu and Pd-Ni-Cu are demonstrated. The surface was sensitized with a 50 A-thick Pd layer obtained from an immersion bath. After 15 min heating at 400 C in N2, a thin barrier layer of either Cr or Ni was deposited from electroless baths operated at temperatures around 90 C. The sintering process was repeated, and a thin copper layer of 500 A was deposited by electroless means. An electrolytic copper bath was used to build the copper layer to 3-4 micron thicknesses. Cells with good I-V curves were obtained, and the all-plated contacts had good adhesion. Preliminary cost estimates show that the process costs approximately 12 cents per watt excluding the cost of the masking procedure L.S.

A81-27198 **High performance BSF silicon solar cell with fire through contacts printed on AR coating.** T. Nunoi, T. Nammori, H. Sawai, and A. Suzuki (Sharp Corp., Tenri, Nara, Japan). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 805-810.

Low-cost wafer processing techniques are used to fabricate a high-performance silicon solar cell. A doped spin-on diffusion source is prepared by mixing phosphoric-titanate compound into a volatile solvent in order to form an N(+) layer and an antireflection coating for P-type silicon simultaneously. The refractive index of the TiO2 film after diffusion within a temperature range of 900-930 C is approximately 2. The silver paste on the front surface and the aluminum paste on the rear surface are fired simultaneously. The front paste containing 70% lead oxide is able to fire through the TiO2 layer, and shows good ohmic contact and adhesion properties. Conversion efficiencies of 13 and 16% are achieved with 75 mm cells without additional treatment such as soldering. L.S.

A81-27199 **Solid source diffusion process for silicon solar cells.** R E. Thomas and A. A. Armstrong (Carleton University, Ottawa, Canada). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 811-814. National Research Council of Canada Grant No. OSX-78-00062.

A solid source diffusion technique for n(+)-p-p(+) or p(+)-n-n(+)

silicon solar cells is outlined The technique allows packing densities of up to 2500 slices/m of furnace hot zone while offering reduced wafer handling and chemical processing Thin solid sources containing boron or phosphorus cut to the same area as the silicon substrates are alternately sandwiched with silicon during cell preparation The stack is loaded into the furnace at a temperature of 1000-1200 C and undergoes diffusion without a carrier gas A moistened air flow is employed to aid in driving off the organic binders. After separation and cleaning, experimental cells with AM1 efficiencies of 12 and 13% are realized without masking or surface protection. The diffusion may be completed with quartz boats which are automatically loaded and unloaded, eliminating repetitive manual procedures L.S.

A81-27200 * Empirical study of the interaction of silicon substrate thinness, device design, and solar cell processing. R A. Pryor (Motorola, Inc., Phoenix, Ariz.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 815-819. Contract No. JPL-955328.

Processing experiments using wire-saw techniques to slice thin silicon wafers are described. Substrates were sliced directly to 17 mil, 8 mil, and 5 mil thicknesses. Some of the 8 mil substrates and all of the 5 mil substrates were chemically etched to 7 and 4 mils, respectively, to guarantee removal of any saw damage. The wafers wire sawed to 17 mil thicknesses were processed as reference cells A baseline process which results in an n(+)-p cell structure, and two advanced processes which provide n(+)-p-p(+) structures were utilized By using a p(+) enhancement layer on the solar cell back surface, the performance of the 7 mil wafers was increased to exceed that of the 17 mil solar cells with simple n(+)-p structures. Cells fabricated by an ion implantation sequence utilizing elemental boron and phosphorus implants were shown to be capable of equalling or exceeding the performance of cells fabricated by an equivalent all-diffusion process . L.S.

A81-27201 * Low-cost ion implantation and annealing technology for solar cells. A H. Kirkpatrick, J. A. Minnucci, and A. C. Greenwald (Spire Corp., Bedford, Mass.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 820-824. 8 refs. Research supported by the U S. Department of Energy and NASA.

Ion implantation and thermal annealing techniques for processing junctions and back surface layers in solar cells are discussed. Standard 10 keV (31)p(+) junction implants and 25 keV (11)B(+) back surface implants in combination with three-step furnace annealing are used for processing a range of silicon materials and device structures. Cells with efficiencies up to 16.5% AM1 are being produced, and large-area terrestrial cells with implanted junctions and back fields being fabricated in pilot production exhibit average efficiencies in excess of 15% AM1 Thermal annealing methods for removal of the radiation damage caused by implantation should be replaced by transient processing techniques in future production. Design studies have been completed for solar cell processing implanters to support 10 MW/yr and 100 MW/yr production lines, and analyses indicate that implantation costs can be reduced to approximately 1 cent/watt. L.S.

A81-27202 Silicon solar cells realized by laser induced diffusion of deposited antimony. R. Stuck, E. Fogarassy, J. C. Muller, A. Grob, J. J. Grob, and P. Siffert (CNRS, Groupe de Physique et Applications des Semiconducteurs, Strasbourg, France). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 829-834. 9 refs.

A81-27203 # DLTS spectra and defect effects on irradiated silicon solar cells. P. J. Drevinsky, H. M. DeAngelis, J. T. Schott (USAF, Rome Air Development Center, Bedford, Mass.), and W. P. Rahilly (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 835-839. 10 refs.

Defects in as-processed and electron-irradiated high-purity silicon solar cells were detected and identified using deep-level transient spectroscopy In as-processed cells, the gallium-doped samples demonstrated a non-uniformly distributed carbon-related defect, and the boron-doped samples showed no clearly definable peaks In the irradiated cells, both the gallium- and boron-doped samples demonstrated two carbon-containing defects as well as divacancy. In the boron-doped samples, a boron-containing minority carrier trap was also present. Irradiation reduced Pmax values for cells with initial efficiencies of 10-15% AMO by about 25%. The spectral response of irradiated cells decreased significantly in the red region, and blue response remained unchanged. L.S.

A81-27205 * Influence of processing on the electrical performance of proton irradiated silicon solar cells. B. E. Anspaugh, J. A. Scott-Monck, R. G. Downing, D. W. Moffett, and T. F. Miyahira (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 847-852. 7 refs. Contract No. NAS7-100.

A81-27207 * # Radiation damage annealing mechanisms and possible low temperature annealing in silicon solar cells. I. Weinberg and C. K Swartz (NASA, Lewis Research Center, Cleveland, Ohio). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 858-862. 9 refs

Deep level transient spectroscopy and the Shockley-Read-Hall recombination theory are used to identify the defect responsible for reverse annealing in 2 ohm-cm n+/p silicon solar cells. This defect, with energy level at Ev + 0.30 eV, has been tentatively identified as a boron-oxygen-vacancy complex. It has been also determined by calculation that the removal of this defect could result in significant annealing at temperatures as low as 200 C for 2 ohm-cm and lower resistivity cells. V.L.

A81-27208 Nuclear radiation effects on the photovoltaic performance and interface states of Cr, p-type, single crystal, MISi solar cells. R. C. Ferraglio (U.S. Naval Air Engineering Center, Lakehurst, N.J.) and W. A. Anderson (New York, State University, Amherst, N.Y.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 863-869. 19 refs.

Radiation studies have been conducted on Cr-single crystal p-MISi solar cells to investigate the damage effects of 1.0 MeV and 1.6 MeV protons and 1.0 MeV electrons. Current-voltage, high-frequency capacitance, spectral response, and diffusion length measurements have been made for each dosage of radiation. By spectral measurements, the radiation induced change in diffusion length has been isolated as a major contributor to the performance decay of MIS solar cells. The connection between the postradiation photocurrent and the diffusion length is characterized. V.L.

A81-27209 * Summary results of the ATS-6 solar cell flight experiment. L. J. Goldhammer (Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif.) and L. W. Slifer, Jr. (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 870-875. 12 refs. Contract No. NAS5-24458.

Synchronous orbit performance data are analyzed for solar cells of 13 different configurations involved in the ATS-6 solar cell radiation damage experiment. It is found that the cells generally performed as expected through 6 to 9 months in orbit, but that after 2-1/3 years were more severely degraded in current than expected. An anomalous additional degradation of 5-9% in short circuit current has been observed for some cells. V.L.

A81-27213 **Photovoltaic research and development projects in Germany.** R. Koepke (Kernforschungsanlage Julich GmbH, Julich, West Germany) In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 893-896.

Photovoltaic research and development efforts in Germany are briefly reviewed with emphasis on the present technical status of silicon cells and generators, amorphous silicon devices, and Cu(x)S-CdS solar cells. The development of the budget is examined, and companies and laboratories involved in the photovoltaic program are mentioned. V L.

A81-27214 **Growth structure of cast silicon and related photovoltaic properties of solar cells.** K. Roy, K.-D. Rasch, and H Fischer (Telefunken AG, Heilbronn, West Germany) In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 897-901. Research supported by the Bundesministerium fur Forschung und Technologie

A81-27216 **POCl3 gettering of titanium, molybdenum and iron-contaminated silicon solar cells.** A. Rohatgi, R. B Campbell, J. R. Davis, R. H Hopkins, P. Rai-Choudhury (Westinghouse Research and Development Center, Pittsburgh, Pa.), H. Mollenkopf, and J. R. McCormick (Hemlock Semiconductor Corp., Hemlock, Mich.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 908-911. 12 refs. Research sponsored by the U.S. Department of Energy

A81-27217 **The outlook for thin solar cells.** A. Kran (IBM East Fishkill Laboratories, Hopewell Junction, N.Y.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 918-922.

Current and projected thin sheet solar cell technologies are discussed in terms of technical parameters and cost. It is shown that the well established process based on Czochralski growth (CZO) plus ID slicing is not competitive with the manufacturing technology based on growing sheet silicon directly from the melt (the capillary action shaping technique - CAST) once it is available For 1986, the CZO plus ID slice sheet price is $50/sq m as compared to $17/sq m for CAST sheet. V.L.

A81-27218 * **Low cost processes for fabricating silicon solar cells.** H. Goldman and M. Wolf (Pennsylvania, University, Philadelphia, Pa.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 923-928. 23 refs. Research supported by the U.S. Department of Energy. Contract No. JPL-954796.

Solar cell fabrication processes, in particular junction formation and metallization, are evaluated in terms of cell efficiencies, process yields, module packing factors, and energy cost effectiveness. It is shown that for junction formation, the diffusion processes provide a relatively low-cost approach. The costs per unit cell area can be further reduced by increased wafer area and mechanized wafer handling The costs for a large number of metallization processes, excluding the costs of the metal, are roughly comparable. However, their varying influence on cell performance leads to a significant spread in the allowable process costs. V.L.

A81-27220 * **Cost effective, high throughput, junction formation techniques using spray-on dopants.** S. R. Chitre (Photowatt International, Inc., Tempe, Ariz.) and C Olson (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 935-940

A81-27221 **Silicon solar cells with screen printed diffusion and metallization.** L Frisson, M Honoré, R Mertens, R Govaerts, and R Van Overstraeten (Leuven, Katholieke Universiteit, Heverlee, Belgium). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 941, 942 Research supported by the National Fonds voor Wetenschappelijk Onderzoek

This paper deals with the simultaneous use of thick film technology for junction and contact formation. The screen printing diffusion and metallization provides a high volume, fully automated, and low cost process for silicon solar cells The totally screen printing process can be optimized so that AM1 efficiencies above 11 percent with a high production yield are obtained. (Author)

A81-27223 * **Nickel contacts for low cost solar cells.** J R Anderson and R C. Petersen (Solarex Corp., Rockville, Md) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 948-951. Contract No. JPL-954854.

It is noted that nickel metallization of silicon solar cells offers a relatively inexpensive method of making electrical contact with the surface of the cell More expensive methods, involving precious metals and costly processes, are widely used, these have been developed for space applications, where considerations of reliability predominate over those of cost Since recent interest in terrestrial applications of solar cells has led to an increased concern over cost, nickel has assumed a position as a major candidate for solar cell metallization It is shown that sintering can improve the integrity of the nickel-silicon bond Evidence that the nickel-silicon contact can survive moderate environmental stress is presented C R

A81-27225 * **Encapsulation of PV cells using silicone materials.** W. E. Dennis (Dow Corning Corp., Midland, Mich.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 958-961. Research sponsored by the U S Department of Energy and NASA.

The use of silicone materials as thin conformal coatings for the protection of photovoltaic cells is investigated. Five silicone materials ranging from soft elastomers to high modulus resins were evaluated after exposure to UV radiation, outdoor weathering, thermal cycling at high humidity and temperature cycling from -40 C to 90 C. The effects of these tests were monitored by periodically measuring the output of two-cell circuit strings encapsulated with the various materials, and one exceptional silicone coating for which no significant changes in cell output were noted after 300 days was chosen as the best of the candidates Because only a thin coating of the substance is needed, material costs 60% lower than those of previous encapsulants are now possible. O C.

A81-27226 * ***An improved lamination technique for solar arrays.*** A Garcia, III (Spectrolab, Inc, Sylmar, Calif.) and C Olson (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 962-964. Research sponsored by the U.S. Department of Energy and NASA

Encapsulating solar cells by lamination has been plagued with problems such as bubbles, cell shifting, ripples, and cracked cells A low-cost laminating procedure has been developed using a double vacuum bagging technique and recently improved formulations of ethylene vinyl acetate, successfully minimizing these problems. The lamination fixturing used is described. The causes and cures of various problems are discussed and solutions to these problems presented. The apparent modulus of the face sheet seen by the module being laminated is believed to be the primary variable which must be optimized. Conditions at the module edge are also considered to be important for producing an acceptable product. (Author)

A81-27227 * Development of glass encapsulation techniques for terrestrial photovoltaic arrays. P. R Younger, R G Tobin, G. A. Landis, W. S. Kreisman, and M. J. Nowlan (Spire Corp., Bedford, Mass.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 965-969. 6 refs. Research supported by the U S Department of Energy and NASA

Two parallel development programs for terrestrial solar cell module encapsulation and fabrication are reviewed, including the status of electrostatic bonding as an encapsulation technique. Current designs of electrostatically bonded modules are discussed, fabrication of which is now routine The design of a high-efficiency module is presented, for which performance reliability features are discussed. This design is compatible with later generation changes such as the introduction of encapsulation by electrostatic bonding. Application of wire mesh contacts by electrostatic bonding has resulted in I-V curve fill factors of 0.74 Cell designs that would allow existing Pyrex glass to be used in electrostatically bonded modules are presented. (Author)

A81-27228 An outlook for automated CIS solar cell factory. K. Rajkanan (General Instrument Corp , Hicksville, N.Y) and R. Singh (Colorado State University, Fort Collins, Colo.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p. 970-975. 11 refs. Natural Sciences and Engineering Research Council of Canada Grant No. 7879-G0089

Recent experimental work on single-crystal silicon conductor-insulator-semiconductor (CIS) solar cells indicates that the performance of these devices is close to that of the best p-n junction solar cells. The CIS structure is a candidate in the manufacture of large-scale solar energy conversion arrays. It is noted that the stage is now set for the commercial production of these solar cells. A study of the manufacture of CIS solar cells using a fully automated production facility is discussed The facility is designed to maximize processing flexibility, control, and testing and to ensure real-time process and product management. It is concluded that if solar-grade silicon can be obtained at $10/kg (the Department of Energy's projected goal) and if CIS factory production is of the order of 250 MW/year, then the 1986 cost goal of $0.50 per peak watt can easily be met. C R.

A81-27229 # Economic feasibility of photovoltaic energy systems. A. S. Clorfeine (U.S Department of Energy, Washington, D.C.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 986-989.

The economic feasibility of photovoltaic systems for family residences, intermediate-sized applications, and central power stations is examined. Economic feasibility is anticipated by 1986 for the homeowner market and non-investor-owned utilities (municipal utilities, rural electrical cooperatives, and federal utilities). The investor-owned utilities may achieve economic feasibility by 1990, but ownership of the residential system by the homeowner is preferable to ownership by the utility because of the higher fixed-charge rate for the latter. The system life-cycle cost will be dominated by balance-of-system items which include marketing and distribution factors L S

A81-27230 Photovoltaic concentrators E C Boes (Sandia Laboratories, Albuquerque, N. Mex) In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p 994-1003 16 refs Research supported by the U S Department of Energy

The current status of photovoltaic concentrator technology is reviewed The developmental status of eight array designs is outlined, and performance and cost information is given Concentrator array components are discussed with attention to high concentration designs, luminescent concentrators, reflective dish designs, and beam splitters. Concentrator cells, cell assemblies, optical concentrators as well as support, tracking, and drive systems are surveyed. The component developments examined include low series resistance silicon cells, multijunction devices, arched and domed acrylic lenses, and chemically strengthened glass L S.

A81-27231 * Photovoltaic applications - Past and future. H L. Macomber (Monegon, Ltd., Gaithersburg, Md.), D Faehn (U S Army, Mobility Equipment Research and Development Command, Fort Belvoir, Va.), S. I. Kaplan (Oak Ridge National Laboratory, Oak Ridge, Tenn), J N Deyo (NASA, Lewis Research Center, Cleveland, Ohio), M D Pope (MIT, Lincoln Laboratory, Lexington, Mass), and D G Schueler (Sandia Laboratories, Albuquerque, N Mex.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p. 1004-1017 25 refs

This paper presents an overview of photovoltaic systems applications since the initiation of the U.S National Photovoltaic Program in 1975 Experiences with these applications are summarized and some conclusions are drawn. Implications for future research, technology development and application experiments are drawn from the experiences to date (Author)

A81-27234 Simulation of a hybrid solar photovoltaic/solar thermal electric power system. S M Moite, J M Kallis (Hughes Aircraft Co., Culver City, Calif), J A Castle, E Aerni (Spectrolab, Inc., Sylmar, Calif.), and R. L Lessley (Bechtel National, Inc , San Francisco, Calif.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p 1036-1041 Research supported by the U S. Department of Energy

The objective of this project was to develop a tool for use in determining whether a hybrid solar electric power system has advantages, in terms of electrical efficiency and cost of electricity, over a pure solar-photovoltaic system or a pure solar-thermal-electric power system. A hybrid system is defined as an actively cooled photovoltaic system in which the waste heat is used to drive a generator. The cost and efficiency of candidate systems predicted by a steady-state design-point calculation were found to agree closely with those predicted by a more time-consuming hour-by-hour simulation. (Author)

A81-27235 Short circuit currents and collection efficiencies in a-SiHx solar cells. C R Wronski, B. Abeles, G D Cody, D L Morel, and T Tiedje (Exxon Research and Engineering Co , Linden, N.J.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1057-1061 10 refs.

Hydrogenated amorphous silicon (SiHx) Schottky barrier solar cells, prepared by RF and dc glow discharge decomposition of silane, were characterized by measurements of their AM1 short circuit currents and the spectral dependence of the collection efficiencies. The collection efficiency is interpreted in terms of a simple model that assumes a constant collection width and photocarrier generation efficiency of unity (Author)

A81-27236 **Design of monolithic, multiple-gap, amorphous Si-Ge solar cells.** V L. Dalal and E. A. Fagen (Delaware, University, Newark, Del). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p 1066-1069. 19 refs.

The design principles for tandem, multiple-gap photovoltaic cells made from thin film materials with limited diffusion lengths and nonabrupt optical absorption edges are described. The principles are applied to a tandem two-cell a-Si, a-(Si, Ge) structure. It is shown that with optimum design such a structure should be capable of 17-20% solar conversion efficiency, even when the effective diffusion lengths are limited (Author)

A81-27237 **Proposed design of a-Si:H solar cells using ultrathin active layer to increase conversion efficiency.** J. C C Fan and C O Bozler (MIT, Lexington, Mass) In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1070-1073. 7 refs USAF-supported research.

The conversion efficiency of amorphous silicon-hydrogen (a-Si H) solar cells is limited because the minority-carrier collection length is much shorter than the solar absorption length. To overcome this limitation, a novel cell design is proposed utilizing an a-Si:H active layer less than one collection length thick, which is incorporated in a multiple-optical-pass structure so that most of the solar photons are absorbed in this ultrathin layer. Preliminary calculations indicate that this design can result in doubling the photocurrent (Author)

A81-27238 **Optimum design and device physics of the horizontally multilayered high voltage solar cells produced by plasma deposited amorphous silicon** Y Hamakawa, H Okamoto, and Y Nitta (Osaka University, Toyonaka, Japan) In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p. 1074-1079 18 refs.

A81-27239 * **Deep-level defects and recombination parameters in proton irradiated AlGaAs-GaAs solar cells.** S. S. Li, W. L. Wang, P. W. Lai (Florida, University, Gainesville, Fla.), R. Y. Loo, G. S. Kamath, and R. C. Knechtli (Hughes Research Laboratories, Malibu, Calif.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1080-1084. 10 refs Grant No. NsG-1425.

The deep-level defects produced in high efficiency AlGaAs-GaAs solar cells by proton energies of 50, 100, 200, and 290 keV are investigated Proton fluences were from 10 to the 10th to 10 to the 13th p/sq cm. The results show that the diode ideality factor varies between 1.9 and 2.1, indicating that the dominant current component is due to the recombination of electron-hole pairs via deep-level traps in the junction space charge region of these diodes. The recombination current increases with increasing proton fluence and proton energy. The reduction of open circuit voltage, short circuit current, and conversion efficiency in the irradiated cells relates directly to the density of the deep-level defects induced by proton irradiation. L.S.

A81-27240 * **Simultaneous radiation damage and annealing of GaAs solar cells.** J. H. Heinbockel (Old Dominion University, Norfolk, Va), E. J Conway, and G. H. Walker (NASA, Langley Research Center, Hampton, Va.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p. 1085-1089. 7 refs.

In this report, concepts and equations are developed to describe the simultaneous radiation damage and annealing of solar cells. The annealing characteristics of three types of defects are employed to study three examples of continuous irradiation and annealing. One example shows that the effective damage could be reduced by a factor of fifty. The difficulty of a laboratory experiment properly simulating the effects in space are discussed. Potential advantages of continuous annealing such as reduction of stable defect formation and omission of radiation cover glasses are presented. (Author)

A81-27242 * **High temperature properties of GaAlAs/GaAs heteroface solar cells.** G. H. Walker, E J Conway (NASA, Langley Research Center, Hampton, Va.), K. H. Hong, and J H. Heinbockel (Old Dominion University, Norfolk, Va.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p 1098-1101. 6 refs

The properties of p-GaAlAs/p-GaAs/n-GaAs heteroface solar cells were determined in the temperature range from 25 C to 350 C. Illumination air mass zero (AM0) current-voltage measurements show that the short circuit current increases as a function of temperature up to 210 C and then decreases up to 350 C. The open circuit voltage and fill factor decrease linearly with increasing temperature The spectral response shifts toward higher wavelengths with increasing temperature (Author)

A81-27243 **GaAs shallow-homojunction solar cells.** J C C Fan, G W Turner, R P Gale, and C. O Bozler (MIT, Lexington, Mass.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p 1102-1105 7 refs. USAF-supported research.

Electron radiation test results are reported for n(+)/p/p(+) shallow-homojunction GaAs solar cells grown by chemical vapor deposition on single crystal substrates of either GaAs or Ge It is found that such cells have superior resistance to 1-MeV electron radiation which produces effects approximating those due to space radiation. The possibility of using inexpensive crystalline Si sheets as substrates for GaAs solar cells is also discussed. V.L.

A81-27244 **Performance evaluation of conceptual hybrid solar photovoltaic/solar thermal electric power systems.** J. A. Castle, E. Aerni (Spectrolab, Inc., Sylmar, Calif.), S. M. Moite, and J. M. Kallis (Hughes Aircraft Co , Culver City, Calif.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1106-1112. 6 refs. Research supported by the U.S. Department of Energy.

Conceptual designs of solar electrical power plants utilizing both photovoltaic and thermal subsystems have been evaluated These systems included both distributed and central receiver type concepts using both silicon and gallium arsenide cells. Heat engine cycles covering a wide range of temperatures were evaluated in the overall optimization. An overall system efficiency of 17% was obtained for a hybrid concept utilizing gallium arsenide solar cells in a distributed field using an organic Rnkine cycle heat engine. Optimum hybrid systems tend toward low operating temperatures and low thermal-electric conversion The economic performance is comparable with photovoltaic-only and thermal-only systems. (Author)

A81-27246 **Photovoltaic intermediate applications.** K. L. Biringer (Sandia Laboratories, Albuquerque, N. Mex.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1121-1125. 18 refs. Research supported by the U.S. Department of Energy.

The paper discusses intermediate applications of on-site photovoltaic systems which cover grid connected applications between residential and central power stations, ranging in size from 20 kW to several megawatts. Characteristics of the load profiles and economic parameters for different users are examined along with energy consumption data for various applications, including commercial, industrial, agricultural, multifamily residential, and municipal. It is pointed out that with the achievement of the DOE 1986 price goal of 70 cents/watt (1980 dollars) for photovoltaic modules, many significant intermediate application subsectors will be economically viable markets for photovoltaics. V.L.

A81-27247 * **Flat-plate photovoltaic array design optimization.** R. G. Ross, Jr. (California Institute of Technology, Jet Propulsion Laboratory, Energy Technology Engineering Section, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Cali'., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 1126-1132. 7 refs.

An analysis is presented which integrates the results of specific studies in the areas of photovoltaic structural design optimization, optimization of array series/parallel circuit design, thermal design optimization, and optimization of environmenta. ,·-·-ection features. The analysis is based on minimiz·ng the total photovoltaic system life-cycle energy cost including repair and replacement of failed cells and modules. This approach is shown to be a useful technique for array optimization, particularly when time-dependent parameters such as array degradation and maintenance are involved. V.L

A81-27248 **Low cost structures for photovoltaic arrays.** H. N. Post (Sandia Laboratories, Albuquerque, N Mex). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 1133-1138. 6 refs. Research supported by the U.S. Department of Energy.

The design and analysis of low cost, ground-mounted flat plate non-tracking array structures for use in large intermediate and central power station applications are described. Design requirements for the array structure, especially wind loading criteria, are discussed and problem areas associated with the integration of the module panel and support structure are identified. Support system costs which include site preparation, foundation and support structure, and installation costs are summarized. Wind effects data derived from comprehensive wind tunnel tests of flat plate array field models are presented and compared with wind loading estimates based on existing design standards. (Author)

A81-27249 **Photovoltaic system sizing analysis.** G J. Jones (Sandia Laboratories, Albuquerque, N. Mex.) and E. M. Mehalick (General Electric Co, Philadelphia, Pa.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1139-1143 Research supported by the U.S. Department of Energy.

A primary concern in designing any photovoltaic system is the determination of its 'optimum' size. In grid-connected applications this is normally considered to be one which delivers energy to the owner's load at the minimum lifecycle cost, including the cost of backup utility energy. A great deal can be learned about system design by making use of simple analytical relationships to study the effect of various design parameters on sizing The purpose of this paper is to show one such model and apply it to study the effect of load and the fixed and variable costs on photovoltaic system sizing. (Author)

A81-27250 **Design and qualification of BSR-solar cells for future solar arrays.** H. Bebermeier (Telefunken AG, Wedel, West Germany). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1144-1147

The development of back-side-reflection (BSR) solar cells is discussed with reference to their design, performance, effect of the cover glass on the in-orbit performance, and qualification testing The optical IR-reflectivity of the cells varies between 60 and 70%; solar absorptance of a covered cell is 0.76. It is shown that cerium doped microsheet glass is a good solution for covering BSR cells due to excellent optical characteristics. V.L.

A81-27251 **Advanced module technique with thin solar cells.** J Koch and W Snakker (Telefunken AG, Fachbereich Neue Technologien, Wedel, West Germany) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 1148-1153 12 refs. Research supported by the Bundesministerium fur Forschung und Technologie.

Test modules of solar cells 80-100 microns thick have been manufactured by a process currently used for all solar arrays in order to find out whether the thin cells would have a higher fracture rate than the thick cells. An analysis of cell performance during manufacturing is given for the following steps n-side welding, cover glass bonding, electrical performance measurement, p-side welding, bonding to substrates, and handling The necessary process modifications are discussed Results of extended environmental tests indicate that the behavior of thin cell modules is not different from that of modules over 200 microns thick V L

A81-27254 * # **Analysis of GaAs and Si solar cell arrays for earth orbital and orbit transfer missions.** K S Jefferies (NASA, Lewis Research Center, Space Propulsion and Power Div, Cleveland, Ohio) In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 1164-1168. 6 refs

Solar array systems have been studied and compared for earth orbital and orbit transfer missions with the principal objective of quantifying the cost tradeoffs between gallium arsenide and silicon array for specific classes of missions and system characteristics. For the missions considered, it is found that the purchase cost advantage of Si arrays is not overcome by the greater radiation resistance of GaAs arrays The use of reflectors for concentration may significantly reduce the power system cost However, GaAs arrays benefit considerably more from solar concentration than Si arrays in terms of mission cost because of their higher allowable temperature. In the case of orbit transfer missions, a cover glass thickness of at least 0.05 cm is recommended to reduce total mission cost. V L

A81-27255 **SnO2/polycrystalline silicon solar cells.** A K. Ghosh, T. Feng, and H. P. Maruska (Exxon Research and Engineering Co, Linden, N.J.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1169-1172. 6 refs Contract No. DE-AC03-79ET-23047

High efficiency solar cells (area greater than 1 sq cm) have been fabricated by spraying $SnCl_4$ onto heated polycrystalline silicon substrates at a temperature lower than 400 C for an interval of a minute or less For poly-Si with grains of approximately 1 mm, the efficiency is approximately 10 percent. After a small initial decrease in efficiency, the SnO_2/Si devices become more stable A theory has been developed which allows the calculation of device parameters for polycrystalline silicon solar cells, and experimental results for SnO_2/Si cells are in good agreement with it. The theory of SnO_2/Si solar cells developed for single crystal devices cannot be totally extended to poly-Si because of grain boundary recombination problems. Results are presented describing grain size effects on device parameters. (Author)

A81-27257 **Degradation of ITO/p-Si solar cells.** S M. Goodnick, C. W Wilmsen, and J. F Wager (Colorado State University, Fort Collins, Colo.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1175-1180 9 refs.

The stability of ITO (indium tin oxide) on p-silicon solar cells has been investigated through accelerated life testing. It is found that

ITO/Si solar cells degrade at temperatures above 255 C due to the growth of interfacial oxide. Extrapolation of experimental data to room temperature shows that this process should occur very slowly and should not be a significant problem in actual cell operation Light and load tests at room temperature and at 82 C are consistent with this conclusion. V.L

A81-27259 **Low-cost high-efficiency SnO2/n/+/-p Si heteroface solar cell fabricated by paint-on-diffusant method.** H. Takakura, Y. Hamakawa (Osaka University, Toyonaka, Japan), and M S. Choe (Osaka University, Toyonaka, Japan; Jeonbug National University, Jeonju, South Korea). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1186-1191. 11 refs.

A new SnO2/n(+)-p Si heteroface solar cell has been developed in which the SnO2 window acts both as a highly conductive surface layer and as an antireflective coating. The cell junction is fabricated by the paint-on-diffusant method, and the SnO2 film is formed by chemical vapor deposition An efficiency of 14.0% has been obtained for a 1 x 1 sq cm cell under 72 mW/sq cm sunlight. V.L.

A81-27260 **Physical and chemical characterization of R.A.D. silicon films.** A. Rocher, C Fontaine (CNRS, Paris; CNRS, Laboratoire d'Optique Electronique, Toulouse, France), M. Oberlin, J. Goma (CNRS, Paris, Orléans, Université, Orléans, France), C. Burggraf, J. P. Deville (CNRS, Paris, Strasbourg I, Université, Strasbourg, France), M. Aucouturier, and A Chari (CNRS, Paris, Paris XI, Université, Orsay, Essonne, France). In· Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1192-1197. 14 refs Research supported by the Centre National de la Recherche Scientifique and Commissariat à l'Energie Solaire

A81-27261 * **Grain size dependence of silicon solar cell parameters.** K. M. Koliwad and T. Daud (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1204-1208. 8 refs Research sponsored by the U.S. Department of Energy and NASA.

Measurements of the non-uniform diffusion length of the minority carriers near grain boundaries in polycrystalline silicon have been used to develop an analytical model for the calculation of solar cell output as a function of grain size. Experimental results are presented which verify the theoretical analysis Variation of open circuit voltage and fill factor with grain size is discussed V.L.

A81-27262 **Development of amorphous silicon cells.** J. J. Hanak, S. Faughnan, V. Korsun, and J. P Pellicane (RCA Laboratories, Princeton, N.J.) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1209-1213. 8 refs. Research sponsored by RCA; Contract No. XJ-9-8254.

A81-27263 **Photovoltaic behavior of amorphous silicon-based alloys.** W. Czubatyj, K. Ng, A. Madan (Energy Conversion Devices, Inc., Troy, Mich.), and M. Shur (Minnesota, University, Minneapolis, Minn.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1214-1217 12 refs.

Experimental results are presented on photovoltaic devices using amorphous Si-H-F alloys as the active layer. Thin films of a-Si-F-H are fabricated from SiF4 and H2 gas mixtures using a capacitive radio frequency glow discharge. The inclusion of H and F leads to a low level of localized states; because of the low mobilities of electrons and holes, the diffusion lengths are low and the light generated current is mainly due to drift. A model is proposed which shows how the short circuit current densities and the light current-voltage characteristics depend on the depletion width. V.L.

A81-27264 **CO-sputtered doped amorphous silicon as a photovoltaic material.** M. G. Thompson and D. K. Reinhard (Michigan State University, East Lansing, Mich.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1218-1220. 8 refs. NSF Grant No. ENG-79-10896.

A81-27265 **Optical absorption by gap states in amorphous silicon.** R. S. Crandall (RCA Laboratories, Princeton, N.J.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1221-1223. 12 refs

Measurements of the steady state primary photocurrent for photon energies between 0.58 and 2.0 eV have been made on a-Si:H solar cell structures by means of blocking contacts. From these, the absorption coefficient for weakly absorbing gap states has been determined. In addition, transient secondary photocurrents have been measured to determine the drift mobility of the majority carriers. It is shown that photon absorption by gap states produces electrons in the same state as absorption by band states This result leads to the conclusion that holes are mobile in gap states above the valence band. V.L.

A81-27266 **Determination of amorphous silicon solar cell barrier properties by measurement of differential current-voltage characteristics.** G A. Swartz and R. Williams (RCA David Sarnoff Research Center, Princeton, N.J.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1224-1228.

Barrier properties, such as barrier height and depletion distances in the p(+) and n layers of amorphous silicon solar cells have been determined from measurements of the differential current-voltage characteristics. The barrier heights determined from these measurements approach the open circuit potential The depletion distances in the n layer, which are calculated from the measured capacitance of test diodes alongside the test solar cells, are in agreement with the depletion distances from the differential of the I-V curves. V.L.

A81-27267 **Review of in-orbit performance of ESA's spacecraft solar arrays.** E G. Suppa and R L. Crabb (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1229-1233.

The predicted performances of solar arrays on ESA spacecraft are compared with the actual orbital data. An analysis of the flight data has made it possible to identify some aspects of solar array design relevant for the optimization of future arrays. These aspects include: the adequacy of the design margin used for sizing solar arrays, the accuracy of the electrical performance test methods and of the solar cell standards used during preflight testing, and the uncertainty in the models of radiation environment. V.L.

A81-27268 # **NTS-2 solar cell experiment after two years in orbit.** R. L. Statler and D. H. Walker (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1234-1239. 11 refs. Navy-USAF-supported research.

In-orbit test data are presented for silicon and gallium arsenide solar cells involved in the solar cell experiment aboard the NTS-2 satellite. Some of the conclusions, after 811 days of orbital performance, are (1) the effect of the trapped electron environment at 11,000 nm, 63 deg inclination orbit on silicon solar cells can be adequately predicted by multiplying the equivalent 1-MeV fluence obtained from the AEI-7 model by two, (2) the total loss in maximum power for production type silicon cells varies from 31.6 to 20.6%, and (3) the (AlGa)As-GaAs cells with 1 micron junction depths retained good maximum power output at a value of 46 2 mW. V.L.

A81-27269 **Integral glass covering of spacecraft solar cells by electrostatic bonding.** P. R. Younger, G A. Landis, and R. G. Tobin (Spire Corp., Bedford, Mass.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 1240-1245. 6 refs. Contract No. F33615-77-C-3120.

The development of electrostatic bonding as a covering technique for spacecraft solar cells is reviewed with reference to the effects on bonding of cell parameters such as base material resistivity, contact metallization, junction depth, cell and metallization thickness, back surface fields, and wraparound contacts. The main cell type investigated is the MLAR coated cell, results of bonding 2 mil thick cells to 3 mil thick covers are reported Yields of over 90% have been demonstrated within single lots of substantial size. V.L.

A81-27270 **High efficiency solar panel - Phase II.** J Fodor and R Opjorden (Spectrolab, Inc, Sylmar, Calif.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 1246-1251 Contract No. F33615-77-C-3108.

The paper reviews the results of the HESP (high efficiency solar panel) project, phase II, whose major objective has been the development of a production ready high-efficiency space qualified device. Process advances incorporated into the HESP device have resulted in maximum power performance improvements of 17 6% BOL and 9 4% after electron irradiation over 1976 production devices The program has also yielded a process which, if applied to 50 micron devices, promises even greater performance and weight advantages. V L

A81-27271 * **Concentrator designs for space photovoltaic arrays.** D E Rockey (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif) and I Baker (Hughes Aircraft Co., El Segundo, Calif.) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 1252-1257 8 refs. Contract No NAS7-100

The unique set of operating constraints determining key concentrating solar array design characteristics for low earth orbital, geosynchronous and interplanetary missions are considered Minimum cost is crucial at low earth orbits, performance and design life are needed in geosynchronous orbit, and structural pointing accuracy and radiation resistance are essential in interplanetary designs The impact of such emerging technologies as ultrathin cells, gallium arsenide cells and cold mirrors is discussed. Power-to-mass ratios as high as 200 W per kilogram at a distance of 1 astronomical unit from the sun are possible, using concentrators in conjunction with gallium arsenide arrays. O C

A81-27272 **SOLCEL II - An improved photovoltaic system analysis computer program.** E. R Hoover (Sandia Laboratories, Albuquerque, N. Mex). In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 1258-1261.

The characteristics and performance of a photovoltaic system analysis program, SOLCEL II, are reported. Possessing greater detail of individual components and flexibility than its precursor, the program simulates the annual performance of specific solar arrays and optimizes design parameters or performs sensitivity studies in a single computer run. It contains 12 orientation and tracking schemes, three types of collectors, different dc/ac inverter models, four economic analysis options and tradeoffs between execution speed and details of each component model. O.C.

A81-27273 **Optimisation of total annual energy output from constant/adjustable tilt solar PV arrays.** R Lahri, Y A. Gnanaidner, and S. K Sangal (Central Electronics, Ltd., Sahibabad, India). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1262-1266 Research supported by the Ministry of Industrial Development

A detailed experimental study of constant-tilt photovoltaic arrays with a view toward electrical storage requirement minimization and annual electrical output maximization is presented. It was found that while seasonal adjustments of the array tilt angle does not appreciably alter the annual electrical output, the distribution of the output is significantly changed. This variation could be matched with the load requirement pattern to reduce size and electrical storage requirements It is concluded that where manual labor is cheap, manually-adjustable arrays are more cost effective than optimized constant-angle systems. O.C.

A81-27274 **Solar input and solar data computation for the engineering of solar systems - Transients' simulation.** G Russo. In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 1267-1271. 9 refs.

The construction of an analytical model of the atmosphere, for computing solar energy data with low computation time, is considered. The selective interaction between the electromagnetic radiation and the atmosphere is studied Graphs giving a comparison of experimental and computed values of the global energy flux are presented. It is concluded that this model is a very good approximation on a monthly basis, and is slightly affected by a lack of frequency of the input data on those days when the global flux equals the diffusion component of the radiation. The model is operational and has been compared with experimental values. K.S.

A81-27275 **PV-TAP - A program for performing electrical and thermal analyses on photovoltaic elements.** T. J. Lambarski, R. M. Turfler, K. E. Bardwell (BDM Corp., Albuquerque, N. Mex.), and C. B. Rogers (Sandia Laboratories, Albuquerque, N. Mex.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 1272-1276. 8 refs

The Photovoltaic Transient Analysis Program (PV-TAP) computer code is described. PV-TAP is able to handle a variety of photovoltaic analyses on systems ranging from single PV cells to megawatt arrays. Trade-off studies can be performed for device fabrication, module, panel, and array design, heat transfer and cooling optimization, and cell burnout protection Analyses can be conducted for power conditioning equipment design, and collector/concentrator selection and design. The effects of illumination and load transients, and of fixed and propagating shadows can also be studied. The input structure is user oriented The program features include a large selection of network elements, and the ability to accept user-defined models. L.S

A81-27276 **A comparison of theory and experiment for photovoltaic/thermal collector performance.** S D Hendrie and P Raghuraman (MIT, Lexington, Mass) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 1277-1283 6 refs Research sponsored by the U S Department of Energy.

The performance of air and liquid combined photovoltaic-thermal (PV-T) collectors is examined. Thermal efficiencies with concurrent electric energy collection and electrical efficiencies are compared with analytical results for each collector. The air PV-T collector demonstrated a low cell-to-fluid conductivity, and the liquid PV-T collector, low cell-to-absorber and cell-to-tube wall conductivities. For both collectors, the computed thermal loss coefficient and transmission absorption product indicate performance improvement areas. The loss coefficients could be lowered by a higher cell-packing factor and a higher cell-to-fluid conductivity. The transmission absorption products could also be improved with a higher cell-packing factor as well as by higher glass cell-encapsulant transmissivity. L.S.

A81-27277 **Performance and reliability of photovoltaic modules at various MIT LL test sites.** S. E. Forman and M. P. Themelis (MIT, Lexington, Mass.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference *Record.* New York, *Institute of Electrical and* Electronics Engineers, Inc., 1980, p. 1284-1289. 8 refs. Research sponsored by the U.S. Department of Energy.

A81-27278 * **Qualification test results for DOE solar photovoltaic flat panel procurement - PRDA 38.** J. S. Griffith (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record.
New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1290-1295. Research sponsored by the U.S. Department of Energy and NASA.

Twelve types of prototypes modules for the DOE Photovoltaic Flat Panel Procurement (PRDA 38) were subjected to qualification tests at the Jet Propulsion Laboratory according to a new specification. Environmental exposures were carried out separately and included temperature cycling, humidity, wind simulation, and hail. The most serious problems discovered were reduced insulation resistance to ground and ground continuity of the metal frames, electrical degradation, erratic power readings, and delamination. The electrical and physical characteristics of the newly received modules are also given. (Author)

A81-27279 * **Influence of module requirements on flat plate module design evolution.** J. C. Arnett and R. G. Ross, Jr. (California Institute of Technology, Jet Propulsion Laboratory, Energy Technology Engineering Section, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1296-1298. Research sponsored by the U.S. Department of Energy and NASA.

Photovoltaic module design features and performance characteristics have undergone significant evolutionary changes between pre-1975 First Generation configurations and current Third Generation design technology. A major contributor to this evolution was an iterative process of continuing design guideline and specification development for major module procurements. Module manufacturers have actively responded to these evolving requirements through progressively improving designs. This iterative/feedback process is described. Interim design guidelines and preliminary design options reflecting the LSA 1982 Module Technical Readiness Specification (November 1979) are described with respect to previous design and performance requirements. (Author)

A81-27280 **Qualification testing of photovoltaic concentrator modules for system application experiments.** J. F. McDowell, D. A. Pritchard, and A. E. Verardo (Sandia Laboratories, Albuquerque, N. Mex.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record.
New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1299-1305. Research supported by the U.S. Department of Energy.

A81-27281 **Improved polycrystalline thin film gallium arsenide MOS solar cells.** S. S. Chu, T. L. Chu, Y T. Lee, C. L. Jiang, and A. B. Kuper (Southern Methodist University, Dallas, Tex.). In. Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1306-1310. 7 refs. Contract No. EG-77-C-01-4042.

Polycrystalline gallium arsenide thin films were deposited on tungsten-coated graphite substrates by the reaction of gallium, hydrogen chloride, and arsine in a hydrogen flow system. The deposited films were used for the fabrication of MOS type solar cells. The current-voltage characteristics of the solar cells can be improved by using a thin gallium arsenide phosphide layer on the surface of, or a brief zinc diffusion into, the gallium arsenide film. Large area (9 sq cm) solar cells with AM1 efficiencies of higher than 5% (without antireflection coating) have been prepared. With proper AR coating, the AM1 efficiency would be higher than 7.5%. (Author)

A81-27282 # ***Grain boundary chemistry and its effects upon* the performance of polycrystalline solar cells.** L. L. Kazmerski, P. J Ireland, and P. Sheldon (Solar Energy Research Institute, Golden, Colo.). In: Photovoltaic Specialists Conference, 14th, San Diego, *Calif., January 7-10, 1980, Conference Record*
New York, Institute of Electrical and Electronics Engineers, Inc:, 1980, p. 1311-1315 13 refs.

The performance of thin-film, polycrystalline, Schottky-barrier GaAs solar cells are evaluated in terms of the chemistry and electrical activity of grain and grain boundary regions. Surface analysis techniques (Auger electron spectroscopy, secondary ion mass spectroscopy, and X-ray photoelectron spectroscopy) are used to determine compositional properties which are correlated with electron-beam induced current measurements of selected areas and with photovoltaic device performance Passivation by grain boundary oxidation is investigated, and the phase and composition of these oxides are evaluated. The quality of the intragrain material is assessed to be as important as the activity of the intergrain regions in determining the performance of these photovoltaic devices. (Author)

A81-27283 **The influence of the electronic structure of grain boundaries on the diode characteristics of polycrystalline solar cells.** L. M. Fraas (Chevron Research Co , Richmond, Calif.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1316-1323. 19 refs.

A81-27284 **Grain boundary edge passivated solar cells on thin film GaAs.** K. P. Pande, D. H. Reep, S. K. Shastry, A. S. Weiner, J. M. Borrego, and S. K. Ghandhi (Rensselaer Polytechnic Institute, Troy, N.Y.). In· Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record.
New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p 1324-1329. 6 refs. Contract No. XI-9-8000-1.

A technique for the fabrication of thin film polycrystalline GaAs solar cells with grain boundary edge passivation is described. The Schottky barrier cells are prepared on molybdenum substrates by the metal-organic process. Selective anodization techniques are used for passivation of the grain boundary edge, resulting in solar cells with a conversion efficiency of 5.7% AM1 with no antireflective coating. The cells have a collection efficiency close to the theoretical value for single crystal cells with no anti-reflective coating (23 mA/sq cm). The relationship of the fabrication process to electrical performance is discussed L S.

A81-27285 **Efficient large-grained GaAs homojunction solar cells.** G. W. Turner, J. C. C. Fan, R. P. Gale, and O. Hurtado (MIT, Lexington, Mass.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record.
New York, Institute of Electrical and Electronics

Engineers, Inc., 1980, p. 1330-1332. 9 refs. USAF-supported research.

Conversion efficiencies exceeding 13% at (AM1) have been obtained for antireflection-coated GaAs homojunction solar cells grown by chemical vapor deposition on large-grained substrates. A new passivation method, involving the surface electroplating of tin and subsequent heat treatment, has been found to significantly improve the open-circuit voltage. Open-circuit voltages approaching 0.9 V have been obtained for the first time in polycrystalline GaAs solar cells. (Author)

A81-27287 * Epitaxial and polycrystalline GaAs solar cells using OM-CVD techniques. Y. C. M. Yeh, K. L Wang, B. K. Shin, and R. J. Stirn (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 1338-1342. 6 refs.

GaAs epitaxial films were grown by chemical vapor deposition using organo-metallic sources (OM-CVD) on single crystal and polycrystalline bulk GaAs, as well as on bulk polycrystalline and recrystallized thin-film Ge substrates. Details of Antireflecting Metal-Oxide-Semiconductor (AMOS) solar cells fabricated on GaAs films grown on bulk polycrystalline Ge and recrystallized Ge thin-film substrates will be discussed, as well as preliminary photovoltaic results obtained for n(+)/p homojunction structures. (Author)

A81-27288 Chemistry and preparation of III-V heterojunction solar cells. K. J Bachmann, F A Thiel, H Schreiber, Jr , W R. Sinclair (Bell Telephone Laboratories, Inc., Murray Hill, N.J.), and T. Bitner (Western Electric Co., Reading, Pa.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1343, 1344. 10 refs.

Solar energy conversion efficiencies of indium tin oxide (ITO) heterojunction solar cells with III-V group alloys are reported. The heterojunctions were obtained by the RF sputtering of ITO on single crystals of p-type InAs and InP and ternary Ga(x)In(1-x)P and InP(y)As(1-y) alloys. In contrast to expectations based on the variation of conversion efficiency with semiconductor bandgap, the efficiencies of the ITO/Ga(x)In(1-x)P junctions are found to decrease monotonically with increasing x, while those of the ITO/InP(y)As(1-y) are found to reach a highest efficiency at y = 0 95. The applicabilities of the ideal heterojunction model, the buried homojunction model and the SIS model of III-V heterojunctions to ITO/InP, InAs and GaP devices are then considered on the basis of Auger and ion microprobe analyses A.L W.

A81-27290 High efficiency MIS/inversion layer silicon solar cells. R. E Thomas, C E. Norman, and R. B North (Carleton University, Ottawa, Canada) In Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 1350-1353 11 refs

The use of tantalum oxides to create an inversion layer in silicon which can be contacted by an MIS grid to form an MIS/inversion layer solar cell is examined Ta2O5 layers were formed by the electron beam evaporation of tantalum films on p- and n-type silicon with subsequent oxidation at 530 C, the swept electron-beam evaporation of Ta2O5 pressed powder and by spin-on processes resulting in the deposition of a Ta2O5 coating containing 20% SiO2 Charge measurements obtained from the aluminum capacitors defined on the Ta2O5 surface reveal charge densities of -3 x 10 to the 11th, 5 x 10 to the 11th and 1-3 x 10 to the 12th/sq cm for the thermal, evaporated and spin-on tantalum oxide coatings, respectively, while all three oxides showed sufficient reflectance to act as antireflection coatings. For solar cells fabricated by the growth of MIS oxide at 450 C, total area AM1 efficiencies up to 16% were measured for the spin-on coatings on single and polycrystalline substrates, with short circuit currents up to 40 mA/sq cm, open circuit voltages up to 0.57 and fill factors of up to 0 80 A L W

A81-27293 MIS silicon grating solar cells on BSF substrates. R. Girisch, F. D'Hoore, P. Van Halen, R Mertens, K. Petit, P. De Pauw, and R. Van Overstraeten (Leuven, Katholieke Universiteit, Heverlee, Belgium). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 1366-1369. 5 refs Research supported by the Nationaal Fonds voor Wetenschappelijk Onderzoek, European Economic Community Contract No. 439-78-1-ESB.

This paper deals with MIS grating type solar cells on single crystalline silicon substrates. Experiments are reported that confirm theoretical predictions showing that a minority carrier blocking backside contact is necessary to obtain good collection efficiencies, at least in MIS grating cells where collection only occurs through a two-dimensional diffusion mechanism On the other hand, in grating cells where an inversion layer is induced in the spacing between the grid pattern, as is the case for SiO2 covered cells, the collection efficiency and the short circuit current depend only weakly on the nature of the backside contact (Author)

A81-27294 A 14 percent efficiency SnO/x/-SiO2-/n/Si solar cell. E. Saucedo and J Mimila-Arroyo (Instituto Politécnico Nacional, Mexico City, Mexico) In: Photovoltaic Specialists Conference, 14th, San Diego, Calif, January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p 1370-1375 26 refs Research supported by the Instituto Politécnico Nacional.

SIS solar cells were fabricated by chemical-spray deposition of a thin SnO(x) film on n-type Si. An analysis of transport properties as a function of temperature showed that two conduction mechanisms exist. a tunnel effect at low forward bias and a mechanism for which an ideality factor of the diode curve of about 1 and an activation energy of 0 87 were found. Under 100 mW/sq cm sunlight, the cells showed the following performance: short-circuit current of 36 mA/sq cm, open-circuit voltage of 525 mV, fill factor of 0.74, and efficiency of 14 percent B J.

A81-27295 Semiconductor-insulator-semiconductor /SIS/ solar cells - Indium-tin-oxide on silicon. D. Burk, J Shewchun (Brown University, Providence, R I , McMaster University, Hamilton, Ontario, Canada), M. Spitzer, J. J. Loferski (Brown University, Providence, R I), R Singh, J Hadrevi (McMaster University, Hamilton, Ontario, Canada), and J. Kukulka (McMaster University, Hamilton; Solar Cells, Ltd., Burlington, Ontario, Canada). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 1376-1383. 12 refs. Research supported by Brown University and National Research Council of Canada, Contract No. XS-9-8233-1.

Experimental results for indium-tin oxide, single crystal silicon solar cells fabricated by ion beam sputtering as well as other methods have plateaued at 12% The theory predicts a maximum efficiency of 20% A systematic study of the process parameters was undertaken along with an examination of loss mechanisms to improve the efficiency above this 12% range An efficiency of 15% was achieved for indium-tin oxide-pSi cell on single crystal material and a 9 5% efficiency on polycrystalline silicon. B.J.

A81-27296 The ecliptic-align v-grooved hyperjunction cell. R R. Lucero (Technical Advent Circle, Honolulu, Hawaii). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 1386, 1387.

A new generation of thin-film solar cell, the ecliptic-align v-grooved hyperjunction cell, is reported. The cell, in which the active layers are deposited on a substrate with a v-grooved surface, have three main advantages. (1) four successive light incidences result in significant reduction of reflectivity, at all sun angles, even with highly reflective surfaces, (2) approximately 2 and 1/2 times the junction area per cell area results in a reduction of relative current density and thus reduces series resistance; and (3) a reflective backing can be added for up to four passes through the active layers. The first two advantages are especially significant for MIS and SIS cells. B.J.

A81-27297 **Stacked multiple-bandgap solar cells prepared by CVD techniques.** R. D. Dupuis, P. D Dapkus, R. P. Ruth, J. J. Coleman, W I. Simpson (Rockwell International Electronics Research Center, Anaheim, Calif.), H.-T. Yang, and S. W. Zehr (Rockwell International Electronics Research Center, Anaheim and Thousand Oaks, Calif.). In Photovoltaic Specialists Conference, 14th, San Diego, Calif., January 7-10, 1980, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc, 1980, p. 1388, 1389. Contract No F33615-78-C-2036.

Thin-film stacked multiple-bandgap solar cell (SMBSC) structures, consisting of two cells electrically and optically in series, have been fabricated entirely by chemical vapor deposition techniques. SMBSCs involving a window-type GaAlAs cell grown on a heteroface GaAs cell, with a thin GaAs n(+)/p(+) tunnel junction interconnection, have been grown by metalorganic CVD and have open-circuit voltage values of greater than 2.0 V under AM0 illumination Other SMBSC structures investigated included a GaAs cell grown by metalorganic CVD on a Ge cell grown by GeH4 pyrolysis, with a GaAs connecting tunnel junction. B.J.

A81-27299 **Thin-film CdS/Cu2S cells with high open-circuit voltage and low reflection losses.** J A. Bragagnolo, R. W. Birkmire, and J. E Phillips (Delaware, University, Newark, Del.). In: Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 1400, 1401

A CdS texturing process and a Cu2S formation procedure have been combined to give CdS/Cu2S cells with low reflectance losses but with high open circuit voltages in excess of 0.54 V As a consequence conversion efficiencies of 10% are anticipated. (Author)

A81-27310 **The aerodynamics of heliostats for solar power plant applications.** J. Xerikos, H. H. Tang (McDonnell Douglas Corp., Huntington Beach, Calif.), J. E. Cermak, and J. A. Peterka (Colorado State University, Fort Collins, Colo.). In. Wind engineering, Proceedings of the Fifth International Conference, Fort Collins, Colo., July 8-14, 1979. Volume 2. Oxford, Pergamon Press, Ltd., 1980, p. 1173-1184. 7 refs

The heliostat field-array test, conducted under the sponsorship of DOE in the meteorological wind tunnel of Colorado State University, investigated the characteristics of the steady-state wind loads produced by airflow patterns in and around several configurations of heliostat clusters with and without a wind fence. The characteristics of natural boundary-layer winds at the actual site were simulated in the tunnel. A key conclusion of the study was that wind loads can be reduced to a minimum level through the use of properly designed and located fences used in combination with an efficiently distributed field array. (Author)

A81-27552 # **Construction and startup performance of the Miamisburg salt-gradient solar pond.** L J Wittenberg and M. J. Harris (Monsanto Research Corp., Miamisburg, Ohio). *ASME, Transactions, Journal of Solar Energy Engineering,* vol 103, Feb. 1981, p. 11-16. 13 refs. Contract No. DE-AC04-76DP-00053.

An account is given of the construction and 1.5 years of operation of the Miamisburg, Ohio salt-gradient solar pond which, with 2020 sq m, is the largest solar collector in the U.S. The 18% sodium chloride solution pond has reached storage temperatures of 64 C in July and 28 C in February. Under steady-state conditions, conservative heat-yield estimates on the order of 962 million Btu have been made. The heat is used to warm-up a summer outdoor swimming pool and in winter a recreational building Installation costs were only $35/sq m, and heat costs based on a 15-year depreciation of installation costs is below that of fuel oil heating, at $9.45 per million Btu Further study is recommended for maintenance of water clarity, metallic component corrosion and assurance of pond water containment O.C

A81-27554 # **Second law analysis and synthesis of solar collector systems.** A. Bejan (Colorado, University, Boulder, Colo), D. W. Kearney, and F Kreith (Solar Energy Research Institute, Golden, Colo.). *ASME, Transactions, Journal of Solar Energy Engineering,* vol 103, Feb 1981, p. 23-28 19 refs. Research supported by the U.S. Department of Energy.

The second law of thermodynamics is used to analyze the potential for energy conservation in solar collector systems. It is shown that the amount of useful energy (exergy) delivered by solar collector systems is affected by heat transfer irreversibilities occurring between the sun and the collector, between the collector and the ambient air, and inside the collector. Using as working examples an isothermal collector, a nonisothermal collector, and the design of the collector-user heat exchanger, the optimum operating conditions for minimum heat transfer irreversibility (maximum exergy delivery) are derived. (Author)

A81-27555 # **An algorithm for calculating monthly-average radiation on inclined surfaces.** S. A. Klein and J C. Theilacker (Wisconsin, University, Madison, Wis.) *ASME, Transactions, Journal of Solar Energy Engineering,* vol 103, Feb 1981, p. 29-33. 14 refs. Contract No. EY-76-S-02-2588-A003.

A81-27556 # **Experimental comparison of control strategies for solar energy systems incorporating dual storage tanks.** R. L T. Wolfson and H. S. Harvey (Middlebury College, Middlebury, Vt.). *ASME, Transactions, Journal of Solar Energy Engineering,* vol 103, Feb 1981, p. 47-51. 5 refs. Contract No. EM-78-S-4719.

Two identical solar collector systems were operated side by side for a 67 day period. Data acquisition and control of both systems were accomplished by a minicomputer One system's control strategy kept its two storage tanks at the same temperature, simulating a single tank The other system employed a dual temperature strategy designed to allow greater flexibility in adjusting to varying isolation. The dual temperature strategy showed a modest 4 percent gain in energy delivered to a load. (Author)

A81-27557 # **High-flux solar absorber concept for central receiver power plants.** B. D. Pomeroy (General Electric Co., Schenectady, N.Y), J. M Roberts (General Electric Co., Sunnyvale, Calif), and T V. Narayanan (Foster Wheeler Development Corp., Livingston, N J) *ASME, Transactions, Journal of Solar Energy Engineering,* vol. 103, Feb. 1981, p. 52-55. 7 refs. Contract No. EM-78-C-03-1725.

For cylindrical receivers with a capacity of about 400 MW/t, an aim-at-the belt focusing strategy can produce average fluxes the order of 0.5 MW/sq m with peaks as high as 2 MW/sq m. An absorber concept is described which uses liquid sodium coolant and a three-header configuration to efficiently capture this solar power The mechanical design of this absorber is discussed and thermal performance estimates are presented showing the solar-capture efficiency over a range of solar intensities. The sodium-flow characteristics and some potential flow-control problems are also described. A thermal-stress analysis is presented which shows that a limiting factor on the flux capability may be tube-wall creep/fatigue failure and not the heat-transfer capability of sodium. (Author)

A81-27558 # **Design improvements in LiBr absorption chillers for solar applications.** G. Grossman, J. R. Bourne, J Ben-Dror, Y. Kimchi, and I Vardi (Tadiran Israel Electronics Industries, Ltd., Tel Aviv, Israel). *ASME, Transactions, Journal of Solar Energy Engineering,* vol. 103, Feb. 1981, p. 56-61.

The present article describes a theoretical evaluation of two design improvements made in a lithium bromide absorption chiller which contribute substantially to its performance in solar application. One is the addition of a solution preheater which allows for a considerable reduction in generator size and cost, and improves performance at part load. The other is the addition of an auxiliary generator which enables the chiller to operate at nominal capacity or higher at all times, while utilizing to a maximum the solar radiation available at the time, however small. This is an effective solution to the problem of backup required in all solar-powered systems. The evaluation has been performed by computer simulation and results are presented for the performance of the unit with different configurations of the above systems. The results indicate the limitations on the part of the load to be supplied by the preheater. They point toward the advantage of using an auxiliary generator in a separate shell from the solar-powered generator and with a separate condenser. Operating curves for the chiller with the design improvements are given. (Author)

A81-27570 **Salt gradient solar pond with reflective bottom - Application to the 'saturated' pond.** C. F. Kooi (U.S. Department of State, Washington, D.C.). *Solar Energy,* vol. 26, no. 2, 1981, p. 113-120. 14 refs.

The 'saturated' salt gradient solar pond operates near the solubility limit. Consequently, temperature fluctuations may cause precipitation of the salt, which can increase the reflectivity of the bottom. It is shown that this can reduce the width of the nonconvective zone and seriously degrade the performance of the pond. The temperature distribution, efficiency and optimum operating conditions are calculated, taking account of diffusely reflected light from the bottom of the pond. The mechanism for narrowing the nonconvective zone is described. A semiquantitative analysis is made of a known case of simultaneous salt precipitation and nonconvective zone destruction. It is argued that the boundary between the nonconvective zone and the lower convective zone will move to its maximum temperature position if the solubility is a sufficiently strong increasing function of temperature. (Author)

A81-27571 **A non-linear flat-plate collector model.** P. I. Cooper and R. V. Dunkle (Commonwealth Scientific and Industrial Research Organization, Div. of Mechanical Engineering, Highett, Victoria, Australia). *Solar Energy,* vol. 26, no. 2, 1981, p. 133-140. 7 refs.

An analytical study is made of the thermodynamic efficiency of a nonlinear flat-plate collector, in which the overall loss coefficient is assumed to be a linear function of the temperature difference between the environment and the collector fluid. Three dimensionless numbers (radiation, size and inlet temperature) are used to characterize the linear and nonlinear models of instantaneous collector performance, and three additional dimensionless numbers express the average daily performance for a constant fluid inlet temperature and an assumed parabolic insulation profile. It is demonstrated that if experimental inaccuracies are taken into account, consideration of anything other than a linear correlation of experimental data to analytical results will not be justified. O.C.

A81-28216 # **Dependence of efficiency of shallow junction silicon solar cells on substrate doping.** E. S. Rittner, A. Meulenberg, and J. F Allison (COMSAT Laboratories, Clarksburg, Md.). *Journal of Energy,* vol 5, Jan.-Feb. 1981, p. 9-14. 30 refs. Research sponsored by the Communications Satellite Corp.

Experimental evidence is provided to support a modification of solar cell theory to include the field-enhanced junction recombination dark current. This term is more important in limiting shallow junction solar cell efficiency as base resistivity is decreased. The anomalously high-diffusion dark current in the n-region is also significant in limiting open-circuit voltage, this excess dark current results from high-surface recombination at the metallic contacts on the front surface along with bandgap narrowing and high Auger volume recombination in the diffused n-region caused by high donor density. Methods are proposed for reducing the magnitude of both dark currents to improve overall cell performance. (Author)

A81-28588 # **Development and study of a lead telluride/germanium telluride solar thermoelectric generator (Razrabotka i issledovanie solnechnogo termoelektricheskogo generatora na osnove celluristogo svintsa i germaniia).** V A. Baum, Ch Agabaev, and N Ovezsakhatov (Akademiia Nauk Turkmenskoi SSR, Nauchno-Proizvodstvennoe Ob'edinenie Solntse, Turkmen SSR) *Akademiia Nauk Turkmenskoi SSR, Izvestiia, Seriia Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk,* no 1, 1981, p 41-47 In Russian.

The paper describes the design and operation of a planar solar thermoelectric generator based on n-type lead telluride and p-type germanium telluride. Experimental results are presented on the output power as a function of temperature drop on the junctions of the device, and on output power as a function of solar flux density. B.J.

A81-28737 **Digital holographic interferometry of convective heat transport.** A. Choudry (Delft, Technische Hogeschool, Delft, Netherlands). *Applied Optics,* vol. 20, Apr 1, 1981, p. 1240-1244. 17 refs. Research supported by the Stichting voor Fundamenteel Onderzoek der Materie.

The analysis and interpretation, using digital techniques, of real-time holographic interferogram data from the study of convective heat transport in a flat plate solar collector are discussed. Special attention is given those optical and physical aspects of the study that will aid in establishing an automated digital process for interference pattern analysis, including the structural systematics of fringe patterns, noise due to spurious optical effects, and the accuracy of digitized optical signals. The result of the study is a two-tiered system of digital analysis in which the interactive mode is first used to find a set of algorithms to calculate the temperature field, and then an automatic analysis is initialized. O.C.

A81-28926 **Theoretical analysis of simplified four wavelength division solar cell system.** S. Sakai and M. Umeno (Nagoya Institute of Technology, Nagoya, Japan). *Japanese Journal of Applied Physics,* vol. 20, Jan. 1981, p. 125-127 6 refs.

A simple method is proposed for dividing the solar spectrum into four parts, and the conversion efficiency of the method is calculated theoretically. The maximum conversion efficiency obtainable with the proposed arrangement is estimated at 31%. Arrangements for the division of spectrum into more than four parts are shown. V.L.

A81-28936 **Chlorophyll sensitized solar photovoltaic cell with cuprous iodide electrode.** K. Tennekone and W. M. R. Divigalpitiya (Sri Jayawardanapura University, Nugegoda, Sri Lanka). *Japanese Journal of Applied Physics,* vol. 20, Jan. 1981, p. 299, 300. 11 refs.

It is noted that if electrolytic photovoltaic cells are to be of any practical importance in the use of solar energy, the semiconductor material in the electrolytic medium must be photostable and sensitive to light in the visible region. The cell discussed here consists of a photocathode of cuprous iodide coated with chlorophyll-a. It is noted that the dye sensitized photocurrent supposedly arises from electron transfer between the excited dye and the semiconductor. CuI is a mixed conductor, and the charge carriers are Cu(+) ions, electrons, or holes. At temperatures lower than 300 C, however, the ionic conduction is found to be insignificant. In the presence of traces of excess iodine, the conduction is due mainly to holes. The CuI layer described here behaves as a p-type semiconductor having a band gap of 0.31 eV C.R.

A81-28954 **Review of conductor-insulator-semiconductor /CIS/ solar cells.** R. Singh (Energy Conversion Devices, Inc., Troy, Mich.), M. A. Green (New South Wales, University, Kensington, Australia), and K. Rajkanan (General Instrument Corp., Hicksville, N.Y.). *Solar Cells,* vol. 3, Mar. 1981, p. 95-148. 314 refs. Research supported by the Natural Sciences and Engineering Research Council of Canada, U.S. Department of Energy, Australian Research Grants

Committee, and National Energy Research Development and Demonstration Council of Australia.

The physics and technology of the conductor-insulator-semiconductor (CIS) solar cells are reviewed. The CIS photovoltaic devices may incorporate an ultrathin interfacial layer in a metal-semiconductor junction (Schottky diode), an oxide semiconductor-base semiconductor heterojunction diode, or an electrolyte-semiconductor diode. Attention is given to the effects of the interfacial layer thickness and the work function of the conductor on the performance of the cells. By ensuring inversion at the interface of the base semiconductor, devices can be fabricated with properties which do not depend strongly on the surface states nor on other nonidealities of the interfacial layer. Experimental data in tabular form are presented on single-crystal MIS and SIS solar cells, polycrystalline CIS solar cells, and amorphous silicon CIS solar cells. K.S.

A81-28958 **High efficiency 1.43 and 1.69 eV band gap Ga/1-x/Al/x/As-GaAs solar cells for multicolour applications.** E. Fanetti, C. Flores, G. Guarini, F. Paletta, and D. Passoni (Centro Informazioni Studi ed Esperienze S.p.A., Milan, Italy). *Solar Cells,* vol. 3, Mar. 1981, p. 187-194. 9 refs.

The fabrication and the most significant characteristics of 1.43 and 1.69 eV band gap Ga(1-x)Al(x)As-GaAs solar cells, designed for high efficiency and high concentration systems, are described. The cells are characterized by a very low series resistance obtained by using beryllium as a p-type dopant and by using a simplified structure including a minimum number of layers grown by liquid phase epitaxy. Conversion efficiencies up to 21.1% and 19.2% were measured at 210 suns, air mass 1.5, for the low gap and high gap cells respectively, while 20% and 18% efficiencies were observed at 1000 suns. For the higher band gap cell a conversion efficiency of 14.2% was also measured at 2500 suns. The overall conversion efficiency of some multicolour systems utilizing the Ga(1-x)Al(x)As-GaAs cells combined with spectrum-splitting optical filters and with a lower band gap (1.1 eV) cell were also estimated under realistic assumptions. (Author)

A81-29032 **Optimization of fin and tube parameters in a flat-plate collector.** H. P. Garg, U. Rani, and R. Chandra (Indian Institute of Technology, New Delhi, India). *Energy* (UK), vol. 6, Jan. 1981, p. 83-92. 16 refs.

A theoretical investigation for optimizing collector-cost effectiveness is carried out by considering various tube diameters, materials, tube spacing, fin materials, and thicknesses for black and other paints. The bond conductance is taken into account for various joining techniques. Various tube geometries are considered and the convective heat-transfer coefficients are calculated. The pressure drops are calculated with allowance for the friction factor due to the skin effect. Since the friction factor for bends and fittings is negligibly small in the laminar flow regime, the pressure drop is calculated for skin friction alone. Efficiency and costs are computed to determine an optimal system. (Author)

A81-29196 **The state of solar technology (Stand der Solartechnik).** M. Kuczera (Dornier System GmbH, Friedrichshafen, West Germany). *Brennstoff-Wärme-Kraft,* vol. 33, Mar. 1981, p. 90-97. 7 refs. In German.

The difficulties and prospects of solar technology are discussed. The difficulties include the necessity of expensive and inefficient solar collectors and the low power density (a maximum 1 kW/sq m) which is an obstacle to achieving higher process temperatures and which necessitates the building of unusually extended installation. The prospects involve the generation of low temperature heat with flat-plate collectors, the generation of high temperature heat with concentrating collectors for the further transformation to mechanical or electrical energy, and the development of cheap solar cells for the direct generation of electrical energy from radiant energy. Measurements are shown for the amount of solar radiation received by various parts of the world, and the present solar technologies are reviewed including solar cells, flat plate collectors, parabolic cylinders, paraboloids and heliostat towers. D.K.

A81-29252 **Simplified methods for analyzing the performance of parabolic dish systems.** S. Dasgupta, A. F. Hildebrandt (Houston, University, Houston, Tex.), and C. E. Mauk (Texas Energy and Natural Resources Council, Austin, Tex.). *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif., Nov. 25-29, 1979) AIChE Symposium Series,* vol. 76, no. 198, 1980, p. 1-5. 10 refs. Contract No. EG-77-C-04-3974.

Simple expressions are given for the determination of incident fluxes inside cavities of various shapes heated by paraboloidal mirrors. Approximate methods are also given to determine the energy loss from cavities due to reflection, reradiation and convection. Some of these results were verified against the results from more exact techniques. Some design considerations for achieving high efficiencies with parabolic dish systems are also discussed (Author)

A81-29253 **Design and performance of a concentrating solar collector.** I. H. Farag (New Hampshire, University, Durham, N.H.). *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif., Nov. 25-29, 1979.) AIChE Symposium Series,* vol. 76, no. 198, 1980, p. 6-14. 5 refs. Research supported by the University of New Hampshire.

Design considerations of a parabolic concentrating solar collector included collector orientation, construction materials, reflective surface shape, and the use of collector pipe internal fins. The collector's surface is approximately 1.4 sq m of high reflectivity mirrored glass, focussing on a 38.1 mm diameter blackened copper pipe, in which air is used as the heat transfer medium. Preliminary tests indicate a 43% efficiency based on daily insulation averages. O.C.

A81-29254 **Performance enhancement of compound parabolic concentrators using air and a liquid simultaneously as heat transfer mediums.** L. M. Scheier (Trane Co., La Crosse, Wis.) and T. H. Kuehn (Iowa State University of Science and Technology, Ames, Iowa). *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif., Nov. 25-29, 1979.) AIChE Symposium Series,* vol. 76, no. 198, 1980, p. 15-20. 7 refs. Research supported by the Iowa State University of Science and Technology.

The thermal efficiency of a compound parabolic concentrator (CPC) solar collector can be enhanced by extracting the solar energy absorbed not only by the receiver but also by the reflectors and aperture cover. Much of the energy that would normally be lost from the front of the collector is used to heat air blown through the collector, which can then be utilized for space or process heating. The present analysis uses a thermal network analogy to predict the radiation, conduction, and convection heat transfer between the CPC collector components and between the collector and its surroundings. Results are presented for concentration ratios of 1.5 and for selection and nonselection absorbers and various air and liquid flow rates. (Author)

A81-29255 **A numerical approach for the prediction of the front losses of a flat-plate solar collector.** G Lauriat (Conservatoire National des Arts et Métiers, Paris, France). *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif., Nov. 25-29, 1979.) AIChE Symposium Series,* vol. 76, no. 198, 1980, p. 21-26 14 refs.

The front losses of a flat-plate solar collector are estimated on the basis of a bidimensional heat conduction in the single cover of the collector. The sensitivity of the performances to the absorption of radiation in the cover is investigated. It is also shown that an optimal spacing between the absorber and the cover cannot be found with the correlations previously reported in the literature. Some results of calculations of the front losses when the temperature distribution of the absorber is non-uniform are given at the end. (Author)

A81-29256 **Concentrating solar collectors for thermal and photovoltaic application.** M. Simon. *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif., Nov. 25-29, 1979.) AIChE Symposium Series,* vol. 76, no. 198, 1980, p. 27-33.

Description of the design and development of a 3 kWe concentrating silicon cell module with four heliostatically mounted cylindrical parabolic concentrating troughs and a concentration factor of between 20 and 40. It was first determined through model calculations that a concentration factor of between 10 and 50 would be optimal for cylindrical parabolic reflectors, depending on specific solar cell and collector costs. A series of indoor tests were then run, using an electrical sun simulator, on a preprototype system with a water pump load simulator. The modular, four-trough prototype system, optimized for maximum daily energy output and low production and maintenance costs, was then tested outdoors. The special development of an integrated heat absorption system using a selective filter mirror to concentrate radiation not converted by the cells is proposed in conclusion. O C.

A81-29261 **Dynamic behavior of a natural circulation loop for a solar collector.** J C. Friedly (Rochester, University, Rochester, N.Y.) and B. H. Davison (California Institute of Technology, Pasadena, Calif.). *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif., Nov 25-29, 1979) AIChE Symposium Series,* vol. 76, no. 198, 1980, p. 69-79 15 refs Contract No. N00014-76-C-0001.

The unsteady state of a natural convection loop for a solar energy collector has been studied theoretically. The nature of the response to small disturbances in a set of model equations has been solved for rigorously. It is shown that under a small, but significant set of operating conditions the nominal steady state can be unstable and oscillations in flow rate can be anticipated. The oscillations result from the interaction of temperature disturbances fed around the loop and the gravitational pressure drops. The oscillation period is determined by the total time required for fluid to circulate around the loop. Computations are presented on the effect of dynamic parameters such as residence times, thermal capacitances and thermal time constants, and some of their implications in the design of passive solar heating systems are discussed Computations of the dominant root of the model characteristic equation are also presented. Under most operating conditions response times of the order of the fluid residence time in the collector can be expected and in some cases the response time can be significantly longer than that. Transients may in fact persist longer than the expected mean time between disturbances to the system. (Author)

A81-29262 **Central solar heating plants - Optimal ratio between solar collector area and heat storage volume.** S.-E. Ramsmark (Lund Institute of Technology, Lund, Sweden). *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif., Nov. 25-29, 1979.) AIChE Symposium Series,* vol. 76, no. 198, 1980, p. 91-96

A81-29265 **Active cooling system alternatives for concentrating photovoltaic systems.** L D. Clements and M. J O'Leary (Texas Tech University, Lubbock, Tex.). *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif, Nov. 25-29, 1979) AIChE Symposium Series,* vol 76, no. 198, 1980, p. 117-122. 5 refs

A design trade-off study was employed to choose an active cooling system for a large concentrating photovoltaic irrigation system. Wet cooling tower, air cooler-pond 'hybrid', and air cooler-evaporator designs were compared with respect to parasitic power requirements, initial cost, operating cost, reliability, maintenance requirements, load matching, and any corrosion, pollutants or residues resulting from operation It is concluded that the evaporator-assisted air cooler is the most attractive alternative due to its lower initial cost and cheap and simple operation, despite relatively high parasitic energy requirements. O.C.

A81-29268 **Production of fuels from high temperature solar thermal systems - Economic analysis.** S. Lakshmanan, F K. Manasse, and V. K. Mathur (New Hampshire, University, Durham, N.H.). *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif, Nov 25-29, 1979.) AIChE Symposium Series,* vol. 76, no. 198, 1980, p. 156-163. 20 refs. Contract No. DE-AC02-79ET-21067.

The employment of existing coal, lignite and peat gasification technology in conjunction with high temperature solar heating is considered. It is required that such hybrid systems be of the gas-recirculation type in order to operate around-the-clock Cost estimates for conventional and hybrid systems using coal, lignite, peat and wood indicate that by 1990 the cost of gas from solar systems will be to 5 to 6% cheaper than that of conventional methods such as Lurgi and HyGas, with an additional saving of 10% of the fossil fuel consumed due to the diurnal availability of solar energy. It is concluded that the fossil fuel savings may reach 30% when high temperature thermal storage becomes available. O.C.

A81-29269 **On the safety to solar electric power generation.** A Z. Ullman, B. B. Sokolow, L. Libby, J. Daniels, J. Hill, R Hudson, P. Hurt, A Kashani, G. Meunier, and P Parekh (California, University, Los Angeles, Calif.) *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif, Nov 25-29, 1979.) AIChE Symposium Series,* vol 76, no. 198, 1980, p 164-172 24 refs.

A series of studies were undertaken to assess the safety hazards in proposed solar thermal power systems (STPS) Among the risks identified are distributed heliostat defocussing, interruption of working fluid flow, receiver meltdown, and leakage of hazardous fluids. It is concluded that unique hazards are presented by sensible heat, latent heat, and thermochemical energy storage systems, although specific sources of danger vary widely among the three types. A tentative preference is established for the salt phase change, latent heat storage type from the standpoint of worker safety O C

A81-29290 * **Effect of zinc impurity on silicon solar-cell efficiency.** C.-T. Sah, P. C. H. Chan, C.-K. Wang (Illinois, University, Urbana, Ill.), K. A Yamakawa, R. Lutwack (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif), and R L.-Y. Sah. *IEEE Transactions on Electron Devices,* vol. ED-28, Mar 1981, p. 304-313. 24 refs. Research supported by the U S Department of Energy and NASA

Zinc is a major residue impurity in the preparation of solar-grade silicon material by the zinc vapor reduction of silicon tetrachloride This paper projects that in order to get a 17-percent AM1 cell efficiency for the Block IV module of the Low-Cost Solar Array Project, the concentration of the zinc recombination centers in the base region of silicon solar cells must be less than 4 x 10 to the 11th Zn/cu cm in the p-base n+/p/p+ cell and 7 x 10 to the 11th Zn/cu cm in the n-base p+/n/n+ cell for a base dopant impurity concentration of 5 x 10 to the 14 atoms/cu cm. If the base dopant impurity concentration is increased by a factor of 10 to 5 x 10 to the 15th atoms/cu cm, then the maximum allowable zinc concentration is increased by a factor of about two for a 17-percent AM1 efficiency. The thermal equilibrium electron and hole recombination and generation rates at the double-acceptor zinc centers are obtained from previous high-field measurements as well as new measurements at zero field described in this paper. These rates are used in the exact dc-circuit model to compute the projections. (Author)

A81-29684 **Solar selective surfaces.** O P. Agnihotri and B. K Gupta (Indian Institute of Technology, New Delhi, India). New York, Wiley-Interscience, 1981. 232 p 384 refs. $35.

Principles of the design, production, evaluation and application of reflection-absorption and reflection-transmission type solar selective surfaces for flat plate or concentrating solar collectors are discussed. The preparation, properties and role of transparent conducting coatings as solar selective surfaces are considered, with attention given to metal films, wide bandgap semiconductors, and geometrical selective spectral surfaces, and aspects of the application of selective surfaces to photothermal conversion are described Transparent conductors used in photovoltaic energy conversion are examined, including ITO/Si, SnO2/Si, ITO/GaAs, ITO/InP and SnO2/GaAs heterojunction devices, and the various measurement techniques used for absorptance and emittance determinations are presented Consideration is then given to the compositions, fabrication and preparation of black reflection-absorption coatings, which may be composed of absorber-reflector tandems, conversion coatings, pure semiconductors, powdered semiconductor-reflector combinations and composite material coatings Recommendations with regard to the further development of transparent conducting coatings, plated coatings, paint coatings, high-temperature selective surfaces and magnetron sputtering fabrication techniques are presented A L W

N81-16437*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
SOLAR-PUMPED GAS LASER DEVELOPMENT
John W Wilson Dec 1980 66 p refs
(NASA-TM-81894) Avail NTIS HC A04/MF A01 CSCL 20E

A survey of gas properties through detailed kinetic models led to the identification of critical gas parameters for use in choosing appropriate gas combinations for solar pumped lasers Broadband photoabsorption in the visible or near UV range is required to excite large volumes of gas and to insure good solar absorption efficiency The photoexcitation density is independent of the absorption bandwidth The state excited must be a metastable state which is not quenched by the parent gas The emission bandwidth must be less than 10 A to insure lasing threshold over reasonable gain lengths The system should show a high degree of chemical reversibility and an insensitivity to increasing temperature Other properties such as good quantum efficiency and kinetic efficiency are also implied Although photoexcitation of electronic vibrational transitions is considered as a possible system if the emission bands sufficiently narrow, it appears that photodissociation into atomic metastables is more likely to result in a successful solar pumped laser system J M S

N81-16558*# Raytheon Co, Waltham, Mass New Products Center
THE HISTORY OF THE DEVELOPMENT OF THE RECTENNA
William C Brown *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 271-280 refs

Avail NTIS HC A16/MF A01 CSCL 10A

The history of the development of the rectenna is reviewed through its early conceptual developmental phases Some selective aspects of the current solar power satellite rectenna development are examined R C T

N81-16559*# Boeing Aerospace Co, Seattle, Wash
RECTENNA SYSTEM DESIGN
G R Woodcock and R W Andryczyk (General Electric Co) *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 281-290

Avail NTIS HC A16/MF A01 CSCL 10A

The fundamental processes involved in the operation of the rectenna system designed for the solar power satellite system are described The basic design choices are presented based on the desired microwave rf field concentration prior to rectification and based on the ground clearance requirements for the rectenna structure A nonconcentrating inclined planar panel with a 2 meter minimum clearance configuration is selected as a representative of the typical rectenna R C T

N81-16572*# General Electric Co, Cincinnati, Ohio Advanced Energy Programs Dept
STORAGE REQUIREMENT DEFINITION STUDY Final Report
L E Stacy, G C Wesling, and W F Zimmerman 15 Dec 1980 120 p refs Sponsored by NASA and DOE Prepared for JPL
(Contract JPL-955388)
(NASA-CR-163882, AED-EO-57, JPL-9950-472) Avail NTIS HC A06/MF A01 CSCL 10C

A dish Stirling solar receiver (DSSR) and a heat pipe solar receiver with TES (HPSR) for a 25 kWe dish Stirling solar power system are described The thermal performance and cost effectiveness of each are analyzed minute by minute over the equivalent of one year of solar insolation Existing designs of these two systems were used as a basis for the study, TES concepts for the DSSR and alternative TES concepts for the HPSR are presented Parametric performance and cost studies were performed to determine the operating and cost characteristics of these systems Data are reported for systems (1) without TES and with varying amounts of TES, (2) with and without a fossil fuel combustor, (3) with varying solar to fossil power input, and (4) with different system control assumptions The principal effects of TES duration, collector area, engine efficiency, and fuel cost sensitivity are indicated Development needs for each of the systems are discussed and the need and nature of possible future TES solar modular experiments are presented and discussed Author

N81-16574*# Fairchild Stratos Corp, Manhattan Beach, Calif
DISH STIRLING SOLAR RECEIVER PROGRAM Final Report
Richard A Haglund 15 Dec. 1980 174 p Prepared for JPL
(Contracts NAS7-100, JPL-955400)
(NASA-CR-163889, JPL-9950-473, ER-79917-3) Avail NTIS HC A08/MF A01 CSCL 10A

A technology demonstration of a Dish Stirling solar thermal electric system can be accomplished earlier and at a much lower cost than previous planning had indicated by employing technical solutions that allow already existing hardware, with minimum modifications, to be integrated into a total system with a minimum of development The DSSR operates with a modified United Stirling p-40 engine/alternator and the JPL Test Bed Concentrator as a completely integrated solar thermal electric system having a design output of 25 kWe The system is augmented by fossil fuel combustion which ensures a continuous electrical output under all environmental conditions Technical and economic studies by government and industry in the United States and abroad identify the Dish Stirling solar electric system as the most appropriate, efficient and economical method for conversion of solar energy to electricity in applications when the electrical demand is 10 MWe and less A R H

N81-16575*# Kinetic Coatings, Inc, Burlington, Mass
DEVELOPMENT OF SIMPLIFIED PROCESS FOR ENVIRONMENTALLY RESISTANT CELLS Final Report, 8 Jun. 1978 - 30 Nov. 1980
William J King Dec 1980 166 p refs Sponsored in part by DOE Prepared for JPL
(Contract JPL-955079)
(NASA-CR-163884, DOE/JPL-955079-80/1, JPL-9950-468) Avail NTIS HC A08/MF A01 CSCL 10A

This report describes a program to develop a simple, foolproof, all vacuum solar cell manufacturing process which can be completely automated and which results in medium efficiency cells which are inherently environmentally resistant All components of the completed cells are integrated into a monolithic structure with no material interfaces The exposed materials (Si, Al2O3, Al, Ni) are all resistant to atmospheric attack and the junction, per se, is passivated to prevent long term degradation Such cells are intended to be incorporated into a simple module consisting basically of a press formed metallic superstructure with a separated glass cover for missile, etc, protection Author

N81-16576*# Solar Power Corp, Woburn, Mass
DESIGN, FABRICATION, TEST, QUALIFICATION AND PRICE ANALYSIS FOR THIRD GENERATION DESIGN SOLAR CELL MODULES Final Report
15 Sep 1980 99 p refs Sponsored in part by NASA and DOE Prepared for JPL

(Contract JPL-955403)
(NASA-CR-163917, DOE/JPL-955403-80/1, JPL-9950-464) Avail NTIS HC A05/MF A01 CSCL 10A

An updated program plan is presented showing the task descriptions depicting the work, progress, achievements, and the cause of any deviations from the original plan (SC-1), and how this impacted on the original schedule of the program In addition there is an update documenting all design alterations made during the pre-production phase and a complete up to date set of engineering and manufacturing documentation (CM-1) The purpose of the work in the original plan was to explore, design, develop, test, and deliver 1000 watts of prototype flat plate, photovoltaic modules appropriate for use in applications in the 20 to 500 kilowatt range and which show potential for meeting the 1986 cost goals E D K

N81-16578*# RCA Labs, Princeton, N J
AUTOMATED ARRAY ASSEMBLY, PHASE 2 Final Report, 1 Sep. 1977 - 31 Dec. 1979
R V DAiello Oct 1980 259 p refs Sponsored in part by DOE Prepared for JPL
(Contracts NAS7-100, JPL-954868)
(NASA-CR-163878, DOE/JPL-954868-80/9, JPL-9950-453) Avail NTIS HC A12/MF A01 CSCL 10A

A manufacturing sequence which is capable of mass producing silicon solar cells is described The sequence was arrived at after the evaluation of many processes and three related manufacturing sequences which are discussed L F M

N81-16580*# Jet Propulsion Lab, California Inst of Tech, Pasadena
PHOTOVOLTAIC MODULE SOILING STUDIES, MAY 1978 - OCTOBER 1980
A R Hoffman and C R Maag 1 Nov 1980 52 p refs
(Contracts NAS7-100, EX-76-A-29-1012)
(DOE/JPL-1012-49, JPL-Pub-80-87) Avail NTIS HC A04/MF A01 CSCL 10C

Comparative electrical and optical performance data from photovoltaic modules and materials subjected to outdoor exposure at field test sites throughout the United States were collected and examined The results show significant time and site dependence During periods when natural removal processes do not dominate the rate of particulate contamination accumulation appears to be largely material-independent The effectiveness of natural removal processes, especially rain, is strongly material-dependent Glass and acrylic top cover materials retain fewer particles than silicone rubber does Side by side outdoor exposure testing for long duration is presently the most effective means of evaluating soiling differences between materials Changes in spectral transmission as a function of time and location and limited scattering data are presented Author

N81-16581*# Jet Propulsion Lab, California Inst of Tech, Pasadena
CRITERIA FOR EVALUATION OF REFLECTIVE SURFACE FOR PARABOLIC DISH CONCENTRATORS
F Bouquet 15 Jul 1980 67 p refs Sponsored in part by DOE
(Contracts NAS7-100)
(NASA-CR-163898, DOE/JPL-1060-39, JPL-Pub-80-81) Avail NTIS HC A04/MF A01 CSCL 10B

Commercial, second surface glass mirror are emphasized, but aluminum and metallized polymeric films are also included Criteria for sealing solar mirrors in order to prevent environmental degradation and criteria for bonding sagged or bent mirrors to substrate materials are described An overview of the technical areas involved in evaluating small mirror samples sections, and entire large gores is presented A basis for mirror criteria was established that eventually may become part of inspection and evaluation techniques for three dimensional parabolic reflective surfaces T M

N81-16592# Sandia Labs Albuquerque N Mex Photovoltaics Div
DESIGN, FABRICATION, AND PERFORMANCE OF A 20 PERCENT EFFICIENT SILICON SOLAR CELL
J L Rodriguez and F W Sexton Oct 1980 26 p refs
(Contract DE-AC04-76DP-000789)
(SAND-80-2225) Avail NTIS HC A03/MF A01

A single crystal concentrator p(+)nn(+) silicon solar cell with maximum efficiency greater than 20% at 27 C is described The intrinsic cell design was used with several metallization patterns targeted for different system designs in the ten to several hundred sums concentration range The design and fabrication of the intrinsic cell is specified Performance data for the best cells of three metal patterns with the intrinsic cell are presented and discussed Author

N81-16593# Sandia Labs, Albuquerque, N Mex Experimental Systems Operations Div
PERFORMANCE OF A SOLAR-HEATED ASSEMBLY BUILDING AT SANDIA NATIONAL LABORATORIES
Dale E Haskins Sep 1980 44 p refs
(Contract DE-AC04-76DP-00789)
(SAND-80-0599) Avail NTIS HC A03/MF A01

The passive solar heating system of the assembly building at Sandia National Laboratories' Photovoltaic Advanced Systems Test Facility is described and the thermal analysis of the building is given Performance predictions are also given, and actual performances for December 1979 and January 1980 are shown E D K

N81-16594# Oak Ridge National Lab, Tenn
APPLICATIONS OF LASER ANNEALING AND LASER-INDUCED DIFFUSION TO PHOTOVOLTAIC CONVERSION Progress Report, 1 Mar. 1980 - 28 Feb. 1981
R T Young, D H Lowndes, and R F Wood 17 Nov 1980 18 p Presented at Topical Polycrystalline Silicon Subcontractors' Rev Meeting, Colorado Springs, Colo, 17 Nov 1980
(Contract W-7405-eng-26)
(CONF-801153-1) Avail NTIS HC A02/MF A01

Laser annealing and laser induced diffusion can be used to control grain boundary diffusion and segregation With these techniques, the near surface region of a sample actually melts but stays molten for such a short time that significant dopant migration cannot occur Furthermore since the grain boundaries as such do not exist while the material is molten rapid diffusion to them and along them does not occur Laser techniques can also be used to promote growth and evidence from EBIC and TEM indicates that pulsed laser annealing changes the elementary structure of some types of grain boundaries The role of lithium in polycrystalline Si was studied It was found that when Li is added to polycrystalline Si, it not only provides an excess free carrier for each ionized Li, but also dramatically improves the carrier mobilities A R H

N81-16595# Research Triangle Inst, Research Triangle Park, N C Semiconductor Research Dept
RESEARCH ON HIGH EFFICIENCY CASCADE SOLAR CELLS Annual Report, Jul 1979 - Jun 1980
S M Bedair, M L Timmons, J R Hauser, J E Andrews, S B Phatak, and M Simons Aug 1980 103 p refs Prepared in cooperation with North Carolina State Univ, Raleigh
(Contract EG-77-C-01-4042)
(SERI/PR-8136-1-T1) Avail NTIS HC A06/MF A01

The technology needed to fabricate two junction cascade solar cells having conversion efficiencies of 30 percent or more under multisun illumination was researched using a number of different III-V semiconductor materials systems that are potential candidate for a cascade solar cell design Work focused on the development of a compatible combination of materials required for the monolithic, multilayer structure using several different epitaxial growth techniques Materials receiving principal attention during the past year have been GaAlAs, GaInP and GaAlAsSb for the high bandgap top cell and GaInAs, GaAsSb and GaAs for the low bandgap bottom cell Liquid phase vapor phase and organometallic chemical vapor deposition growth techniques were explored E D K

N81-16606# Ames Lab, Iowa
PHOTOELECTROCHEMICAL SOLAR CELLS BASED ON d-BAND ELECTROCHEMISTRY AT TRANSITION METAL DISELENIDES Technical Progress Report, 1 Dec. 1979 - 29 Feb. 1980
Bruce A Parkinson and Thomas E Furtak May 1980 32 p refs
(Contract EG-77-C-01-4042)
(IS-4745) Avail NTIS HC A03/MF A01

Topographic photogenerated carrier collection analysis and sub bandgap photoexcitation studies have confirmed that edge states associated with lattice imperfections on WSe2 are the principal detrimental factor contributing to poor power conversion efficiency in photoelectrochemical solar cells based on this material Efficiency improvement was achieved by inactivating the edge states. Author

N81-16607# Sandia Labs, Albuquerque, N Mex
PHOTOVOLTAIC ADVANCED SYSTEMS TEST FACILITY: DESCRIPTION AND OPERATIONS PLAN
Howard J Gerwin Oct 1980 46 p Sponsored by DOE
(SAND-80-1612) Avail NTIS HC A03/MF A01

The Photovoltaic Advanced Systems Test Facility is described Photovoltaic modules and arrays are tested, along with power conditioning units and energy storage equipment related to photovoltaic systems The test facility description, collector test plan, and user interface information are presented S F.

N81-16608# Sandia Labs, Albuquerque, N. Mex Geo Energy Systems Analysis Div
COMPARATIVE ANALYSIS OF COMBINED FLAT-PLATE PV/T COLLECTORS WITH SEPARATE PV/T COLLECTORS
Eddie R Hoover Sep 1980 44 p refs Sponsored by DOE
(SAND-80-1494) Avail NTIS HC A03/MF A01

The conditions under which a combined photovoltaic/thermal (PV/T) collector is more cost effective than separate flat plate photovoltaic and thermal collectors are determined The annual performance of the separate PV/T system and four different combined PV/T systems are simulated in two geographical locations using a system analysis computer program Based on equivalent electrical and thermal outputs and the 1986 DOE goal for PV modules (70 cents/Wp), the maximum allowabe incremental cost to upgrade the conventional thermal collector to a combined PV/T collector is determined For all of the cases considered, the separate PV/T collectors are more cost effective than the combined PV/T collectors E D K

N81-17266*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
COMMERICAL (TERRESTRIAL) AND MODIFIED SOLAR ARRAY DESIGN STUDIES FOR LOW COST, LOW POWER SPACE APPLICATIONS
Joseph C Kolecki and Thomas J Riley Dec 1980 21 p refs
(NASA-TM-81622, E-632) Avail NTIS HC A02/MF A01 CSCL 10A

The suitability of commercial (terrestrial) solar arrays for use in low Earth orbit is examined It is shown that commercial solar arrays degrade under thermal cycling because of material flexure, and that certain types of silicones used in the construction of these arrays outgas severely Based on the results, modifications were made The modified array retains the essential features of typical commercial arrays and can be easily built by commercial fabrication techniques at low cost The modified array uses a metal tray for containment, but eliminates the high outgassing potting materials and glass cover sheets Cells are individually mounted with an adhesive and individually covered with glass cover slips, or clear plastic tape The modified array is found to withstand severe thermal cycling for long intervals of time M G

N81-17518* National Aeronautics and Space Administration Pasadena Office, Calif
SOLAR ENERGY RECEIVER FOR A STIRLING ENGINE Patent
M. Kudret Selcuk, inventor (to NASA) (JPL) Issued 2 Dec 1980 5 p Filed 6 Apr 1979 Supersedes N79-20513 (17 - 11, p 1449) Sponsored by NASA
(NASA-Case-NPO-14619-1, US-Patent-4,236,383, US-Patent-Appl-SN-027559, US-Patent-Class-60-641, US-Patent-Class-60-524, US-Patent-Class-126-419) Avail US Patent and Trademark Office CSCL 10A

A solar energy receiver includes a separable endless wall formed of a ceramic material in which a cavity of substantially cylindrical configuration is defined for entrapping solar flux An acceptance aperture is adapted to admit to the cavity a concentrated beam of solar energy The wall is characterized by at least one pair of contiguously related segments separated by lines of cleavage intercepting the aperture At least one of the segments is supported for pivotal displacement A thermal-responsive actuator is adapted to respond to excessive temperatures within the cavity for initiating pivoted displacement of one segment, whereby thermal flux is permitted to escape from the cavity Official Gazette of the U S Patent and Trademark Office

N81-17521*# Photowatt International, Inc, Tempe, Ariz
AUTOMATED ARRAY ASSEMBLY TASK DEVELOPMENT OF LOW-COST POLYSILICON SOLAR CELLS Final Report
Gregory T Jones Nov 1980 86 p refs Sponsored by DOE Prepared for JPL
(Contract JPL-955265)
(NASA-CR-163939, DOE/JPL/955265-80/3) Avail NTIS HC A05/MF A01 CSCL 10A

Development of low cost, large area polysilicon solar cells was conducted in this program Three types of polysilicon material were investigated A theoretical and experimenal comparison between single crystal silicon and polysilicon solar cell efficiency was performed Significant electrical performance differences were observed between types of wafer material, i e fine grain and coarse grain polysilicon and single crystal silicon Efficiency degradation due to grain boundaries in fin grain and coarse grain polysilicon was shown to be small It was demonstrated that 10 percent efficient polysilicon solar cells can be produced with spray on n+ dopants This result fulfills an important goal of this project, which is the production of batch quantity of 10 percent efficient polysilicon solar cells Author

N81-17522*# Solarex Corp, Rockville, Md
DEVELOPMENT OF A HIGH EFFICIENCY THIN SILICON SOLAR CELL Final Report
G Storti, J Culik, and C Wrigley Dec 1980 79 p refs Prepared for JPL
(Contracts NAS7-100, JPL-954883)
(NASA-CR-163931, SX/115/F) Avail NTIS HC A05/MF A01 CSCL 10A

Significant improvements in open-circuit voltage and conversion efficiency, even on relatively high bulk resistivity silicon, were achieved by using a screen-printed aluminum paste back surface field A 4 sq cm 50 micron m thick cell was fabricated from textured 10 omega-cm silicon which had an open-circuit voltage of 595 mV and AMO conversion efficiency at 25 C of 14 3%. The best 4 sq cm 50 micron thick cell (2 omega-cm silicon) produced had an open-circuit voltage of 607 mV and an AMO conversion efficiency of 15% Processing modifications are described which resulted in better front contact integrity and reduced breakage These modifications were utilized in the thin cell pilot line to fabricate 4 sq cm cells with an average AMO conversion efficiency at 25 C of better than 12 5% and with lot yields as great as 51% of starts, a production rate of 10,000 cells per month was demonstrated A pilot line was operated which produced large area (25 cm) ultra-thin cells with an average AMO conversion efficiency at 25 deg of better than 11 5% and a lot yield as high as 17% A R H

N81-17523*# General Electric Co, Cincinnati, Ohio Advanced Energy Programs Dept
A CONCEPTUAL DESIGN STUDY OF A HIGH TEMPERATURE SOLAR THERMAL RECEIVER (ADDED TASKS 6 AND 7) Final Report
C. S Robertson, L R McCreight, A Gatti, and H W Semon 7 Nov 1980 39 p refs Prepared for JPL
(Contract JPL-955455)

(NASA-CR-163944, JPL-9950483, AED-EO-48) Avail NTIS HC A03/MF A01 CSCL 10A

The key component of this concept is a coiled tube of silicon nitride which acts as a heat exchanger appears to be ideal from the standpoint of utilizing structural ceramics at around 2500 F under severe thermal shock conditions However the size and configuration of this coil are beyond the state of the art for fabricating such materials as silicon nitride and carbide A two-task program to develop and demonstrate the feasibility of extruding and forming a section of thin walled silicon nitride tubing was undertaken as an addition to the original program A promising polyvinyl butyral-based binder lubricant was identified Fourteen full size extrusion experiments were conducted Two trial firings of 1-1/4 turn helices were made T M

N81-17525*# Westinghouse Electric Corp, Trafford, Pa Power Circuit Breaker Div

LOW COST SOLAR ARRAY PROJECT SILICON MATERIALS TASK. DEVELOPMENT OF A PROCESS FOR HIGH CAPACITY ARC HEATER PRODUCTION OF SILICON FOR SOLAR ARRAYS Final Technical Report

Maurice G Fey 1981 234 p refs Prepared for JPL
(Contract JPL-954589)
(NASA-CR-163943, JPL-9950491, DOE/JPL-954589-80/9) Avail NTIS HC A11/MF A01 CSCL 10A

The experimental verification system for the production of silicon via the arc heater-sodium reduction of SiCl4 was designed, fabricated, installed, and operated Each of the attendant subsystems was checked out and operated to insure performance requirements These subsystems included the arc heaters/reactor, cooling water system, gas system, power system, Control & Instrumentation system, Na injection system, SiCl4 injection system, effluent disposal system and gas burnoff system Prior to introducing the reactants (Na and SiCl4) to the arc heater/reactor, a series of gas only-power tests was conducted to establish the operating parameters of the three arc heaters of the system Following the successful completion of the gas only-power tests and the readiness tests of the sodium and SiCl4 injection systems, a shakedown test of the complete experimental verification system was conducted T M

N81-17531*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

SPACE PHOTOVOLTAIC RESEARCH AND TECHNOLOGY 1980. HIGH EFFICIENCY, RADIATION DAMAGE AND BLANKET TECHNOLOGY

1980 395 p refs Conf held in Cleveland, 15-17 Oct 1980
(NASA-CP-2169, E-469) Avail NTIS HC A17/MF A01 CSCL 10A

The application of silicon solar cells are discussed with respect to their importance in the exploration of space Several aspects of the technology associated with the development of photovoltaic devices are reported

N81-17532*# National Aeronautics and Space Administration, Washington, D C

NASA'S HIGH EFFICIENCY AND RADIATION DAMAGE SOLAR CELL PROGRAM

Lynwood P Randolph *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 1-3

Avail NTIS HC A17/MF A01 CSCL 10A

The conversion efficiency and the life expectancy of solar cells and arrays were evaluated for space applications Efforts were made to improve the understanding of the conversion of electromagnetic radiation to useful forms of energy A broad range of advanced concepts were evaluated R C T

N81-17533*# Air Force Wright Aeronautical Labs, Wright-Patterson AFB, Ohio

SOLAR POWER R AND D FOR AIR FORCE SPACE REQUIREMENTS

Joseph F Wise *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 5-10
Avail NTIS HC A17/MF A01 CSCL 10A

The requirements for improved solar power system technology for DOD satellites are reported It is shown that the technology is required in several areas including solar cells, array blanket technology, energy storage and power system operation, and regulation and control It is further shown that as the missions become more critical to defence, military aspects such as survivability, hardening, and eventually defence must be addressed R C T

N81-17534*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

RECENT PROGRESS IN HIGH-OUTPUT-VOLTAGE SILICON SOLAR CELLS

A. Muelenberg (COMSAT Labs, Clarksburg, Md), R A Arndt (COMSAT Labs., Clarksburg, Md), J F Allison (COMSAT Labs, Clarksburg, Md), and V Weizer *In its* Space Photovoltaic Res and Technol 1980 p 11-14 refs

(Contract NAS3-22217)
Avail NTIS HC A17/MF A01 CSCL 10A

The status of the technology associated with the development of high output voltage silicon solar cells is reported The energy conversion efficiency of a double diffusion process is compared to that of a single diffusion process The efficiency of a 0 1 ohm/cm solar cell is characterized both before and after covering R.C T

N81-17537*# Purdue Univ, Lafayette, Ind

COMPUTER MODELING OF HIGH-EFFICIENCY SOLAR CELLS

R J Schartz and M S Lundstrom *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 37-50 refs Sponsored by DOE Prepared for Sandia Labs Albuquerque, N Mex
Avail NTIS HC A17/MF A01 CSCL 10A

Transport equations which describe the flow of holes and electrons in the heavily doped regions of a solar cell are presented in a form that is suitable for device modeling Two experimentally determinable parameters, the effective bandgap shrinkage and the effective asymmetry factor are required to completely model the cell in these regions Nevertheless, a knowledge of only the effective bandgap shrinkage is sufficient to model the terminal characteristics of the cell The results of computer simulations of the effects of heavy doping are presented The insensitivity of the terminal characteristics to the choice of effective asymmetry factor is shown along with the sensitivity of the electric field and quasielectric fields to this parameter The dependence of the terminal characteristics on the effective bandgap shrinkage is also presented Author

N81-17541*# Communications Satellite Corp, Clarksburg, Md

SILICON RESEARCH AND TECHNOLOGY WORKSHOP REPORT

A Meulenberg, Jr *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 71-72

Avail NTIS HC A17/MF A01 CSCL 10A

The materials, structures, processing, modeling and measurements of high efficiency silicon solar cells were surveyed In the materials area, highlights included (1) the possibility of improving cell voltages by reducing minority carrier mobilities in critical regions of the solar cells, (2) the need for and possibility of lowering the surface recombination velocity for improvement of open circuit voltage in shallow junction cells, (3) the present need for improved lifetime in high resistivity cells, and (4) the potential for new materials such as polycrystalline or dendritic web material to perform well at end of life in a radiation environment In the area of structures, distinction was made between those for terrestrial use and those that would survive radiation environments Areas such as epitaxial growth and laser or elctron beam annealing (and diffusion) were proposed as having certain advantages over more conventional techniques R C T

N81-17542*# Air Force Wright Aeronautical Labs, Wright-Patterson AFB, Ohio

THE GaAs SOLAR CELL RESEARCH AND DEVELOPMENT PROGRAMS OF THE AIR FORCE
Kenneth T Masloski *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 73-78 ref

Avail NTIS HC A17/MF A01 CSCL 10A
The compound GaAs is of interest for space application photovoltaics due to its inherent advantages over silicon Higher efficiencies, superior radiation hardness, and a greater temperature resistance are the major advantages of GaAs over Si Air Force programs look for ways of maximizing these advantages while minimizing disadvantages such as higher costs and weights Four programs in GaAs photovoltaics are described and each program is discussed in terms of its objective, approach and status T M

N81-17543*# Jet Propulsion Lab, California Inst of Tech., Pasadena
HIGH EFFICIENCY EPITAXIAL GaAs/GaAs AND GaAs/Ge SOLAR CELL TECHNOLOGY USING OM/CVD
K L Wang, Y C M Yeh, R J Stirn, and S Swerdling *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 81-85 Sponsored in part by DOE and AF

(Contract NAS7-100)
Avail NTIS HC A17/MF A01 CSCL 10A
A technology for fabricating high efficiency, thin film GaAs solar cells on substrates appropriate for space and/or terrestrial applications was developed The approach adopted utilizes organometallic chemical vapor deposition (OM-CVD) to form a GaAs layer epitaxially on a suitably prepared Ge epi-interlayer deposited on a substrate, especially a light weight silicon substrate which can lead to a 300 watt per kilogram array technology for space The proposed cell structure is described The GaAs epilayer growth on single crystal GaAs and Ge wafer substrates were investigated T M

N81-17544*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
STUDY OF PROCESS TECHNOLOGY FOR GaAlAs/GaAs HETEROFACE SOLAR CELLS
Edmund J Conway, Gilbert H Walker, Charles E Byvik, and David W Almgren *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 87-94

Avail NTIS HC A17/MF A01 CSCL 10A
Two processes were considered the infinite melt process and the finite melt process The only technique that is developed to the point that 10,000 cells could be produced in one year is the infinite melt liquid phase epitaxy process The lowest cost per cell was achieved with the advanced metal organic chemical vapor deposition process Molecular beam epitaxy was limited by the slow growth rate The lowest cost, an 18 percent efficient cell at air mass zero, was approximately $70 per watt T M

N81-17545*# Varian Associates, Palo Alto, Calif
HIGH EFFICIENCY COMPOUND SEMICONDUCTOR CONCENTRATOR PHOTOVOLTAICS
Peter Borden, Paul Gregory, Ram Saxena, Richard Owen, and Ozzie Moore *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 95-112 refs

Avail NTIS ,HC A17/MF A01 CSCL 10A
Special emphasis was given to the high yield pilot production of packaged AlGaAs/GaAs concentrator solar cells, using organometallic VPE for materials growth, the demonstration of a concentrator module using 12 of these cells which achieved 16 4 percent conversion efficiency at 50 C coolant inlet temperature, and the demonstration of a spectral splitting converter module that achieved in excess of 20 percent efficiency This converter employed ten silicon and ten AlGaAs cells with a dichroic filter functioning as the beam splitter A monolithic array of AlGaAs/GaAs solar cells is described T M

N81-17546*# Rockwell International Corp, Thousand Oaks, Calif Electronics Research Center
STATUS OF ROCKWELL-ERC HIGH EFFICIENCY SOLAR CELL PROGRAMS
S W Zehr, J A Cape, D L Miller, and H T Yang *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 113-119
Avail NTIS HC A17/MF A01 CSCL 10A
Programs aimed at developing large area, high efficiency GaAs heteroface cells for low concentration space applications and high concentration terrestrial applications as well as other programs aimed at developing high efficiency multicolor devices for use in similar applications are described An additional program aimed at achieving improved power to weight ratio by parting thin film solar cells from their growth substrates prior to their incorporation into an array assembly is also described There is potential for multiple reuse of the substrates which could lead to reduced costs for such devices Highlights of these programs and their interrelated contributions toward the goals of reducing specific weight, volume and cost of photovoltaic space power systems are discussed Overall goals are summarized and current programs and their funding sources are listed T M

N81-17547*# Hughes Research Labs, Malibu, Calif
GaAs WORKSHOP REPORT
G S Kamath *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 121-124

Avail NTIS HC A17/MF A01 CSCL 10A
The advantages of GaAs over silicon are discussed The substrate problem in solar cell fabrication was reviewed Future trends in solar energy technology were predicted with special emphasis on cost of production T M

N81-17548*# Air Force Wright Aeronautical Labs, Wright-Patterson AFB, Ohio
RESULTS OF THE AIR FORCE HIGH EFFICIENCY CASCADED MULTIPLE BANDGAP SOLAR CELL PROGRAMS
W P Rahilly *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 125-129 refs

Avail NTIS HC A17/MF A01 CSCL 10A
The III-V semiconductor materials system that was selected for continued cascade cell development was the AlGaAs cell on GaAs cell structure The tunnel junction used as transparent ohmic contact between the top cell and the bottom cell continued to be the central difficulty in achieving the program objective of 25 percent AMO efficiency at 25 C During the tunnel junction and top cell developments it became apparent that the AlGaAs cell has potential for independent development as a single junction converter and is a logical extension of the present GaAs heteroface technology T M

N81-17549*# Midwest Research Inst, Golden, Colo Solar Energy Research Inst
INCORPORATION OF SUPERLATTICE CRYSTAL LAYERS IN MULTIJUNCTION SOLAR CELLS
A E Blakeslee and K W Mitchell *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 131-136 refs
Avail NTIS HC A17/MF A01 CSCL 10A
Superlattice layers are effective in decreasing the density of dislocations in lattice mismatched heterostructures at least four orders of magnitude Hence it was proposed to utilize this feature of superlattices to alleviate the problems due to misfit dislocations generated in the regions between two or more photovoltaic collecting junctions A further advantage is that the possibility is presented for using silicon as a low cost substrate as well as for the low band gap junction In the test case, a silicon low gap cell was connected to a GaAs 7P 3 high gap cell through a connecting region containing a GaAs/GaP superlattice T M

N81-17550*# Research Triangle Inst, Research Triangle Park, N C
AlGaAs-GaAs CASCADE SOLAR CELL
M F Lamorte and D H Abbott *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 137-156

refs

(Contract F33615-78-C-2077)
Avail NTIS HC A17/MF A01 CSCL 10A

Computer modeling studies are reported for a monolithic, two junction, cascade solar cell using the AlGaAs GaAs materials combination An optimum design was obtained through a serial optimization procedure by which conversion efficiency is maximized for operation at 300 K, AM 0, and unity solar concentration Under these conditions the upper limit on efficiency was shown to be in excess of 29 percent, provided surface recombination velocity did not exceed 10,000 cm/sec T M

N81-17551*# Research Triangle Inst, Research Triangle Park, N C

FABRICATION OF AlGaAs/GaAs CASCADE SOLAR CELL BY LPE

S M Bedair *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 157-164

Avail NTIS HC A17/MF A01 CSCL 10A

Stacking two or more photovoltaic junctions in electrical and optical series results in higher conversion efficiency since each junction can be tailored to respond more efficiently to a smaller range of photon energies An efficiency of about 30 percent was predicted for a two junction cascade cell having the optimum bandgap values A number of III-V materials systems were considered for use in fabricating cascade solar cells The Al-Ga-As system is attractive from a developmental standpoint since it employs a proven materials system that is closely lattice matched throughout its compositional range This system employs a GaAs low bandgap cell and 1 9 eV AlGaAs high bandgap cell connected by an AlGaAs tunnel junction Although this cell does not possess the optimum bandgap values, an efficiency of 25 percent was predicted at 300 K under AMO, 1 sun illumination T M

N81-17552*# Varian Associates, Palo Alto, Calif

OM-VPE GROWN MATERIALS FOR HIGH EFFICIENCY SOLAR CELLS

Ram Saxena, B Cooper, III, M Ludowise, P Borden, and P Gregory *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 165-173 refs

Avail NTIS HC A17/MF A01 CSCL 10A

Organometallic sources are available for all the III-V elements and a variety of dopants, thus it is possible to use the technique to grow a wide variety of semiconductor compounds AlGaAsSb and AlGaInAs alloys for multijunction monolithic solar cells were grown by OM-VPE While the effort concentrated on terrestrial applications, the success of OM-VPE grown GaAs/AlGaAs concentrator solar cells (23% at 400 suns) demonstrates that OM-VPE is suitable for growing high efficiency solar cells in large quantities for space applications In addition, OM-VPE offers the potential for substantial cost reduction of photovoltaic devices with scale up and automation and due to high process yield from reproducible, uniform epitaxial growths with excellent surface morphology T M

N81-17553*# Research Triangle Inst, Research Triangle Park, N C

CASCADE SOLAR CELL WORKSHOP REPORT

J A Hutchby *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 175-180

Avail NTIS HC A17/MF A01 CSCL 10A

Issues related to the feasibility, research and development, and demonstration of a 30% AMO cascade solar cell discussed include the material selection, growth and fabrication techniques, and device development strategy for a monolithic (two terminal) cascade cell, a hybrid (four terminal) cascade cell, and a spectral splitting device (three cells) Workshop recommendations include (1) initiate a long range research program to develop a three junction, monolithic, cascade cell using either AlGaAsSb-GaAsSb or AlGaInAs-GaInAs material system, (2) emphasize OM-CVD epitaxial growth technique, perhaps combined with other technologies in the near term to obtain tunnel junctions, (3) develop a two junction device first, (4) initiate a cascade solar cell modeling program to study and compare performance of two and four terminal cascade devices exposed to electron and proton irradiation, and (5) envourage and be open to new ideas for developing four terminal, hybrid, cascade cells exploiting novel component cell interconnect technologies A R H

N81-17569*# Naval Research Lab, Washington, D C

THREE YEAR PERFORMANCE OF THE NTS-2 SOLAR CELL EXPERIMENT

R L Statler and D H Walker *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 219-228 refs Sponsored in part by AF

Avail NTIS HC A17/MF A01 CSCL 10A

Twelve different solar cell modules from the NTS 2 experiment are functioning after more than three years in a severe trapped radiation orbit of 20,367 km (10,990 nm) circular, 63 deg inclination The rate of maximum power degradation may be fit to a predicted rate which is based on twice the value of 1 MeV electron equivalent damage fluence calculated from the space electron model AEI 7 The photovoltaic parameters of the cells are compared to their original values to demonstrate rank order of performance Author

N81-17572*# Jet Propulsion Lab, California Inst of Tech, Pasadena

PROSPECTS FOR ENHANCING SEP ARRAY PERFORMANCE

John A Scott-Monck *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 351-361 refs

(Contract NAS7-100)
Avail NTIS HC A17/MF A01 CSCL 10A

Three advanced blanket design models, all employing the OAST thin cell, were developed for potential incorporation into the SEP array The beginning of life (BOL) specific power of the these blankets ranges from 180 to 660 W/kg Coupling these blanket designs to the baseline SEP array structure yields array specific powers of from 90 to 200 W/kg It is shown that certain modifications to the SEP array structure, coupled with the advanced blanket designs, could allow the BOL specific power to reach approximately 250 W/kg J M S

N81-17573*# Astro Research Corp, Carpinteria, Calif

EFFICIENT STRUCTURES FOR GEOSYNCHRONOUS SPACECRAFT SOLAR ARRAYS

John M Hedgepeth *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 363-377 refs

(Contract NAS7-100)
Avail NTIS HC A17/MF A01 CSCL 10A

Structural concepts for deploying and supporting lightweight solar array blankets for geosynchronous electrical powr are evaluated First, the requirements for more mass efficient solar arrays is established by describing future needs Then analytical results are set forth which show that not only must lighter weight blankets be developed but also the supporting structure must be improved proportionately The SEPS configuration is taken to be the state of the art point of departure for improved structural concepts Several directions for improvement are indicated J M S

N81-17574*# Spectrolab, Inc, Sylmar, Calif

THE HEWAC PILOT LINE EXPERIENCE

M Gillanders and R Opjorden *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 379-386

(Contract NAS3-21270)
Avail NTIS HC A17/MF A01 CSCL 10A

Advanced silicon solar cells with both electrical contacts on the back side of the cell are described These high efficiency wrap around contact solar cells (HEWACS) utilize a screen printed dielectric insulation layer to isolate the 'n' and 'p' contacts from each other Development of a device exhibiting high AMO conversion efficiencies is addressed along with the processing of such cells to a point where cell fabrication can be carried out by production personnel under operating production line conditions J M S

N81-17575*# TRW Defense and Space Systems Group, Redondo Beach, Calif
DESIGN REQUIREMENTS FOR HIGH-EFFICIENCY HIGH CONCENTRATION RATIO SPACE SOLAR CELLS
H Rauschenbach and R Patterson *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 387-400 ref
(Contract NAS8-32986)
Avail: NTIS HC A17/MF A01 CSCL 10A

A miniaturized Cassegrainian concentrator system concept was developed for low cost, multikilowatt space solar arrays The system imposes some requirements on solar cells which are new and different from those imposed for conventional applications The solar cells require a circular active area of approximately 4 mm in diameter High reliability contacts are required on both front and back surfaces The back area must be metallurgically bonded to a heat sink The cell should be designed to achieve the highest practical efficiency at 100 AMO suns and at 80 C The cell design must minimize losses due to nonuniform illumination intensity and nonnormal light incidence The primary radiation concern is the omnidirectional proton environment J M S

N81-17576*# Jet Propulsion Lab, California Inst of Tech, Pasadena
BLANKET TECHNOLOGY WORKSHOP REPORT
John A Scott-Monck *In* NASA Lewis Research Center Space Photovoltaic Res and Technol 1980 p 401-403

Avail NTIS HC A17/MF A01 CSCL 10A

The solar array blanket, defined as a substrate covered with interconnected and glassed solar cells, but excluding the necessary support structure, deployment, and orientation devices, is considered The interactions between the blanket and the structure that is used to package, deploy, support and, if necessary restow it, are addressed along with systems constraints such as spacecraft configuration, size, and payload requirements The influence on blanket design is emphasized The three main mission classes considered are low Earth orbital (LEO), intermediate, or LEO to GEO transfer, and geosynchronous (GEO) Although interplanetary missions could be considered to be a separate class, their requirements, primarily power per unit mass, are generally close enough to geosynchronous missions to allow this mission class to be included within the third type Examination of the critical elements of each class coupled with considerations of the shuttle capabilities is used to define the type of blanket technology most likely required to support missions that will be flown starting in 1990 J M S

N81-17579# Solarex Corp, Rockville, Md
SILICON SOLAR CELL OPTIMIZATION Interim Report, Aug. 1978 - Feb. 1980
John H Wohlgemuth and A L Scheinine Wright-Patterson AFB, Ohio AFWAL Jun 1980 78 p refs
(Contract F33615-78-C-2039)
(AD-A092908, AFWAL-TR-80-2059) Avail NTIS HC A05/MF A01 CSCL 10/2

This research program has resulted in improvements in vertical junction solar cell techniques leading to higher efficiencies and improved handleability Vertical junction solar cells have now been fabricated with AMO conversion efficiency greater than 15% (25 C) A variety of cells have been fabricated including different groove depths, substrate thicknesses and bulk resistivities Cell performance has been measured both before and after irradiation Theoretical analysis has been performed to generate computer models of I-V curves for various cell geometries These models have been compared with actual cell performance to aid in the understanding of the mechanisms responsible for cell performance GRA

N81-17586# OAO Corp, Washington, D C
FUELS AND CHEMICALS MADE FROM SOLAR ENERGY: OPTIONS FOR THE 1990'S AND BEYOND
Aug 1980 13 p
(Contract DE-AC01-79ET-21051)
(DOE/CS-21051/01) Avail NTIS HC A02/MF A01

The concept and feasibility of using solar thermal systems to produce gaseous and liquid fuels and feedstocks from non-renewable resources such as coal, lignite, and peat and from renewable resources such as water and waste organic materials are discussed Some of the commercially important reactions considered as candidates for solar thermal technology are mentioned including synthesis gas production, shale oil processing, decomposition of water, ammonia production, styrene manufacture, and inorganic chemicals processes DOE research programs in this area are briefly discussed DOE

N81-17587# Biphase Energy Systems, Inc, Santa Monica, Calif
EVALUATION OF A TWO-PHASE TURBINE FOR SOLAR ELECTRIC POWER GENERATION Final Report
William E. Amend 17 Nov 1980 129 p refs
(Contracts DE-AC03-76ET-20431, EY-76-C-03-1255)
(DOE/ET-20431/T1) Avail NTIS HC A07/MF A01

The Biphase turbine has the potential to produce shaft power at a higher efficiency than conventional Rankine type cycles operating between the same temperature limits Also, the two phase system has the potential to effectively operate at higher heat source temperatures than the Rankine system without having to employ extremely high pressures In addition, capital costs of the Biphase system are projected to be some 30 percent below those for an equivalent Rankine vapor system Since the Biphase turbine is inherently a low speed, high torque device, conventional mechanical elements can be employed to build a highly reliable, low maintenance system Thus the cost of electrical power produced from a field of solar collector by a Biphase system is projected to be significantly below that from a Rankine system The design, fabrication, analysis, and preliminary testing of a 58 7 hp Biphase system designed to produce electrical power from a field of solar collectors delivering energy at 540 F and 500 psia are described DOE

N81-17589# Nuovo Pignone S p A, Florence (Italy)
CONSTRUCTION OF A COMPLETE ALL SEASON CONDITIONING WITH SOLAR ENERGY OF AN OFFICE BUILDING OF 260 m2 AND ITS OPERATION Final Report
Ferrari G P Aggradi 1980 86 p refs
(EUR-6702-EN) Avail NTIS HC A05/MF A01

The building and the solar plant are described including the control system, and the main ways of operation The results of the first year tests are reported for every day A description of the data acquisition system is given, including the type of data, and the measurement frequency required in each case The main troubles occurred during the test, and the methods used to solve them are described as well The performance of the collector and the absorption refrigerant units are analyzed DOE

N81-17592# Unibilt Industries, Vandalia, Ohio
PASSIVE AND HYBRID SOLAR MANUFACTURED HOUSING AND BUILDINGS Final Report
Doug Scholz, Curt Bowling, Steven Winter, Emanuel Levy, Rita Marks, and Al Zgolinski 1981 163 p Prepared in cooperation with Winter (Steven) Associates, Inc, New York Prepared for Midwest Research Inst, Golden, Colo
(Contract DE-FC02-80CS-30384)
(DOE/CS-30384/1) Avail NTIS HC A08/MF A01

After reviewing alternative insulation, glazing, and water wall schemes, five options were identified for detailed energy use and life cycle cost analysis Using the PASCALC/SLR analysis procedure, the performance of the base case home and each of the energy conservation options was calculated DOE

N81-17593# Commission of the European Communities, Brussels (Belgium) Directorate General for Research, Science and Education
ENERGY: SOLAR ENERGY PROGRAMME OF THE

COMMISSION OF THE EUROPEAN COMMUNITIES
1980 181 p
(EUR-6959-EN) Avail NTIS (US Sales Only) HC A09/MF A01; DOE Depository Libraries

Abstracts are presented of the final reports of projects in the fields of solar energy applications for dwellings, a 1 MWe solar thermal power plant, photovoltaic power generation, and energy from biomass DOE

N81-17595# Stanford Univ, Calif Dept of Materials Science and Engineering
PHOTOELECTRONIC PROPERTIES OF ZINC PHOSPHIDE CRYSTALS, FILMS AND HETEROJUNCTIONS Quarterly Progress Report, 1 Jul. - 30 Sep. 1980
Richard H. Bube 1980 17 p refs Sponsored by DOE Prepared for Midwest Research Inst., Golden, Colo.
(SERI/PR-8031-1-T2, QPR-6) Avail NTIS HC A02/MF A01

The role of crystalline defects and impurities in Zn3P2, the nature of the electronic charge transport in single crystal and thin film material, and the properties of photovoltaic heterojunctions involving Zn3P2 were studied The scope of the program extends from basic investigations of materials properties on single crystals to the preparation and characterization of all thin film heterojunction devices One of the principal motivations behind this research program is the realization that Zn3P2 is a relatively uninvestigated yet ideal component for photovoltaic heterojunction use in solar energy conversion The program concentrates on the basic materials problems involved with Zn3P2, providing the kind of information needed for other more developmental program directed toward actual practical cells Results are reported DOE

N81-17596# Mueller Associates, Inc, Baltimore, Md.
PROGRAM PLAN FOR RELIABILITY AND MAINTAINABILITY IN ACTIVE SOLAR HEATING AND COOLING SYSTEMS
Oct 1980 62 p refs
(Contract DE-AC01-80CS-36010)
(DOE/CS-36010/01) Avail NTIS HC A04/MF A01

Specific objectives are as follows provide all groups that have solar R & M concerns with the information that is available to the program and that can assist in alleviating those concerns, assist the solar energy industry in improving levels of R & M performance in state of the art solar energy systems, components, and materials, assist in the early development of a viable infrastructure for the design, manufacture, installation, and maintenance of reliable, maintainable, and durable solar energy systems; assist in the development of appropriate standards, code provisions, and certification programs relating to the R & M performance of solar energy systems, components, and materials, and develop the information required to support the other activities within the R & M program. These objectives correspond to five areas of action regulations, research and development, technology transfer, solar industry infrastructure development, and data collecton and analysis TM

N81-17600# Midwest Research Inst., Golden, Colo Solar Energy Research Inst.
APPROPRIATE SIZING OF SOLAR HEATING SYSTEMS
P Bendt Sep 1980 33 p refs
(Contracts DE-AC02-77CH-00178, EG-77-C-01-4042)
(SERI/TR-333-320) Avail NTIS HC A03/MF A01

It is demonstrated that the uncertainty in future economic trends makes the results of system sizing by minimizing its life cycle cost questionable The design conditions for minimum cost are extremely broad and all practical systems have a solar fraction within the limited range of 30 percent to 90 percent. Thus, by choosing only three collector areas that give systems within this range, one is assured of selecting a nearly optimal system for any realistic economic scenario. Selecting one of these three systems is essentially equivalent to economic optimization, but simpler. Procedures are derived for determining the sizes of the three systems The conclusion is that the collector areas should be about 1/8, 1/5, and 1/3 of the building floor area. This rule of thumb eliminates the need to design solar systems individually, allowing the possibility of mass produced homes with standardized solar heating systems. DOE

N81-17604# Lincoln Lab., Mass Inst of Tech, Lexington
RESIDENTIAL USE OF PHOTOVOLTAICS
E C. Kern, Jr. 1980 7 p refs Presented at 1980 Photovoltaic Solar Energy Conf., Cannes, France, 27-31 Oct. 1980
(Contract DE-AC02-76ET-20279)
(DOE/ET-20279/109, CONF-801097-2) Avail NTIS HC A02/MF A01

Residential electricity demand data and forecasts for France, Japan and the United States are presented as background information pertinent to the market for solar photovoltaic power systems Current residential photovoltaic system development activities in the United States were reviewed Issues related to the eventual adoption of such systems are discussed DOE

N81-17605# Ontario Research Foundation, Mississauga.
SOLAR ENERGY PROGRAM: PROTECTIVE SOLAR COLLECTOR SYSTEMS FROM CORROSION
[1981] 35 p refs Sponsored by National Research Council, Ottawa, Ontario
(NP-25154) Avail NTIS (US Sales Only) HC A02/MF A01; DOE Depository Libraries

Corrosion by galvanic means is described and methods of fabrication which minimize this type of corrosion are discussed Minimizing corrosion at the design and operating stages of a solar heating system by properly choosing materials, coatings, and heat transfer fluids is considered DOE

N81-17608# Battelle Inst, Frankfurt am Main (West Germany)
DEVELOPMENT OF A CADMIUM SELENIDE THIN FILM SOLAR CELL Final Report
Dieter Bonnet Bonn Bundesministerium fuer Forschung und Technologie Dec 1979 86 p refs In GERMAN, ENGLISH summary Sponsored by Bundesministerium fure Forschung und Technologie
(BMFT-FB-T-79-72, ISSN-0340-7608) Avail NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 18.50

A CdSe MIS thin film solar cell was developed Fourteen materials were studied with regard to their suitability as I-layers Two these compounds, i e, ZnSe and Sb2Se3, give cells with relatively high photovoltage and high photocurrent The preparation procedure for the 2 micron thick active CdSe film was optimized with respect to all essential parameters Commercial, nominally very pure CdSe material from six manufactures was found either to be unsuited or to lead to properties greatly varying from batch to batch The best results were reproducibly obtained with a material directly synthesized from the elements which are commercially available in highly pure form Experimental cells achieve efficiencies of 4 5%. Short circuit current densities of more than 25 mA/sq cm for incident solar radiation of 100 mV/sq cm and open circuit voltages around 600 mV are obtained Further enhancement of the photovoltage up to 700 to 800 mV seems possible by suitable doping of the CdSe layer and compensation of the doping near the surface This as well as an enhancement of the fill factor from 55 to 70% can lead to cells of 9 to 10% efficiency. Author (ESA)

N81-17609# Kernforschungsanlage, Juelich (West Germany) Gesellschaft mit beschraenkter Haftung
TEST STATIONS FOR FLAT PLATE COLLECTORS IN IRAN, BRAZIL AND INDIA Final Report
K Scharmer and U Kleinhaus Bonn Bundesministerium fuer Forschung und Technologie Dec 1979 15 p ref In GERMAN, ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-79-94, ISSN-0340-7608) Avail NTIS HC A02/MF A01, Fachinformationszentrum, Karlsruhe, West Germany DM 3.40

A solar collector test facility was developed to evaluate the characteristics of flat plate collectors The collectors are described Three collector setups were sent to research institutes in Iran, Brazil and India These test facilities will determine the extent of collector development in those countries and test collectors under the climatic conditions of the three countries Author (ESA)

N81-17617*# Acurex Corp, Mountain View, Calif Environmental Div
SURVEY OF EPA FACILITIES FOR SOLAR THERMAL ENERGY APPLICATIONS Final Report, 1 Nov. 1977 - 30 Jun. 1978
E V Nelson, P T Overly, and D M Bell Oct 1980 155 p refs
(Contract EPA-68-03-2567)
(NASA-CR-162469, EPA-600/7-80-176, PB81-109316, ACUREX-80-40/EE) Avail NTIS HC A08/MF A01 CSCL 13A

A study was done to assess the feasibility of applying solar thermal energy systems to EPA facilities A survey was conducted to determine those EPA facilities where solar energy could best be used These systems were optimized for each specific application and the system/facility combinations were ranked on the basis of greatest cost effectiveness GRA

N81-17681# Department of Energy, Washington, D. C Office of Energy Research
INTRODUCTION TO METEOROLOGICAL MEASUREMENTS AND DATA HANDLING FOR SOLAR ENERGY APPLICATIONS
Oct. 1980 219 p refs
(DOE/ER-0084) Avail: NTIS HC A10/MF A01

Five project areas, called tasks, were identified for cooperative activities within the IEA Program to Develop and Test Solar Heating and Cooling Systems The objective of one task was to obtain improved basic resource information for the design and operation of solar heating and cooling systems through a better understanding of the required insolation (solar radiation) and related weather data, and through improved techniques for measurement and evaluation of such data At the February 1978 initial experts meeting in Norrkoeping, Sweden, the participants developed the objective statement into two subtasks, (1) an insolation handbook, and (2) a portable meteorological instrument package The handbook provides a basis for a dialogue between solar scientists and meteorologists DOE

N81-18114 Purdue Univ, Lafayette, Ind
FLASH PHOTOLYSIS STUDIES OF THE SEMICONDUCTOR/ELECTROLYTE INTERFACE Ph.D. Thesis
Jeffrey Rosenthal 1980 196 p
Avail Univ Microfilms Order No 8102700

The semiconductor/electrolyte interface, as applicable to solar energy conversion, was studied using the technique of flash photolysis with electrochemical monitoring Two important observations came out of these studies First, the intermediates or products of a light induced reaction at a semiconductor/electrolyte interface are electrochemically detectable at the semiconductor This was demonstrated by the detection of a photo-oxidation product shown to exist under continuous irradiation by cyclic voltammetry Also detected were the light induced decomposition products of n-type and p-type semiconductors, at conditions consistent with the literature observations Second, charge transfer between a semiconductor electrode and a species in solution can be so slow that detection on the time scale of a flash photolysis experiment is not possible
Dissert Abstr

N81-18225# California Univ, Livermore
SOLAR COAL GASIFICATION: PLANT DESIGN AND ECONOMICS
William R Aiman, Charles B Thorsness, and David W Gregg 12 Nov 1980 50 p refs Presented at the 73rd Ann Meeting of the AICE, Chicago, 16-20 Nov 1980
(Contract W-7405-eng-48)
(UCRL-84610, CONF-801104-6) Avail NTIS HC A03/MF A01

A plant was layed out and analyzed with the aid of a code that calculates process flows and plant economics This plant is the simplest, most straightforward plant and thus the most appropriate for initial analysis Solar energy is focused directly on the reacting coal The process analysis shows that 40% more product can be produced from a given amount of coal and that the fraction of the solar energy that can be converted into usable energy is greater than that for any other method with the exception of conversion to simple thermal energy The economic analysis shows that for a gasification plant that produces a given amount of product per year, the capital costs are much higher but the operating costs are much lower These cost differences reflect the 8 hr per day operation and the lower coal consumption for the SCG plant Product costs were derived as a function of coal cost DOE

N81-18488 California Univ, Los Angeles
EFFECT OF WALL SUCTION ON LAMINAR ENTRANCE FLOW WITH APPLICATION TO SOLAR AIR HEATERS Ph.D. Thesis
Seung Joon Rhee 1980 340 p
Avail Univ Microfilms Order No 8104035

Numerical solutions are obtained for hydrodynamically and thermally developing steady-state laminar flow in a long rectangular cavity with uniform suction on one wall and uniform temperature or heat flux independently prescribed at each wal Collection efficiencies for several solar air heaters are predicted by performing a system analysis A two dimensional thermal system model is considered, where temperature variation along the direction of flow is allowed in each system element Five selective black metal plate experimental solar air heaters with and without transpiration were designed, fabricated, and tested to compare their technical merits and to prove how well the theoretical results and system analysis predict performance of actual solar collectors Discussion of the design of a full-scale selective black metal plate solar air heater with transpiration through slots is presented Discussed are (1) The number of teflon films for cover glazing assembly, (2) the spacing between glazing elements, (3) the spacing between the absorber plate and the inner glazing, and (4) the design of inlet and outlet manifolds Dissert Abstr

N81-18492*# United Stirling A B Malmo (Sweden)
DESIGN STUDY OF A KINEMATIC STIRLING ENGINE FOR DISPERED SOLAR ELECTRIC POWER SYSTEMS Final Report, 1979 - 1980
1980 124 p refs
(Contract DEN3-56, EX-76-A-29-1060)
(NASA-CR-159588, DOE/NASA/0056-79/2) Avail NTIS HC A06/MF A01 CSCL 10B

The concept evaluation shows that the four cylinder double acting U type Stirling engine with annular regenerators is the most suitable engine type for the 15 kW solar application with respect to design, performance and cost Results show that near term performance for a metallic Stirling engine is 42% efficiency Further improved components show an impact on efficiency of the future metallic engine to 45% Increase of heater temperature, through the introduction of ceramic components, contribute the greatest amount to achieve high efficiency goals Future ceramic Stirling engines for solar applications show an efficiency of around 50% T M

N81-18493*# National Aeronautics and Space Administration Lyndon B Johnson Space Center, Houston, Tex
SOLAR POWER SATELLITE SYSTEM SIZING TRADEOFFS
G D Arndt and L G Monford Feb 1981 44 p ref
(NASA-TP-1804, S-505) Avail NTIS HC A03/MF A01 CSCL 10A

Technical and economic tradeoffs of smaller solar power satellite systems configured with larger antennas, reduced output power, and smaller rectennas, are considered The differential costs in electricity for seven antenna/rectenna configurations operating at 2 45 GHz and five satellite systems operating at 5 8 GHz are calculated Two 2 45 GHz configurations dependent upon the ionospheric power density limit are chosen as examples If the ionospheric limit could be increased to 54 mW sq/cm from the present 23 mW sq/cm level, a 1 53 km antenna satellite operating at 2 45 GHz would provide 5 05 GW of output power from a 6 8 km diameter rectenna This system gives a 54 percent reduction in rectenna area relative to the reference solar power satellite system at a modest 17 percent increase in electricity costs At 5 8 GHz, an 0 75 km antenna providing

2 72 GW of power from a 5 8 km diameter rectenna is selected for analysis This configuration would have a 67 percent reduction in rectenna area at a 36 percent increase in electricity costs Ionospheric, atmospheric, and thermal limitations are discussed Antenna patterns for three configurations to show the relative main beam and sidelobe characteristics are included A R H

N81-18495*# Solarex Corp, Rockville, Md
COPLANAR BACK CONTACTS FOR THIN SILICON SOLAR CELLS Final Report, 24 Jul. 1978 - 15 Jul. 1980
G Storti, A Scheinine, D Whitehouse, J Wohlgemuth, C Wrigley, and M Giuliano Jan 1981 38 p refs
(Contract NAS3-21250)
(NASA-CR-165272) Avail NTIS HC A03/MF A01 CSCL 10A

The type of coplanar back contact solar cell described was constructed with interdigitated n(+) and p(+) type regions on the back of the cell, such that both contacts are made on the back with no metallization grid on the front This cell construction has several potential advantages over conventional cells for space use namely, convenience of interconnects, lower operating temperatures and higher efficiency due to the elimination of grid shadowing However, the processing is more complex, and the cell is inherently more radiation sensitive The latter problem can be reduced substantially by making the cells very thin (approximately 50 micrometers) Two types of interdigitated back contact cells are possible, the types being dependent on the character of the front surface The front surface field cell has a front surface region that is of the same conductivity type as the bulk but is more heavily doped This creates an electric field at the surface which repels the minority carriers The tandem junction cell has a front surface region of a conductivity type that is opposite to that of the bulk The junction thus created floats to open circuit voltage on illumination and injects carriers into the bulk which then can be collected at the rear junction For space use, the front surface field cell is potentially more radiation resistant than the tandem junction cell because the flow of minority carriers (electrons) into the bulk will be less sensitive to the production of recombination centers, particularly in the space charge region at the front surface T M

N81-18499# Von Karman Inst for Fluid Dynamics, Rhode-Saint-Genese (Belgium) Environmental and Applied Fluid Dynamics Dept
HEAT EXCHANGE AND SOLAR ENERGY, VOLUME 1
1980 223 p refs Partly in ENGLISH and FRENCH Proceedings of 1980 Lecture Ser, Rhode-Saint-Genese, Belgium, 28 Jan - 1 Feb 1980 2 Vol
(VKI-LS-1980-2-Vol-1) Avail NTIS HC A01/MF A01

Lectures were presented surveying the heat transfer problems arising in connection with the collection, storage and utilization of solar energy Special emphasis is given to the modeling of complete solar systems, including computer simulation of their transient response

N81-18500# Mons Univ (Belgium)
GENERAL INTRODUCTION TO THERMAL CONVERSION OF SOLAR ENERGY
J Bougard *In* Von Karman Inst for Fluid Dyn Heat Exchange and Solar Energy, Vol 1 1980 35 p refs

Avail NTIS HC A10/MF A01

The daily distribution and monthly repartition of direct and diffuse solar energy is shown for Belgium The thermodynamic limitations of thermal conversion are reviewed relative to solar heating and cooling systems Optical systems, absorbers, and the global energy balance are discussed for thermal solar collectors Energy flow charts shown are for several configurations of solar heating systems Author (ESA)

N81-18501# Institut Royal Meteorologique de Belgique, Brussels Radiometry Section
METEOROLOGICAL DATA: MEASUREMENT TECHNIQUES AND SOLAR COMPONENTS
R Dogniaux *In* Von Karman Inst for Fluid Dyn Heat Exchange and Solar Energy, Vol 1 1980 28 p refs

Avail NTIS HC A10/MF A01

The users of solar radiation data are identified and their respective accuracy requirements are given Quantities and units are defined for direct, diffuse and global solar radiation measurements, and for long wave radiation flux Techniques for estimating solar radiation data from sunshine hourly data are mentioned, and for deriving mean radiation components from parameters associated with the astronomical coordinates of the Sun, the geographical coordinates of the station, and atmospheric turbidity Author (ESA)

N81-18502# Mons Univ (Belgium)
METEOROLOGICAL DATA: TREATMENT OF RADIATION DATA, TEST REFERENCE YEAR
Andre Pilatte and Philippe Nicolas *In* Von Karman Inst for Fluid Dyn Heat Exchange and Solar Energy, Vol 1 1980 29 p *Sponsored by EEC and Belgium Ministry of Scientific Policy*
Avail NTIS HC A10/MF A01

A test reference year (TRY) is defined as a set of real measured hourly values for dry temperature, for global, diffuse and direct normal solar radiation, and for wind velocity The data are in true sequence within each month The months are selected from a multiple year data set of observations for a given location such that the resulting TRY is typical for the location Three methods for selecting a TRY are outlined One is purely statistical, the second depends on manual evaluation of data by a meteorologist, and the third depends on the effects of input data on a given system, (a building or a domestic hot water system) Each method is used to select a TRY and a climatological evaluation is performed with a solar heating system simulation program SYS4 The methods generate usable TRYS, with the statistical method costing the least Author (ESA)

N81-18503# Joint Research Centre of the European Communities, Ispra (Italy)
THERMAL PROCESSES IN FLAT PLATE SOLAR COLLECTORS
E Aranovitch *In* Von Karman Inst for Fluid Dyn Heat Exchange and Solar Energy, Vol 1 1980 49 p

Avail NTIS HC A10/MF A01

Heat losses from radiation, natural convection and from conduction in nonfocusing flat plate collectors are described and evaluated The fin and bond effect is discussed and a method is shown for deriving the temperature profile in an aluminum fin The principles of radiation transmission through transparent covers are reviewed, including Fresnel reflections at interfaces, and absorption coefficients within material Methods for calculating heat losses and efficiency of a collector are shown Methods for improving transmittance of covers are mentioned, including use of double glass, selective surfaces, and honeycomb structures between the cover and the absorber plate Author (ESA)

N81-18504# Joint Research Centre of the European Communities, Ispra (Italy)
DESCRIPTION AND THERMAL PERFORMANCE OF CORRUGATED SOLAR COLLECTORS [DESCRIPTION ET PERFORMANCES THERMIQUES DE COLLECTEURS SOLAIRES A CORRUGATIONS]
P Colaiemma (ALUMETAL), X Micheletti (ALUMETAL), E Aranovitch, F Farfaletti, M Ledet, and C Roumengous *In* Von Karman Inst for Fluid Dyn Heat Exchange and Solar Energy Vol 1 1980 21 p In FRENCH

(Contract ISPRA-145-75-PIPGI)
Avail NTIS HC A10/MF A01

Full scale tests were conducted of a flat plate solar collector fabricated from modular aluminum extrusions The anodized extruded backplates contained integral fluid tubes and triangular corrugations Plates painted black, brown and green were evaluated at entry temperatures between 40 C and 90 C, and were found to be of nearly equal efficiency Anodized plates were 40% more efficient Curves are shown for monochromatic reflectance as a function of length of anodizing treatment The extrusion profile tested presented a nonnegligible thermal resistance Author (ESA)

N81-18505# Calabria Univ, Cosenza (Italy)
ADVANCED SOLAR COLLECTORS (CONCENTRATING TROUGHS)
Orazio A Barra, L Franceschi, and E Pugliese Carratelli *In* Von Karman Inst for Fluid Dyn Heat Exchange and Solar Energy, Vol 1 1980 31 p refs

Avail NTIS HC A10/MF A01
The optical characteristics of short focus and long focus parabolic troughs are listed A statistical analysis of the photothermal conversion and thermal losses of a cylindrical pipe and a cavity receiver is made A steady state heat transfer equation is used to perform a dynamic analysis of the temperature profiles of the fluid flowing inside the receivers Finite difference methods are employed to solve the equation with boundary conditions supplied by statistical analysis and with experimental data to estimate the equation parameters Solutions for several physical and geometrical variants are discussed Parabolic trough solar plant designs are given Author (ESA)

N81-18506# Calabria Univ, Cosenza (Italy)
A NATURAL CONVECTION SOLAR HOUSE SYSTEM
O A Barra, E Pugliese Carratelli, and G Salzano (Rome Univ) *In* Von Karman Inst for Fluid Dyn Heat Exchange and Solar Energy, Vol 1 1980 16 p refs

(Contract CNR-78-02438 07)
Avail NTIS HC A10/MF A01
An instrumented house heated by air circulated past a south facing wall was constructed and a computer model prepared to simulate the operation of the system The wall was thermally decoupled from the collector, and a thin metal absorber plate introduced between the transparent cover and the wall The absorber radiated from both sides in the naturally circulating air flow The model supplied a synthetic series of hourly values of direct and diffused solar radiation and external ambient temperature, assuming a statistical distribution of historical data of the site Some graphical model results are given Author (ESA)

N81-18515# First Manufactured Homes, Inc., Lubbock, Tex
PASSIVE AND HYBRID SOLAR MANUFACTURED HOUSING AND BUILDINGS
15 Sep 1980 217 p
(Contract DE-EC02-80CS-30371)
(DOE/CS-30371/1) Avail. NTIS HC A10/MF A01
The eleven Conceptual Options, three Preliminary Designs for the Technical Review and three types of thermal storage hat could be used with any of the three plans are included Also, the appropriate thermal calculations, life cycle cost, cost estimates and market analysis are included GRA

N81-18520# Midwest Research Inst, Golden, Colo Solar Thermal, Ocean, and Wind Div
OMNIUM-G PARABOLIC DISH OPTICAL EFFICIENCY: A COMPARISON OF TWO INDEPENDENT MEASUREMENT TECHNIQUES
M Bohn and H Gaul Oct 1980 16 p refs
(Contract DE-AC02-77CH-00178)
(SERI/TR-631-544) Avail NTIS HC A02/MF A01
Measurements made at SERI of the optical efficiency of the Omnium-G parabolic dish concentrator are described Two independent techniques are emphasized the cold water calorimeter method, and the heat of fusion method Results from both techniques indicate that the optical efficiency for a 10 cm receiver aperture is 25 percent An optical alignment procedure is described that resulted in the increase in optical efficiency from 21 percent to the current value of 25 percent DOE

N81-18521# Institute of Gas Technology, Chicago, Ill
ELECTROCHEMICAL PHOTOVOLTAIC CELLS Quarterly Technical Progress Report, 1 Aug. - 31 Oct. 1980
Peter G P Ang and A F Sammells Dec 1980 22 p refs
(Contract DE-AC02-77CH-00178)
(SERI/PR-9175-1-T2) Avail NTIS HC A02/MF A01
Experimental approaches for electrochemical photovoltaic cells that not only show promise of high power conversion efficiencies but also have the potential to achieve long life and the capacity for energy storage were identified The work is organized as follows selection of high efficiency semiconductor photoelectrode/electrolyte systems, development of long life electrochemical photovoltaic cells, development of an all solid state electrochemical photovoltaic cell with in situ storage and demonstration of laboratory size photoelectrochemical cell with redox storage This program is directed toward identifying a suitable match between the proposed semiconductor and the redox species present in aqueous, nonaqueous, and solid electrolytes for achieving the necessary performance and semiconductor stability requirements Emphasis is on aqueous electrolyte based systems where fast kinetics are favored The proposed systems will be compatible with convenient storage of the electroactive species generated and their later electrochemical discharge in a redox cell DOE

N81-18522# Battelle Pacific Northwest Labs Richland Wash
BARSTOW HELIOSTAT MIRROR GLASS CHARACTERIZATION
M A Lind and C Q Buckwalter Sep 1980 40 p refs
(Contract DE-AC06-76RL-01830)
(PNL-3576) Avail NTIS HC A03/MF A01
The technical analysis performed on the special run of low iron float glass for a ten megawatt solar thermal/electric pilot power plant is discussed The topics that are addressed include the optical properties and the relative durability of the glass Two optical parameters, solar transmittance and optical flatness, were measured as referenced in the specification and found to be better than the stated tolerances The average solar transmittance exceeded 0 890 transmittance units The glass also exhibited optical angular flatness deviations less than + or - 1 0 mrad as required Both qualitative and quantitative accelerated weathering tests were performed on the glass in order to compare its durability to other soda lime float glass and alternate composition glasses of interest to the solar community In both the quantitative leaching experiments and the more qualitative room temperature and elevated temperature water vapor exposure experiments the heliostat glass exhibited the same characteristics as the other soda lime silicate float glasses DOE

N81-18523# Midwest Research Inst, Golden, Colo
SOLAR CENTRAL RECEIVER SYSTEMS COMPARATIVE ECONOMICS
P J Eicker Apr 1980 9 p refs Presented at Solar Central Receiver Semiann Rev Meeting, Williamsburg, Va, 11 Sep 1979
(Contract DE-AC02-77CH-00178)
(SERI/SP-633-637, CONF-7909189-1) Avail NTIS HC A02/MF A01
Several major conceptual design studies of solar central receiver systems and components were completed in the last year The results of these studies were used to compare the projected cost of electric power generation using central receiver systems with that of more conventional power generation The cost estimate for a molten salt central receiver system is given Levelized busbar energy cost is shown as a function of annual capacity factor indicating the fraction of the cost due to each of the subsystems The estimated levelized busbar energy cost for a central receiver (70 to 90 mills per kilowatt hour) is compared with the levelized busbar energy cost for a new coal fired Rankine cycle plant Sensitivities to the initial cost of coal and the delta fuel escalation are shown DOE

N81-18530# Rockwell International Science Center, Thousand Oaks, Calif Electronics Research Center
GALLIUM ARSENIDE PHOTOVOLTAIC DENSE ARRAY FOR CONCENTRATOR APPLICATIONS Final Report
J A. Cape Dec 1980 108 p refs
(Contract DE-AC04-76DP-00789)

(SAND-78-7056) Avail NTIS HC A06/MF A01

The feasibility of operating a photovoltaic subsystem on a solar central receiver was explored with emphasis on the possible application of the photovoltaic device as part of a compound receiver for cogeneration of heat and electricity, a so-called total energy system Progress is reported in the design, performance, and testing of a dense array of GaAs concentrator cells Specific requirements for the array design were (1) achieve 16% array efficiency (including area losses) at 1000 SUNs, (2) yield a working output voltage between 220 to 300 volts, (3) have integral heat sinking optimized for efficient total energy utilization, (4) meet the test conditions of 25(0) to 180(0)C and 50 to 1500 SUNs, (5) have a modular structure so that larger units could be built up, (6) be compatible with CRTF test system (coolant loop, and optical acceptance angle, etc), and (7) be protected against shorts, shadowing, individual cell open circuit failure and load fluctuations Progress is reported including design, performance, and testing details DOE

N81-18532# *Foster-Miller Associates, Inc, Waltham, Mass*

DEVELOPMENT OF AN AUTOMATIC HELIOSTAT CLEANING SYSTEM Final Technical Report

Paul Tremblay and Elizabeth Poulin Dec 1980 120 p refs

(Contract DE-AC04-79DP-00789)

(SAND-79-8184, SAN-7908) Avail NTIS HC A06/MF A01

An automatic washing system was designed consisting of a water treatment system, a pressurized underground water distribution system, an automatic spray washing module for each heliostat, a water collection system, and appropriate controls to operate this equipment In order to determine the required values for the various washing parameters, a series of washing tests was undertaken in which mirrors were soiled and then cleaned by a high pressure water spray Reflectivity was measured for the clean, soiled and washed conditions to determine the effectiveness of the cleaning A heliostat spray module was constructed and operated mainly to obtain information on the mechanical operation of one concept This testing showed that this system was generally satisfactory, but did show some areas for improvement Water distribution and waste water systems were designed and evaluated with the main conclusion that conventional waste water collection is complex and the most expensive part of the system DOE

N81-18533# Hughes Research Labs, Malibu, Calif

INDIUM PHOSPHIDE/CADMIUM SULFIDE THIN-FILM SOLAR CELLS Final Report, May 1979 - Jul. 1980

K Zanio Sep 1980 71 p refs

(Contract DE-AC02-77CH-00178)

(SERI/TR-8170-1-T2) Avail NTIS HC A04/MF A01

Thin-film InP/RXCdS/ITO/GLASS devices were prepared by depositing ITO on low-cost glass substrate, depositing CdS on the ITO by thermal evaporation, increasing the CdS lateral grain size by recrystallization, and depositing p-type InP by planar reactive deposition (PRD) on the recrystallized CdS (RXCdS) Yields of the RXCdS/ITO/GLASS substrates were increased to 90% with lateral dimensions of the RXCdS grains as large as 0 3 mm P-type InP layers were obtained with Be doping S-doping via vapor transport from the CdS was eliminated by capping the entire RXCdS substrate with InP For InP deposited on RXCdS at 380 C, devices showed blocking action with a barrier height of about 0 5 V but no light response, possibly due to an intermediate approx 3 micrometers thick n-InP layer from diffusion of S from the RXCdS These results were achieved despite poor InP epitaxy due to an approx 0 5 micrometer-thick In-Cd-S transition layer between the InP and the RXCdS InP films were subsequently deposited on RXCdS at the reduced substrate temperature of 280 C to reduce S-diffusion and improve the quality of the epitaxy DOE

N81-18537# New Mexico Inst of Mining and Technology, Socorro Dept of Metallurgical and Materials Engineering

MICROSTRUCTURAL AND MECHANICAL PROPERTY EVALUATION OF BLACK CHROME AND ZINC OXIDE COATED SOLAR COLLECTORS Annual Report, Jun. 1979 - Mar. 1980

O T Inal, L E Murr, and A E Torma 1980 85 p refs

(Contract DE-AS04-78AL-04266)

(DOE/AL-04266/T1, AR-2) Avail NTIS HC A05/MF A01

Plating parameters for black chrome system were optimized with respect to selectivity utilizing simplex evolutionary operation procedures in sixteen sets of experiments Overgrowths produced with the optimized parameters were evaluated for optical, structural, thermal stability and mechanical properties It is observed that the coatings produced possess consistently high selectivity values, are durable against exposure to high temperature, are well attached to their structure, and are ductible Black zinc oxide surfaces created on leaf zinc, electroplated zinc on steel, and hot-dip zinc coated steel substrates show selectivity values that vary between 6-9, are seen to maintain their physical integrity as well as optical properties The plating parameters utilized in deposition of the coatings are seen to alter quantity and distribution of the elemental component and affect optical properties of these surfaces DOE

N81-18538# Harvard Univ, Cambridge, Mass Energy and Environmental Policy Center

BOSTON SOLAR RETROFITS: STUDIES OF SOLAR ACCESS AND ECONOMICS

Michael Shapiro and Shauna Doyle Nov 1980 101 p refs

(Contract DE-AT01-79CS-10047)

(DOE/CS-10047/T5) Avail NTIS HC A06/MF A01

Studies of solar access and solar retrofit economics are described for residential applications in the City of Boston The study of solar access was based upon a random sample of 94 buildings, the sample was stratified to ensure a broad geographic representation from the city's various sections Using available data on the heights and orientations of the sampled structures and surrounding buildings, each building's hourly access to sunlight was computed separately for the roof and south facing walls The second study was a comparative analysis of the economics of several solar heating and hot water systems Next, a number of alternative approaches for solar space and water heating were identified from interviews with individuals and groups involved in solar retrofit projects in the Boston area DOE

N81-18540# Argonne National Lab, Ill Components Technology Div

SOME BASIC CONSIDERATIONS AND POSSIBLE IMPROVEMENTS ON THE SOLAR POND

W T Sha, Y S Cha, K V Liu, and S L Soo Jun 1980 49 p refs

(Contract W-31-109-eng-38)

(ANL-CT-80-23) Avail NTIS HC A03/MF A01

Experimental results were compared to theoretical stability criteria of a salt gradient solar pond Cellular motion in the nonconvective layer is expected Innovative concepts on friction stabilization using stabilizing barriers and longitudinal stratification to improve pond heat extraction efficiency are presented DOE

N81-18542# Battelle Pacific Northwest Labs, Richland, Wash

ASSESSMENT OF SOLAR OPTIONS FOR LARGE POWER APPLICATIONS

Walter J Apley Oct 1980 12 p refs Presented at the Solar Central Receiver Semi-Annual Meeting, San Francisco, 15 Oct. 1980

(Contract DE-AC06-76RL-01830)

(PNL-SA-8968, CONF-8010129-1) Avail NTIS HC A02/MF A01

Comparative analyses of solar thermal conversion concepts were performed with the purpose of characterizing, evaluating, and ranking the principal solar thermal power concepts under consideration in the DOE-Solar Thermal Power Program, on the basis of an engineering and economic analysis of alternative power plant configurations Conceptual designs developed for the selected systems were based on common assumptions of available technology in the 1990 to 2000 time frame Designs best suited for a comparative evaluation of the concepts were formulated Costs were estimated on the basis of identical assumptions, ground rules, methodologies, and unit costs of materials and labor applied uniformly to all of the concepts

Seven generic types of collectors, together with associated subsystems for electric power generation, were considered in the study The collectors can be classified into three categories two-axis tracking (with compound-curvature reflecting surfaces), one-axis tracking (with single-curvature reflecting surfaces), and nontracking (with low-concentration reflecting surfaces) DOE

N81-18545# Brookhaven National Lab, Upton, N Y Dept of Energy and Environment

THIN-FILM FLAT-PLATE SOLAR COLLECTORS FOR LOW COST MANUFACTURE AND INSTALLATION

John W Andrews and William G Wilhelm Mar 1980 37 p refs

(BNL-51124) Avail NTIS HC A03/MF A01

A solar energy collector design using thin film plastics in both the absorber and glazing is described The design approach proceeded in two steps First, cost constraints on solar collectors were determined using reasonable economic projections Second, engineering was applied only to those ideas which had hope of falling within those cost boundaries The use of thin film plastics appeared most attractive according to these criteria The nature of the marketing and distribution network can be expected to have a strong impact on the final installed cost of the collector, the proposed design has characteristics which could make possible a reduced price markup DOE

N81-18551# Sandia Labs, Albuquerque, N Mex Experimental Systems Operations Div

MIDTEMPERATURE SOLAR SYSTEMS TEST FACILITY PROGRAM FOR PREDICTING THERMAL PERFORMANCE OF LINE-FOCUSING, CONCENTRATING SOLAR COLLECTORS

Thomas D Harrison Nov 1980 29 p refs

(Contract DE-AC04-76DP-00789)

(SAND-80-1964) Avail NTIS HC A03/MF A01

The qualifications of the laboratories selected to do the testing and the procedure for selecting commercial collectors for testing are given The testing program is outlined The computer program for performance predictions is described An error estimate for the predictions and a sample of outputs from the program are included DOE

N81-18552# State Univ of New York Buffalo Dept of Electrical Engineering

FABRICATION AND TESTING OF MIS SOLAR CELLS ON a-Si:F:H Final Report, 15 Sep 1979 - 15 Sep. 1980

M K Han and Wayne A Anderson 3 Nov 1980 56 p refs Sponsored in part by Midwest Research Inst Golden, Colo

(Contract DE-AC02-77CH-00178)

(SERI/TR-8041-9-T1) Avail NTIS HC A04/MF A01

Fabrication techniques and improved a-Si H film processing were achieved to produce a short circuit current density of 7 5 mA sq/cm and open circuit voltage of 740 mV on large area a-Si cells by the deposition of an inexpensive semitransparent metal (Cr) as a top electrode on a N-I-P structure This corresponds to a 2% efficiency using AMI illumination A V(sub oc) of 830 mV and fill factor of 0 54 were also separately obtained A relatively simple and inexpensive deposition technique using a one pumpdown vacuum system, Al grid, and thin metal film structure were applied to reduce the cost of a-Si H cell fabrication A SEM study of a-Si film quality shows the substrate texture to greatly influence the film morphology This in turn serves to influence the uniformity of photovoltaic response on completed solar cells The studies of optical transmittance of various thin metal films promote the utilization of Cr and Cu as a top electrode Dark and illuminated I-V characteristics show that current conduction mechanisms and recombination phenomena are not the same under dark and illuminated conditions DOE

N81-18555# Monosolar, Inc, Santa Monica, Calif

EMERGING MATERIALS FOR SOLAR CELL APPLICATIONS. ELECTRODEPOSITED CdTe Quarterly Report, 16 May - 15 Aug. 1980

Robert L Rod, Bulent Basol and Oscar Stafsudd 10 Sep 1980 15 p

(Contract DE-AC02-77CH-00178)

(SERI/PR-9152-1-T1, QR-2) HC A02/MF A01

Work was centered about improving electroplating processes and cell fabrication techniques, with emphasis being given to three differing n-CdTe/Au Schottky configurations The highest values of efficiency related paramèters achieved with a simulated solar irradiation of 100 mW/sq cm were 0 57V for open circuit voltage, 0 6 for fill factor, and 6 mA/sq cm for short circuit current Four important parameters are known to control the quality of the Monosolar electrodeposition process and resultant solar cells They are electrolyte temperature, Te concentration in the solution at a specific pH deposition or quasi-rest potential and flow pattern of the electrolyte (stirring) The first three considerations are believed to be fully understood and optimized Work is underway to further understand the effects of stirring on the diffusion of ionic components and the effects on CdTe film performance Work was accelerated during the quarter to increase the short circuit current Parallel programs using laser irradiation of finished CdTe films heat treatment, and changes in the electrodeposition process itself to recrystallize films were started DOE

N81-18557# Poly Solar, Inc, Garland, Tex

THIN FILM POLYCRYSTALLINE SILICON SOLAR CELLS Technical Progress Report, 16 Jul. - 15 Oct. 1980

Oct 1980 32 p

(Contract DE-AC02-77CH-00178)

(SERI/PR-9192-1-T2, TPR-2) Avail NTIS HC A03/MF A01

The objectives of this contract are to fabricate large area thin film silicon solar cells with AM1 efficiency of 10% or greater with good reproducibility and good yield and to assess the feasibility of implementing this process for manufacturing solar cells at a cost of $300/kWe Efforts were directed to the purification of metallurgical silicon, the preparation and characterization of substrates and epitaxial silicon layers, and the fabrication and characterization of solar cells The partial purification of metallurgical silicon by extraction with aqua regia was further investigated in detail, and the resulting silicon was analyzed by the atomic absorption technique The unidirectional solidification of aqua regia extracted metallurgical silicon on graphite was used for the preparation of substrates, and the impurity distribution in the substrate was determined and compared with the impurity content in metallurgical silicon The effects of heat treatment on the impurity distribution in the substrate and in the epitaxial layer were also investigated DOE

N81-18559# Westinghouse Research and Development Center, Pittsburgh, Pa

DEVELOPMENT OF COPPER SULFIDE/CADMIUM SULFIDE THIN FILM SOLAR CELLS Technical Progress Report, 13 Jan - 12 Apr 1980

J R Szedon, F A Shirland, J A Stoll H C Dickey, and W J Biter 23 Jul 1980 39 p refs

(Contract DE-AC02-77CH-00178)

(SERI/PR-8143-1-T2 TPR-3) Avail NTIS HC A03/MF A01

During the course of this quarter, peak cell performance was improved from 0 455V to 0 510V, from 11 8 to 20 2 mA sq/cm, and from 3 3% to 6 5% as regards open circuit voltage, short circuit current density, and conversion efficiency, respectively Information exchanges and critical reviews of process details were made with the cooperation of the group at the Institute of Energy Conversion, University of Delaware As a result of these, two areas were identified which lead to higher cell performance Substrate temperature control and monitoring during deposition were improved by the use of a thermocouple welded to the foil substrate Fast thorough rinsing of the CdS films in the interval between the etch for surface texturing and the immersion in cuprous chloride for barrier formation current and open circuit voltage performance DOE

N81-18560# Texas A&M Univ, College Station Dept of Chemistry

PHOTOCHEMICAL SOLAR ENERY CONVERSION IN SURFACTANT VEHICLES Annual Progress Report, 1 Mar. - 30 Nov. 1980

J H Fendler 1980 8 p refs

(Contract DE-AS05-80ER-10601)
(DOE/ER-10601/1) Avail NTIS HC A02/MF A01
This report lists the personnel, journal publications, oral presentations, and summarizes the scientific activities the neodymium-yag laser system was installed, based on this laser, a nonosecond flash photolysis system was constructed, water soluble 5,10,15,20-*tetra-p-n-methyl-pyridinochloride* zinc-porphyrin were synthetized purified and characterized, and photosensitized electron transfer, charge separation a hydrogen production were demonstrated in surfactant DOE

N81-18561# Virginia Polytechnic Inst and State Univ Blacksburg
THE CdSiAs2 THIN FILMS FOR SOLAR CELL APPLICATIONS Final Report, 9 Apr. 1979 - 8 Mar 1980
L C Burton and L H Slack Jun 1980 71 p refs
(Contract DE-AC04-79ET-23007)
(DOE/ET-23007/4) Avail NTIS HC A04/MF A01
Compounds of Cd-Si-As required for sputtering targets and evaporation charges were synthesized by direct fusion These include CdSiAs2, Cd3As2, CdAs2 and SiAs Polycrystalline ingots of CdSiAs2 were found to be porous, with the chalcopyrite structure, and with minor amounts of other phases such as CdAs2, SiAs,As and Cd3As2 Sputtered films were formed in a single target RF system A homogeneous CdSiAs2 target was initially used, followed by composite targets consisting of CdAs2 + Si Films from the latter targets were superior to the others and were more extensively studied As deposited films were amorphous off stoichiometry, with resistivities over 10 to the 8th power cm and band gaps of approx 1 4 eV Subsequent reactive heat treatments in the 515 to 615 C range resulted in crystalline films, resistivities of 1 to 10 cm, CdSiAs2 compositions within 15 of stoichiometry, energy gap of approx 1 55 eV, absorption coefficient of 0002/ cm at 0 6 micrometers, but with poor mechanical properties (mainly cracking) A Ta/SiO2 substrate proved to be the best for these films DOE

N81-18564 Stanford Univ, Calif
SILICON SOLAR CELL DESIGN FOR MEDIUM CONCENTRATION APPLICATIONS Ph.D. Thesis
Frederick Chien-Ming Wu 1980 127 p
Avail Univ Microfilms Order No 8103577
Two solar cell processes were developed leading to solar cells that are fabricated directly on an existing commercial integrated circuits processing line The computer model developed used a simple but realistic equivalent circuit approach Through simulation of variations arising from carrier lifetime, resistance and surface effects, the program shows that for typical values obtained from a commercial line, a surface junction structure, where a p-n junction is formed over the entire top surface of the cell, gives maximum energy conversion efficiencies for 1 to 200 times solar concentrations Two different surface junction solar cells were designed to maximize current collection Laser annealing cannot be substituted as an ion-implantation damage annealing step The remaining point defects are enough to cause a degradation of cell performance, and a subsequent thermal anneal is necessary to restore the expected efficiency
Dissert Abstr

N81-18566 Connecticut Univ, Storrs
THERMAL PERFORMANCE PREDICTIONS OF FLAT-PLATE SOLAR COLLECTOR AIR HEATERS Ph.D. Thesis
Thomas Charles ONeill 1980 250 p
Avail Univ Microfilms Order No 8103219
A computer program was written that models heat exchanges occurring within flat plate solar air collectors and which computes the incoming solar flux and heat losses to the environment Internal collector temperatures and thermal efficiencies are predicted for either steady state or transient cases from finite difference solutions to a set of energy balance equations These relations are written for thermal modes that are generated and linked together by the internal deck logic The program was utilized in a study of three types of air collectors The first two configurations employed crossflow impingement along the backside of their absorbers to augment heat transfer coefficients developed at those surfaces, while the third used a rock matrix absorber to expand its surface area for heat transfer In addition the first collector replaced the conventional stationary plate absorber of the second design by a traveling belt Dissert Abstr

N81-18572# Bolt, Beranek and Newman, Inc Canoga Park Calif
EVALUATION OF THE NOISE IMPACT OF SATELLITE POWER SYSTEM VEHICLES ON THE COMMUNITY AND ECOLOGY AT THE LAUNCH SITE
Karl S Pearson, Pritchard H White, and John F Wilby Dec 1980 109 p refs
(Contract W-7405-eng-48)
(LBL-11978, BBN-4210) Avail NTIS HC A06/MF A01
Placement of the Satellite Power System (SPS) satellites into orbit will require the launch of many heavy space vehicles over a 30 year period These vehicles will generate rocket noise at launch and sonic booms at launch and on return to the landing site In this study, rocket noise levels and sonic boom pressures are predicted for the region around a typical launch/landing site The response of humans and animals to broadband and impulsive noise is reviewed briefly and the appropriate information is applied to the specific noise levels and sonic boom pressures predicted for the region around the launch/landing site It is estimated that noise levels will be high enough that hearing protection will be required for personnel at the launch site and that there will be significant annoyance (more than 5% highly annoyed) to the population within 9 km from the launch site Infrasound (sub-audio frequencies) will probably cause significant annoyance over a larger region With launches over the ocean, the very high sonic boom pressures during ascent will occur over unpopulated areas However, booms generated during descent of the orbiters will occur over populated areas and it is predicted that there will be significant annoyance at distances up to 45 km from the launch/landing site DOE

N81-19177*# Rockwell International Corp, Seal Beach, Calif Satellite Systems Div
SUMMARY OF LSST SYSTEMS ANALYSIS AND INTEGRATION TASK FOR SPS FLIGHT TEST ARTICLES
H S Greenberg *In* NASA Langley Research Center Large Space Systems Technol, 1980, Vol 1 Feb 1981 p 167-182 refs
Avail NTIS HC A19/MF A01 CSCL 22B
The structural and equipment requirements for two solar power satellite (SPS) test articles are defined The first SPS concept uses a hexagonal frame structure to stabilize the array of primary tension cables configured to support a Mills Cross antenna containing 17,925 subarrays composed of dipole radiating elements and solid state power amplifier modules The second test article consists of a microwave antenna and its power source, a 20 by 200 m array of solar cell blankets, both of which are supported by the solar blanket array support structure The test article structure, a ladder, is comprised of two longitudinal beams (215 m long) spaced 10 m apart and interconnected by six lateral beams The system control module structure and bridge fitting provide bending and torsional stiffness, and supplement the in plane Vierendeel structure behavior Mission descriptions, construction, and structure interfaces are addressed M G

N81-19550* National Aeronautics and Space Administration Pasadena Office Calif
COPPER DOPED POLYCRYSTALLINE SILICON SOLAR CELL Patent
Krishna M Koliwad (JPL California Inst of Tech Pasadena) and Taher Daud, inventors (to NASA) (JPL California Inst of Tech, Pasadena) Issued 10 Feb 1981 4 p Filed 30 May 1979 *Supersedes N79-25512 (17 - 16, p 2147)*
(NASA-Case-NPO-14670-1, US-Patent 4 249 957
US-Patent-Appl-SN-043941, US-Patent-Class 136-258,
US-Patent-Class-357-30 US-Patent-Class-357-59,
US-Patent-Class-357-63 US-Patent-Class-252-62 3E) Avail US Patent and Trademark Office CSCL 10A
Fabrication of improved performance photovoltaic cells is described They are fabricated from polycrystalline silicon containing copper segregated at the grain boundaries T M

N81-19562*# Rockwell International Corp., Downey, Calif Space Operations and Satellite Systems Div
SATELLITE POWER STUDY (SPS) CONCEPT DEFINITION STUDY (EXHIBIT D). VOLUME 1 EXECUTIVE SUMMARY Final Report
G M Hanley Washington NASA Mar 1981 50 p refs
(Contract NAS8-32475)
(NASA-CR-3392, SSD-80-0108-1) Avail NTIS HC A03/MF A01 CSCL 10A

Efforts concentrated on updating of the Rockwell reference concept, definition of new system options, studies of special emphasis topics, further definition of the transportation system, and further program definition The Rockwell reference satellite concept has a gallium arsenide (GaAs) solar cell array having flat concentrators with an effective concentration ratio of 1 83 at end of life Alternatives to this concept includes solid state power amplifiers or magnetrons for dc/RF conversion and multibandgap solar cells for solar to dc energy conversion Two solid state concepts were studied It was determined that the magnetron approach was the lowest mass and cost system T M

N81-19564*# Rockwell International Corp., Downey, Calif
SATELLITE POWER SYSTEMS (SPS). LSST SYSTEMS AND INTEGRATION TASK FOR SPS FLIGHT TEST ARTICLE Final Report
H S Greenberg Washington NASA Feb 1981 142 p refs
(Contract NAS8-32475)
(NASA-CR-3375, SSD-80-0102) Avail. NTIS HC A07/MF A01 CSCL 10A

This research activity emphasizes the systems definition and resulting structural requirements for the primary structure of two potential SPS large space structure test articles. These test articles represent potential steps in the SPS research and technology development Author

N81-19565*# Rockwell International Corp., Downey, Calif
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY (EXHIBIT D). VOLUME 3: TRANSPORTATION ANALYSIS Final Report
G M Hanley Washington NASA Mar 1981 85 p refs
(NAS8-32475)
(NASA-CR-3394, SSD-80-0108-3) Avail NTIS HC A05/MF A01 CSCL 10A

Additional analyses and investigations were conducted to further define transportation system concepts that will be needed for the developmental and operational phases of an SPS program To accomplish these objectives, transportation systems such as the Shuttle and its derivatives were identified, new heavy lift launch vehicle (HLLV) concepts, cargo and personnel orbital transfer vehicles (EOTV and POTV), and intraorbit transfer vehicle (IOTV) concepts were evaluated, and, to a limited degree, the program implications of their operations and costs were assessed The results of these analyses were integrated into other elements of the overall SPS concept definition studies T M

N81-19567*# Hughes Aircraft Co., El Segundo, Calif
CONCEPTUAL DESIGN STUDY OF CONCENTRATOR ENHANCED SOLAR ARRAYS FOR SPACE APPLICATIONS. PERFORMANCE EVALUATION OF 5 KW AND 20 KW SYSTEMS IN SI AND GaAs AT 1 AU EMPLOYING A FLAT PLATE TROUGH CONCENTRATOR Final Report
20 Oct 1980 72 p refs
(Contracts NAS7-100 JPL-955194)
(NASA-CR-164038, JPL-9950-463, Hughes-Ref-E3258) Avail NTIS HC A04/MF A01 CSCL 10A

A simple, efficient and very lightweight preliminary design for a 5 KW and 20 KW BOL output concentrated array evolved and is described by drawings The relative effectiveness of this design, as compared to an unconcentrated planar array of equal power output, was measured by comparing power to mass performance of and the solar cell area required by each Improvements in power to mass performance as high as 42% together with array area size reduction of 57% are possible in GaAs systems By contrast, when the same concentrator design is applied to silicon systems, no improvement in power to mass can be obtained although array area reductions as high as 35% are obtainable. L.F.M

N81-19568*# Clemson Univ., S C Dept of Electrical and Computer Engineering
INVESTIGATION OF RELIABILITY ATTRIBUTES AND ACCELERATED STRESS FACTORS ON TERRESTRIAL SOLAR CELLS Annual Report
J W Lathrop, R A Hartman, and C R Saylor Jan 1981 255 p refs Sponsored in part by DOE Prepared for JPL
(Contract NAS7-100)
(NASA-CR-164012, JPL-9950-481, AR-3, DOE/JPL-954929-81/8) Avail NTIS HC A12/MF A01 CSCL 10A

Major effort during this reporting period was devoted to two tasks improvement of the electrical measurement instrumentation through the design and construction of a microcomputer controlled short interval tester, and better understanding of second quadrant behavior by developing a mathematical model relating cell temperature to electrical characteristics In addition, some preliminary work is reported on an investigation into color changes observed after stressing T M

N81-19569*# RCA Corp., Princeton, N J Solid State Div
DEVELOPMENT OF MEGASONIC CLEANING FOR SILICON WAFERS Final Report
A Mayer Sep 1980 96 p refs Sponsored in part by DOE Prepared for JPL
(Contracts NAS7-100; JPL-955342)
(NASA-CR-164011, DOE/JPL-955342-79/2, JPL-9950-498) Avail NTIS HC A05/MF A01 CSCL 10A

A cleaning and drying system for processing at least 2500 three in diameter wafers per hour was developed with a reduction in process cost The system consists of an ammonia hydrogen peroxide bath in which both surfaces of 3/32 in spaced, ion implanted wafers are cleaned in quartz carriers moved on a belt past two pairs of megasonic transducers The wafers are dried in the novel room temperature, high velocity air dryer in the same carriers used for annealing A new laser scanner was used effectively to monitor the cleaning ability on a sampling basis T M

N81-19570*# Lamar Univ., Beaumont, Tex
PROCESS FEASIBILITY STUDY IN SUPPORT OF SILICON MATERIAL TASK 1 Final Report, 1 Oct. 1975 - 6 Feb. 1981
Carl L Yaws, Ku-Yen Li, Jack R Hopper, C S Fang, and Keith C Hansen 6 Feb 1981 461 p refs Prepared for JPL
(Contracts NAS7-100, JPL-954343)
(NASA-CR-164009) Avail. NTIS HC A20/MF A01 CSCL 10A

Results for process system properties, chemical engineering and economic analyses of the new technologies and processes being developed for the production of lower cost silicon for solar cells are presented Analyses of process system properties are important for chemical materials involved in the several processes under consideration for semiconductor and solar cell grade silicon production Major physical, thermodynamic and transport property data are reported for silicon source and processing chemical materials T M

N81-19571*# Acurex Corp., Mountain View, Calif Alternate Energy Div
ADVANCED SOLAR CONCENTRATOR MASS PRODUCTION, OPERATION, AND MAINTENANCE COST ASSESSMENT Final Report
W A Niemeyer, R J Bedard, and D M Bell Jan 1981 101 p refs
(Contracts NAS7-100, JPL-955477)
(NASA-CR-164039, ACUREX-FR-80-14/AE, DRL-015, DRO-SE003) Avail NTIS HC A06/MF A01 CSCL 10A

The object of this assessment was to estimate the costs of the preliminary design at production rates of 100 to 1,000,000 concentrators per year, concentrators per aperture diameters of 5, 10, 11, and 15 meters; and various receiver/power conversion package weights The design of the cellular glass substrate Advanced Solar Concentrator is presented The concentrator is an 11 meter diameter, two axis tracking, parabolic dish solar concentrator. The reflective surface of this design consists of inner and outer groups of mirror glass/cellular glass gores. T.M.

N81-19572*# Photowatt International, Inc., Tempe, Ariz.
ARRAY AUTOMATED ASSEMBLY TASK LOW COST SILICON SOLAR ARRAY PROJECT, PHASE 2 Final Report
Clayton Olson Dec. 1980 321 p refs Sponsored in part by DOE Prepared for JPL Prepared in cooperation with Sensor Technology, Inc., Chatsworth, Calif
(Contract JPL-954865)
(NASA-CR-164037, DOE/JPL-954865-80/9, JPL-9950-509) Avail NTIS HC A14/MF A01 CSCL 10A

Analyses of solar cell and module process steps for throughput rate, cost effectiveness, and reproductibility are reported In addition to the concentration on cell and module processing sequences, an investigation was made into the capability of using microwave energy in the diffusion, sintering, and thick film firing steps of cell processing Although the entire process sequence was integrated, the steps are treated individually with test and experimental data, conclusions, and recommendations T M

N81-19574 Ecole Polytechnique Federale de Lausanne (Switzerland) Inst de Thermique Appliquee
TECHNICAL EVALUATION OF GASEOUS SUSPENSIONS OF GRAPHITE FOR THE ABSORPTION OF CONCENTRATED SOLAR RADIATION
Mohamed A M Abdelrahman 1979 174 p refs Sponsored in cooperation with Federal Institute of Technology, Lussanne, and Sudan National Council for Research
(EPFL-ITA-6, ISBN-3-2600-4592-9) Avail Issuing Activity

The direct absorption of concentrated solar radiation by a gaseous suspension of graphite was investigated The problem of agglomeration and deposition as well as the particle size distribution as a function of time were studied theoretically and experimentally Suspended particles of about the incident radiation wavelength size were shown to absorb adequately in a technically reasonable suspension thickness and have, in addition, selective properties (low emittance in the infrared) Agglomeration and deposition properties were shown to change if the particles are coated with a silicone base layer Author (ESA)

N81-19578# Martin Marietta Aerospace, Denver, Colo
TERRESTRIAL PHOTOVOLTAIC SYSTEM ANALYSIS Final Report, Feb. - Nov. 1979
Matthew S Imamura, Roger Giellis, and Robert L Moser Wright-Patterson AFB, Ohio AFWAL Jul 1980 117 p refs
(Contract F33615-79-C-2001, AF Proj 3145)
(AD-A094827, MCR-80-683, AFWAL-TR-80-2074) Avail NTIS HC A06/MF A01 CSCL 10/1

The purpose of this program was to evaluate the use of an actively cooled photovoltaic power system at Tinker Air Force Base, Oklahoma, which required both electrical and thermal energy The thrust of the study was to identify a preliminary design of an actively cooled photovoltaic concentrator configuration including the necessary details of integrating it into the facility, and compare the cost of this system and that of the present energy sources. A conventional utility-connected arrangement was selected for the Tinker AFB electroplating facility mainly because of simplicity in its implementation and availability of the inverter, which is the key component in the system The system uses a direct energy transfer arrangement with a peak array power tracking inverter, no electrochemical storage batteries are used The thermal energy distribution system interfaces directly with the plating tanks in the facility The estimated initial installed cost of the combined photovoltaic/thermal system is $28 per watt The use of thermal energy for the plating tanks is costly ($3 per watt) because of an extensive distribution system and use of exotic heat exchangers GRA

N81-19582# Institute of Gas Technology, Chicago, Ill
ELECTROCHEMICAL PHOTOVOLTAIC CELLS Final Technical Progress Report, 15 Apr. 1979 - 17 Apr. 1980
Peter G P Ang and Anthony F Sammells Sep 1980 103 p refs Prepared for Midwest Research Inst, Golden, Colo
(Contract EC-77-C-01-4042)
(SERI/TR-8002-5-T1) Avail NTIS HC A06/MF A01

Increasing solar energy conversion efficiencies and identifying potentially long-life systems were emphasized Semiconductor/redox couple systems were selected on the basis of the apparent positions of their conduction and valence band energy levels at the interface, together with the semiconductor decomposition potential Selected redox couples should possess equilibrium potentials that lie negative of the semiconductor decomposition potential and positive of the semiconductor conduction band Liquid-junction solar cells were characterized using n-$MoSe_2$, N-MoS_2, n-WSe_2, n-CdSe, and n-GaAs as photo-anodes T M

N81-19587# Colorado State Univ, Fort Collins Solar Energy Applications Lab
CSU SOLAR HOUSE 3 SOLAR HEATING AND COOLING SYSTEM PERFORMANCE Annual Technical Summary Report, 1 Oct. 1978 - 30 1979
D S Ward, John C Ward, and H S Beroi Oct 1980 85 p refs
(Contract DE-AC02-79CS-30122)
(DOE/CS-30122/T1) Avail NTIS HC A05/MF A01

The practicality of an integrated flat plate state-of-the-art liquid-heating solar collector and absorption cooling system is studied This was accomplished by designing and installing a complete solar heating and cooling system (including appropriate data acquisition equipment and instrumentation), performing a detailed analysis and evaluation of all aspects of the solar system, and comparing the seasonal performance of the system with two other solar heating and cooling systems installed in adjacent buildings with virtually identical thermal characteristics DOE

N81-19595# General Electric Co, Philadelphia, Pa Space Systems Operations
DEVELOPMENT OF A COMBINED PHOTOVOLTAIC/THERMAL LINEAR RECEIVER FOR A PARABOLIC TROUGH CONCENTRATOR Final Report
Dec. 1980 61 p
(Contract DE-AC04-76DP-00789)
(SAND-80-7138) Avail NTIS HC A04/MF A01

The development of a receiver design for a linear focus concentrator is discussed The design concept described employs a pair of nested glass tubes A specially configured inner borosilicate glass tube functions as the mounting surface for the solar cell circuit in this dual focus receiver geometry This inner tube, which is capped at each end to provide an interior dead air space, is inserted within a 2 inch ID glass pipe which is part of Corning Pyrex beaded pressure process piping system The selected receiver coolant, which is designated as Synfluid (2 centistokes kineamatic viscosity), is circulated through the outer glass pipe in direct contact with the solar cell circuit active area The concentrated irradiance from the parabolic trough impinges on the outer glass pipe and is optically transmitted through the clear synthetic mineral oil to the solar cell circuit Two prototype receivers of this design were fabricated and assembled DOE

N81-19605# California Univ, Livermore Lawrence Livermore Lab
SOLAR GASIFICATION OF CARBONACEOUS MATERIALS
R W Taylor, R Berjoan (CNRS, Odeillo, France), and J P Coutures (CNRS, Odeillo, France) Apr 1980 39 p refs
(Contract W-7405-eng-48)
(UCRL-53063) Avail NTIS HC A03/MF A01

Charcoal, wood, and paper were gasified in a packed bed reactor using steam and solar energy The steam was generated by spraying water directly onto the surface of the fuel and, at the same time, heating the fuel at the focus of a solar furnace The steam was generated by solar energy Half of the steam reacted with carbon, and 30% of the incident solar energy was stored as chemical energy The performance of a fluidized bed reactor was compared to that of a packed bed reactor using charcoal and CO_2 The fraction of the incident solar energy utilized to produce CO (stored) was 10% in the case of the fluidized bed reactor and 40% for the packed bed reactor DOE

N81-19607# Midwest Research Inst., Golden, Colo Solar Energy Research Inst
PASSIVE SOLAR ENERGY INFORMATION USER STUDY
W W Belew, B L Wood, T L Marle, and C L Reinhardt Nov 1980 278 p refs
(Contract DE-AC02-77CH-00178)
(SERI/TR-751-746) Avail NTIS HC A13/MF A01

The results of a series of telephone interviews with groups of users of information on passive solar heating and cooling are described These results, part of a larger study on many different solar technologies, identify types of information each group needed and the best ways to get information to each group The overall study provides baseline data about information needs in the solar community DOE

N81-19609# Brookhaven National Lab., Upton, N Y Dept of Energy and Environment
SOLAR/PERFORMANCE GOALS FOR SOLAR AND GROUND-COUPLED HEAT PUMP SYSTEMS
John W Andrews Sep 1980 31 p refs
(Contract DE-AC02-76CH-00016)
(BNL-51259) Avail NTIS HC A03/MF A01

Cost goals for combined solar/heat pump systems are developed Three methods of analysis are used, simple payback, positive cash flow, and life cycle costing The goals are parameterized on system energy efficiency, with the air-to-air heat pump as the conventional system which is used as a basis for comparison Cost goals for nine systems are determined in three generic climates DOE

N81-19610*# Battelle Columbus Labs., Ohio
SATELLITE POWER SYSTEMS (SPS) SPACE TRANSPORTATION COST ANALYSIS AND EVALUATION
Nov 1980 141 p refs Sponsored by NASA
(Contract W-31-109-eng-38)
(NASA-CR-164020, DOE/ER-0086) Avail NTIS HC A07/MF A01 CSCL 22B

A picture of Space Power Systems space transportation costs at the present time is given with respect to accuracy as stated, reasonableness of the methods used, assumptions made, and uncertainty associated with the estimates The approach used consists of examining space transportation costs from several perspectives to perform a variety of sensitivity analyses or reviews and examine the findings in terms of internal consistency and external comparison with analogous systems These approaches are summarized as a theoretical and historical review including a review of stated and unstated assumptions used to derive the costs, and a performance or technical review These reviews cover the overall transportation program as well as the individual vehicles proposed The review of overall cost assumptions is the principal means used for estimating the cost uncertainty derived The cost estimates used as the best current estimate are included DOE

N81-19612# Sandia Labs., Livermore, Calif
FATIGUE-CREEP LIFETIME ANALYSIS OF FOUR ADVANCED CENTRAL RECEIVER CONCEPTS
J Jones Jan 1981 20 p refs
(Contract DE-AC04-76DP-00789)
(SAND-80-8047) Avail NTIS HC A02/MF A01

Four advanced central receiver concepts were analyzed for their fatigue-creep design lifetimes Using the flux profiles provided by the designers, the thermal hydraulic performance of an individual tube in a receiver panel was ascertained by computer analysis A linear model of the tube crown strain for the tube on given thermal and structural finite element analyses were performed The computed stresses and strains were used in evaluation of the creep and fatigue design lifetimes by N-47 and compared to the desired lifetime of 30 years Three of the four designs met or exceeded the desired lifetime and the fourth met the desired lifetime when the factor of safety incorporated in N-47 was reduced All four designs were judged adequate for the current level of design effort DOE

N81-19613# Sandia Labs., Albuquerque, N Mex Component and Subsystem Development Div
DEVELOPMENT OF SHEET MOLDING COMPOUND SOLAR COLLECTORS WITH MOLDED-IN SILVERED GLASS REFLECTIVE SURFACES
Roscoe L Champion and Ronald E Allred Dec 1980 41 p refs
(Contract DE-AC04-76DP-00789)
(SAND-80-0702) Avail NTIS HC A03/MF A01

Parabolic test moldings were fabricated from a general purpose sheet molding compound with flat chemically strengthened glass, flat annealed glass, and thermally formed glass Attempts to mold with annealed sheet glass (1 mm thick) and thermally formed glass (1 25 mm thick) were unsuccessful, only the chemically strengthened glass (1 25 mm thick) was strong enough to survive molding pressures Because of the mismatch in thermal expansion between glass and sheet molding compound, the as-molded panels contained a sizeable residual stress The results are given of dimensional changes taking place in the panels under accelerated thermal cycling and outdoor aging conditions, these results are compared to an analytical model of the laminate In addition, the sheet molding compound is examined for thermomechanical properties and flow behavior in the rib sections Results indicated that lowering the thermal expansion coefficient of the sheet molding compound through material modifications would produce a more stable structure DOE

N81-19614# Sandia Labs., Albuquerque, N Mex Experimental Systems Operations Div
PUMP HEAT LOSS TEST REPORT
M A Quintana and L E Torkelson Jan 1981 23 p
(Contract DE-AC04-76DP-00789)
(SAND-80-2526) Avail NTIS HC A02/MF A01

A test is described which measures the heat loss from a centrifugal pump under both insulated and uninsulated conditions Results showed a 27% reduction in loss by insulating the pump and seal not requiring liquid cooling DOE

N81-19615# Sandia Labs., Livermore, Calif Thermal Subsystems Div
COST-PERFORMANCE COMPARISON OF WATER-STEAM RECEIVERS FOR SOLAR CENTRAL ELECTRIC POWER PLANTS
P D Laquil, C T Schafer, and S E Faas Dec 1980 39 p refs
(Contract DE-AC04-76DP-00789)
(SAND-80-8245) Avail NTIS HC A03/MF A01

An evaluation of the relative cost performance of large solar central receiver electric power plants utilizing water/steam receivers was performed The investigation consisted of a systems integration of receiver conceptual designs from three major boiler manufacturers with advanced turbine conditions and thermal storage designs The methodology and results of the evaluation are described The results of the evaluation are described The results indicate which combinations of receiver designs, storage types, and thermodynamic conditions hold promise for significant cost performance improvements when compared to first generation water/steam technology DOE

N81-19618# Midwest Research Inst., Golden, Colo Systems Development Branch
COMPARATIVE RANKING OF 0.1 TO 10 MW SUB E SOLAR THERMAL ELECTRIC POWER SYSTEMS. VOLUME 1: SUMMARY OF RESULTS Final Report
John P Thornton, Kenneth C Brown, Joseph G Finegold, James B Gresham, F Ann Herlevich, John S Kowalik, and Thomas A Kriz Aug 1980 151 p refs
(Contracts DE-AC02-77CH-00178, EG-77-C-01-4042)
(SERI/TR-351-461-Vol-1) Avail NTIS HC A08/MF A01

The original objective of the study was to project the mid 1990 cost and performance of selected generic solar thermal electric power systems for utility applications and to rank these systems by considered plants with rated capacities of 1 to 10 MW sub e, operating over a range of capacity factors from the no storage case to 0 7 and above The study was extended to include systems with capacities from 0 1 to 1 MW sub e, a range that is attractive to industrial and other non-utility applications DOE

N81-19621# Harvard Univ, Cambridge, Mass
OPTIMIZATION OF TRANSPARENT ELECTRODE FOR SOLAR CELLS Technical Progress Report, 15 Sep. - 15 Dec. 1980
Roy G Gordon 1980 9 p
(Contract DE-AC02-77CH-00178)
(SERI/PR-9318-1-T1) Avail NTIS HC A02/MF A01

Films of fluorine-doped tin oxide were studied The current research has as its goal further improvements in the properties of this transparent electrode material The first phase of the work sought to find out what mechanisms limit the transparency and electrical conductivity of this material It is suspected that certain chemical impurities, and also mechanical imperfections at boundaries between small grains in the films, may have deleterious effects The second phase of the work attempted to minimize those deleterious factors which were identified in the first phase Some samples of optimal films were made, under the best conditions obtained Progress is summarized DOE

N81-19622# California Univ, Los Angeles School of Engineering and Applied Science
TRANSPARENT GLASS HONEYCOMB STRUCTURES FOR ENERGY LOSS CONTROL Final Summary Report, Jan. 1976 - Oct., 1979
Jun 1980 102 p refs
(Contract DE-FG03-76CS-31084, Grant EY-76-G-03-1084)
(UCLA-ENG-8039) Avail NTIS HC A06/MF A01

It was demonstrated that properly shaped glass honeycomb placed between a nonselective absorber and the coverglass of a flat plate solar collector gives collection efficiencies significantly higher than those of conventional flat plate units, even those with selective absorbers, collecting solar energy at temperatures required for heating and cooling buildings Three basic glass honeycomb shapes were analyzed and tested thin walled cylindrical glass tube honeycomb in square or hexagonal arrays, corrugated thin glass sheets stacked peak to trough to form double sinsuoid shaped cells, and flat thin glass sheets stacked to form long parallel slots DOE

N81-19624# Southern California Gas Co, Los Angeles
PROJECT SAGE. SOLAR ASSISTED GAS ENERGY Final Report
Mar 1980 219 p refs
(Grant NSF PTP-75-03457)
(DOE/TIC-11105, NSF/RA-790330/31) Avail NTIS HC A10/MF A01

Plans are formulated to improve solar assisted gas energy (SAGE) technical design and performance, reduce SAGE costs, refine SAGE market assessment, and identify policies to encourage the use of SAGE Two SAGE water heating systems were installed and tested One system was retrofit onto an existing apartment building, the other was installed in a new apartment building Each installation required approximately 1000 square feet of collector area tilted to an angle of 37(0) from the horizontal, and each was designed to supply about 70 percent of the energy for heating water for approximately 32 to 40 units of a typical two-story apartment complex, in Southern California Construction costs were compiled, and both installations were equipped with performance monitoring equipment The operating and maintenance requirements of each installation was evaluated by gas company maintenance engineers Market penetration was assessed by developing a computer simulation program using the technical and economic analysis from the installation experience DOE

N81-19625# Centro Informazioni Studi Esperienze, Milan (Italy)
GaAs(GaAl)AS SOLAR CELLS TO BE USED UNDER CONCENTRATED SOLAR LIGHT CONDITION
G. Fabri and G Fiorito Commission of the European Communities 1980 37 p refs Sponsored by Commission of the European Communities
(EUR-6934-EN) Avail NTIS HC A03/MF A01

A LPE facility for growing GaAs-GaAlAs epitaxial structures suitable for solar cells was designed and constructed This facility allows growths on substrates up to 4 sq cm in area and the use of solutions for several growths After an investigation of GaAlAs and dopant phase diagrams, based on thermodynamic considerations, the growth critical parameters were set-up A simple model analysis on the cell behavior allowed to identify the fundamental characteristics of both GaAs-GaAlAs structures and single layers The obtained results evidenced the possibility of growing GaAs and GaAlAs layers with composition, doping and electric characteristics fitting solar cells DOE

N81-19626# Acurex Corp, Mountain View, Calif Alternate Energy Div.
SOLAR PRODUCTION OF INDUSTRIAL PROCESS HOT WATER: OPERATION AND EVALUATION OF THE CAMPBELL SOUP HOT WATER SOLAR FACILITY Final Report, 1 Sep. 1979 - 10 Dec. 1980
John I Kull, William N Neimeyer, and Stanley B Youngblood Dec 1980 162 p refs
(Contract DE-AC03-78CS-31218)
(SAN-1218-4) Avail NTIS HC A08/MF A01

The operation and evaluation of a solar hot water facility is summarized The period of evaluation was for 12 months from October 1979 through September 1980 The objective of the work was to obtain additional, long term data on the operation and performance of the facility Minor modifications to the facility were completed The system was operated for 15 months, and 12 months of detailed data were evaluated The facility was available for operation and of the time during the last 8 months of evaluation A detailed description of the solar facility and of the operating experience is given, and a summary of system performance for the 12 month operation/evaluation period is presented Recommendations for large scale solar facilities based on this project's experience are given and an environmental impact assessment is provided DOE

N81-19628# Motorola, Inc, Phoenix, Ariz Solar Operations
NEAR-TERM IMPLEMENTATION OF PROJECTION COST REDUCTIONS FOR PHOTOVOLTAIC CONCENTRATOR ARRAY Final Report, 18 Dec. 1978 - 7 Jan. 1980
L Grenon Dec 1980 43 p refs
(Contract DE-AC04-76DP-00789)
(SAND-80-7073) Avail NTIS HC A03/MF A01

A chronological review of the process sequence is presented as well as an explanation of each process step and its production readiness status Topics covered include (1) evaluation of use of thin silicon substrates (7 mil), (2) selection of a wax material capable of protecting selected surfaces of the solar cell from attack by various chemical etches during processing, (3) evaluation of ion implantation processes and annealing techniques, (4) development of a fine surface texturing process for improved absorption of incident illumination, (5) provision for subsequent development of fine line front surface metallization patterning, (6) optimization of the metallization processes, and (7) determination of those parameters that must be tested in order to determine the quality of a finished concentrator solar cell Processes that have evolved that have direct application to satisfying a near-term cost effective process sequence include plasma etching, plasma patterning, and evaluation of a lower cost nickel-copper metallization process DOE

N81-19629# Plasma Physics Corp, Locust Valley, N Y
PLASMA-ASSISTED CVD OF FLUORINATED, HYDROGENATED AMORPHOUS SILICON Final Technical Report, 15 Sep. 1979 - 15 Sep 1980
John H Coleman, John P Hammes, and Harold J Wiesmann 1980 31 p refs Sponsored by Midwest Research Inst, Golden, Colo
(Contract DE-AC02-77CH-00178)
(SERI/TR-8041-2-T1) Avail NTIS HC A03/MF A01

Approximately 300 large-area PIN hydrogenated amorphous silicon (a-Si H) solar cells were fabricated and tested The a-Si H PIN cells which were plasma deposited at 200 to 350 C were found to have high internal currents, whereas those which were deposited by CVD at 500 to 650 C had low internal currents

When corrected for optical losses in the top electrode, the internal quantum efficiency vs wavelength for the PIN cells indicated a peak value above 80% at about 525nm, which decreased monotonically to zero at about 725 nm When the published values of the RCA and EXXON were corrected similarly for optical loss, nearly identical values of internal quantum efficiencies were found DOE

N81-19630# Pacific Sun, Inc, Palo Alto, Calif
SOLAR-HEATED HOT WATER INSTRUMENTATION PROJECT FOR EPRI HEADQUARTERS COMPLEX, PALO ALTO, CALIFORNIA Final Report
H T Whitehouse and P Ortiz Jan 1981 172 p refs
(EPRI Proj 1191-1)
(EPRI-EM-1654) Avail NTIS HC A08/MF A01

A data acquisition and analysis effort charted the performance of a solar assisted, hot water preheat system supplying a portion of the service water needs Detailed load and performance data for the system are presented, the merits of the data acquisition system employed are discussed, and recommendations for future monitoring efforts are provided. DOE

N81-19631# Radiation Monitoring Devices, Inc, Watertown, Mass
LOW COST SPRAYED CdTe SOLAR CELL RESEARCH Quarterly Report, 15 Nov. - 14 Feb. 1980
P Sienkiewicz, S Lis, M G Serreze, and G Entine Mar 1980 16 p refs Prepared for Midwest Research Inst, Golden, Colo
(Contract EG-77-C-01-4042)
(DSE-4042-T34) Avail NTIS HC A02/MF A01

Two approaches showed great promise X-ray diffraction analysis showed that CdTe can be produced from solutions containing $CdCl_2$ and (NH_4) TeO_4 with either hydrazine dihydrochloride or oxalic acid as the reducing agent Films produced from the oxalic acid experiments yielded reducing agent Films produced from the oxalic acid experiments yielded encouraging infrared scans, and as a result this approach received the most effort In addition, good quality, photoconductive, CdS films were produced via traditional methods and characterized using optical and electrical measurements Overall film uniformity for both CdS and CdTe was improved by the installation of a stainless steel, gravity fed, spray nozzle and mechanical linkage DOE

N81-19634# Rockwell International Corp, Anaheim, Calif Electronic Devices Div
CHEMICAL VAPOR DEPOSITION OF THIN-FILM POLYCRYSTALLINE Si FOR LOW COST SOLAR CELLS Quarterly Technical Progress Report, 2 Feb. - 2 May 1980
Ralph P Ruth, William I Simpson, Jane J J Yang, Lavada A Moudy, and Richard E Johnson May 1980 102 p refs
(Contract DE-AC03-79ET-23045)
(SAN-3045-3, QTPR-3) Avail NTIS HC A06/MF A01

The program emphasized a study of the transport properties of p type polycrystalline Si films as functions of average grain size and impurity doping concentration Preliminary investigations of nucleation and early stage growth phenomena in such films were carried out to provide improved understanding of the fundamental properties of the films that limit photovoltaic performance and thus to establish a good technical basis for subsequent attempts to achieve improved performance in solar cells using such films Also, the study of transport properties was extended to n type polycrystalline Si films DOE

N81-19635*# PRC Energy Analysis Co, Los Angeles, Calif
SATELLITE POWER SYSTEM (SPS) PUBLIC OUTREACH EXPERIMENT
S R McNeal Dec 1980 69 p refs Sponsored by NASA
(Contract DE-AC01-79ER-10041)
(NASA-CR-164022, DOE/ER-10041/T11) Avail NTIS HC A04/MF A01 CSCL 10A

An outreach experiment was conducted to improve the results of the satellite power system (SPS) concept development and evaluation program The objectives of the outreach were to (1) determine the areas of major concern relative to the SPS concept and (2) gain experience with an outreach process for use in future public involvement The response to the outreach effort was positive, suggesting that the effort extended by the SPS project division to encourage an information exchange with the public was well received The responses were analyzed and from them some questions and answers about the satellite power system are presented E D K

N81-19638# AEG-Telefunken, Wedel (West Germany) Fachbereich Neue Technologien, Raumfahrt
A 10 kW SMALL SOLAR POWER STATION AND OPERATIONS OPTIMIZATION Final Report
Joachim Gloel Bonn Bundesministerium fuer Forschung und Technologie Dec 1980 123 p refs In GERMAN, ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-79-139, ISSN-0340-7608) Avail NTIS HC A06/MF A01

Characteristics of the plant are unpressurized hot water (95 C) for transport and storage of thermal energy, screw expansion engine operating with freon R114 for thermomechanical energy conversion, and an ac three phase generator interconnected with a static converter to provide line voltages and frequencies A solar collector simulator was used in testing Selection, assembly, and function of the system and each subsystem are detailed Component performance results are listed Component by component operation optimization results show the importance of correctly regulating the thermal cycle temperature as well as the freon expansion pump circuit pressure Author (ESA)

N81-19640# Swedish Council for Building Research, Stockholm
A SOLAR HEATING PLANT IN STUDSVIK: DESIGN AND FIRST YEAR OPERATIONAL PERFORMANCE
Rutger Roseen and Bengt Perers 1980 98 p
(PB81-114480, ISBN-91-540-3265-2) Avail NTIS HC A05/MF A01 CSCL 13A

Group solar heating plants offer one of the most promising ways of economically utilizing solar energy for space heating purposes A relatively advanced prototype installation was built at Studsvik on the Swedish east coast south of Stockholm The installation is based on a cheap, excavated and insulated water store with a floating insulating cover The solar collectors are mounted on the cover, which turns to track the Sun This increases the efficiency of the concentrating collectors by between 30 and 50 percent The heat is used as the sole heat source for an adjacent office building, designed for low temperature heating GRA

N81-19647# Franklin Research Center, Philadelphia, Pa
HOT WATER FROM THE SUN: A CONSUMER GUIDE TO SOLAR WATER HEATING
Beth McPherson May 1980 115 p refs Sponsored in part by DOE and HUD
(PB81-128597, HUD-0001752, HUD/PDR-548) Avail NTIS HC A06/MF A01 CSCL 13A

Consumer information and guidance are provided relating to solar heating of water for residential use Information to help the homeowner decide whether to install a solar hot water system is provided The components which make up a solar hot water system, the various kinds of systems available, and the benefits and limitations of each type are discussed The physical orientation of the house, site vegetation, and ways to determine if the house has enough sunlight to make good use of the Sun are also analyzed The elements of cost in a solar energy system are outlined, and a method is provided to help the reader estimate whether a solar unit is justified GRA

N81-19648# American Planning Association, Chicago, Ill
RESIDENTIAL SOLAR DESIGN REVIEW. A MANUAL ON COMMUNITY ARCHITECTURAL CONTROLS AND SOLAR ENERGY USE
Martin Jaffe and Duncan Erley Jul 1980 87 p refs Sponsored in part by DOE, Washington, D C
(Contract HUD-H-2573)
(PB81-128605, HUD-0001753, HUD/PDR-579) Avail NTIS HC A05/MF A01 CSCL 13A

Intended primarily for members of private architectural review committees working for homeowners associations, this guidebook examined some of the design review committees to solar installations and buildings in relation to existing aesthetic goals in their communities The guide describes typical solar energy systems and explains why they look the way they do Design alternatives for highlighting concealing, and integrating solar equipment into buildings were examined GRA

N81-19665# Automation Industries, Inc, Silver Spring, Md Vitro Lab Div

ENVIRONMENTAL DATA FOR SITES IN THE NATIONAL SOLAR DATA NETWORK

Dec 1980 245 p
(Contract DE-AC01-79CS-30027)
(SOLAR/0010-80/12) Avail NTIS HC A11/MF A01

The solar sites are grouped into 12 zones, each of which consists of several adjacent states The solar energy sites are in alphabetical sequence within each zone The tables provide available meteorological data for reporting sites in the NSDN as follows Insolation - the insolation table presents the total, diffuse direct, maximum, and extra-terrestrial radiation for the solar site It also shows the ratio of total extra-terrestrial radiation, as a percent Temperature - the temperature table gives the average daytime, nightime, maximum, minimum and inlet water temperatures for the solar site Additional tables are presented for some of these NSDN sites, supplying either wind or relative humidity data, or both DOE

N81-20173*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

ANALYSIS OF COSTS OF GALLIUM ARSENIDE AND SILICON SOLAR ARRAYS FOR SPACE POWER APPLICATIONS

Kent S Jefferies Mar 1981 16 p refs
(NASA-TP-1811, E-536) Avail NTIS HC A02/MF A01 CSCL 10A

A parametric analysis was performed to compare the costs of silicon and gallium arsenide arrays for Earth orbital missions The missions included electric power in low Earth orbit (LEO), electric power in geosynchronous Earth orbit (GEO), and power for electric propulsion of a LEO to GEO orbit transfer mission Inputs to the analysis for all missions included launch and purchase costs of the array For the orbit transfer mission, the launch and purchase costs of the electric propulsion system were added Radiation flux as a function of altitude and radiation tolerance as a function of cell type were used to determine power degradation for each mission Curves were generated that show the sensitivity of launch-array cost and total mission cost to a variety of input parameters for each mission These parameters included mission duration, cover glass thickness, array specific cost, array specific mass, and solar cell efficiency Solar concentration was considered and the sensitivities of cost to concentration ratio, concentrator costs, and concentrator mass were also evaluated Results indicate that solar cell development should give a high priority to reducing array costs and that the development of low cost, lightweight, solar concentrators should be pursued Author

N81-20536 Michigan State Univ, East Lansing

CONSIDERATIONS IN THE DESIGN OF SOLAR ENGINES Ph.D. Thesis

L D Ryan 1980 215 p
Avail Univ Microfilms Order No 8106436

The basic problem is to develop simple engines to convert solar radiation into useful work Chapters are included on solar insolation and solar collectors, both flat plate and concentrators The initial research centered on the Stirling engine It became obvious that the displacement piston was an expensive means to add the reject heat The displacement piston was eliminated by rotating the entire engine through the heat source for 180 degrees of rotation and cooling over the remaining 180 degrees This modification resulted in the development of a new engine Limited studies were conducted on the gas inside the heat ring Pressure versus time was measured for air and Freon 12 when subjected to radiation Freon 12 responded significantly better Since friction is a deterrent to solar engine development, methods to minimize friction are discussed Dissert Abstr

N81-20537*# Rockwell International Corp, Downey, Calif Space Operations and Satellite Systems Div

SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY (EXHIBIT D). VOLUME 6, PART 1: COST AND PROGRAMMATICS Final Report

G M Hanley Washington NASA Mar 1981 84 p refs
(Contract NAS8-32475)
(NASA-CR-3397, SSD-80-0108-6-1) Avail NTIS HC A05/MF A01 CSCL 10A

A summary of the cost data reviewed as well as conclusions and recommendations are presented Cost and programmatic aspects of Rockwell's SPS CR-2 reference configuration were based on the results of several contracts with NASA and independent company-sponsored activities by the Space Operations and Satellite Systems Division of Rockwell International TM

N81-20544*# Jet Propulsion Lab, California Inst of Tech, Pasadena

LSA FIELD TEST Annual Report, Aug. 1979 - Aug. 1980

Peter Jaffe 30 Dec 1980 44 p refs
(Contract NAS7-100, DE-AI01-76ET-20356)
(NASA-CR-164083, JPL-PUB-81-12, DOE/JPL-1012-52) Avail NTIS HC A03/MF A01 CSCL 10A

After almost four years of endurance testing of photovoltaic modules, no fundamental life-limiting mechanisms were identified that could prevent the twenty-year life goal from being met The endure data show a continual decline in the failure rate with each new large-scale procurement Cracked cells and broken interconnects continue to be the principal causes of failure Although the modules are more adversely affected physically by hot, humid environments than by cool or dry environments there are insufficient data to correlate failure with environment There is little connection between the outward physical condition of a module and changes in its electrical performance TM

N81-20545*# Jet Propulsion Lab, California Inst of Tech, Pasadena

PROCEEDINGS OF THE 16TH PROJECT INTEGRATION MEETING Progress Report, Apr. - Sep. 1980

R R McDonald Sep 1980 492 p refs
(Contract NAS7-100, DE-AI01-76ET-20356)
(NASA-CR-164073 JPL-Pub-80-100, DOE/JPL-1012-51, PR-16) Avail NTIS HC A21/MF A01 CSCL 10A

The principal achievement of the Low Cost Solar Array Project in 1980 was the attainment of $2 80/Wp Technical Readiness, and that processes and equipment now commercially available can make possible a deliverable product in 1982 A prototype array for intermediate load applications was demonstrated using frameless modules It was proof tested to 40 lb/sq ft loading, and priced at $24/sq m, including array fabrication, module installation, shipping to the site and site installation for quantities of 20 MW LFM

N81-20546*# Jet Propulsion Lab California Inst of Tech, Pasadena

THE CORRECTION FOR SPECTRAL MISMATCH EFFECTS ON THE CALIBRATION OF A SOLAR CELL WHEN USING A SOLAR SIMULATOR

Clay H Seaman 15 Jan 1981 10 p refs
(Contracts NAS7-100 DE-AI01-76ET-20356)
(NASA-CR-164074, JPL-Pub-81-1, DOE/JPL-1012-50) Avail NTIS HC A02/MF A01 CSCL 10A

A general expression was derived to enable calculation of the calibration error The information required includes the relative spectral response of the reference cell, the relative spectral response of the cell under test, and the relative spectral irradiance of the simulator (over the spectral range defined by cell response) The spectral irradiance of the solar AMX is assumed to be known TM

N81-20548*# Jet Propulsion Lab, California Inst of Tech, Pasadena
RESULTS OF THE 1980 NASA/JPL BALLOON FLIGHT SOLAR CELL CALIBRATION PROGRAM
C H Seaman and R S Weiss 15 Mar 1981 15 p refs
(Contract NAS7-100)
(NASA-CR-164078 JPL-Pub-81-18) Avail NTIS HC A02/MF A01 CSCL 10A
Thirty-eight modules were carried to an altitude of about 36 kilometers In addition to the cell calibration program, an experiment to evaluate the calibration error versus altitude was performed The calibrated cells can be used as reference standards in simulator testing of cells and arrays T M

N81-20549# Von Karman Inst for Fluid Dynamics, Rhode-Saint-Genese (Belgium)
HEAT EXCHANGE AND SOLAR ENERGY, VOLUME 2
1980 337 p refs Proc of 1980 Lecture Ser, Rhode Saint Genese Belgium 28 Jan - 1 Feb 1980 2 Vol
(VKI-Lec-Ser-1980-2-Vol-2) Avail NTIS HC A15/MF A01
The heat transfer problems arising in connection the collection, storage, and utilization of solar energy are examined The treatment of solar and meteorological data, the instrumentation and measurement technique used to obtain them as well as mathematical models and operational characteristics of various solar heating systems and their individual components are covered Special emphasis is given to the modeling of complete solar systems, including computer simulation of their transient response Advantages and disadvantages of energy storage based on sensible heat, phase change, and chemical reaction, along with thermomechanical solar power generation and calculation of the thermal load requirement of buildings are discussed An analysis of economic aspects and future prospects for solar energy utilization is made

N81-20550# Mons Univ (Belgium)
LATENT AND CHEMICAL STORAGE
Roger Jadot *In* Von Karman Inst for Fluid Dynamics Heat Exchange and Solar Energy, Vol 2 1980 53 p refs

Avail NTIS HC A15/MF A01
The thermodynamics of solar heat storage through the use of hydrates and chemical reactions are discussed The properties of salt hydrates, and the use of encapsulation to facilitate heat flow are reviewed in the context of home systems Glauber's salt and calcium chloride hexahydrate are cited as examples The use of organic compounds in latent heat storage is mentioned, and a list of over 200 compounds selected from the literature is given Reactions of NH_3 with inorganic salts and other reactions are mentioned for use in a chemical heat pump Author (ESA)

N81-20551# Technische Physische Dienst TNO-TH, Delft (Netherlands)
THE BENEFITS OF ADVANCED HEAT STORAGE SYSTEMS
C denOuden *In* Von Karman Inst for Fluid Dynamics Heat Exchange and Solar Energy, Vol 2 1980 11 p refs

Avail NTIS HC A15/MF A01
A prototype installation using sodium hydrates encapsulated in a polymer matrix with a nucleating agent was constructed Performance tests using a version of ASHREA standard 94-77 were carried out over 300 aging cycles Results show a 10% decrease in latent heat of fusion Rock bed heat storage and adsorbent material heat storage are also compared For a temperature range of 20 to 80 C, Sorbead R has a seven to ten times higher stored energy density than a rock bed
Author (ESA)

N81-20552# Technische Physische Dienst TNO-TH, Delft (Netherlands)
A METHOD TO TUNE THE VARIOUS COMPONENTS OF A SOLAR HEATING SYSTEM
C denOuden *In* Von Karman Inst for Fluid Dynamics Heat Exchange and Solar Energy, Vol 2 1980 20 p
Avail NTIS HC A15/MF A01
The cost effectiveness of solar space and hot water heating was modeled using as a reference system an instrumented solar house The reference system has 35 sq m of collectors and a two cu m heat storage tank The mean annual energy yield was calculated for the climate of the Netherlands For given component and installation costs, optimal collector area and storage tank volumes are computed Author (ESA)

N81-20553# Katholieke Universiteit te Leuven (Belgium) Lab voor Warmteoverdracht en Reaktorkunde
PERFORMANCE OF AIR COLLECTOR HOUSE HEATING SYSTEMS WITH ROCK BED STORAGE
W L Dutre *In* Von Karman Inst for Fluid Dynamics Heat Exchange and Solar Energy Vol 2 1980 31 p Sponsored by Belgium Govt
Avail NTIS HC A15/MF A01
A solar air heating system and its control system are described and a computer model describing the dynamic behavior of the system is presented The model is validated against short term measurements on an experimental facility An acceptable agreement was shown between the model and the measured temperature of the storage system The system differential equations are solved with a half-hour time step, using half-hourly averaged meteorological data Model runs indicate that the system performance can be improved mainly by additional storage insulation, improved heat transfer in the air collectors, and through the use of highly selective absorbers The combination with a heat pump eliminates the need for a thermal auxiliary heating system only in the case of large storage capacities, or permits the same system efficiency with a considerably smaller storage as in the case without a heat pump Author (ESA)

N81-20554# Mons Univ (Belgium)
WATER SYSTEMS MODELING
J Lagneau and C Boussemaere *In* Von Karman Inst for Fluid Dynamics Heat Exchange and Solar Energy, Vol 2 1980 30 p Sponsored by Natl Belgium Program of Energy

Avail NTIS HC A15/MF A01
Mathematical models of two simple solar collectors and three complete solar heating systems are described and compared Flat plate, double cover, liquid medium collectors were simulated Hourly values of ambient temperature and global insolation on the collectors are used in the simulations of the behavior of heating systems A finite difference scheme is used in one model and the modified Euler's method in another Results from the former compare favorably with those from the Los Alamos Study Center model A simplified program is described which calculates for each day the storage tank temperature resulting from the heating load, heat loss, and energy output of the collector Author (ESA)

N81-20555# Von Karman Inst for Fluid Dynamics, Rhode-Saint-Genese (Belgium)
SYSTEM MODELING USING TRNSYS COMPUTER SIMULATION
N Connor *In its* Heat Exchange and Solar Energy, Vol 2 1980 23 p refs
Avail NTIS HC A15/MF A01
Use of the program TRNSYS for design and system optimization is illustrated by transient simulation of a water heating system comparing two different types of collector, and for a swimming pool heating system The data required for the simulations, the program modules used, and the information flow through the program are shown Curves are presented for one year of operation, showing energy requirements, optimum collector area, and minimum annual cost all for various collector options Performance curves are given for the pool heater Author (ESA)

N81-20556# Joint Research Centre of the European Communities, Ispra (Italy)
THERMOMECHANICAL SOLAR POWER/ELECTRICITY GENERATION. TECHNICO-ECONOMIC PROBLEMS AND PROSPECTIVES OF DEVELOPMENT AND APPLICATION
Joachim Gretz *In* Von Karman Inst for Fluid Dynamics Heat

Exchange and Solar Energy, Vol 2 1980 38 p refs

Avail NTIS HC A15/MF A01

The thermodynamics of high temperature solar energy conversion are presented and the one MW Helioelectric Power Plant EURELIOS of the European Communities is described Some particularities of hydrogen, its production with solar energy and transportation of solar energy by means of hydrogen and/or hydrogenated fuels are discussed The solar power plant represents 80% of the overall costs and is the most cost-intensive component in the system Solar energy conversion into mechanical power, electrolysis, and transportation of chemicals over long distances (several 1000 km) over land and sea to the user's site are surveyed Liquid and gaseous hydrogen, methanol, and ammonia are considered Industrial solar hydrogen production is discussed, emphasizing electrolysis. Some qualitative considerations on the influence of large scale solar energy conversion on climate indicate that there should be atmospheric heating above a plant and only a slight cooling of the ground underneath the mirrors

Author (ESA)

N81-20558# Michigan Univ, Ann Arbor Heat Transfer Lab

THE A PRIORI DECISION IN SOLAR ENERGY AND CONSERVATION ECONOMICS

John A Clark *In* Von Karman Inst for Fluid Dynamics Heat Exchange and Solar Energy, Vol 2 1980 57 p refs Repr from Solar Energy and Conservation Systems, 1980

Avail NTIS HC A15/MF A01

The initial decision concerning the economic viability of a solar energy heating system or an energy conservation system is shown to involve technical, physical, meteorological, geographic, design and cost factors as well as the source of funding and type of arrangements made to finance the system Four basic economic/technical models, which include the influence of increasing fuel costs, are presented and compared with other possible kinds of investments to determine the economic viability of the system It is found that different economic conclusions are both possible and justifiable for investment situations having different constraints

Author (ESA)

N81-20559# Michigan Univ, Ann Arbor

A LIFE-CYCLE MODEL FOR SOLAR HEATING SYSTEM DESIGN AND ECONOMIC EVALUATION MICHIGAN ECONOMIC MODEL FOR SOLAR HEATING (MESH)

John A Clark *In* Von Karman Inst for Fluid Dynamics Heat Exchange and Solar Energy, Vol 2 1980 37 p refs Presented at Solar Energy and Conservation Symp Miami, 11-13 Dec 1978

Avail NTIS HC A15/MF A01

A model is presented which allows for both design selection and economic optimization of a solar heating system within the U S This model relates the life-cycle total cost of a solar heating system to the escalating cost of fuel, installed system costs per unit area of collector, the cost of capital (capital recovery factor under a mortgage contract), taxes, collector type, building load factor, degree-day heating factor, conversion efficiency of the back-up system, solar load fraction, and solar input-collector performance factors derived from the Los Alamos solar heating model The influence of cost escalation in fuel is included by an inflation function determined by the analysis The circumstances corresponding to an arbitrary and/or optimum (minimum total life-cycle cost) design condition are identified and explicitly determined The influence of the principal governing parameters on solar heating design and economics in the U S is shown in a simple but complete form

Author (ESA)

N81-20567# Technical Planning, Inc, Beltsville, Md

COORDINATION AND MANAGEMENT TASKS FOR THE IEA SOLAR HEATING AND COOLING PROGRAM AND CCMS SOLAR ENERGY PILOT STUDY Final Report

Sheila B Blum and William J Kennish Oct 1980 35 p refs (Contract DE-AC02-79CS-30108)

(DOE/CS-30108/T3, TPI/IEA/F-7) Avail NTIS HC A03/MF A01

Both the management assistance and technical involvement are discussed for a solar system performance validation effort An overview of the program accomplishments is presented as well as conclusions for future work

R C T

N81-20568# American Heliothermal Corp, Denver, Colo

EVALUATION OF SOLAR COLLECTORS FOR HEAT PUMP APPLICATIONS Final Report

Gary Skartvedt, Donald Pedreyra, Robert McMordie, James Kidd, Jerome Anderson, and Richard Jones Aug 1980 154 p refs (Contracts DE-AC04-78CS-35351, EM-78-C-04-5351)

(DOE/CS-35351/T1) Avail NTIS HC A08/MF A01

The potential utility of very low cost (possibly unglazed and uninsulated) solar collectors to serve as both heat collection and rejection devices for a liquid source heat pump was evaluated The approach consisted of exercising a detailed analytical simulation of the complete heat pump/solar collector/storage system against heating and cooling loads derived for typical single family residences in eight US cities The performance of each system was measured against that of a conventional air to air heat pump operating against the same loads In addition to evaluation of solar collector options, water tanks and buried pipe grids to provide thermal storage was considered A determination of night sky temperature and convective heat transfer coefficients for surfaces with dimensions typical of solar collectors was included The experiments were conducted in situ by placing the test apparatus on the roofs of houses in the Denver, Colorado, area

DOE

N81-20570# Midwest Research Inst, Golden, Colo Information Outreach and Dissemination Branch,

PHOTOVOLTAICS INFORMATION USER STUDY

W W Belew, B L Wood, T L Marie, and C L Reinhardt Oct 1980 220 p refs

(Contracts DE-AC02-77CH-00178, EG-77-C-01-0442)

(SERI/TR-751-652) Avail NTIS HC A10/MF A01

The results of a series of telephone interviews with groups of users of information on photovoltaics are described These results, part of a larger study on many different solar technologies, identify types of information each group needed and the best ways to get information to each group Baseline data about information needs in the solar community is given The following technological areas are emphasized photovoltaics, passive solar heating and cooling, active solar heating and cooling, biomass energy solar thermal electric power, solar industrial and agricultural process heat, wind energy, ocean energy and advanced energy storage

DOE

N81-20572# Varian Associates, Palo Alto, Calif

FURTHER DEVELOPMENT OF A NOVEL SOLAR CELL CONCENTRATOR PHOTOVOLTAIC CONVERTER SYSTEM Final Report

H A VanderPlas and P E Gregory Oct 1980 45 p refs (Contract DE-AC04-76DP-00789)

(SAND-80-7072) Avail NTIS HC A03/MF A01

A photovoltaic converter using an optical filter to split the solar spectrum and focus the light onto two cells was built and tested Conversion efficiencies for the test module ranged from 27 0 percent at 113 suns to 28 0 percent at 489 suns The construction of this module was guided by a theoretical analysis of the efficiencies to be expected from a variety of bandgap combinations Elements of the splitting approach were investigated with emphasis on the extension of the spectral splitting principle to a three gap converter This includes the extension of the theoretical analysis to include the properties of the optical filter The theoretical analysis is given, and the feedback provided by this analysis to the rest of the program is emphasized Research on germanium, silicon, and AlGaAs/Al(sub x/)Ga(sub l-x/)As solar cells is described

DOE

N81-20574# New Mexico Univ, Albuquerque Bureau of Engineering Research

OPTIMIZATION OF STORAGE IN PASSIVE SOLAR HEATING SYSTEMS Final Report

Raymond J Bahm May 1980 228 p refs

(Contract DE-AS04-78CS-35405, EM-78-S-04-5405)

(DOE/CS-35405/T1, TR-BER-4(80)DOE-720-1) Avail NTIS HC A11/MF A01

The search for a simple method of estimating the optimum amount of storage for passive solar space heating system designs and the results of that search are described The project goals, and why the project is important are described The major project results are presented in the order of their importance with respect to meeting the project goal A narrative description of the project is given The various approaches attempted are described, giving the reasons for failure in those areas that were not successful Most of the data is presented in graphical form DOE

N81-20582# Higgins, Auld and Associates Albuquerque, N Mex

SOLAR COLLECTOR FOUNDATION DESIGNS

Harry E Auld and Jeffrey B West Sep 1980 35 p refs

(Contract DE-AC04-76DP-00789)

(SAND-80-7070) Avail NTIS HC A03/MF A01

Foundation designs for a solar collector facility proposed for construction at Sandia Laboratories are presented A suggested method for placement and construction is included A cost estimate is provided in Appendix A and the complete design calculations are presented in Appendix B DOE

N81-20583# Sandia Labs, Albuquerque, N Mex Component and Subsystem Development Div

HANDBOOK FOR CALCULATING SOLAR-INFLUENCED BUILDING HEAT LOSSES

Raymond W Harrigan, Herbert E Anderson, and Irving J Hall Oct 1980 180 p refs

(Contract DE-AC04-76DP-00789)

(SAND-79-2173) Avail NTIS HC A09/MF A01

Monthly heat losses and gains are presented for single-pane windows having different orientations In addition, computational techniques in both analytical and graphical form are presented to extend this information to the computation of heat losses and gains from other building elements and the evaluation of wind speed on building heat loss Heat loss data is presented for 26 SOLMET sites An example problem illustrates the computations involved DOE

N81-20585# Radiation Monitoring Devices, Inc, Watertown, Mass

LOW COST, SPRAYED CdTe SOLAR CELL RESEARCH Annual Progress Report, 15 Aug. 1979 - 14 Aug. 1980

H B Serreze, M Squillante, S Lis, R Turcotte, M Talbot, and G Entine Sep 1980 35 p refs

(Contract DE-AC02-77CH-00178)

(SERI/PR-8104-3-T2, AR-1) Avail NTIS HC A03/MF A01

Techniques to produce sprayed CdTe solar cells by utilizing experimental methods similar to those previously developed to produce device quality CdS and CdSe thin films were examined The existing technology is extended by making use of inorganic tellurium salts and by appropriately modifying the process parameters Using this approach films of CdTe were spray deposited Furthermore, the spray solution is very stable and the process is reproducible Preliminary Schottky barrier solar cell devices showed very encouraging AM 1 photovoltaic behavior DOE

N81-20587# Los Alamos Scientific Lab, N Mex

SOLAR COAL GASIFICATION Quarterly Progress Report, 1 Oct. - 31 Dec. 1980

J A Sullivan and R J Jensen 1980 21 p refs

(Contract W-7405-eng-36)

(DOE/TIC-11384) Avail NTIS HC A02/MF A01

The concept of solar coal gasification is investigated in the laboratory using the beam from a CO2 laser to simulate the radiation from a solar furnace The parameters influencing the pyrolysis of stationary samples of Western sub-bituminous coal and the reaction of the char product with CO2 to form CO were investigated, and many of the experimental conditions required for maximizing gas yields were determined Tests of solar coal gasification were conducted using small furnaces DOE

N81-20588# Automation Industries, Inc, Silver Spring, Md Vitro Labs

OCTOBER 1980 ENVIRONMENTAL DATA FOR SITES IN THE NATIONAL SOLAR DATA NETWORK

Oct 1980 248 p refs

(Contract DE-AC01-79CS-30027)

(SOLAR/0010-80/10) Avail NTIS HC A11/MF A01

Tables of available meteorological data for reporting sites in the National Solar Data Network are presented for the following insolation, temperature, wind, and humidity A technical discussion of the instruments and measurements used to obtain these data tables is included A map illustrating the climate zones is provided DOE

N81-20595# Microwave Associates Inc Burlington, Mass

HIGH CONCENTRATION SILICON PHOTOVOLTAIC CELL DEVELOPMENT Interim Report, Nov 1978 - Feb 1980

G Allendorf, R Frank, J Goodrich, and W Matthei Jun 1980 113 p refs

(Contract DE-AC04-76DP-00789)

(SAND-80-7068) Avail NTIS HC A06/MF A01

The objective of this study is to develop practical semiconductor photocells for use in high concentration system (at least 25 suns at air mass one), having 18 percent or more efficiency, using state of the art silicon material and device technology, and amenable to low cost photovoltaic production of electrical energy from solar radiation Work accomplished at Microwave Associates from the initiation of the contract on 27 November 1978 to 29 February 1980, is described DOE

N81-20596# PRC Energy Analysis Co, Los Angeles, Calif

SATELLITE POWER SYSTEM (SPS) UTILITY INTEGRATION: INSTITUTIONAL PLANNING AND OPERATIONAL ISSUES

Meredith Crist, John Hill Allan D Kotin, and James A Rabe Oct 1980 205 p refs

(Contract DE-AC01-79ER-10041)

(EAC-R-4015) Avail NTIS HC A10/MF A01

Management and organizational arrangements are needed to incorporate 300 GW of Satellite Power System (SPS) electrically into the US utility grid Locating a sufficient number of suitable rectenna sites in the eastern United States to serve projected load centers on a proportional basis appears to be difficult Transmission distances from rectennas to load centers could be a problem in the western United States Long transmission distances are undesirable from a technical point of view but can be managed More significant is the fact that long transmission lines associated with SPS would consistently cross state (and other regulatory) boundaries However, siting exercises suggest that 60 rectennas could be located in eligible areas within the continental United States to serve projected load centers without violating the current state of the art of electricity transmission and load management DOE

N81-20599# Martin Marietta Aerospace, Denver Colo

THE 10-KILOWATT PHOTOVOLTAIC CONCENTRATOR ARRAY FABRICATION

J A Sanders, R L Donovan and S Broadbent Dec 1980 292 p refs

(Contract DE-AC04-76DP-00789)

(SAND-80-7062) Avail NTIS HC A13/MF A01

The PCA is based on the use of an acrylic Fresnel lens to concentrate sunlight on high intensity solar cells The array with modified heat sinks was fabricated to determine the impact on electrical performance due to lower weight heat sinks and reduced thermal dissipation surfaces The cost optimization study identified a new lower weight heat sink design that would reduce the heat sink weight by 50% and the array cost by approximately 3 1% for a loss of only 7% in annularized electrical power generation The production cost estimate provides an indicator that an overall 87% learning curve can be achieved and the cost of the 5000th unit could be $5 30 per watt in 1979 dollars DOE

N81-20600# AEG-Telefunken, Wedel (West Germany) Fachbereich Neue Technologien, Raumfahrt

EXPERIMENTAL STUDY TO DEFINE DEVELOPMENTS FOR TERRESTRIAL SOLAR CELL GENERATORS Final Report

Hans Gochermann Willi Pschunder, and G Wahl Bonn

Bundesministerium fuer Forschung und Technologie Dec 1979 144 p refs In GERMAN, ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-79-143, ISSN-0340-7608) Avail NTIS HC A07/MF A01

Materials, industrial processes, and design configurations were analyzed in order to define an economically attractive photovoltaic solar generator System analyses and tests were performed, interconnection and encapsulation techniques for solar cells were developed, and a 1kW solar generator was built for performance measurements Special solar cells were developed and fabricated, using single crystalline silicon and unconventional polycrystalline silicon Cost reductions through the use of large area wafers and from the modification of process steps for solar cell fabrication are demonstrated Further cost reduction are shown possible by using cheaper materials for contacts, interconnectors, encapsulation, etc Using the fabricated prototype cells, two types of solar cell modules, i e, glass and plastic encapsulations were developed, favoring the modular design of solar generators Accelerated life test results for solar cell aging characteristics along with generator operational electrical data are given
Author (ESA)

N81-20602# Laboratoires d'Electronique et de Physique Appliquee, Limeil-Brevannes (France)
FABRICATION OF AMORPHOUS SILICON SOLAR CELLS, USING AN INDUSTRIAL PROCESS Final Report [REALISATION DE CELLULES SOLAIRES A BASE DE SILICIUM AMORPHE PAR UN PROCEDE INDUSTRIEL]
E Fabre and S Laou Aug 1980 18 p refs In FRENCH, ENGLISH summary
(Contract DGRST-78 7 0050)
(LEP-80 638 SME-689-A) Avail NTIS HC A02/MF A01

An industrial way of depositing amorphous silicon was investigated using a commercially available plasma reactor with a large throughput (AMP 300, APPLIED MATERIALS) A conversion efficiency of 1% was obtained for a metal insulator semiconductor structure with platinum and a 1 cu cm area An important field effect was observed upon the collection efficiency The homogeneity of the layers is very good R C T

N81-20605# Swedish Council for Building Research, Stockholm
FLAT PLATE THERMAL SOLAR COLLECTORS A PHYSICAL BACKGROUND
Per Isakson 1980 105 p refs
(PB81-135741, ISBN-91-540-3329-2 D35-1980) Avail NTIS HC A06/MF A01 CSCL 10A

A physical background to the energy balance of flat plate solar collectors is provided This background gives an idea of the wide range of literature available on the subject GRA

N81-20912 Arizona Univ, Tucson
THE RETARDATION OF CRYSTALLIZATION OF CVD AMORPHOUS SILICON AND THE STUDY OF ITS STRUCTURAL AND OPTICAL PROPERTIES Ph.D. Thesis
Donald Clarke Booth 1980 271 p
Avail Univ Microfilms Order No 8102243

Amorphous silicon alloys containing boron, carbon, germanium, and nitrogen were prepared using chemical vapor deposition (CVD) and the effects of composition on their optical and structural properties for use as high temperature stable absorbers in photothermal solar energy conversion were determined It was found that the ratio of silicon to alloy element in the film was not in general the same as in the gas mixture The structure of all as-deposited alloy films was amorphous The profiles of the absorption coefficients of the as-deposited amorphous silicon alloys resemble closely those of the nonalloyed material, even for large amounts of the alloying element present in the film, except for the existence of a large absorption tail at low photon energies The refractive index, on the other hand, varies strongly with the alloyant concentration, decreasing significantly for large concentrations of the alloy element High temperature anneal experiments were conducted to determine the structural stability with anneal of these alloyed amorphous silicon films It was found that silicon-carbon alloys were structurally stable to temperatures of 900 C to 1000 C, depending on the carbon concentration Dissert Abstr

N81-20936# Los Alamos Scientific Lab, N Mex
STUDY OF THE EFFECTIVENESS OF SELECTIVE ABSORBER COATINGS AND PHASE CHANGE MATERIALS IN PASSIVE SOLAR SPACE HEATING
W O Wray, I C Hyde, and L E Bourdeau (Lab CRNR-PIRDES dEnergie Solaire, Nice, France) 1980 5 p refs Presented at the 1980 Passive and Hybrid Solar Energy Program Update Meeting, Washington, D C, 21-24 Sep 1980
(Contract W-7405-eng-36)
(LA-UR-80-2930, CONF-800972-6) Avail NTIS HC A02/MF A01

The performance of selective absorber coatings in passive solar heating systems is assessed The relative performance of thermal storage wall buildings when equipped either with a selective absorber coating or movable night instalation is studied The advantages a phase change thermal storage wall might have over a conventional system that employs either masonary or water as the thermal storage medium are determined Phase change material walls were tested with and without a diatomaceous Earth thickening agent that suppresses convection and in both vented and unvented configurations Results are presented and discussed DOE

N81-21489 International Institute for Applied Systems Analysis, Laxenburg (Austria)
SOLAR OPTIONS IN CENTRAL EUROPE. A SYNTHESIS OF SOLAR TECHNOLOGY ASSESSMENT AND CONTEMPORARY CRITERIA IN 1978-1979
Charles R Bell Dec 1979 32 p refs Transl into ENGLISH of Revue de l'Energie (Paris), Mar 1979
(IIASA-RR-79-14) Avail Issuing Activity

Solar energy as a potential substitute for fossil fuels is evaluated, and the time phase in which solar technology can become a significant part of the energy supply mix is discussed Constraints, such as the characteristic uncertainties of solar energy inputs, the developmental status of solar technology, and the evolution of other energy supply alternatives, are also described The options that are at present most viable for solar energy exploitation in central Europe as well as the economic and technical parameters of these options are identified A correlation with prototype data is made whenever possible to maximize the usefulness of the results Author (ESA)

N81-21491*# Rockwell International Corp, Downey Calif Space Operations and Satellite Systems Div
SATELLITE POWER SYSTEM (SPS) CONCEPT DEFINITION STUDY (EXHIBIT D) VOLUME 2. SYSTEMS/SUBSYSTEMS ANALYSES Final Report
G M Hanley Washington NASA Mar 1981 338 p refs
(Contract NAS8-32475)
(NASA-CR-3393, SSD-80-0108-2) Avail NTIS HC A15/MF A01 CSCL 10A

Modifications to the reference concept were studied and the best approaches defined The impact of the high efficiency multibandgap solar array on the reference concept design is considered System trade studies for several solid state concepts including the sandwich concept and a separate antenna/solar concept, are described Two solid state concepts were selected and a design definition is presented for each Magnetrons as an alternative to the reference klystrons for dc/RF conversion are evaluated System definitions are presented for the preferred klystron and solid state concepts Supporting systems are analyzed, with major analysis in the microwave, structures, and power distribution areas Results of studies for thermal control, attitude control, stationkeeping, and details of a multibandgap solar cell study are included Advanced laser concepts and the meteorological effects of a laser beam power transmission concept are considered J D H

N81-21492*# Rockwell International Corp, Downey, Calif
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY (EXHIBIT D). VOLUME 4, PART 2. COST AND PROGRAMMATICS APPENDIX Final Report

G M Hanley Washington NASA Mar 1981 401 p 7 Vol
(Contract NAS8-32475)
(NASA-CR-3398, SSD-80-0108-6-2) Avail NTIS HC A18/MF A01 CSCL 10A

Cost and programmatic aspects of a recommended satellite power system are documented Computer generated summaries are presented, and the detailed computer runs structured in a Work Breakdown Structure are given The six configurations developed during the study period are summarized J D H

N81-21523*# National Aeronautics and Space Administration Goddard Space Flight Center, Greenbelt, Md
SOLAR MAXIMUM MISSION (SMM) IN-FLIGHT PERFORMANCE
Richard J Broderick *In its The 1980 Goddard Space Flight Center Battery Workshop* Mar 1981 p 349-359

Avail NTIS HC A19/MF A01 CSCL 10C

The modular power system is discussed. Typical and analytical orbit data are compared with life test data for the batteries. E.D K.

N81-21535*# La Quinta Motor Inns, Inc, San Antonio, Tex
SOLAR HOT WATER SYSTEM INSTALLED AT LAS VEGAS, NEVADA Final Report
Jan 1981 40 p refs Sponsored by NASA
(Grant EG-77-G-01-1654)
(NASA-CR-161642) Avail NTIS HC A03/MF A01 CSCL 10A

A solar energy hot water system installed in a motor inn at Las Vegas, Nevada is described The inn is a three story building with a flat roof for installation of the solar panels. The system consists of 1,200 square feet of liquid flat plate collectors, a 2,500 gallon insulated vertical steel storage tank, two heat exchangers, and pumps and controls The system was designed to supply approximately 74 percent of the total hot water load. M G

N81-21541*# Spectrolab, Inc, Sylmar, Calif
SILICON SOLAR CELL PROCESS DEVELOPMENT, FABRICATION AND ANALYSIS Final Report
Joseph A Minahan 9 Mar 1981 75 p refs Sponsored by NASA and DOE Prepared for JPL
(Contract JPL-955055)
(NASA-CR-164164, DOE/JPL-955055-81/6, JPL-9950-523) Avail NTIS HC A04/MF A01 CSCL 10A

The fabrication of solar cells from several unconventional silicon materials is described and cell performance measured and analyzed Unconventional materials evaluated are edge defined film fed grown (EFG), heat exchanger method (HEM), dendritic web grown and continuous CZ silicons Resistivity, current voltage, and spectral sensitivity of the cells were measured Current voltage was measured under AM0 and AM1 conditions Maximum conversion efficiencies of cells fabricated from these and other unconventional silicons were compared and test results analyzed The HEM and continuous CZ silicon were found to be superior to silicon materials considered previously J D H

N81-21546*# Honeywell Corporate Material Sciences Center Bloomington, Minn
SILICON-ON-CERAMIC PROCESS: SILICON SHEET GROWTH AND DEVICE DEVELOPMENT FOR THE LARGE-AREA SILICON SHEET TASK OF THE LOW-COST SOLAR ARRAY PROJECT Annual Report, 29 Sep 1979 - 30 Sep 1980
A B Whitehead, J D Zook, B L Grung J D Heaps F Schmit, S B Schuldt, and P W Chapman 5 Jan 1981 79 p refs Sponsored by NASA and DOE Prepared for JPL
(Contract JPL-954356)
(NASA-CR-164134, DOE/JPL-954356-80/14, JPL-9950-495 AR-5) Avail NTIS HC A05/MF A01 CSCL 10A

The technical feasibility of producing solar cell quality sheet silicon to meet the DOE 1986 cost goal of 70 cents/watt was investigated The silicon on ceramic approach is to coat a low cost ceramic substrate with large grain polycrystalline silicon by unidirectional solidification of molten silicon Results and accomplishments are summarized T M

N81-21553# Automation Industries, Inc, Silver Spring, Md Vitro Labs Div
HULLCO CONSTRUCTION, PRESCOTT, ARIZONA: SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION OCTOBER 1979 - MAY 1980
Paul C Miller and Edward Pollock 1980 88 p refs
(Contract DE-AC01-79CS-30027)
(SOLAR/1043-80/14) Avail NTIS HC A05/MF A01

A single-family passive solar residence located in Prescott, Arizona was designed to supply 97 percent of the heating load Included in the system is an attached greenhouse, a Trombe wall, rock bin, direct gain floor slab, and secondary storage in the building mass The actual solar contribution was 91 percent in this colder than average season DOE

N81-21554# Automation Industries, Inc, Silver Spring, Md Vitro Labs Div
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION, KALWALL CORPORATION, MANCHESTER, NEW HAMPSHIRE Progress Report, Oct. 1979 - May 1980
J W Spears 1980 81 p refs
(Contract DE-AC01-79CS-30027)
(SOLAR/2015-80/14) Avail NTIS HC A05/MF A01

The direct-gain passive solar energy system was designed to supply approximately 50% of the annual space heating demand The addition of roof insulation has resulted in system performance which exceeds these design projections The structure is equipped with 1750 sq ft of vertical south-facing glazing and 850 sq ft of vertical east-facing glazing The storage system consists of 817,000 pounds of dark-colored concrete in the eight inch floor slab Additional storage is in the materials stored in the warehouse Auxiliary space heating is provided by two liquid-to-air heat exchangers supplied by the building boiler DOE

N81-21555# Automation Industries, Inc, Silver Spring, Md Vitro Labs Div
TROY-MIAMI LIBRARY, TROY, OHIO: SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION Progress Report, Nov 1979 - Apr. 1980
Stephen Dudzik 1980 77 p refs
(Contract DE-AC01-79CS-30027)
(SOLAR/2029-80/14) Avail NTIS HC A05/MF A01

The solar system utilizes 3264 sq ft of Owens-Illinois Sunpak Shaped Reflector evacuated tube collectors and a 5000 gallon undergound steel-lined fiberglass water storage tank to heat the 23,000 sq ft building The solar system performance can be briefly summarized solar fraction, 31%, solar savings ratio, 0 20, conventional fuel savings, 11421 kWh, system performance factor, 0 29, solar system COP, 2 96 DOE

N81-21556# Automation Industries, Inc, Silver Spring, Md Vitro Labs Div
PERFORMANCE OF ACTIVE SOLAR DOMESTIC HOT WATER HEATING SYSTEMS Progress Report, 1979 - 1980
M A Cramer, P W Kendall, J M Rosenbusch, and R A Weinstein 1980 249 p refs
(Contract DE-AC01-79CS-30027)
(SOLAR/0024-80/41) Avail NTIS HC A11/MF A01

The most recent composite results of analysis performed by Vitro Laboratories of solar hot water heating data for selected hot water sites in the National Solar Data Network (NSDN) are presented Results presented were developed on the basis of analysis of instrumented sites monitored through 1979-1980 A total of 45 sites in the National Solar Data Network (NSDN) were examined for this study Eighteen of these were selected for in-depth treatment because of the availability of valid long term data System descriptions, schematic diagrams and energy flow diagrams for these 18 sites are presented T M

N81-21557# Automation Industries, Inc, Silver Spring, Md Vitro Labs Div
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION:

HEI WAI WONG, HONOLULU, HAWAII, NOVEMBER AND DECEMBER 1979 AND APRIL THROUGH AUGUST 1980
M A Cramer 1980 76 p refs
(Contract DE-AC01-79CS-30027)
(SOLAR/1014-80/14) Avail NTIS HC A05/MF A01

The instrumented system consists of an array of flat-plate collectors with an area of 807 4 square feet The collector and storage subsystem consists of a 1230-gallon storage tank mounted on the roof with the bottom of the tank slightly higher than the top of the collector panels When the Sun heats the water in the collectors above the tank water temperature, a thermosiphon current is induced When the temperature in storage exceeds the temperature of the water in the collectors, the thermosiphon flow ceases The solar energy system at Hei Wai Wong supplied 98% of the energy required for hot water for the six apartments and the laundry DOE

N81-21564# California Univ, Livermore Lawrence Livermore Lab
WORLD ACTIVITY IN SOLAR PONDS
David W Dorn 20 Jan 1980 7 p refs
(Contract W-7405-eng-48)
(UCID-18900) Avail NTIS HC A02/MF A01

The United States and Israel appear to be the only two countries actively developing solar salt gradient pond technology, which uses the pond water both as a direct absorber of solar energy and as a storage medium for the thermal energy collected Current US pond projects and past present, and future Israeli pond projects are presented Israel which is clearly leading in the development, has brought its research to a point considered near commercial and is beginning to market the technology in other countries DOE

N81-21566# Colorado State Univ, Fort Collins Solar Energy Applications Lab
HANDBOOK OF EXPERIENCES IN THE DESIGN AND INSTALLATION OF SOLAR HEATING AND COOLING SYSTEMS
Dan S Ward and Harjinder S Oberoi Jul 1980 231 p refs
(Contract DE-AC01-76CS-32224)
(DOE/CS-32224/T1) Avail NTIS HC A11/MF A01

A large array of problems encountered are detailed, including design errors, installation mistakes, cases of inadequate durability of materials and unacceptable reliability of components, and wide variations in the performance and operation of different solar systems Durability, reliability, and design problems are reviewed for solar collector subsystems, heat transfer fluids, thermal storage, passive solar components, piping/ducting, and reliability/operational problems Performance topics covered include criteria for design and performance analysis, domestic hot water systems, passive space heating systems, active space heating systems, space cooling systems, analysis of systems performance, and performance evaluations DOE

N81-21568# Sandia Labs, Albuquerque, N Mex
MIDTEMPERATURE SOLAR SYSTEMS TEST FACILITY PREDICTIONS FOR THERMAL PERFORMANCE OF THE ACUREX SOLAR COLLECTOR WITH FEK 244 REFLECTOR SURFACE
Thomas D Harrison Jan 1981 22 p ref
(Contract DE-AC04-76DP-00789)
(SAND-80-1964/3) Avail NTIS HC A02/MF A01

A detailed account of the methods used to make the predictions is given The performance predictions are part of a program to measure the characteristics of commercially available solar collectors that have the potential for use in industrial process heat and enhanced oil recovery applications TM

N81-21571# Sandia Labs, Albuquerque, N Mex
PHOTOVOLTAIC CONCENTRATOR TECHNOLOGY DEVELOPMENT PROJECT
Oct 1980 306 p Presented at the 6th Project Integration Meeting, Albuquerque, N Mex, 5-6 Nov 1980
(Contract DE-AC04-76DP-00789)
(SAND-80-2373, CONF-801151) Avail NTIS HC A14/MF A01

Thirty-three abstracts and short papers describe the current status of research, development, and demonstration of concentrator solar cell technology Solar concentrations discussed include the parabolic trough, linear focus Fresnel lens, point focus Fresnel lens, and the parabolic dish Solar cells studied include silicon, GaAs, and AlGaAs Research on multiple junction cells, combined photovoltaic/thermal collectors, back contact solar cells, and beam splitter modules is described Concentrator solar cell demonstration programs are reported DOE

N81-21574# General Electric Co, Philadelphia Pa Valley Forge Space Center
PHOTOVOLTAIC CONCENTRATOR ARRAY PRODUCTION PROCESS STUDY. VOLUME 2: STUDY RESULTS Final Report, 25 Jan 1979 - 24 Jan. 1980
R C Hodge Jan 1981 198 p refs
(Contract DE-AC04-76DP-00789)
(SAND-79-7055/2) Avail NTIS HC A09/MF A01

Photovoltaic concentrator array designs were evaluated in terms of their low production and life cycle cost analysis Salient program design guidelines were defined which established the basic performance assumptions, environmental issues and design trade-off variables Available design detail was then compiled Preliminary manufacturing costs were estimated for each of the array concepts Using energy costs, and assessments as to each array's technology readiness and improvement potential, the various arrays were ranked The most promising arrays selected for the more detailed design optimization and cost studies were the point focus Fresnels, linear Fresnels, and one-axis troughs DOE

N81-21575# General Electric Co, Philadelphia, Pa Space Div
DESIGN OF A SIDE-BY-SIDE PHOTOVOLTAIC THERMAL SYSTEM FOR A NORTHEAST ALL-ELECTRIC RESIDENCE
E M Mehalick, G OBrien, G F Tully, J Johnson, J Parker, N Truncellito, and R Felice Nov 1980 204 p refs
(Contract DE-AC04-76DP-00789)
(SAND-80-7148) Avail NTIS HC A10/MF A01

There are three major system elements the photovoltaic array, the electric power conversion subsystem, and the thermal subsystem A key to the sizing of the PV and thermal array is the relative cost of each system Therefore, the ratio of the costs associated with each system was varied parametrically to define ultimate sizing of the PV and thermal array In general, the results indicate larger PV array area and minimal thermal array area for the set of cost assumptions described DOE

N81-21577# Midwest Research Inst, Golden, Colo Solar Energy Research Inst
INTERIM PERFORMANCE CRITERIA FOR PHOTOVOLTAIC ENERGY SYSTEMS
Richard DeBlasio, Steven Forman (MIT/Lincoln Lab), Steve Hogan, Gary Nuss, Hal Post (Sandia National Labs) Ronald Ross (JPL), and Harry Schafft (NBS) Dec 1980 230 p refs
(Contracts DE-AC02-77CH-00178, EG-77-C-01-4042)
(SERI/TR-742-654) Avail NTIS HC A11/MF A01

The performance criteria address characteristics of present-day photovoltaic systems that are of interest to manufacturers government agencies purchasers and all others interested in various aspects of photovoltaic system performance and safety The performance criteria apply to the system as a whole and to its possible subsystems array, power conditioning monitor and control, storage, cabling and power distribution They are further categorized according to the following performance attributes electrical thermal mechanical/structural safety durability/reliability, installation/operation/maintenance, and building/site DOE

N81-21579# Midwest Research Inst, Golden, Colo
YEARLY AVERAGE PERFORMANCE OF THE PRINCIPAL SOLAR COLLECTOR TAPES
Ari Rabl Jan 1981 56 p refs
(Contracts DE-AC02-77CH-00178, EG-77-C-01-4042)

(SERI/TR-631-716) Avail NTIS HC A04/MF A01

The results of hour by hour simulations for 26 meteorological stations were used to derive universal correlations for the yearly total energy that can be delivered by the principal solar collector types, flat plate, evacuated tubes, CPC, single and dual axis tracking collectors, and central receiver The correlations are first and second order polynomials in yearly average insolation, latitude, and threshold (= heat loss/optical efficiency) With these correlations, the yearly collectible energy can be found by multiplying the coordinates of a single graph by the collector parameters, which reproduces the results of hour by hour simulations with an accuracy (rms error) of 2% for flat plates and 2% to 4% for concentrators DOE

N81-21583# Ames Lab, Iowa
PHOTOELECTROCHEMICAL SOLAR CELLS BASED ON d-BAND ELECTROCHEMISTRY AT TRANSITION METAL DISELENIDES Final Technical Progress Report
Bruce A Parkinson Oct 1980 35 p refs
(Contracts W-7405-eng-82, EG-77-C-91-4042)
(IS-4759) Avail NTIS HC A03/MF A01

The work with tungsten diselenide and molybdenum diselenide can be divided into two major directions The first direction is the growth of high quality single crystals of the materials to establish the practical maximum solar energy conversion efficiency of layered compounds The second effort utilizes less perfect single crystals with edge sites exposed as models of a polycrystalline device with the goal of understanding the mechanism by which recombination limits the efficiency of these materials and to devise methods for reducing the recombination Progress is reported DOE

N81-21591# RCA Labs, Princeton, N J
AMORPHOUS THIN FILMS FOR SOLAR-CELL APPLICATIONS Final Report, 11 Sep. 1979 - 10 Sep. 1980
D E Carlson, R S Crandall, J Dresner, B Goldstein, J. J Hanak, A R Moore, H E Schade, D. L. Staebler, and H A Weakliem Oct 1980 92 p refs
(Contract DE-AC02-77CH-00178)
(SERI/PR-0-8254-F) Avail NTIS HC A05/MF A01

The drift mobility was measured in doped amorphous silicon by measuring the current transient in a Schottky-barrier device during a reverse bias voltage pulse Mass spectroscopy studies indicate that the film growth cannot be a simple ion surface recombination process but is probably due to either thermal decomposition of higher silanes or free radical surface reaction The photoelectromagnetic effect was used to measure the hole diffusion length in undoped a-Si:H DOE

N81-21598# SRI International Corp, Menlo Park, Calif
LINE-FOCUS SOLAR CENTRAL POWER SYSTEM, PHASE 1. VOLUME 1: EXECUTIVE SUMMARY Final Report, 29 Sep. 1978 - 30 Apr. 1980
Arthur J Slemmons Apr 1980 51 p ref 3 Vol
(Contracts DE-AT03-76ET-20550, EY-76-C-03-0115)
(DOE/ET-20550/2-Vol-1) Avail NTIS HC A04/MF A01

The SRI International industrial team completed a subsystem and system parametric analysis, a 100 MW sub e commercial plant conceptual design, and a cost and performance analysis A commercial assessment was made of the system DOE

N81-21599# SRI International Corp, Menlo Park, Calif
LINE-FOCUS SOLAR CENTRAL POWER SYSTEM, PHASE 1. VOLUME 2: TEXT Final Report, 29 Sep. 1978 - 30 Apr. 1980
Arthur J Slemmons Apr 1980 414 p refs 3 Vol
(Contracts DE-AT03-76ET-20550, EY-76-C-03-0115)
(DOE/ET-20550/2-Vol-2) Avail NTIS HC A18/MF A01

The conceptual design, parametric analysis, cost and performance analysis, and a commercial assessment of a 100 MWe high temperature line focus central power system are presented Parametric analyses and conceptual design of the heliostat subsystem, receiver subsystem, heat transport subsystem, energy storage subsystem, electrical power generating subsystem and master control subsystem are included A market analysis and development plan are given DOE

N81-21600# SRI International Corp, Menlo Park, Calif
LINE-FOCUS SOLAR CENTRAL POWER SYSTEM, PHASE 1. VOLUME 3: APPENDICES Final Report, 29 Sep. 1978 - 30 Apr. 1980
Arthur J Slemmons Apr 1980 75 p refs 3 Vol
(Contracts DE-AT03-76ET-20550, EY-76-C-03-0115)
(DOE/ET-20550/2-Vol-3) Avail NTIS HC A04/MF A01

Methods of determination of molten salt heat-transfer coefficients and tube-wall temperatures are discussed Inputs for STEAEC programs, description of system analysis computer program, receiver analysis program, and heliostat production plan and design methodology are described DOE

N81-21601# Spectrolab, Inc, Sylmar, Calif
THE 10 KILOWATT PHOTOVOLTAIC CONCENTRATOR SYSTEM AS INSTALLED AT SANDIA LABORATORIES, 1979 Final Technical Progress Report
K Ronney Dec. 1980 87 p
(Contract DE-AC04-78DP-00789)
(SAND-80-7063) Avail NTIS HC A05/MF A01

The photovoltaic concentrator system is described Included are system description, problems encountered and resolved during fabrication, and system performance analysis DOE

N81-21603# Stanford Univ, Calif
SOLAR SPACE AND WATER HEATING SYSTEM AT STANFORD UNIVERSITY, CENTRAL FOOD SERVICES BUILDING Final Report
May 1980 143 p
(Contract DE-AB03-77CS-31522)
(DOE/CS-31522/T1) Avail NTIS HC A07/MF A01

This active hydronic domestic hot water and space heating system was 840 sq ft of single-glazed, liquid, flat plate collectors and 1550 gal heat storage tanks The following are discussed energy conservation, design philosophy, operation, acceptance testing, performance data, collector selection, bidding, costs, economics, problems, and recommendations An operation and maintenance manual and as-built drawings are included in appendices DOE

N81-21605# Battelle Pacific Northwest Labs, Richland, Wash
ASSESSMENT OF GENERIC SOLAR THERMAL SYSTEMS FOR LARGE POWER APPLICATIONS: ANALYSIS OF ELECTRIC POWER GENERATING COSTS FOR SYSTEMS LARGER THAN 10 MWe, VOLUME 1
W J Apley, S P Bird, D R Brown, M K Drost, J A Fort, B A Garrett-Price, W P Patton, and T A Williams Nov 1980 200 p refs
(Contract DE-AC06-76RL-01830)
(PNL-3533-Vol-1) Avail NTIS HC A09/MF A01

Seven generic types of collectors, together with associated subsystems for electric power generation, were considered The collectors can be classified into three categories two-axis tracking (with compound-curvature reflecting surfaces), one-axis tracking (with single-curvature reflecting surfaces), and nontracking (with low-concentration reflecting surfaces) All seven collectors were analyzed in conceptual system configurations with Rankine-cycle engines In addition, two of the collectors were analyzed with Brayton-cycle engines, and one was analyzed with a Stirling-cycle engine With these engine options, and the consideration of both thermal and electrical storage for the Brayton-cycle central receiver, 11 systems were formulated for analysis DOE

N81-21607# Lincoln Lab, Mass Inst of Tech, Lexington
CONSTRUCTION OF A PHOTOVOLTAIC POWER SYSTEM AT NATURAL BRIDGES NATIONAL MONUMENT
A E Benoit Dec 1980 25 p
(Contract DE-AC02-76ET-20279)
(DOE/ET-20279/94) Avail NTIS HC A02/MF A01

A 100 kW peak photovoltaic (PV) power system at Natural Bridges National Monument in Utah is described This system is the largest of its kind in the world The construction phases of the program are described, and a chronological history of the events and problems encountered when such a large and complex task is undertaken in a remote area with very limited fabrication

facilities is given This experiment demonstrates the application of solar energy to the variety of loads found in a small and remote community This solar energy system was designed to meet all electrical requirements when there is no utility grid, with only occasional back-up from an existing diesel generator
DOE

N81-21608# Massachusetts Inst of Tech, Cambridge
CHALCOGENIDE-GLASS SOLAR CELLS Final Technical Progress Report, 6 Apr. 1979 - 31 Oct. 1980
D Adler and John S Haggerty 1980 66 p
(Contract DE-AC03-79ET-23043)
(DOE/ET-23043/T1) Avail NTIS HC A04/MF A01
A wide array of glasses in the Se-Te-As system were prepared by RF-sputtering in either Ar or Ar/H2 atmospheres and characterized optically and electrically Some films were co-sputtered with small concentrations of Li, Na, or K Glasses with optical gaps of 1 2 to 1 5 eV were investigated in solar-cell configurations The Se-Te glasses without As exhibited transient behavior, the time-varying effects persisting for the order of several minutes or more These transients were explained by invoking the unique properties of the valence alternation pairs (VAPs) which must exist in such glasses in large densities Small concentrations (1 to 5%) of As effectively suppressed the transient effects
DOE

N81-21609# Lincoln Lab, Mass Inst of Tech, Lexington
MEASURING DIRT ON PHOTOVOLTAIC MODULES, PART 2
E B Murphy Nov 1980 20 p refs
(Contract DE-AC02-76ET-20279)
(COO-4094-86-Pt-2) Avail NTIS HC A02/MF A01
Two techniques for measuring and quantifying surface dirt and its effects on module output are described One technique, using a standard portable glossmeter, measures the scattering of specular light by surface-dirt particles This measured value can then be correlated with the peak power performance before and after cleaning A second technique is also described which enables an investigator, in the field, to take dirt samples or replicas of the accumulated surface dirt from the PV module Photomicrographs of urban, suburban, and rural dirt particles are shown Measurements of module peak power before and after cleaning indicate that dirt particles in urban environments are more degrading to PV performance than dirt particles found in rural areas
DOE

N81-21617# Sandia Labs, Livermore, Calif Energy Systems Studies Div
METHODOLOGY FOR ESTIMATING FUTURE MARKET VALUES OF SOLAR THERMAL TECHNOLOGIES
Larry D Brandt Dec 1980 24 p refs Sponsored by DOE
(SAND-80-8248) Avail NTIS HC A02/MF A01
Projections of the future market value of solar systems are needed to derive cost goals for the emerging solar thermal technologies The research documented has developed a methodology for projecting market values based on economic parity with the estimated future costs of conventional (fossil-fueled) technologies Representative solar system values are presented for exemplary sets of economic assumptions including those under consideration by the Solar Thermal Cost Goals Committee The effects on market value of variations in the rates of return required by potential users and the costs of alternative fuels are illustrated
DOE

N81-21619# Commerce Dept, Washington, D C
PHOTOVOLTAICS INDUSTRY PROFILE
Oct 1980 34 p
(Contract DE-AC06-76RL-01830)
(DOE/RL-01830/T3) Avail NTIS HC A03/MF A01
A description of the status of the U S photovoltaics industry is given Principal end user industries are identified, domestic and foreign market trends are discussed, and industry organized and U S government organized trade promotion events are listed Trade associations and trade journals are listed, and a photovoltaic product manufacturers list is included
DOE

N81-21621# Sandia Labs, Albuquerque, N Mex Nondestructive Testing Technology Div
AN ACOUSTIC MEASUREMENT OF BOILING INSTABILITIES IN A SOLAR RECEIVER
Alan G Beattie 1 Oct 1980 56 p
(SAND-80-2409) Avail NTIS HC A04/MF A01
An acoustic technique was developed and used to search for boiling instabilities in the protoype receiver for the Barstow 10 MW Solar Thermal Pilot Plant Instabilities consisting of movements of the transition zone between regions of nucleate and film boiling, were observed The periods of these fluctuations ranged between three and fifteen seconds with no indications of preferred frequencies The peak to peak amplitudes of the fluctuations averaged 0 4 meters under steady state conditions at absorbed power levels between 2 0 and 3 2 MW Transient fluctuations with amplitudes up to 2 0 meters were also seen These transients usually lasted between 30 and 300 seconds It was not possible to pinpoint the causes of these transients
Author

N81-21628# Technische Univ, Berlin (West Germany) Inst fuer Luft- und Raumfahrt
ANALYSIS OF THE UTILIZATION OF LUNAR RESOURCES FOR SPACE POWER SYSTEMS. PART 1: SYSTEM DEFINITION AND MODEL STRUCTURE
H H Koelle and B Johenning 1980 44 p refs
(ILR-Mitt-73/1980-Pt-1) Avail. NTIS HC A03/MF A01
The possible utilization of lunar resources for manufacturing and assembling solar power satellites in a geostationary orbit is examined The system consists of three complexes (Earth, Moon and geostationary orbit) having 10 subsystems and 49 elements Based on functional considerations, preliminary specifications for these elements are given Some qualitative statements are made concerning energy and manpower requirements Emphasis is on the investments needed for the lunar complex (mass, energy, manpower) to deliver a given amount of raw and construction materials to orbit for the assembly of solar power satellite systems to produce electrical energy for consumption on the Earth's surface
Author (ESA)

N81-21668# New Mexico Univ, Albuquerque Bureau of Engineering Research
PREPARATION OF MONTHLY MAPS OF SOLAR AVAILABILITY FOR NEW MEXICO BASED ON SATELLITE PHOTOGRAPHY Technical Completion Report, 1 Feb. 1979 - 30 Sep. 1979
R J Bahm Jan 1981 29 p refs Sponsored by New Mexico Energy and Minerals Dept and New Mexico Energy Inst
(EMD-78-2131) Avail NTIS HC A03/MF A01
A set of 12 maps, one for each month, of solar radiation availability over the state of New Mexico is presented The results indicate that long term solar radiation availability actually varies little over the state and that long term values for Albuquerque may be used over the entire state for most solar space heating design purposes
T M

N81-21710# Automation Industries, Inc, Silver Spring, Md Vitro Labs Div
ENVIRONMENTAL DATA FOR SITES IN THE NATIONAL SOLAR DATA NETWORK, JANUARY 1981
Jan 1981 241 p
(Contract DE-AC01-79CS-30027)
(SOLAR/0010-81/01) Avail NTIS HC A11/MF A01
Insolation, temperature, wind, and humidity data recorded during the month of January 1981, at the National Solar Data Network for residential and commercial building solar demonstration sites throughout the United States are presented The insolation tables present the total, diffuse, direct, maximum, and extraterrestrial radiation The temperature tables give the average, daytime, nighttime, maximum, minimum and inlet-water temperatures for the solar sites Additional tables are presented for some of the sites, supplying either wind or relative humidity data, or both These data are used to determine the thermal performance of the solar systems
DOE

03
HYDROGEN

Includes hydrogen production, storage, and distribution

A81-21504 **Perspectives for metal hydride technology.** H Buchner (Daimler-Benz AG, Stuttgart, West Germany) *Progress in Energy and Combustion Science,* vol 6, no 4, 1980, p 331-346 37 refs.

Hydrogen storage in the form of metal hydrides offers a series of interesting technical applications The dual function of heat and fuel storage in hydrides is described for application in cars as well as for stationary use It is shown that hydrides can act as electrochemically reversible storage electrodes in alkaline accumulators and as a means for isotope separation Heat storage and waste heat recovery with the aid of hydrides and domestic possibilities for hydrogen production are discussed (Author)

A81-21955 **Hydrogen and oxygen from water V - The ROC system** J E Noring, R B Diver, and E A Fletcher (Minnesota, University, Minneapolis, Minn) *Energy* (UK), vol 6, Feb 1981, p 109-121 28 refs Contracts No ER-78-02-4737, No DE-AC02-79ER-10450

A thermodynamic analysis of a two-membrane reactor-separator system is presented The system can be made to operate at a reduced oxygen concentration (ROC) in the reactor-separator, thus greatly increasing the number and kinds of materials that may be considered candidates for separation membranes The range of operation, thermal efficiencies and operating characteristics of an idealized model are presented Candidate materials for hydrogen passing membranes are discussed The unique characteristics of the ROC system make materials which might ordinarily be considered unsuitable in a reactor-separator environment worthy of experimental investigation (Author)

A81-23014 **H2 as an energy vector - Hydrogen production by the ELOFLUX electrolytic cell (H2 comme vecteur de l'énergie - Production d'hydrogène par l'electrolyseur ELOFLUX)** P Brennecke, H Ewe, and E Justi (Braunschweig, Technische Universitat, Braunschweig, West Germany) *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique,* 2nd Semester, 1980, p 50-54 11 refs In French

The ELOFLUX electrolytic cell is presented as an efficient means for the production of hydrogen to be used as a multipurpose energy carrier The fabrication and operating properties of porous nickel electrodes, on which tne ELOFLUX cell is based, are reviewed, and it is pointed out that the greater surface area afforded by porous electrodes allows the reduction of local current densities and thus the overvoltages related to interfacial charge transitions, resulting in reduced energy consumption The design and operation of the continuous flow filter-press water electrolysis cell are discussed, and the necessity of using a protective surface coating of NiO to prevent anode oxidation is pointed out Testing results demonstrating a degradation in cell efficiency from 72 to 68 4 percent over the course of 1200 hours of operation at full charge are presented, and it is concluded that the ELOFLUX cell represents a favorable means of hydrogen production A L W

A81-23531 **Design and efficiency estimation of a thermochemical system of hydrogen production (Auslegung und Abschätzung des Wirkungsgrades einer Anlage zur thermochemischen Wasserstofferzeugung)** W Frie and B Grave (Siemens AG, Forschungslaboratorien, Erlangen, West Germany) *Siemens Forschungs- und Entwicklungsberichte,* vol 10, no 1, 1981, p. 1-8 16 refs In German

An iron-chlorine thermochemical cycle for the production of hydrogen from water was investigated The energy required in H2O-HCl separation is of special importance Starting from a state of thermodynamic equilibrium, it was possible to estimate the energy expended The efficiency thus determined was about 18% Improved separating processes could raise this to about 27%, hence, the efficiency is below that obtained by present-day electrolytic processes. B J

A81-24012 **Hydrogen Production and marketing; Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979** Symposium sponsored by the American Chemical Society Edited by W N Smith (General Electric Co , Philadelphia, Pa) and J G Santangelo (Air Products and Chemicals, Inc , Allentown, Pa) Washington, D C , American Chemical Society (ACS Symposium Series, No 116), 1980 437 p $36 50

The studies included in this volume provide an overview of hydrogen research and development and examine the problems of industrial technology and economics of hydrogen production, commercial distribution and safety, the potential of advanced hydrogen technologies, and applications Papers are presented on the hydrogen production from partial oxidation of residual fuel oil, coal gasification for hydrogen manufacture, production and application of electrolytic hydrogen, and hydrogen from fuel desulfurization V L

A81-24013 **The economics of hydrogen production.** D P Gregory, C L Tsaros, J L Arora, and P Nevrekar (Institute of Gas Technology, Chicago, Ill) In Hydrogen Production and marketing, Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979 Washington, D C , American Chemical Society, 1980, p 3-26 5 refs

A range of hydrogen costs is estimated on a parametric basis for various hydrogen production processes including steam reforming, partial oxidation of residual oil, Koppers-Totzek gasification of coal, steam-iron process, water electrolysis, and thermochemical hydrogen production Consideration is given to the effect of major variables such as feedstock price and by-product credits V L

A81-24014 **Hydrogen technology - An overview** F J Salzano, A Mezzina, M Beller, G Strickland, and S Srinivasan (Brookhaven National Laboratory, Upton, N Y). In Hydrogen Production and marketing, Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979 Washington, D C , American Chemical Society, 1980, p 33-44 Research sponsored by the U S Department of Energy

The state-of-the-art of hydrogen technology is reviewed with reference to hydrogen shipment, storage, hydrogen energy systems and fuel cells, applications, and economics Attention is also given to international cooperation on hydrogen programs and research and development incentives and requirements V L

A81-24015 **Hydrogen production from partial oxidation of residual fuel oil** C L Reed and C J Kuhre (Shell Oil Co , Process Engineering-Refining Dept , Houston, Tex) In Hydrogen Production and marketing, Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979 Washington, D C , American Chemical Society, 1980, p 95-121

The heat and material balance are presented along with the associated costs for a Shell gasification process hydrogen plant sized to produce 100 million scf of hydrogen per stream day The estimated manufacturing cost for hydrogen is $2 22/100 scf H2 based on the use of a heavy high-sulfur fuel oil valued at $15 17/bbl, the plant cost is estimated at 85 million dollars (mid-1979, U S Gulf Coast), including an arbitrary allowance of 35% of onsite capital cost for offsites and 10% for contingencies V L

A81-24017 **Technical and economic advances in steam reforming of hydrocarbons** R. G. Minet (KTI Corp , Pasadena, Calif) and O Olesen (United Technologies Corp , South Windsor, Conn) In Hydrogen Production and marketing, Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979 Washington, D C , American Chemical Society, 1980, p 147-175 13 refs.

Advances in the technology of high-temperature steam reforming of hydrocarbons are reviewed with emphasis on improvements in efficiency, feedstock range, and operating parameters. It is shown that proper integration of advanced reformer design with adsorption purification systems can reduce overall feed and fuel requirements below 400 Btu per standard cubic foot of hydrogen. V.L.

A81-24018 **Coal gasification for hydrogen manufacturing.** W G Schlinger (Texaco Research Center, Montebello, Calif.), J. Falbe (Ruhrchemie AG, Oberhausen, West Germany), and R. Specks (Ruhrkohle AG, Essen, West Germany). In: Hydrogen. Production and marketing, Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979 Washington, D.C., American Chemical Society, 1980, p 177-190 8 refs.

Two processes for converting heavy residual fuels into synthesis gas, a 50-50 mixture of hydrogen and carbon monoxide, are presented These processes are (1) the Texaco synthesis gas generation process for gasification of fluids pumpable at temperatures as high as 600 F, and (2) the Texaco coal gasification process for gasification of solid carbonaceous materials fed as a slurry in water or other carrier fluid. Both processes are shown to be commercially viable and environmentally acceptable. V.L.

A81-24019 **Production and application of electrolytic hydrogen - Present and future.** L. J. Nuttall (General Electric Co., Wilmington, Mass) In Hydrogen Production and marketing; Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979. Washington, D.C., American Chemical Society, 1980, p 191-212

Developments in the large scale production of hydrogen by water electrolysis are reviewed with particular reference to an advanced electrolysis technology based on the use of a solid polymer electrolyte cell originally developed for aerospace fuel·cell and electrolysis applications It is shown that the advanced solid polymer electrolyte technology has the potential to reduce the cost of electrolytic hydrogen from $15-20 to $9-13 per MBTU. V.L.

A81-24021 **Rechargeable metal hydrides - A new concept in hydrogen storage, processing, and handling.** G. D. Sandrock (Inco Research and Development Center, Suffern, N.Y.) and E. Snape (MPD Technology Corp., Ergenics Div., Waldwick, N.J.). In: Hydrogen Production and marketing, Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979 Washington, D C, American Chemical Society, 1980, p 293-322. 30 refs.

The science of rechargeable metal hydrides is reviewed with reference to their basic chemistry, thermodynamics, and engineering properties The main families of commercially available rechargeable hydrides are examined and potential applications of hydrides within the existing hydrogen industry are summarized. V.L.

A81-24022 **Closing the loop for the sulfur-iodine cycle.** G. Caprioglio, K McCorkle, and R. Sharp (General Atomic Co., San Diego, Calif) In Hydrogen Production and marketing; Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979. Washington, D C, American Chemical Society, 1980, p 323-332 7 refs Research sponsored by the Gas Research Institute and General Atomic Co, Contract No. EY-76-C-03-0167-PA-63.

The current status of a program to develop the sulfur-iodine thermochemical water-splitting cycle for hydrogen production is reviewed, with emphasis on the operation of the closed loop cycle demonstrator The advantages of the proposed process include (1) well characterized chemical reactions involving only fluids, (2) heat utilization within a temperature range accessible to heat sources utilizing existing materials technology (specifically, a high-temperature gas-cooled reactor), and (3) thermal efficiency of about 50% V.L.

A81-24023 **Hydrogen from fuel desulfurization.** M. E. D. Raymont (Sulphur Development Institute of Canada, Calgary, Alberta, Canada) In: Hydrogen Production and marketing, Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979. Washington, D.C, American Chemical Society, 1980, p. 333-348. 19 refs.

Several types of thermal decomposition techniques which make it possible to recover both sulfur and hydrogen from hydrogen sulfide are examined, including upset equilibrium systems, closed cycle loops, open cycle loops, and electrochemical methods Commercial and economic aspects of the proposed processes are compared with those of the Claus plants now commonly used for the processing of hydrogen sulfide V L

A81-24024 **The sulfur-cycle hydrogen production process.** G H. Farbman and G. H. Parker (Westinghouse Electric Corp, Advanced Energy Systems Div, Pittsburgh, Pa) In Hydrogen Production and marketing, Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979. Washington, D.C, American Chemical Society, 1980, p 359-389

The paper reviews the current development status of the sulfur-cycle hydrogen production process, a closed-cycle hybrid electrochemical/thermochemical water splitting technique The process is capable of operating with high-temperature nuclear or solar heat sources and is expected to be able to produce hydrogen at an overall thermal efficiency of 45%, including the inefficiencies associated with the generation of the required electric power V.L.

A81-24556 **Hydrogen/metal interactions with special reference to electrochemical approaches** H. J Flitt (South Australia, Flinders University, Adelaide, Australia) and J. O Bockris (Texas A & M University, College Station, Tex). *International Journal of Hydrogen Energy*, vol. 6, no 2, 1981, p. 119-138 142 refs.

A comprehensive review of hydrogen interactions in metals has been made with special emphasis on the electrochemical viewpoint. The object of this article is to provide the reader with a general knowledge of the physico-chemical aspects of hydrogen embrittlement of metals. (Author)

A81-24557 **High temperature solar reactors for hydrogen production.** E. Bilgen and J Galindo (Ecole Polytechnique, Montreal, Canada) *International Journal of Hydrogen Energy*, vol 6, no 2, 1981, p. 139-152. 21 refs. National Research Council of Canada Contract No. 115Q31025-7-1509-5

It has been shown recently that one-step, direct decomposition of water and two-step thermochemical cycles are feasible processes to produce hydrogen by using concentrated solar energy The temperature level required for direct decomposition is above 2500 K in order to have a reasonable hydrogen yield The temperature level for two- or three-step cycles may be about 1800 K These temperatures can easily be obtained in industrial solar furnaces Although the equilibrium temperatures at the receiver can be estimated, the precise information regarding the receiver efficiency at high temperatures is not readily available in the literature In this paper, the receiver efficiency is analyzed and the theoretical results are compared to experimental findings (Author)

A81-24559 **Heavy water recovery from combined electrolytic and non-electrolytic hydrogen streams.** M. Hammerli, J P Butler, A. S. Denovan (Atomic Energy of Canada, Ltd, Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada), and R L LeRoy (Electrolyser, Inc., Etobicoke, Ontario, Canada) *International Journal of Hydrogen Energy*, vol 6, no 2, 1981, p 167-179 21 refs

A method is described for heavy water recovery as a valuable by-product from combined electrolytic and non-electrolytic hydrogen streams. The process is based on an important modification of the combined electrolysis and catalytic exchange-heavy water process (CECE-HWP) The CECE-HWP is now in the small pilot plant stage of development. A highly dispersed platinum-carbon-Teflon catalyst on a ceramic carrier achieves efficient deuterium exchange between hydrogen gas and liquid water The range of acceptable ratios of electrolytic to non-electrolytic hydrogen which may be chosen in the Modified CECE-HWP is discussed Bench-scale results are presented which clearly demonstrate recovery of heavy water from both the *electrolytic and non-electrolytic hydrogen streams* The potential application of the process to ammonia production is discussed and other possible applications are mentioned briefly. Advantages of adopting the process are outlined, including the important benefit of conserving fossil resources (Author)

A81-24560 **Hydrogen storage in aluminium-substituted TiFe compounds.** G Bruzzone, G Costa, M Ferretti, and G. L Olcese (Genova, Università, Genoa, Italy) *International Journal of Hydrogen Energy*, vol 6, no 2, 1981, p 181-184 5 refs

A81-25017 **Engineering development of a HYCSOS chemical heat pump.** J S Horowitz, P. A. Nelson, and C. A. Blomquist (Argonne National Laboratory, Argonne, Ill.). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 2. Washington, D C., Hemisphere Publishing Corp, 1981, p 629-639. 10 refs.

The paper focuses on the engineering development of a HYCSOS (hydride conversion and storage system) heat pump which uses a tubular hydride bed capable of being rapidly cycled. The design features a large number (about 200) of individual tubes, each containing a high-temperature hydride at one end, and a low-temperature hydride at the other end. The central portion of the tube is designed to allow hydrogen to flow freely between the ends but retard the flow of heat between the ends V.L.

A81-25137 **Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 8 - Hydrogen energy.** Conference supported by the International Association for Hydrogen Energy, IAEA, ISES, Florida International University, and University of Miami. Edited by T N Veziroglu (Miami, University, Coral Gables, Fla) Washington, D.C., Hemisphere Publishing Corp, 1981 428 p Price of nine volumes, $595

The book discusses the topics of electrolytic hydrogen production, thermochemical hydrogen production, solar hydrogen production, metal hydrides, and hydrogen utilization Several papers are presented on the development status of the steam-iron process for hydrogen production, the production of hydrogen from carbonaceous materials, biophotolysis systems for hydrogen production, and heat transfer enhancement in metal hydride systems Fixed site hydrogen storage is examined with a view to the applications impact, and a comparison of technologies and economics L S.

A81-25139 **Fusion reactors for hydrogen production via electrolysis.** J A. Fillo, J R Powell, and M Steinberg (Brookhaven National Laboratory, Upton, N Y.) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 8 Washington, D.C, Hemisphere Publishing Corp, 1981, p. 3259-3265 5 refs Research sponsored by the U.S. Department of Energy

The decreasing availability of fossil fuels emphasizes the need to develop systems which will produce synthetic fuel to substitute for *and supplement the natural supply An important first step in the* synthesis of liquid and gaseous fuels is the production of hydrogen. Thermonuclear fusion offers an inexhaustible source of energy for the production of hydrogen from water. Depending on design, electric generation efficiencies of 40 to 60% and hydrogen production efficiencies by high temperature electrolysis of 50 to 70% are projected for fusion reactors using high temperature blankets (Author)

A81-25140 **An exergetic/energetic/economic analysis of three hydrogen production processes - Electrolysis, hybrid, and thermochemical.** J E Funk and W. Eisermann (Kentucky, University, Lexington, Ky) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 8 Washington, D C., Hemisphere Publishing Corp., 1981, p. 3285-3320 15 refs.

This paper presents the results of a combined first and second law analysis, along with capital and operating costs, for hydrogen production from water by means of electrolytic, hybrid, and thermochemical processes The processes are SPE and Lurgi electrolysis with light water reactor power generation and sulfur cycle hybrid, thermochemical and SPE electrolysis with a very high temperature reactor primary energy source Energy and Exergy (2nd law) flow diagrams for the process are shown along with the location and magnitude of the process irreversibilities. The overall process thermal (1st law) efficiencies vary from 25 to 51% and the exergetic (2nd law) efficiencies, referred to the fuel for the primary energy source, vary from 22 to 45% Capital and operating costs, escalated to 1979 dollars, are shown for each process for both the primary energy source and the hydrogen production plant All costs were taken from information available in the open literature and are for a plant capacity of 100 x 10 to the 6th SCF/day Production costs vary from 10 to 18 $/GJ, based on the higher heating value of hydrogen, and are based on a 90% plant operating factor with a 21% annual charge on total capital costs (Author)

A81-25141 **Status of the development of the general atomic thermochemical water-splitting cycle.** G Besenbruch, G Caprioglio, K. McCorkle, J Norman, D O'Keefe (General Atomic Co, San Diego, Calif), and M Yoshimoto (Idemitsu Kosan Co, Ltd, Tokyo, Japan) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 8 Washington, D C, Hemisphere Publishing Corp, 1981, p 3323-3334 Research sponsored by the Gas Research Institute and General Atomic Co, Contract No. DE-AT03-76SF-90351

A81-25142 **Development status of the Steam-Iron Process for hydrogen production.** R Biljetina and P B. Tarman (Institute of Gas Technology, Chicago, Ill) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 8 Washington, D C, Hemisphere Publishing Corp, 1981, p 3335-3347

A description of the Steam-Iron Process for hydrogen production and operating results from a large-scale pilot facility are presented. Significant achievements of the pilot plant program are discussed Commercial applications and economic advantages of the process are presented (Author)

A81-25143 **Thermochemical water-splitting cycles based upon reactions of cerium- and alkaline earth phosphates** P R Robinson and C E Bamberger (Oak Ridge National Laboratory, Oak Ridge, Tenn) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 8 Washington, D C, Hemisphere Publishing Corp, 1981, p 3349-3353 Contract No W-7405-eng-26

Cerium(IV) oxide, CeO2, reacts with derivatives of phosphoric acid, metaphosphate salts, and pyrophosphate salts at 600-1000 C to produce oxygen and cerium(III) phosphates The cerium(III) phosphates are oxidized to CeO2 by steam at 700-1200 C in the presence *of alkaline earth oxides, carbonates, or halides These two sets of* reactions form the basis for a family of thermochemical cycles based upon the redox couple Ce(IV)/(III) (Author)

A81-25144 **Non-corrosive, two-reaction, low temperature T/C cycles.** W H Dorrance (Organization Control Systems, Inc, Ann Arbor, Mich) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 8 Washington, D C, Hemisphere Publishing Corp, 1981, p. 3355-3388 16 refs Research supported by the Consolidated Natural Gas Research Co.

A reaction model is presented for redox reactions taking place within electrolytic solid state solutions The model is applied to closed, two-reaction, thermochemical cycles for producing hydrogen and oxygen from water The solid state solution employed is metal cation exchanged large-port mordenite The entropies and enthalpies of reaction are advantageously determined by properly adjusting the concentration parameter Si/Al ratio within the mordenite solution Fourteen metal cations are found to be suitable for use with such cycles Cycle efficiencies between 35 and 50 are possible at maximum reaction equilibrium temperatures not exceeding 827 C No corrosive materials are employed A continuous flow system design concept is described. Both hydrogen and oxygen are produced at 68 atmospheres (1000 psia) with the cycle efficiencies and reaction equilibrium temperatures as cited above (Author)

A81-25145 **Thermoelectrochemical hydrogen production using sodium chloride.** A.-M A El-Bassuoni, J. W. Sheffield, and T. N. Veziroglu (Miami, University, Coral Gables, Fla) In· Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 8. Washington, D C , Hemisphere Publishing Corp., 1981, p. 3383-3403. 11 refs

Three closed-cycle processes for the thermoelectrochemical production of hydrogen from water using sodium chloride are under investigation. The maximum required temperature of 700 C can be achieved by solar energy using various concentration techniques By means of photovoltaic cells or a solar power station, the required electric power can be obtained The cycles are based on electrolysis of sodium chloride, production of hydrogen chloride gas, reaction between hydrogen chloride and metal or metal oxide, reaction between the metal chloride and water, and regeneration of the original raw materials In these hybrid cycles hydrogen is produced in two steps of the five-step water splitting process. The characteristics of these cycles are being evaluated and their efficiencies will be compared with each other and with other hybrid cycles (Author)

A81-25146 **Production of hydrogen from carbonaceous materials.** A J Darnell (Rockwell International Corp, Energy Systems Group, Canoga Park, Calif) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 8 Washington, D.C , Hemisphere Publishing Corp , 1981, p 3405-3415. 9 refs

A method is presented for producing hydrogen from carbonaceous materials such as coal and biomass The process, referred to as the bromination process, consists of a two-step cycle (1) the carbonaceous material is reacted with bromine and water at 250-300 C to form an aqueous solution of hydrobromic acid and CO2, (2) the aqueous hydrobromic acid is electrolyzed to form hydrogen at a voltage less than that required for the electrolysis of water, the bromine formed in the electrolysis is returned to the first step of the process. The theoretical thermal energy conversion efficiency of the process is 70% The process is particularly suited to feedstocks with a water content up to 45%. V L

A81-25147 **Automotive dual-mode hydrogen generation system.** D. A Kelly (Technidyne Associates, Maspeth, N Y) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 8 Washington, D C., Hemisphere Publishing Corp , 1981, p 3417-3427

The automotive dual mode hydrogen generation system is advocated as a supplementary hydrogen fuel means along with the current metallic hydride hydrogen storage method for vehicles This system consists of utilizing conventional electrolysis cells with the low voltage dc electrical power supplied by two electrical generating sources within the vehicle Since the automobile engine exhaust manifold(s) are presently an untapped useful source of thermal energy, they can be employed as the heat source for a simple heat engine/generator arrangement The second, and minor electrical generating means consists of multiple, miniature air disk generators which are mounted directly under the vehicle's hood and at other convenient locations within the engine compartment The air disk generators are revolved at a speed which is proportionate to the vehicles forward speed and do not impose a drag on the vehicles motion. (Author)

A81-25148 **Overall efficiencies for conversion of solar energy to a chemical fuel.** J D Fish (Sandia Laboratories, Livermore, Calif.) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 8 Washington, D C., Hemisphere Publishing Corp , 1981, p 3431-3452 41 refs Contract No DE-AC04-76DP-00789

A complete and consistent scheme for determining the overall efficiency of a generalized process for the conversion of solar energy into a chemical fuel (e g hydrogen) is developed and applied to seven conversion processes thermal, thermochemical, photovoltaic, photogalvanic, photoelectrolysis, photosynthesis and photochemical conversion It is demonstrated that the overall efficiency of each of these processes is determined by ten common factors maximum theoretical efficiency, inherent absorption losses, inherent internal losses, rate limiting effects, reflection losses, transmission losses, coverage losses, system construction requirements, parasitic losses and harvesting and conversion losses Both state-of-the-art and optimistic values are assigned to each factor for each of the seven conversion processes. State-of-the-art overall efficiencies ranged from 5% for thermal conversion down to essentially zero for thermochemical Optimistic values in the range of about 10 to 15% are calculated for several of the processes. D K.

A81-25149 **Feasibility study on the Porshe - Optimum design of solar collection on a fluctuating base.** T Ohta and A Shimamura (Yokohama National University, Yokohama, Japan) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 8 Washington, D C , Hemisphere Publishing Corp., 1981, p 3453-3460

The solar collection methods and structural dynamics of the Plan of Ocean Raft System for Hydrogen Economy (Porshe) platform, full scale models of which are intended to supply not only electrolytic hydrogen production and storage, but ocean floor mining and ammonia and heavy water production as byproducts, are presented Particular attention is given the sensing and control of wind and wave-induced fluctuations of the structure O C

A81-25151 **Hydrogen generation from the chlorophyll water splitting reaction - Photochemical conversion and solar energy storage.** F K Fong (Purdue University, West Lafayette, Ind) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 8 Washington, D.C , Hemisphere Publishing Corp , 1981, p 3477-3482. 29 refs

In this paper we describe the developments leading to the production of hydrogen and organic fuels from water and carbon dioxide using sunlight and the chlorophyll extracted from green plants Product analyses were made by a variety of physical measurements The conversion of light into electrochemical potential is depicted in terms of the photoactivation overpotential derived from the photooxidation of hydrated chlorophyll aggregates The chlorophyll functions as the photocatalyst, reducing and oxidizing the water to yield hydrogen and oxygen through a one-electron cyclic pathway that is readily observed by electron spin resonance measurements The significance of the in vitro solar energy storage experiments relative to the long-term solution of the energy crisis is discussed (Author)

A81-25152 **Photosynthetic bacteria as alternative energy sources - Overview on hydrogen production research.** A Mitsui, Y Ohta J Frank, S Kumazawa, C Hill, D Rosner, S Barciella, J Greenbaum, L Haynes, and L Oliva (Miami, University, Miami, Fla.). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 8 Washington, D C , Hemisphere Publishing Corp , 1981, p 3483-3510 154 refs NSF Grants No AER-75-11171; No AER-76-17159, No AER-77-11545, Contract No RR-98036

A81-25153 **Biologically-assisted hydrogen production - Attempts at optimizing the use of polymeric viologen mediators in a bioreactor based on the hydrogenase-catalyzed decomposition of dithionite.** R W Williams, B W. Toye, and S. M Martin (National Research Council, Ottawa, Canada). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 8. Washington, D C, Hemisphere Publishing Corp, 1981, p 3511-3522. 8 refs

A81-25154 **Bulk hydrogen storage using metal hydrides.** G Strickland and M. J Rosso, Jr (Brookhaven National Laboratory, Upton, N.Y). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 8. (A81-25137 09-44) Washington, D C., Hemisphere Publishing Corp., 1981, p. 3525-3532. 13 refs. Research sponsored by the U S Department of Energy

The considerations involved in design and use of a process unit, or reservoir, for storing bulk quantities of hydrogen via solid particles of titanium-iron-manganese are described along with several applications Also included are one type of reservoir having improved design features, and the service system in which it was installed for testing. The reservoir has a nominal storage capacity of 50 lb (23 kg) of hydrogen and is rated for hydrogen charging and discharging times in the 5 to 10-hour range. (Author)

A81-25155 **Hydrogen in thin film hydriding alloys** J W Larsen, M L. Fuller, and B. R Livesay (Georgia Institute of Technology, Atlanta, Ga) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 8 Washington, D.C., Hemisphere Publishing Corp, 1981, p. 3533-3538. 11 refs. Contract No E(40-1)-5246.

Thin films of hydrogen storage alloys provide a well defined gas-metal interface for the study of the surface properties of these metal storage alloys. Sufficiently thin films remain intact during hydride cycling, whereas bulk alloys are reduced to powders Thin films show other differences from the bulk, specifically in the pressure composition characteristics and the kinetics. Magnetization, sheet resistance and film stresses were measured in situ in specialized apparatus These measurements indicate a much more sloped pressure composition curve with higher transition pressures and not the flat plateau exhibited by bulk specimens They further suggest that substrate induced stresses are probably responsible for this deviation from bulk behavior (Author)

A81-25156 **Heat transfer enhancement in metal hydride systems.** M J Rosso, Jr and G. Strickland (Brookhaven National Laboratory, Upton, N Y) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 8 Washington, D C., Hemisphere Publishing Corp., 1981, p 3539-3545 11 refs. Research sponsored by the U S Department of Energy.

An attempt has been made to enhance the heat transfer of hydrogen storage metal hydride systems by the addition of small fraction of high conductivity materials in various configurations Results indicate that the form of the enhancement material rather than its composition is the more critical factor The addition of over 6% aluminum foam enhances the effective thermal conductivity of a hydride bed by a factor of 2 6 V.L.

A81-25157 **Efficiency of hydrogen compression by means of hydrides.** R W Meyerhoff (Inco Research and Development Center, Suffern, N.Y). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 8. Washington, D.C., Hemisphere Publishing Corp, 1981, p 3555-3567

Several devices, such as water pumps, heat pumps and compressors, have been proposed which all share a common feature, namely, the use of heat in conjunction with a reversible hydride to compress hydrogen Several factors will determine the technical and economic viability of these devices One of these factors is the thermal efficiency of hydride compressors. This paper discusses the maximum efficiencies obtainable for hydride compressors as a function of the temperature of the heat source, T2, the temperature of the heat sink, T1, and X which is the ratio Cp/Delta H where Cp is the system heat capacity (hydride plus container) per mole of hydrogen capacity and Delta H is the heat of absorption per mole of hydrogen (Author)

A81-25158 **Development of solar-hydrogen systems using metal hydrides.** E. Snape (Ergenics, Wyckoff, N J), E L Huston, and G. D. Sandrock (Inco Research and Development Center, Suffern, N.Y). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 8. Washington, D C., Hemisphere Publishing Corp., 1981, p 3569-3586. 12 refs

An investigation is made of ways in which metal hydride hydrogen storage systems may be integrated with hydrogen utilization systems and with photosynthetic, photocatalytic, photochemical, electrolytic, thermochemical, and pyrolytic systems of solar hydrogen production. It is concluded that hydride storage systems are the safest, cheapest and most practical methods for widespread, dispersed hydrogen fuel utilization in industry nad transportation O C

A81-25159 **Fixed site hydrogen storage. I - Applications impact.** J J Iannucci and S L Robinson (Sandia Laboratories, Livermore, Calif) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 8 Washington, D.C., Hemisphere Publishing Corp, 1981, p 3595-3605 13 refs Contract No DE-AC04-76DP-00789

The potential applications and requirements for fixed site storage in a scenario of wide spread hydrogen use are examined and quantified An envisioned hydrogen production/distribution/end-use cycle is scrutinized to identify the storage needs for both continuous and intermittent sources including solar The most pressing need for storage is found to be at the distribution point, in concurrence with current natural gas practice. Caverns and similar underground storage techniques are shown to be the most promising modes due to their low cost relative to all other options examined Since a large volume of natural gas storage is presently in service, a pressing need to develop fixed site hydrogen storage technology (beyond the conversion of this underground storage to hydrogen) has not been identified. (Author)

A81-25160 **Fixed site hydrogen storage. II - Comparison of technologies and economics** S L Robinson and J J Iannucci (Sandia Laboratories, Livermore, Calif) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 8 Washington, D C, Hemisphere Publishing Corp, 1981, p. 3607-3625 57 refs Contract No DE-AC04-76DP-00789

Presently available and future fixed site hydrogen storage technologies are examined, to identify the minimum cost storage technique for various combinations of quantity, cycling frequency and parasitic energy costs The forms studied are, pressurized gas, cryogenic liquid, hydride, and microballoon storage For each form, installed capital cost, filling and emptying equipment costs and parasitic energy costs are developed and parameterized by electric rates. The energy intensive systems are economical for long-term cycling (seasonal storage) but unfavorable for short term (daily cycling) Low-pressure gas storage is favored for short term and intermediate term storage Development of microballoon storage is recommended as a possible low-cost long-term storage option (Author)

A81-25493 # **Hydrogen absorption and hydriding of Ti-based intermetallic compounds** M Someno, M Arita (Tokyo Institute of Technology, Tokyo, Japan), R Kinaka (Kawasaki Steel Corp., Chiba Works, Chiba, Japan), and Y Ichinose (Nagaoka, Technological University, Nagaoka, Japan) In Hydrogen in metals, Proceedings of the Second International Symposium, Minakami, Gumma, Japan, November 26-29, 1979 Sendai, Japan, Japan Institute of Metals, 1980, p 325-328

The effects of partially replacing Fe in TiFe by Co, Mn, and Cr and varying the Mn composition in TiMn(2-y) on the hydriding pressure were studied Decomposition of TiCu and TiNi to TiH2 and lower compounds was also studied It is found that the partial replacement of Fe in TiFe lowers the hydriding pressure The same effect is found for decreasing the Mn content in TiMn(2-y) A thermal activation process for decomposition of TiNi is discussed Diffusivity of hydrogen in TiMn(2-y) was determined from absorption rate measurements (Author)

A81-25494 # **Hydrogen storage properties of FeTi/1+x/** M Amano and Y Sasaki (National Research Institute for Metals, Tokyo, Japan) In Hydrogen in metals, Proceedings of the Second International Symposium, Minakami, Gumma, Japan, November 26-29, 1979 Sendai, Japan, Japan Institute of Metals, 1980, p 329-332. 6 refs

A81-25496 # **Hydrogen in LaNi5 intermetallic compound.** S Tanaka (Hokkaido University, Sapporo, Japan) and T B Flanagan (Vermont, University, Burlington, Vt). In Hydrogen in metals, Proceedings of the Second International Symposium, Minakami, Gumma, Japan, November 26-29, 1979 Sendai, Japan, Japan Institute of Metals, 1980, p 337-340 6 refs

The data of hydrogen absorption in LaNi5 follow Sieverts' law only at the very low hydrogen contents, and positive deviations from Sieverts' law are observed at the higher hydrogen contents The partial enthalpy and entropy of solution of hydrogen were determined at various values of hydrogen content The exothermicity of absorption declines with hydrogen content The apparent H/H interaction energy is positive and decreases with temperature (Author)

A81-25497 # **Investigations of intermetallic alloy film hydriding mechanisms.** B R Livesay and J W Larsen (Georgia Institute of Technology, Atlanta, Ga) In Hydrogen in metals, Proceedings of the Second International Symposium, Minakami, Gumma, Japan, November 26-29, 1979 Sendai, Japan, Japan Institute of Metals, 1980, p 345-348. Contract No E(40-1)-5246

Hydriding mechanisms have been investigated in AB5 alloys using specimens prepared in the form of both thin films and bulk powders Property investigations using only bulk storage alloys lack full definition because several hydrogen sorption-desorption cycles reduce the specimens to powders Films of the same alloys prepared with thickness less than about one micron remain coherent even with repeated hydrogenation cycles The kinetics for hydrogen absorption and desorption processes fitted the relationship (F(t) = 1 e/-(t/tau) exp n/ for both powder and film specimens The measured exponent n has a value 2 for SmCo5 powders and films with thicknesses greater than 1400 A A 500 A SmCo5 film yielded a value of n = 1/2 which is identified with initial rates of hydrogen absorption The measured time constants show that initiation of the beta-phase is slowed but not prevented in thicker films (Author)

A81-25498 # **Surface segregation effects in Mg2Cu, Mg2Ni and Mg-Mg2Ni hydrogen storage compounds** L Schlapbach, T von Waldkirch, and A Seiler (Zurich, Eidgenossische Technische Hochschule, Zurich, Switzerland) In Hydrogen in metals, Proceedings of the Second International Symposium, Minakami, Gumma, Japan, November 26-29, 1979 Sendai, Japan, Japan Institute of Metals, 1980, p 349-352 7 refs

A81-25499 # **Kinetics of the reaction between Mg2Ni and H2** K Nomura, E Akiba, S Ono (National Chemical Laboratory for Industry, Yatabe, Ibaraki, Japan), and S Suda (Kogakuin University, Tokyo, Japan) In Hydrogen in metals, Proceedings of the Second International Symposium, Minakami, Gumma, Japan, November 26-29, 1979 Sendai, Japan, Japan Institute of Metals, 1980, p 353-356 7 refs

A81-25500 # **Effects of adsorbed gas molecules on hydrogen-sorbing behaviour of magnesium-nickel alloys** S Ono, Y Ishido (National Chemical Laboratory for Industry, Tsukuba, Japan), and J Kitagawa (Chiba Institute of Technology, Narashino, Japan) In Hydrogen in metals, Proceedings of the Second International Symposium, Minakami, Gumma, Japan, November 26-29, 1979 Sendai, Japan, Japan Institute of Metals, 1980, p 357-360

A newly developed high pressure thermal analysis installation was used for the investigation of the hydrogen-sorbing characteristics of the Mg-Ni alloy This apparatus made possible to measure DTA and TG curves simultaneously under hydrogen pressures up to 50 kgf/sq cm Effects of exposing powdered hydrides in various gas atmospheres such as air, N2, CO2, CO, and CH4 were investigated by the isobaric thermal cycling experiments and the shift of the initiation temperature for desorption was observed corresponding to the 'deactivation' by the gas molecules adsorbed on surface The degree of shift was largest in the case of CO2 and CO (Author)

A81-26584 **Hydrides of ternary TiFe/x/M/1-x//M = Cr, Mn, Co, Ni/ intermetallics.** M H Mintz, S Vaknin (Negev, University, Atomic Energy Commission, Negev Nuclear Research Centre, Beersheba, Israel), S Biderman, and Z Hadari (Negev, University, Beersheba, Israel) *Journal of Applied Physics*, vol 52, Jan 1981, p 463-467 17 refs Research supported by the Ministry of Energy, Infrastructure and Communication

The effect of partial substitutions of iron in TiFe by different 3-d transition metals on the hydrogenation of the corresponding ternary compounds was studied These substitutions produce the stabilization of the monohydride beta phases and reduce hysteresis in the absorption-desorption isotherms A model which assumed local interactions of H with the nearest-neighbor metal atoms showed a linear dependence of the enthalpies of monohydride formation on the Fe concentration A T

A81-26872 **Natural convection heat leak in supercritical hydrogen tanks.** A J Barrett (Beech Aircraft Corp, Boulder, Colo) In Advances in cryogenic engineering Volume 25 - Proceedings of the Cryogenic Engineering Conference, Madison, Wis, August 21-24, 1979 New York, Plenum Press, 1980, p 483-488

Consideration is given to the occurrence of natural convection in small-diameter tubes that are filled with supercritical hydrogen, the warm end of the tube is at ambient temperature and is located below the cold reservoir The study was initiated to develop a method of predicting natural convection for variations in system geometry, fluid properties, and temperature gradients. The natural convection heat leak was determined from test data, and an empirical correlation was obtained for the prediction of natural convection The equation which is obtained may be used during the design phase of supercritical fill and vent lines to select the proper tube diameter to reduce the natural convection heat leak P T H

A81-26880 **Liquid hydrogen as an automotive fuel** W F Stewart (California, University, Los Alamos, N. Mex) In Advances in cryogenic engineering Volume 25 Proceedings of the Cryogenic Engineering Conference, Madison, Wis, August 21-24, 1979 New York, Plenum Press, 1980, p 822-830 19 refs Research sponsored by the U S Department of Energy

The paper describes six hydrogen fuel projects (involving seven container designs and six vehicles) that have involved liquid hydrogen storage Perris Smogless Automobile Association, Billings Energy Research Corporation, Los Alamos Scientific Laboratory, UCLA, Musashi Institute of Technology, and DFVLR Some of these projects used existing laboratory-type containers, some used adapted liquefied natural gas containers, others used containers designed especially for the project. A completely automatic liquid-hydrogen refueling station proposed by Stewart and Edeskuty (1974) is described in detail. P.T.H.

N81-16323# Institute of Gas Technology, Chicago, Ill
STUDY OF THE BEHAVIOR OF GAS DISTRIBUTION EQUIPMENTS IN HYDROGEN SERVICE, PHASE 2
Walter J Jasinowski and H Ding Huang 1980 7 p refs Presented at DOE Advan Conserv Technol and Chem Storage Branch Contract Rev Meeting, McLean, Va, 13-16, Oct 1980 Sponsored by DOE
(CONF-801055-5) Avail NTIS HC A02/MF A01

The characteristics of gas distribution pipe in hydrogen service were studied In experiments with three types of commercially availabe polyethylene natural gas piping, hydrogen permeation was found to be 4 to 6 times greater than methane permeation Ring tensile tests showed no significant difference in apparent strength of exposed and as received pipe samples, although the exposed specimens show greater elongation after testing to failure Leakage experiments with methane hydrogen blends showed no selective leakage of hydrogen via Poisenille, turbulent or orifice flow through leaks Leak rates increased with increasing pressure and decreasing specific gravity RCT

N81-16483# Los Alamos Scientific Lab, N Mex
A LIQUID-HYDROGEN-FUELED BUICK
Walter F Stewart Nov 1980 15 p
(LA-8605-MS) Avail NTIS HC A02/MF A01

A 1979 Buick Century sedan with a displacement turbocharged V-6 engine and automatic transmission was converted to operation on hydrogen supplied to the engine from a liquid hydrogen tank installed in the trunk of the car The liquid hydrogen tank is refilled using a semiautomatic refueling station designed to be operated by personnel with minimal training The Buick has a fuel economy corresponding to 8 9 km/l (21 miles/gal) of gasoline and a range of 274 km (170 miles) in the high altitude area of Los Alamos, New Mexico Author

N81-19339# Technische Hochschule, Aachen (West Germany) Lehrstuhl fuer Technische Thermodynamik
DEVELOPMENT OF MULTISTEP PROCESSES FOR THERMOCHEMICAL HYDROGEN PRODUCTION USING NUCLEAR HEAT. A SUMMARY Final Report
Helmut Wolfgang Cremer Peter Schuster, Gerhard Steinborn, G Wozny, and G Wuester Bonn Bundesministerium fuer Forschung und Technologie Dec 1979 62 p refs In GERMAN, ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-79-121, ISSN-0340-7608) Avail NTIS HC A04/MF A01 Fachinformationszentrum, Karlsruhe, West Germany DM 12 85

A thermochemical water splitting technique, using heat at temperatures lower than 1000 C, is described Several chemical reactions based on multistep processes of the iron/chlorine family are involved The additional chemical components are recycled, the necessary energy is supplied by a high temperature nuclear reactor Many thermochemical cycles are considered among which the more favorable are selected by means of thermodynamic, chemical and engineering criteria, experimental studies of the individual chemical reactions and of sequences of reactions, and by means of balance and optimization calculations underlying process flow schemes The selected Fe/Cl system is discussed comprehensively emphasizing the self regenerating nature of each reaction subsystem and the overall integration of the separation processes Author (ESA)

N81-19971# Escher Technology Associates, St Johns, Mich
LIQUID-HYDROGEN AUTOMOTIVE ONBOARD STORAGE AND SERVICING SYSTEM PROJECT Progress Report
Walter Finley Stewart and William Julius Daniel Escher 1981 8 p Presented at the Soc of Automotive Engr Intern Eng Congr and Exposition, Detroit, 23-27 Feb 1981
(Contract W-7405-eng-36)
(LA-UR-80-3491; CONF-810206-4) Avail. NTIS HC A02/MF A01

An intermediate sized automobile adapted to liquid hydrogen fuel was road tested A semiautomatic fueling station is used to service (refuel) the experimental vehicle A 150-l (39 6-gal) cryogenic liquid hydrogen storage tank mounted in the trunk compartment and the dashboard fuel gauging system are described The V-6 turbocharged engine was converted to hydrogen operation DOE

N81-20287 Virginia Univ, Charlottesville
IMPROVEMENTS IN THE ELECTROLYTIC GENERATION OF HYDROGEN Ph.D. Thesis
Patrick Joseph Moran 1980 142 p
Avail Univ Microfilms Order No 8101054

The hydrogen economy is a scheme proposed to alleviate many of the problems of energy transition by the utilization of hydrogen as a synthetic fuel An attractive method for the production of hydrogen is electrolysis of aqueous potassium hydroxide liberating both hydrogen and oxygen gases The future utilization of hydrogen producing electrolyzers depends on two main factors The first of these involves capital investment, particularly when small gas volumes are required A new electrolyzer was designed and fabricated and is discussed in detail The second factor influencing the future of electrolytic generation is energy efficiency, especially when considering large scale production Two areas were researched in connection with efficiency The first of these involves the investigation of polycrystalline nickel whisker electrodes Mechanical stability was proven and electrochemical performance on a geometric surface area basis demonstrated encouraging results The final area concerned with efficiency involves time dependent increases in cell voltage which represent continual decreases in efficiency It was demonstrated that hydrogen absorption at nickel cathodes is one mechanism responsible for the voltage-time variation Dissert Abstr

N81-20300# Brookhaven National Lab, Upton, N Y
REVIEW OF FUSION SYNFUELS
J A Fillo 1980 14 p refs Presented at the 4th ANS Topical Meeting on the Technol of Controlled Nucl Fusion, King of Prussia, Pa, 14-17 Oct 1980
(Contract DE-AC02-76CH-00016)
(BNL-28627, CONF-801011-74) Avail NTIS HC A02/MF A01

Thermonuclear fusion offers an inexhaustible source of energy for the production of hydrogen from water Depending on design electric generation efficiencies of about 40 to 60% and hydrogen production efficiencies by high temperature electrolysis of about 50 to 65% are projected for fusion reactors using high temperature blankets Fusion/coal symbiotic systems appear economically promising for the first generation of commercial fusion synfuels plants Coal production requirements and the environmental effects of large scale coal usage would be greatly reduced by a fusion/coal system In the long term, there could be a gradual transition to an inexhaustible energy system based solely on fusion DOE

N81-21210*# Battelle Memorial Inst, Geneva (Switzerland)
DIRECT THERMAL WATER SPLITTING BY CONCENTRATED SOLAR RADIATION FOR HYDROGEN PRODUCTION. PHASE O: PROOF OF CONCEPT EXPERIMENT Final Report
P Genequand Jun 1980 59 p refs Sponsored in part by DOE
(Contracts NAS7-100, JPL-955277)
(NASA-CR-164137, JPL-9950-512) Avail NTIS HC A04/MF A01 CSCL 21D

The direct production of hydrogen from water and solar energy concentrated into a high temperature aperture is described A solar powered reactor able to dissociate water vapor and to separate the reaction product at high temperature was developed, and direct water splitting has been achieved in a laboratory reactor Water vapor and radiative heating from a carbon dioxide laser are fed into the reactor, and water vapor enriched in hydrogen and water vapor enriched in oxygen are produced The enriched water vapors are separated through a separation membrane, a small disc of zirconium dioxide heated to a range of 1800 k to 2800 k To avoid water vapor condensation within the reactor,

the total pressure within the reactor was limited to 0 15 torr A few modifications would enable the reactor to be operated at an increased pressure of a few torrs More substantial modifications would allow for a reaction pressure of 0 1 atmosphere
J D H

N81-21627# Dornier-Werke G m b H , Friedrichshafen (West Germany) *Bereich Neue Technologien*
HIGH TEMPERATURE WATER VAPOR ELECTROLYSIS (HOT ELLY) Final Report
Wolfgang Doenitz, Hajo Hermeking, Ingo Kitzmann, Alfred Koch, Reinhard Roettenbacher, Wolfgang Schaefer, Rainer Schmidberger, Juergen Schumacher, and Hartwig vonZuelow Bonn Bundesministerium fuer Forschung und Technologie Aug 1980 273 p refs In GERMAN, ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-80-051, ISSN-0340-7608) Avail NTIS HC A12/MF A01

The practicability of high temperature water vapor electrolysis was demonstrated on a laboratory scale The component raw materials selection is described, and the manufacture of high temperature electrolysis cells is delineated Electrolytic operation of single cells and of tubular batteries built of series connected cells, at ambient as well as at high pressure, is described Results show that the specific electrical energy necessary for this method of hydrogen production is significantly lower than in conventional electrolysis processes Author (ESA)

04

FUELS AND OTHER SOURCES OF ENERGY

Includes fossil fuels, nuclear fuels, geothermal and ocean thermal energy tidal energy, and wind energy

A81-19847 **Classification of bituminous coals - Application of the technique of optimal sections in coal classification.** C. Peng (Peking Research Institute of Coal Chemistry, Peking, Communist China). *Energy* (UK), vol 6, Jan 1981, p 47-60. 9 refs.

The method of optimal sections was used for the classification of bituminous coals according to the degree of metamorphism and processing properties (e g , the caking property) Coals are classified into low volatile, medium-low volatile, and high volatile depending on the amounts of volatiles with metamorphism section points of 20, 28, and 36% on a dry and ash-free basis Based on the coke strength as the cross-reference, the coals are grouped into the noncaking, weakly caking, medium caking, and strongly caking types Finally, the coals are subdivided into seven groups including noncaking and extra-strongly caking, thus, a natural classification is evolved and a numerical system set up for their classification. A T

A81-20804 # **The Cyclocentrifuge - An advanced gas/solids separator for coal conversion processes.** J T McCabe and P R. Albrecht (Mechanical Technology, Inc., Latham, N.Y.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo., Jan. 12-15, 1981, Paper 81-0395* 9 p

The Cyclocentrifuge, a high-velocity particulate separator whose development is being underwritten by the U S. Department of Energy, is discussed as a possible gas cleanup system The separation principle here relies on centrifugal force generated by a bladed rotor located in a cyclone-shaped vessel A laboratory model (inlet flow, 1000 actual cubic feet per minute) tested at one atmosphere and 100 F is described Test results include velocity profiles and particulate separation efficiency measurements The design of a high-temperature unit is also discussed, and plans to test this unit using 1000 F, 250-psi synthesis gas from a coal gasifier are presented. C R

A81-20815 # **A preliminary investigation into the characteristics of a Rijke Tube pulsating combustor** A T Zimmerman *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan 12-15, 1981, Paper 81-0411* 9 p 9 refs Contract No DE-AS05-79ER-10068

Recent work in the Soviet Union has indicated that the Rijke Tube might be a highly efficient, simple, and low cost coal combustor utilizing pulsating combustion A low cost Rijke Tube experiment was designed Tests were performed to investigate the claim of a higher burn rate for pulsating combustion over that for steady state This experience was to be used later in the design of a more sophisticated Rijke Tube experiment Pulsating combustion was demonstrated burning charcoal at the quarter-length position in the Tube The burn rate for pulsating combustion was slightly but consistently faster than that for steady state An hypothesis of faster burn rates for larger masses of fuel negating somewhat the advantage of pulsating combustion was advanced Starting and damping mechanisms were also proposed (Author)

A81-22207 # **Calculations of the anomalies of the vertical temperature gradient using the horizontal temperature distribution (Die Bestimmung der Anomalien des vertikalen Temperaturgradienten aus horizontalen Temperaturverteilungen)** R Rösler, H Lindner, and C Oelsner (Freiberg, Bergakademie, Freiberg, East Germany). *Gerlands Beiträge zur Geophysik*, vol 89, no 5, 1980, p 389-398. 10 refs In German

This paper examines the determination of heat flow at the earth surface in relation to geothermal studies Anomalies of the vertical temperature gradient can be calculated with the Hilbert transformation of surface temperature measured along a profile The procedure is carried out with temperature values over the Supetau anticline at the Fergana basin R C

A81-22273 **Mechanism of coal hydrogenation-liquefaction - Effect of temperature and coal particle size** J M Lytle, R E Wood, and W H Wiser (Utah, University, Salt Lake City, Utah) *Fuel Processing Technology*, vol 4, Jan 1981, p 3-19 23 refs

The effect of coal particle size, hydrogen pressure and temperature on the extent of coal conversion in an entrained flow reactor is presented Coal hydrogenation is done by feeding dry coal with $ZnCl_2$ catalyst into a continuous stream of hydrogen The hydrogen-coal stream enters a long, small internal-diameter reactor (coiled tube reactor) controlled at about 500 C and 12 4 MPa hydrogen At these conditions the coal particles become plastic and sticky The hydrogen provides the energy to force the sticky coal particles through the reactor Conversion of 85% of the coal to liquids and gases is easily attained A physical mechanism is presented based on the unreacted-core-shrinking model This mechanism aids in the explanation of the effect of process variabes on reaction rates Projections beyond the range of the variables studied are presented These projections indicate that the pressure of coal liquefaction processes may be reduced by (1) the use of dry coal particles and (2) the reduction of the particle size Significant reaction rates may be attained at pressures as low as 0.6 MPa by proper adjustment of particle size and temperature (Author)

A81-22274 **Effects of pore diameter and catalyst loading in hydroliquefaction of coal with $CoO/MoO_3/Al_2O_3$ catalysts** P N Ho (New York, State University, Amherst, N Y , Phillips Petroleum Co , Bartlesville, Okla) and S W Weller (New York, State University, Amherst, N.Y) *Fuel Processing Technology*, vol 4, Jan 1981, p 21-29 10 refs Contract No EX-76-C-01-2013

A81-22275 **Motor fuels from coal - Technology and economics** K H Eisenlohr and H Gaensslen (Lurgi Kohle und Mineraloltechnik GmbH, Frankfurt am Main, West Germany) *Fuel Processing Technology*, vol 4, Jan 1981, p 43 61

Present technical methods for transforming coal into automotive fuels are discussed The overall thermal efficiency is used as an important economic criterium in the evaluation of the different processes Capital investment and production costs are determined and mutually compared Finally, the influence of the selling price of gaseous products on the cost of automotive liquid fuels is analyzed (Author)

A81-22278 **Statistical model fitting of remote induction sounding data from underground coal gasification site - Hanna II, phases 2 and 3.** E A Queincy, M M Rahman (Wyoming, University, Laramie, Wyo), J H Richmond (Ohio State University, Columbus, Ohio), and M L Rhoades (IBM Corp , Boulder, Colo) *IEEE Transactions on Geoscience and Remote Sensing*, vol GE-19, Jan 1981, p 29-42. 23 refs Contract No E(49-18)-2414

The statistical model fitting of field measurements of the location, shape and size of the coal burned during underground coal gasification at a site near Hanna, Wyoming taken with a wideband loop-loop induction sounding system is discussed Soundings were taken immediately after the burn and one year later by a system using audio frequency electromagnetic coupling between transmitter and receiver loops, and pseudo-noise pulse trains and cross correlation with averaging at the receiver to obtain minimum mean-square-error time domain signatures Wire grid approximations of induction models were employed to compute model responses of simulated reaction zones consisting of buried metal boxes, cylinders and spheres in a conducting overburden A dual-parameter Bayes minimum mean-square-error estimator was used to estimate model dimensions from magnitude responses extracted from field data at 1 kHz Box model estimates of the volumes of coal gasified are shown *to compare favorably with those obtained by chemical estimation,* however the location of the conducting anomaly was shifted laterally from the gasification wells and was observed to migrate upwards with site aging A L W

A81-22350 • **Liquefaction of biomass as a source of fuels or chemicals** I J Miller and S K Fellows (Department of Scientific and Industrial Research, Chemistry Div , Petone, New Zealand) *Nature,* vol 289, Jan 29, 1981, p 398, 399 7 refs

Although biomass is one of the few renewable sources of liquid fuels and chemicals, relatively little work has been carried out on its direct liquefaction It is reported that wood or cellulose can be almost totally converted to liquids or gases when heated under pressure of 350 C in the presence of phenol, water, an acid or base catalyst, and either hydrogen or nitrogen The resultant liquids were separated into a neutral fraction, which was partly characterized by gas chromatography-mass spectrometry and found to contain mainly aromatic compounds with or without an oxygen-containing ring, and a phenolic fraction The nature of these compounds was found to be dependent on the catalyst, but not appreciably on the physical conditions used (Author)

A81-22511 **Recent progress in inertial confinement fusion at the Lawrence Livermore Laboratory.** H G. Ahlstrom and K R Manes (California, University, Livermore, Calif) In Electro-Optics/Laser 79 Conference and Exposition, Anaheim, Calif , October 23-25, 1979, Proceedings Chicago, Industrial and Scientific Conference Management, Inc , 1979, p 487-501 16 refs Contract No W-7405-eng-48

The Shiva and Argus laser systems at Livermore have been developed to study the physics of inertial confinement fusion Both laser system designs are predicated on the use of large aperture Nd-glass disk amplifiers and high power spatial filters During the past year, DT filled microshell targets with and without polymer coatings have been irradiated Recently new instruments have been developed to investigate implosion dynamics and to determine the maximum fuel density achieved by these imploded fusion pellets A series of target irradiations with thin wall microshells at 15 to 20 TW, exploding pusher designs, resulted in a maximum neutron yield of 3 x 10 to the 10th Polymer coated microshells designed for high compression were subjected to 4 kj for 0 2 nsec and reached fuel densities of 2 0 to 3 0 g/cu cm (Author)

A81-22774 **Suppression of stream condensate corrosion at Wairakei Geothermal Project.** R James (Department of Scientific and Industrial Research, Wairakei, New Zealand) *Geothermal Energy,* vol 8, Mar 1980, p 11-21, 23, 24 9 refs

A81-22849 **Thermodynamic calculations for coal gasification processes (Thermodynamische Berechnungen zu Kohlevergasungsprozessen)** K-K Neumann and F Keil (Uhde GmbH, Dortmund, West Germany) *Brennstoff-Warme-Kraft,* vol 33, Jan 1981, p 22-25 13 refs In German

It is shown that gasification reactors for most coal gasification processes can be described by models that assume simultaneous chemical equilibrium between all parts of the reaction A computer program incorporating such a simultaneous equilibrium model can be used to describe the processes of a gasification plant with regard to mutually connected mass and enthalpy balances B.J

A81-23069 # **The estimation of the parameters of the distribution of wind speed and direction.** B McWilliams and D. Sprevak (Belfast, Queen's University, Belfast, Northern Ireland) *Wind Engineering,* vol 4, no 4, 1980, p 227-238 7 refs.

Statistical properties of the joint distribution of wind speed and direction are presented and used in an improved and simplified method of estimation of the parameters of the distribution The proposed estimation procedure is tested against wind data from all available sites in Ireland The agreement obtained between theory and observations gives further evidence to support the suitability of the theoretical model and the estimation procedure for the distribution of wind speed and direction (Author)

A81-23227 # **The efficiency of conical pellets for laser fusion (Ob effektivnosti konicheskikh mishenei dlia lazernogo termoiadernogo sinteza)** A V Borovskii and V V Korobkin (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR) *Kvantovaia Elektronika* (Moscow), vol 8, Jan 1981, p 5 12 10 refs In Russian

The paper analyzes laser power reduction, laser pulse lengthening, and neutron yield increase for an ideal conical pellet with absolutely rigid and heat proof walls as compared to a spherical pellet of the same mass A simple theory is proposed that makes it possible to take account of the influence of walls on the fusion process in the conical pellet with gaseous fuel and heavy shell Energy losses due to wall deformation and heat conduction are estimated, and the influence of these factors on neutron yield is considered B J

A81-23495 **Formation and behaviour of coal free radicals in pyrolysis and liquefaction conditions** L Petrakis and D W Grandy (Gulf Research and Development Co , Pittsburgh, Pa) *Nature,* vol. 289, Feb 5, 1981, p 476, 477 11 refs Contract No DE-AC01-79ET-14940

A81-23562 # **Petroleum exploration with Landsat in Bay County, Michigan - An interim case study** R K Vincent and D H Coupland (Geospectra Corp , Ann Arbor, Mich) In International Symposium on Remote Sensing of Environment, 14th, San Jose, Costa Rica, April 23-30, 1980, Proceedings Volume 1 Ann Arbor, Mich , Environmental Research Institute of Michigan, 1980, p 379-387

Results are presented from a Landsat study of an area in Bay County, Michigan performed for the purposes of petroleum exploration A lineation mapped from a contrast-stretched color composite was thought to be a fault trending NE-SW from the Southeastern corner of Saginaw Bay Seismic data were used to confirm the existence of the fault and support an adjacent graben structure hypothesis The second of two holes drilled on the northwestern margin found a significant show of gas and a minor oil show Groundwater action along the fault trace may have been responsible for the appearance of the linear features in the computer-processed Landsat images L S

A81-23587 # **Remote sensing techniques for identification and evaluation of geothermal areas.** L del Rio, P N Pascaud, S Camacho, and N Galvan (Universidad Nacional Autonoma de Mexico, Mexico City, Mexico) In International Symposium on Remote Sensing of Environment, 14th, San Jose, Costa Rica, April 23-30, 1980, Proceedings Volume 2 Ann Arbor, Mich., Environmental Research Institute of Michigan, 1980, p 731-742 25 refs

A81-23590 # **Application of aerial remote sensing to the study of geothermal resources in the desertic north of Chile and environmental pollution in Santiago, Chile.** A F Mauricio (Universidad de Chile, Santiago, Chile) In International Symposium on Remote Sensing of Environment, 14th, San Jose, Costa Rica, April 23-30, 1980, Proceedings Volume 2 Ann Arbor, Mich , Environmental Research Institute of Michigan, 1980, p. 761, 762

The technology and field methodology employed in the remote sensing of geothermal resources in desert regions of Chile are found to provide good information and to be suitable for use in other parts of the country. Over Santiago, it is found that the use of aerial multispectral photography (multiband camera) and images (thermal infrared line scanner) is very effective in detecting pollution sources Air ventilation tubes, machines (vehicles and other motors), factories, and industries are readily distinguished on thermal infrared images It is pointed out that these potential pollution sources can be identified in the multiband photography, where the near infrared band has a potential to penetrate the smog Water pollution is found to be dramatically illustrated, especially on thermal images C R

A81-23630 # **Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County - State of Goiás - Brazil** P Veneziani and C Eustáquio dos Anjos (Instituto de Pesquisas Espaciais, São José dos Campos, São Paulo, Brazil) In International Symposium on Remote Sensing of Environment, 14th, San Jose, Costa Rica, April 23-30, 1980, Proceedings Volume 2 Ann Arbor, Mich, Environmental Research Institute of Michigan, 1980, p 1239-1242 10 refs

The objective of this research was to study thermally anomalous areas associated with hot waters in the County of Caldas Novas, State of Goiás, Brazil Data collection was conducted using a 50-cm soil thermometer and a precision radiation thermometer The temperature data, processed by a Trend Surface Analysis Program, indicated the presence of 4 principal anomaly areas, the town of Caldas Novas, Córrego Tucum, Pousada do Rio Quente, and Lagooa Pirapetinga These areas were verified in the field In the area of the town of Caldas Novas, of 14 deep wells drilled, 9 revealed water temperatures from 33 to 41 C, 2 contained hot mud, 1 contained sulfurous water measured at 29 C Two dry wells were also encountered (Author)

A81-23690 **Meteorological aspects of wind energy - Assessing the resource and selecting the sites.** W. T. Pennell, W R. Barchet, D. L Elliott, L. L Wendell, and T R. Hiester (Battelle Pacific Northwest Laboratories, Richland, Wash) *Journal of Industrial Aerodynamics*, vol 5, May 1980, p 223-246 15 refs Contract No. EY-76-C-06-1830.

A regional wind energy assessment of five Northwestern states is presented as a model for large-scale analysis of the wind energy potential and distribution of an area Frequency distributions of wind speed and direction, and duration curves for speed and power summarize the statistical distribution while the annual, monthly and diurnal curves show the temporal variation of the wind power resource on a station-by-station basis The various site selection techniques described include numerical and physical modeling and biological, geological, topographical and social and cultural indicators. Site selection strategy is discussed in terms of mesoscale evaluation, candidate site screening, and candidate site evaluation. It is concluded that experience with the initial wind turbine installations will be critical in evaluating current siting approaches. (Author)

A81-23691 **Wind energy resource survey methodology.** N. J Cherry (Lincoln College, Canterbury, New Zealand) *Journal of Industrial Aerodynamics*, vol 5, May 1980, p 247-280 32 refs

National wind energy resource surveys from Vermont, France, Spain, Israel, India, the U K. and New Zealand are reviewed in light of a general discussion of methodologies and instrumentation It is noted that in the absence of detailed data, empirical relationships involving the site mean wind speed and the mean roughness length of the site can be used to estimate the parameters of the wind speed frequency distribution and can provide an estimate of the mean wind energy force with an uncertainty of about 15%, though erring on the conservative side A comprehensive resource assessment of a region can be carried out using robust cup anemometers with an electronic data-logger which records 1 to 5 minute mean wind speeds installed on existing towers on well-exposed elevated or coastal sites L S.

A81-23692 **An investigation of wind-energy prospects in the Otago region of New Zealand.** P J Edwards and K. R Dawber (Otago, University, Dunedin, New Zealand) *Journal of Industrial Aerodynamics*, vol 5, May 1980, p 281-296 21 refs New Zealand Energy Research and Development Committee Contract No 3096

The investigation covers the Otago region of the south island of New Zealand east of 169 deg east longitude, an area of 2 5 x 10 to the 6th hectares centered near 45 deg latitude. Three years of data from an anemometer network installed as part of a national wind-energy resource survey have been analyzed to provide (1) an inventory of the wind energy available annually in the region, and (2) a description of the characteristics of prospective aerogeneration sites The total resource is estimated to exceed 80 TW h per annum (9 GW average power) of which 10% might be utilized without either significant land use conflict or severe environmental impact Characterization of prospective sites in terms of wind-speed frequency, gust and lull distributions, wind-speed height profile, and longitudinal turbulence using data with high time resolution yields parameters similar to those found in other temperate maritime and continental climatic regimes. (Author)

A81-23693 **Wind-tunnel simulation of the flow over hills and complex terrain.** R N Meroney (Colorado State University, Fort Collins, Colo) *Journal of Industrial Aerodynamics*, vol 5, May 1980, p. 297-321 20 refs Contracts No EG-77-S-06-1043, No. EY-76-S-06-2438.

A study has been completed to evaluate the accuracy of a wind tunnel investigation of flow over a complex terrain model Both terraced and contoured models of the Rakaia River Gorge region of New Zealand were prepared to an undistorted geometric scale of 1.5000 The contoured model was examined for three separate surface roughness conditions. On two spring days, selected for strong adiabatic down valley wind flow, three teams of investigators surveyed up to 27 sites on either side and within the river gorge Measurements consisted of wind speed and direction at a 10 m height The laboratory simulation results were compared with the available field data by means of statistical correlation and scatter diagrams The model and field results have been used to assess the value of laboratory experiments as part of a strategy to develop and demonstrate efficient and economical techniques for identifying favorable wind energy conversion sites (Author)

A81-24016 **Synthetic gas production for methanol - Current and future trends.** J A. Camps and D. M Turnbull (Davy Powergas, Inc, Lakeland, Fla) In Hydrogen Production and marketing, Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979 Washington, D C, American Chemical Society, 1980, p 123-146

Synthesis gas (carbon monoxide/hydrogen mixture) generation from the various accepted feedstocks and methanol synthesis are discussed with reference to the efficiency, limitations, and economics of different processes Current and future markets for methanol are briefly reviewed V L

A81-24020 **Hydrogen requirements in shale oil and synthetic crude from coal.** J L Skinner (ARCO Oil and Gas Co, Dallas, Tex) In Hydrogen Production and marketing, Proceedings of the Symposium, Honolulu, Hawaii, April 2-6, 1979 Washington, D.C, American Chemical Society, 1980, p 279-291 6 refs

Analysis of the total hydrogen requirements for liquid fuels derived from oil shale and coal indicates that the amount of hydrogen is dependent on the feed raw material and the desired liquid product. For the production of a synthetic crude product from oil shale, about 2,000 scf of hydrogen per barrel (15 06 kmol/cu m) is required, while the production of synthetic crude from coal will require 7,000-8,000 scf per barrel (52 70-60 23 kmol/cu m). For fuel oil produced from coal, the hydrogen requirements will range between 5,000 and 6,500 scf per barrel (37.64-48.94 kmol/cu m) V L.

A81-24265 **Gasification combined cycle R&A assessment.** J. H Witt and M C. Neely (ARINC Research Corp, Annapolis, Md). In: Annual Reliability and Maintainability Symposium, Philadelphia, Pa., January 27-29, 1981, Proceedings New York, Institute of Electrical and Electronics Engineers, Inc, 1981, p 156-162 Research supported by the Electric Power Research Institute.

This paper describes the development and application of a methodology for assessing the reliability and availability of coal gasification combined cycle (GCC) power plant designs The methodology was developed for and applied to a design of an 1100-

megawatt baseload GCC power plant. The specific objectives of the analysis were to obtain baseline reliability and availability values for the GCC plant design and to develop criticality rankings of the plant's components based on their impact on the system's reliability and availability measures. (Author)

A81-24302 **The mass discharge of a geofluid from a geothermal reservoir - Well system with flashing flow in the bore.** D. J Ryley (Liverpool, University, Liverpool, England) *Geothermics,* vol 9, no 3-4, 1980, p. 221-235 8 refs. Contract No. EY-76-5-02-4051-A001

A81-24303 **Thermal techniques for characterizing magma body geometries.** H. C. Hardee and D. W. Larson (Sandia Laboratories, Albuquerque, N. Mex.). *Geothermics,* vol. 9, no. 3-4, 1980, p. 237-249. 14 refs. Contract No. AT(29-1)-789.

Surface heat flux distributions produced by magma bodies can be used in the characterization of the magma source. Closed-form analytical solutions for the conductive heat transfer from various idealized magma geometries, such as dikes, sills and spheres, were obtained using either the Schwarz-Christoffel transformation theorem or the 'method of images' with superposition. Comparison of these analytically determined heat flux distributions with field data from active geothermal areas at Yellowstone, Avachinsky volcano, Kilauea Iki, and the Coso geothermal area indicates that these fields may be conduction dominant, at least over certain depths. Results are in good agreement with several independent geophysical measurements. O.C.

A81-24304 **Construction of a probe for measuring temperature and pressure in deep wells.** N Adorni (Centro Informazioni Studi e Esperienze S p A , Milan, Italy), L Ceppatelli, A Grassi, A. Palama, and P Rosselli (Ente Nazionale per l'Energia Elettrica, Centro Ricerca Geotermica, Pisa, Italy) *Geothermics,* vol 9, no. 3-4, 1980, p 251-259 European Economic Communities Contract No. 166-76-1-EGI

Measurement techniques for geothermal wells are discussed with emphasis on a particular temperature and pressure recording system. Details of the probe, the cable for mechanical and electrical connection to the surface instrumentation, and the surface equipment itself are presented The system is shown to be operable down to 3000 m in depth, up to pressures of 250 bar, and temperatures of 240 C D K

A81-24306 **Hydrothermal metamorphism in the Larderello geothermal field.** G Cavarretta (CNR, Centro di Studio per la Geologia dell'Italia Centrale, Rome, Italy), G Gianelli, and M. Puxeddu (CNR, Istituto Internazionalle per le Ricerche Geotermiche, Pisa, Italy) *Geothermics,* vol 9, no. 3-4, 1980, p. 297-314. 61 refs. Research supported by the Consiglio Nazionale delle Ricerche.

The various tectonic units underlying the Larderello-Travale geothermal region have undergone hydrothermal metamorphism. The hydrothermal mineral assemblages are generally consistent with the temperatures now measured in the wells, leading to the hypothesis that solid phases deposited from a liquid medium during a hot-water stage that preceded the vapor-dominated one. (Author)

A81-24427 **Utilization of biomass in the U.S. for the production of ethanol fuel as a gasoline replacement. I - Terrestrial resource potential. II - Energy requirements, with emphasis on lignocellulosic conversion.** J D. Ferchak and E K Pye (Pennsylvania, University, Philadelphia, Pa.). *Solar Energy,* vol. 26, no. 1, 1981, p 9-25 91 refs Contract No EY-76-S-02-4070

The paper assesses the biomass resource represented by starch derived from feed corn, surplus and distressed grain, and high-yield sugar crops planted on set-aside land in the U.S It is determined that the quantity of ethanol produced may be sufficient to replace between 5 to 27% of present gasoline requirements Utilization of novel cellulose conversion technology may in addition provide fermentable sugars from municipal, agricultural and forest wastes, and ultimately from highly productive silvicultural operations. The potential additional yield of ethanol from lignocellulosic biomass appears to be well in excess of liquid fuel requirements of an enhanced-efficiency transport sector at present mileage demands. No conflict with food production would be entailed A net-energy assessment is made for lignocellulosic biomass feedstocks' conversion to ethanol and an almost 10 1 energy yield/energy cost ratio determined. It is also found that novel cellulose pretreatment and enzymatic conversion methods still under development may significantly improve even that figure, and that both chemical-feedstocks and energy-yielding byproducts such as carbon dioxide, biogas and lignin make ethanol production potentially energy self-sufficient A final high-efficiency production approach incorporates site-optimized, nonpolluting energy sources such as solar and geothermal O.C.

A81-24749 **Tapping the main stream of geothermal energy.** *Geothermal Energy,* vol 8, Aug -Sept. 1980, p. 3-12

The development of geothermal energy resources in the United States is discussed. The distribution of underground water resources at temperatures above 90 C and depths up to 3 km in the continental U S. is examined, and it is pointed out that whereas geothermal resources have been detected under 24 states, only 220 quadrillion Btu of energy recoverable as 24 GW of electricity for 30 years has been conclusively located, all of it in the western states Direct-flash technology, which generates electricity from hydrothermal fluid at a temperature above 210 C with an efficiency of 15% is presented, and the binary cycle technology required to generate electricity from lower-temperature fluids such as those in the 180 C reservoir of low-salinity brine at Heber in southern California is examined in detail. Questions of minerals and heat control in a geothermal turbine system and the environmental emissions from geothermal plants are addressed The geothermal resources of the United States are classified as petrothermal, geopressurized and hydrothermal, and methods for extracting heat from these dry rocks, pressurized water and natural gas deposits and systems of steam and hot water are indicated It is concluded that as fossil fuel energy costs rise, the trend favors geothermal energy, particularly that which can be developed from known hydrothermal resources S.C S

A81-24750 **China starts tapping rich geothermal resources.** D Guang *Geothermal Energy,* vol 8, Aug -Sept 1980, p 22, 23.

Attention is given to the electric and power installation running on geothermal energy at Yangbajain, Tibet Other geothermal projects in Tibet, the Yunnan Province and the North China Plain are also outlined. Applications of geothermal energy are described, including the heating of homes and factories, spinning, weaving, paper-making and the making of wine. S C S

A81-24751 **The Philippines geothermal success story.** R. J. Birsic *Geothermal Energy,* vol 8, Aug -Sept 1980, p. 35-44.

Geothermal electrical plants currently in operation in the Philippines are presented. Following a brief review of the geographical and energy situation of the nation, attention is given to the first 55,000-kW unit of the Tiwi Geothermal Electric Plant, which commenced operation in January 1979, the portable 3,000-kE Leyte Geothermal Pilot Plant, which commenced operation in July, 1977 as the first geothermal power plant in the country, the Makiling-Banahaw (Mak-Ban) Geothermal Power Plant, the first 55,000-kW unit of which began operation in May, 1979 and the second 55,000-kW unit of the Tiwi plant, which came into service in June, 1979, thus making the Philippines the fourth largest producer of geothermal electricity in the world. Factors favoring the use of geothermal plants in developing nations are pointed out, including low capital costs, no foreign exchange costs for fuel, small units, and little environmental impact, and the start-up of two more plants, the second 55,000-kW unit at Mak-Ban in September 1979 and the third Tiwi unit in January 1980, are noted. It is predicted that in 1981, when the Philippines is expected to become the largest user of geothermal energy from hot-water fields, it will have a total capacity of 552 MW from the Mak-Ban, Tiwi and Leyte sites. Further areas with geothermal potential are also pointed out. S C.S.

A81-24900 **Gasoline from alcohols.** C R Morgan, J P Warner, and S Yurchak (Mobil Research and Development Corp, Paulsboro, N J) *(American Chemical Society, National Meeting, 179th, Houston, Tex, Mar 24, 1980) I & EC - Industrial and Engineering Chemistry, Product Research and Development*, vol 20, Mar 1981, p 185-190 6 refs Contract No EX-76-C-01-2490

This paper discusses laboratory and vehicle performance test results obtained from gasoline produced by the Mobil methanol conversion process Antiknock qualities, driveability performance, exhaust emission levels, plus other in-car and laboratory characterization tests show the gasoline to compare very favorably with conventional petroleum derived high-octane unleaded gasolines The methanol conversion process, and its advantages relative to the blending of alcohol-containing fuels, also is discussed briefly (Author)

A81-25066 **Wood energy in West Virginia.** C. L. Aton, L. P Fisher, J C Wyvill, and J L Birchfield (Georgia Institute of Technology, Atlanta, Ga.). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 4
Washington, D C, Hemisphere Publishing Corp, 1981, p 1501-1516

The use of wood energy in West Virginia is examined. A five step determination process found 9,021,200 acres of commercial forest land available for the production of wood. Eighty percent of the state requires a manual element in the felling and retrieval process because of the hilly terrain The methods and costs of hillside harvesting are outlined. The major technologies for the conversion of wood fuel to energy are described, and wood energy applications in supplementing natural gas for direct heat drying, steam production, and machine drive are delineated L.S.

A81-25090 **The relationship between the temperature-gradient distribution and geological structure in the Izmir-Seferihisar geothermal area, Turkey.** T Esder and S. Simsek (Mineral Research and Exploration Institute of Turkey, Izmir, Turkey) In. Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 5. Washington, D C., Hemisphere Publishing Corp., 1981, p. 1919-1940 20 refs

A81-25091 **Hot Dry Rock Geothermal Energy Development Program.** P R Franke (California, University, Los Alamos, N Mex.). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 5. Washington, D C., Hemisphere Publishing Corp, 1981, p. 1993-2007.

The Hot Dry Rock (HDR) Geothermal Energy Development Program is reviewed The principal operational tasks include the development and analysis of a 20 to 50 MW HDR reservoir at Fenton Hill with the potential construction of a pilot electric generating station, as well as the selection and evaluation of future target prospect areas A small subterranean system at Fenton Hill comprised of two boreholes connected at a depth of 3 km by hydraulic fracturing was evaluated. A closed-loop surface system has been constructed and tests have yielded promising data on heat extraction, geofluid chemistry, flow impedance, and loss of water through the underground reservoir between the two holes With positive program results, it will be possible to begin delivering commercial HDR-derived power-on-line in the final decade of this century. L.S.

A81-25093 **Geothermal energy and biofuel production in agriculture.** P De Marchi Desenzani (Pavia, Università, Pavia, Italy). In Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 5 Washington, D C., Hemisphere Publishing Corp, 1981, p 2023-2031. 5 refs

While the usefulness of geothermal heat is limited by the temperature constraints, heat resources such as low-temperature geothermal water can be used profitably as aids to Italian agricultural production and in the processing of agricultural products A synergistic relationship between geoheat utilization and biofuel production is examined, and a reference system integrating solar, wind and geothermal energy is presented The production of liquid or gaseous fuels from raw biomass and geothermal heat is reviewed Liquid production offers better near-term opportunities than gas production, although methane is to be considered ultimately more useful than ethanol L S

A81-25107 **Synthetic fuel production in a particle-beam driven fusion reactor.** J W. Fisk and D M Woodall (New Mexico, University, Albuquerque, N Mex) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 6
Washington, D C., Hemisphere Publishing Corp, 1981, p 2659-2669 16 refs.

An overview of the operation of an inertial confinement fusion reactor is presented explaining in particular the function of a buffer gas in the reaction chamber The use of water vapor and carbon dioxide as a buffer gas are discussed with the intention of showing that they not only perform as buffer gases, but produce hydrogen and carbon monoxide as synthetic fuels as well when carbon dust is introduced with these feed gases Equilibrium calculations for carbon dust and water vapor are performed for temperatures of 2000 and 4500 K and for carbon dust and carbon dioxide at 3500 K. The conversion times for 15-micron-diameter carbon particles were calculated using a shrinking core model Tritium contamination of the products is also discussed. (Author)

A81-25108 **Realistic assessment of direct radiolysis for synthetic fuels production using fusion radiation sources.** J H Pendergrass, L. A. Booth, F. T. Finch, and T G Frank (California, University, Los Alamos, N. Mex). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 6
Washington, D.C, Hemisphere Publishing Corp., 1981, p. 2671-2710 67 refs

A characterization of fusion reactors as radiation sources and a review of the fundamentals of radiolysis are presented. Substantial technological obstacles to development of efficient and economical radiolytic processes for synthetic fuel production are identified. Combined radiolytic/thermochemical cycles that have been proposed for synthetic fuels production are analyzed for potential for commercialization. Preliminary studies of radiolysis economics process are not encouraging All grounds for optimism of which we are aware are summarized (Author)

A81-25109 **Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 7 - Hydrocarbon conversion.** Conference supported by the International Association for Hydrogen Energy, IAEA, ISES, Florida International University, and University of Miami Edited by T. N. Veziroglu (Miami, University, Coral Gables, Fla). Washington, D.C., Hemisphere Publishing Corp., 1981. 517 p. Price of nine volumes, $595

Consideration is given to such topics as coal gasification and liquefaction, the combustion of alcohol fuels, hydrocarbon upgrading and combustion technology, novel engines using hydrocarbon fuel, and hydrocarbons economics and planning. Particular papers are presented on the role of high-Btu coal gasification technology, ethanol from municipal cellulosic wastes, the fluidized bed combustion of coal, the behavior of gas distribution equipment in hydrogen service, and the economics of advanced technologies for electricity generation from coal B J

A81-25110 **In situ and modified in situ recovery of fossil fuels.** D W Stout (Energy Production Systems Corp, North Palm Beach, Fla.). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 7. Washington, D C, Hemisphere Publishing Corp, 1981, p. 2713-2715

An analysis is made of improvements in laser devices and digital signal processing whose application to in situ drilling of fossil fuel deposits may yield higher resource-recovery rates Significant differences are seen in the operational characteristics of low- and high-power lasers, and in laser wavelength interactions with small and large particles. O.C

A81-25111 **Pricetown I - In-situ coal conversion field test for bituminous coals.** R E. Zielinski, P W Seabaugh, A. K Agarwal, R J. Larson (Monsanto Research Corp, Miamisburg, Ohio), A. J. Liberatore, J. W Martin, and J D McClung (U S. Department of Energy, Morgantown Energy Technology Center, Morgantown, W Va). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 7. Washington, D.C., Hemisphere Publishing Corp., 1981, p 2717-2748. Contract No. DE-AC04-76DP-00053

The effectiveness of the in situ, underground Linked Vertical Well method of bituminous coal gasification was investigated by a field test in West Virginia The test, involving air injection and reverse combustion linkage, was continuously monitored in real time by a minicomputer system The high methane content of the evolved gas is attributed to the thermal- and hydro-cracking of tars and oils along with hydropyrolysis and hydrogasification of coal char O.C

A81-25112 **The role of high-Btu coal gasification technology.** M. I German (American Gas Association, Arlington, Va) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7. Washington, D.C., Hemisphere Publishing Corp, 1981, p. 2749-2762

An analysis is given of the role and economic potential of Lurgi-technology gasification of coal to the year 2000, in relation to other gas-supply options, the further development of gasifier designs, and probable environmental impact It is predicted that coal gasification may reach 10% of total gas supplies by the year 2000, with Eastern U.S. coal use reaching commercially significant use in the 1990's It is concluded that coal gasification is the cleanest way of using coal, with minimal physical, chemical, biological and socioeconomic impacts. O.C.

A81-25113 **Low-Btu coal char gasification by a pressurized two-stage fluidized bed - Sunshine project.** J Kawabata, M. Yumiyama, Y Tazaki, S Honma, S Takeda, K. Kitano, H Yamaguchi (Government Industrial Development Laboratory, Sapporo, Japan), T Chiba (Hokkaido University, Sapporo, Japan), and K Yoshida (Tokyo, University, Tokyo, Japan) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp., 1981, p 2763-2768

A81-25114 **Catalytic hydrogenation of Turkish lignites to oxygen free oil and gas.** Y Yorulmaz (Middle East Technical University, Ankara, Turkey) and A H. Weiss (Worcester Polytechnic Institute, Worcester, Mass) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp, 1981, p. 2769-2778. 8 refs. Research supported by the Turkish Coal Corp.

A81-25115 **Fluid bed hydrogenation of agglomerating bituminous coals.** B. Liss (City College, New York, N Y) and C. Welter (Union Carbide Corp, South Charleston, W.Va.) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 7. Washington, D.C., Hemisphere Publishing Corp., 1981, p 2779-2795 7 refs

A technique was developed and demonstrated at Union Carbide Corporation in 1977 for the processing of raw caking coals in a fluidized bed without preprocessing, and under severe conditions of high hydrogen partial pressure and low injection-gas/coal ratio Fluid bed operating limits were explored by sequential dynamic testing of the key operating variables, and it was determined that the energy required to sustain fluid bed operation is less than 1%. The process represents an economically viable and technically feasible approach to processing agglomerating coals such as Illinois No. 6 and Pittsburgh No. 8. O.C.

A81-25116 **The conversion of peat - Recent developments in simultaneous dewatering and hydrogenolysis.** E. Chornet, R Fonseca, and R P. Brown (Sherbrooke, Université, Sherbrooke, Quebec, Canada) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 7 Washington, D.C., Hemisphere Publishing Corp., 1981, p. 2797-2807. 16 refs

The paper presents the work done on laboratory level to convert peat into a bitumen-like material. It discusses the main aspects of the work accomplished including the study on the reactivity of the organic material in peat as related to hydrogenolysis, and a direct conversion of peat in its natural state using carbon monoxide and steam. The results of the experiments indicate that the conversion of peat into a bitumen-like material is possible in the presence of water 350 C is the most convenient operating temperature The significance of carbon dioxide consumption is also realized and various methods to reduce it are reviewed. (Author)

A81-25117 **The development of biogas technology in India.** C Chiranjivi, A Raviprasad, and K. V. Rao (Andhra University, Visakhapatnam, India) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7. Washington, D C., Hemisphere Publishing Corp, 1981, p 2809-2821 9 refs.

Biogas from organic wastes is a potential renewable energy to meet the domestic energy needs in India The fundamentals of bio-gasification by anaerobic digestion are presented The production of biogas from cattle manure in small anaerobic digesters is discussed, illustrated by a popular digester model The need for the development of community digesters for the needs of a village and its implications are mentioned The research work on biogasification at Andhra University is summarized A T

A81-25118 **Gasification of biomass as a source of synfuels for developing countries.** J R Moreira and M J Antal, Jr (Princeton University, Princeton, N J) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp, 1981, p 2823-2833 23 refs

The economic viability of forest biomass gasification in furnishing feedstocks for synfuels production in Brazil is argued, on grounds of high net energy yield (due to minimal use of mechanization in the cultivation of timber such as Eucalyptus) and the high efficiency of acid hydrolysis and fast pyrolysis methods already being used A thermochemical process still under development promises still higher efficiency and greater economy than coal gasification and coal-fired electrical generation Assuming a feedback cost of $1 00 per million Btu, a minimum gasoline precursor cost would be $0 35 a gallon

O C

A81-25120 **Production of liquid fuels with a high-temperature gas-cooled reactor.** R N Quade, D L Vrable, and L Green, Jr (General Atomic Co, San Diego, Calif) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp, 1981, p 2847-2858 9 refs Contract No DE-AT03-76SF-71061

An exploration is made of the technical, economic and environmental impact feasibility of integrating coal liquefaction methods directly and indirectly with a nuclear reactor source of process heat, with stress on the production of synthetic jet fuel

Production figures and operating costs are compared for indirect conventional and nuclear processes using Lurgi-Fischer-Tropsch technology with direct conventional and nuclear techniques employing the advanced SRC-II technology, and it is concluded that significant advantages in coal savings and environmental impact can be expected from nuclear reactor integration O.C

A81-25121 **Future of alcohol fuels programs in Brasil.** A. V Carvalho, Jr, E. Rechtschaffen, and L Goldstein, Jr. (Centro de Technologia Promon, Rio de Janeiro, Brazil). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7. Washington, D C, Hemisphere Publishing Corp, 1981, p. 2867-2877. 8 refs.

An updating is given of the Brazilian National Alcohol Program's production and utilization achievements to date in the substitution of ethanol and methanol for imported oil products A series of Eucalyptus forestry and processing-industry projections are made for fuel output and jobs creation that may be expected by the year 2000 With few exceptions, methanol produced from wood grown on poorer soils than can now be used for sugarcane substitute for oil products and result in jobs creation several orders of magnitude higher than petroleum fuels O C.

A81-25122 **Alcohols as auxiliary fuels for diesel engines.** B H Rao (Banaras Hindu University, Varanasi, India). In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 7 Washington, D C, Hemisphere Publishing Corp., 1981, p 2879-2885

A81-25124 **Ethanol from municipal cellulosic wastes.** A J. Parker, Jr., T. J Timbario (Mueller Associates, Inc., Baltimore, Md.), and J A. Mulloney, Jr. (American Solarhol Corp., Baltimore, Md.). In. Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 7 Washington, D.C., Hemisphere Publishing Corp, 1981, p. 2909-2922 18 refs

This paper addresses the use of municipal cellulosic wastes as a feedstock for producing ethanol fuels, and describes the application of enzymatic hydrolysis technology for their production. The concept incorporates recent process technology developments within the framework of an existing industry familiar with large-scale ethanol fermentation (the brewing industry). Preliminary indications are that the cost of producing ethanol via enzymatic hydrolysis in an existing plant with minimal facility modifications (low capital investment) can be significantly less than that of ethanol from grain fermentation (Author)

A81-25125 **An update in the 'development of alternate liquid fuels'.** M J Rose (Brookhaven National Laboratory, Upton, N Y). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 7 Washington, D.C, Hemisphere Publishing Corp, 1981, p 2923-2928

The Brookhaven National Laboratory has formulated a series of Alternate Liquid Fuels (AIF), compounded from combustible fluids such as alcohols, mineral oils and solvents, found in the waste streams of the cosmetic, petrochemical, electronics and other industries These fuels are now being processed by a pilot plant with a productive capacity of 40,000 gallons in 8 hours, at direct costs ranging from $0 26 to $0 29 a gallon depending on selected feedstocks and blend ratios O.C.

A81-25126 **Coal conservation and stabilization during storage** M O Kestner and A A. Kober (Apollo Technologies, Inc., Whippany, N.J) In Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp., 1981, p. 2943-2948.

A survey is made of current coal-stockpiling methods intended to prevent atmospheric oxidation, spalling and fracturing, and acid runoff on exposure to rain Data obtained from accelerated oxidative tests demonstrate that a novel method, the chemical pretreatment of coal (with a proprietary formulation) effectively prevents Btu losses, minimizes changes in free-swelling indices, and decreases acid runoff Comparative photographic records of spalling and fracturing demonstrate the extent of morphological changes in treated and untreated coals. O C

A81-25127 **Advanced synfuels production/power systems utilizing laser particulate control** T. E Botts, J R Powell, and J A Fillo (Brookhaven National Laboratory, Upton, N Y) In Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C., Hemisphere Publishing Corp, 1981, p. 2949-2953 8 refs

Consideration is given to the use of laser-induced fragmentation of entrained particulates, in the combustion-product stream of a direct coal-fired gas turbine's pressurized cyclone combustor, to sizes below 3 microns. This apparatus represents a combined-cycle system ideal for high-temperature water-electrolysis synfuels production, using heat extraction in the combustion chamber's radiant zone as well as electrical generation. O C

A81-25128 **Bed expansion and attrition studies in a coal-fired fluidized bed.** G Miller, V. Zakkay, A Kolar, J Franceschi, and W. Skelley (New York University, New York, N Y) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7. Washington D C, Hemisphere Publishing Corp., 1981, p. 2955-2968 19 refs Contract No EF-76-C-01-2256.

A81-25129 **Combustion of coal suspension fuels using air atomizers.** S. C. Kranc (South Florida, University, Tampa, Fla) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp., 1981, p. 2969-2982 18 refs

Experiments have been conducted to examine the use of air atomizers in conjunction with coal-liquid fuel mixtures These fuels were formed by suspending pulverized coals in various liquid fuels such as Diesel and methanol The fuels were burned in an atmospheric pressure water jacketed flame tube with a disk baffle flame stabilizer. A parametrical study of atomizer performance was made. Mass fractions as high as 40 percent have been tested Thermal outputs obtained with coal in suspension are discussed in comparison with results for the pure liquid fuels (Author)

A81-25130 **Fluidized bed combustion of coal** J Tatebayashi, Y Okada, K. Yano, T Takada, and K Handa (Kawasaki Heavy Industries, Ltd, Osaka, Japan) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D.C., Hemisphere Publishing Corp, 1981, p 2983-2997 Research supported by the Ministry of International Trade and Industry.

The effect of various parameters on combustion efficiency, desulfurization efficiency and NO emission in fluidized bed combustion of coal were investigated by using two test combustors whose sectional areas were 200 mm and 500 mm square It has been revealed that by employing two-stage combustion and setting the primary air ratio, secondary air injection height and other parameters to optimum levels, NO emission can be greatly reduced while barely impairing combustion efficiency or desulfurization efficiency. Also, NO emission of less than 50 ppm and desulfurization efficiency of as high as 93% were achieved These results have ensured good prospects for the development of a coal combustion boiler system which can satisfy the strictest environmental protection regulations, without installing special desulfurization and de-NO(X) facilities (Author)

A81-25133 **Coal-oil mixtures - Their technical and commercial status** M A Viola and G D Botsaris (Tufts University, Medford, Mass) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp, 1981, p 3071 3077 22 refs

The commercial and technical status of coal-oil mixtures (COM) are discussed Although this technology is commercially available and economic incentives for its use exist, it is argued that optimization of fuel properties and the refinement of its production methods to prepare environmentally 'clean' COM will, along with the growing differential between coal and oil prices, increase its viability as an alternative fuel Some industrial corporations have to date demonstrated preparation facilities and potential applications O C

A81-25134 **The economics of advanced technologies for electricity generation from coal.** D F Hemming, R Johnston, and M Teper (International Energy Agency, London, England) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp, 1981, p 3079-3097 18 refs

The International Energy Agency's Coal Research Program is presented, along with a review of advances made to date in the development of coal-fueled electrical generation processes such as fluidized bed combustion, gasifier effluent liquid and pyrolysis The IEA is composed of countries such as the U S, the U K and West Germany, for which coal represents a major energy resource An assessment of the economic climate for coal technology development in the member countries is also made, stressing methods used in capital costs assessment, financing, and regulatory and tax policies O C

A81-25135 **Economics and concepts of industrial coal fluidized bed combustion in Brazil** M Saddy and J Szego (Centro de Tecnologia Promon, Rio de Janeiro, Brazil) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp, 1981, p 3177-3189 10 refs

A81-25136 **Economic aspects of coal gasification and liquefaction in Belgium** G Labeau and P Lermusieau (Mons, Faculté Polytechnique, Mons, Belgium) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10 13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp, 1981, p 3191-3198

A81-25162 **Trash to energy.** D J Damiano (Greeley and Hansen Consulting Engineers, Philadelphia, Pa). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 9 Washington, D C, Hemisphere Publishing Corp., 1981, p 3629-3636

The recovery of urban solid waste for conversion to energy is discussed for the example of Philadelphia The refuse-fired steam generating facility planned for the city is described, and the combination of a front-end separation plant with a semi-suspension fired boiler is surveyed The environmental, social and economic aspects of the question are reviewed. L.S.

A81-25163 **The Bridgeport resource recovery system.** J G. Lucchesi (Combustion Equipment Associates, Inc, New York, N Y) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 9 Washington, D C, Hemisphere Publishing Corp, 1981, p 3637-3643

A process used in Connecticut is described for converting municipal solid waste into a coal-like fuel The fuel is a high-quality, low-sulphur fuel with a higher heating value of 7800-8000 Btus per pound. The fuel's low moisture content permits indefinite storage, and its high bulk density ensures economical storage, handling and market distribution The fuel can be fired in conjunction with coal in existing coal burners without major modifications to the boilers, firing systems or pollution control systems L S

A81-25225 **Design and management for resource recovery. Volume 2 - High technology - A failure analysis.** B Harrison and P A Vesilind (Duke University, Durham, N C) Ann Arbor, Mich, Ann Arbor Science Publishers, Inc, 1980 107 p 100 refs $29.95

The book examines five projects for reclaiming materials and energy from solid waste with the aim of investigating their planning, design, and operation and of determining factors which result in failures or successful resource recovery The facilities discussed are the Nashville Thermal Transfer Corporation plant, the St. Louis Union Electric solid waste utilization system proposal, the Baltimore pyrolysis system, the Lowell incinerator residue project, and the San Diego flash pyrolysis system. It was shown that the major factors affecting the operation of a recovery system include area markets, initial funding, technical viability, waste flow control, alternate disposal possibilities, and time pressure A.T.

A81-25551 **Design and management for resource recovery Volume 1 - Energy from waste** Edited by T C Frankiewicz Ann Arbor, Mich, Ann Arbor Science Publishers, Inc, 1980 221 p $29 95

The compilation covers municipal waste as a resource and a pollutant, the Chicago Southwest supplemental fuel processing facility, methane production from the Mountain View landfill, Wisconsin Electric Co, characterization of Americology refuse-derived fuel, and the Ames resource recovery facility Powdered fuel from solid waste, the China lake trash to-gasoline process, Albany biomass-to-oil project, and conversion of cellulosic wastes to liquid fuels are also discussed A T

A81-25552 **The Chicago Southwest Supplemental Fuel Processing Facility** E F Nigro (Chicago, Dept of Streeets and Sanitation, Chicago, Ill) In Design and management for resource recovery Volume 1 Ann Arbor, Mich, Ann Arbor Science Publishers, Inc, 1980, p 11-19

Empirical solutions were developed to improve refuse-derived fuel (RDF) throughput and quality at the Chicago Southwest Supplementary Fuel Processing Facility The solutions included innovative process line balancing and modifications to unit processes Implementations through May 1979 are discussed along with contemplated improvements Also discussed are safety procedures and equipment such as explosion prevention practices and blast energy control This chapter concludes with insights into methodologies to reduce maintenance and repair costs developed for the Chicago Southwest Supplementary Fuel Processing Facility which may be applicable to other RDF plants (Author)

A81-25553 **Methane production from the Mountain View landfill** S C James and C W Rhyne (U S Environmental Protection Agency, Cincinnati, Ohio) In Design and management for resource recovery Volume 1 Ann Arbor, Mich, Ann Arbor Science Publishers, Inc, 1980, p 21-31 5 refs

The paper reviews the current status of the Mountain View gas recovery project designed to produce 0 003 to 0 44 cu m of raw landfill gas (44% methane) per kg of solid waste The heating value of raw landfill gas is approximately 16,800 kJ/cu m The discussion covers the installation of production wells, treatment plant construction and operation, and the results of test runs V L

A81-25554 **The Pompano Beach RefCOM facility** H R Geisser (L Robert Kimball and Associates, Ebensburg, Pa) In

Design and management for resource recovery Volume 1 Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 33-42

To date, the process concept of solid waste anaerobic digestion to produce methane gas has not received a fair test at the RefCOM facility in Pompano Beach, Fla This is largely due to operational difficulties in the feed processing and preparation system for the digesters These difficulties are reviewed along with the successful implementation of several problem solutions Additional process flow changes are also suggested to eliminate the remaining impediments to the continuous, design capacity operation of this facility (Author)

A81-25555 **Wisconsin Electric's characterization of Americology's refuse-derived fuel** R S Alberg (Wisconsin Electric Power Co , Milwaukee, Wis) In Design and management for resource recovery Volume 1 Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 43-52

The initial selections of important refuse-derived fuel (RDF) properties are reviewed A sampling method was developed to obtain a representative gross sample of RDF and the 'baling and coring' method for subsampling the gross sample is described Some specific studies have been performed to substantiate initial sampling assumptions In the absence of any standard analysis methods for this new fuel, analytical methods were developed Whenever possible these methods were adaptations of existing fuel analysis methods An evaluation of the present state-of the art of RDF characterization, as demonstrated by Wisconsin Electric's experience, highlights the successes of the program, but also notes the need for improved or additional characterization methods such as automatic sampling, 'effective' heating value, mass flow, density and slagging potential to evaluate better the proper use of RDF (Author)

A81-25556 **Eco-Fuel and the Bridgeport facility.** F Hasselriis (Combustion Engineering Associates, Inc , New York, N Y) In Design and management for resource recovery Volume 1 Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 53-63

The genesis of Eco-Fuel as an economical RDF alternative, and the planning and construction of the Bridgeport, CT, resource recovery facility is discussed The unit operations used to produce Eco Fuel are described Perspectives on the use of RDF for energy production are presented, and it is concluded that RDF will be a major source of fuel in the future (Author)

A81-25557 **The Niagara Falls resource recovery system** R P Krueger (Hooker Chemical Co , Houston, Tex) and C B Reale (Occidental Resource Recovery Systems, Inc , Irvine, Calif) In Design and management for resource recovery Volume 1 Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 65-82 18 refs

The project development technique which the Occidental Petroleum Corporation learned from its construction of an energy-from-waste facility at Niagara Falls is discussed The technique is considered to illustrate the success that can be achieved when a company needs fuel to stay in business, opts for waste as fuel, makes a strong corporate commitment, takes the initiative, and works patiently through the political, social, and financial complexities of long-term contracts and massive capital investment It is noted that the project development technique may be as important as the technology employed at the facility This technique is described, and a comparison of the significant characteristics of bark and municipal wastes is made In discussing the project development technique, attention is given to refuse supply, tipping fees and product revenues, taxes and utility status, project financing, and permits and public acceptance C R

A81-25558 **The Ames Resource Recovery facility.** A O Chantland (Ames, Dept of Public Works, Ames, Iowa) In Design and management for resource recovery Volume 1 Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 87-93

The diminishing availability of natural gas, the use of high-sulfur coal and the need to dispose of waste material prompted the City of Ames, IA, to build a facility to produce refuse-derived fuel (RDF) and to recover other valuable resources from the city's solid waste Recovery is through mechanical processes The fuel is used to fire two types of boilers as a supplement to coal in an electric generating plant Ferrous metals and miscellaneous materials are also recovered and marketed (Author)

A81-25559 **Technology for powdered fuel preparation from solid waste** N L Hecht, B L Fox, D S Duvall, and A A Ghazee (Dayton, University, Dayton, Ohio) In Design and management for resource recovery Volume 1 Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 97-112 Research supported by the U S Environmental Protection Agency

It is noted that while many of the systems developed by communities to recover valuable products, in particular, fuel, from municipal wastes have been relatively successful, the quality and consistency of the fuel obtained have not been completely satisfactory One technology considered to hold promise involves the production of powdered fuels from cellulose wastes A study of this technology undertaken by the University of Dayton is discussed Here, the powdered fuels are produced from cellulose by pyrolysis and embrittlement It is noted that the production of carbon char by low-temperature pyrolysis and the embrittlement of cellulose waste by chemical treatment is of particular interest The laboratory development of chemical treatments for powder fuel production forms the basis in the study for engineering and economic analysis for full-scale facilities C R

A81-25560 **Commercialization potential of the China Lake trash-to-gasoline process** J Diebold and G Smith (U S Naval Weapons Center, China Lake, Calif) In Design and management for resource recovery Volume 1 Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 113-139 39 refs Research supported by the U S Environmental Protection Agency

The China Lake trash-to-gasoline process involves a series of noncatalytic petrochemical processes to convert organic wastes to a synthetic hydrocarbon crude oil containing about 90% high-octane gasoline and 10% fuel and lubricating oils By-product char and gases would be consumed for process energy Key features of the process, the relative confidence of commercial scale up and the projected economics based on an independent third-party evaluation are discussed (Author)

A81-25561 **Municipal solid waste comminution by steam explosion.** J A Burke, Jr (Burke, Davoud and Associates, Richmond, Va) In Design and management for resource recovery Volume 1 Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 141 147 Research sponsored by the U S Department of Energy

Results of a program with pilot sized equipment are described A 200-psi steam discharge reduces paper and other organic materials to very small sizes The extent of reduction of metal and glass containers depends on pressure The advantages of explosive decompression are described Residual energy from the explosion is conserved and reused in downstream processes With steam, heat is retained for bioconversion With dry gases, momentum of discharging gas and refuse is used for separation of refuse-derived fuels (RDF) Discharges have low abrasion, hence, equipment is subject to low maintenance (Author)

A81-25562 **Albany biomass-to-oil project** S Ergun, L Schaleger, and M Seth (California, University, Berkeley, Calif) In Design and management for resource recovery Volume 1 Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 149-158

A process development unit constructed in Albany in 1976 is discussed, noting that this particular effort is being supplemented by research and engineering programs conducted elsewhere It is pointed out that the chemical and stoichiometric base of cost estimates is replete with inconsistencies and invalid assumptions After a careful evaluation of the results of recent research on wood liquefaction at Battelle Pacific Northwest Laboratories and Lawrence Berkeley Laboratory and a comparison of these results with those reported by the Bureau of Mines, the following chemical bases are presented (1) liquefaction produces 46 4 ton oil/80 ton dry wood, a conversion efficiency of 58%, the necessary carbon monoxide and heat for treating 80 tons of dry wood will be obtained by gasifying 20 tons of dry wood, and the oil produced will have a heating value of about 31,300 J/g The gross thermal efficiency from these bases is put at 78%, a figure that does not include electricity Using Lawrence Berkeley Laboratory's chemical bases and process costs provided by Bechtel, the break-even cost of oil is shown to be about $26/bbl C R

A81-25563 **Conversion of organic wastes to oil by reductive formylation** G R Youngquist, R Partch (Clarkson College of Technology, Potsdam, N Y), and L G Donaruma (New Mexico Institute of Mining and Technology, Socorro, N Mex) In Design and management for resource recovery Volume 1

Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 159-180 7 refs Research supported by the Eastman Kodak Co

Conversion of various solid organic wastes to oil by reduction using formic acid species has been studied using laboratory-scale batch and continuous reactors Data on the effect of operating conditions on product yield and quality are presented for a variety of starting materials, including sewage and industrial waste treatment sludges Reaction mechanisms, based on model compound experiments are discussed Results for cracking of the product oils to lower-molecular weight hydrocarbons are also described (Author)

A81-25564 **Conversion of cellulosic wastes to liquid fuels** J L Kuester (Arizona State University, Tempe, Ariz) In Design and management for resource recovery Volume 1

Ann Arbor, Mich , Ann Arbor Science Publishers, Inc , 1980, p 181-195 5 refs Research supported by the Arizona Solar Energy Research Commission, Contract No EY-76-S-02-2982

Liquid fuels such as diesel, kerosene, jet fuel, and high-octane fractions are processed from renewable biomass by direct liquefaction using thermal gasification and catalytic synthesis The process can use urban, agricultural, forest, and industrial feedstocks producing 50-100 gallons of liquid fuel/ton of dry, ash free feedstock/day It is proposed to evaluate alternative feedstocks and to optimize the gasification reaction, profitable operation of 270-900 metric ton/day will be developed using a 9 metric ton/day pilot plant A T

A81-26195 # **Thermodynamic and thermophysical properties of combustion products Volume 10 - Fuels that are in current use, in the research stage, and considered a possibility. Part 2 - Multicomponent fuel compositions /Handbook/ (Termodinamicheskie i teplofizicheskie svoistva produktov sgoraniia Volume 10 - Primeniaemye, issleduemye i vozmozhnye topliva Part 2 - Mnogokomponentnye toplivnye kompozitsii /Spravochnik/).** V E Alemasov, A F Dregalin, A P Tishin, V A Khudiakov, and V N Kostin Moscow, Izdatel'stvo VINITI, 1980 395 p In Russian

A81-26474 # **An investigation on Tehran municipal solid waste with the view of electricity generation** H Chokouhmand, Z Nejat, J Shayegan (Teheran, University, Teheran, Iran), M S Massoudi, and A Ostadhosseini (Arya Mehr University of Technology, Teheran, Iran) *Regional Journal of Energy, Heat and Mass Transfer*, vol 2, Oct 1980, p 235-241 6 refs

An investigation of the physical and chemical composition of Teheran municipal waste is presented with consideration given to the incineration method of electrical conversion Daily tonnages varied from 1600 to 3000 tons during 1977 with a composition consisting primarily of foodstuffs and paper A total of 28,000 kWh could be generated daily from 2400 tons of waste with a 59% moisture content and an average calorific value of 1100 kCal/kg The lack of incinerator technology in Iran coupled with the high level of pollutants found in Teheran's air render the incineration method of electrical conversion impractical at present L S

A81-26477 **Coal conversion /combustion and gasification/** J A Gray and F Starr (British Gas Corp , London, England) In Behaviour of high temperature alloys in aggressive environments Proceedings of the Petten International Conference, Petten, Netherlands, October 15-18, 1979 London, Metals Society, 1980, p 3 24, Discussion, p 25 27 41 refs

The paper deals with some of the high-temperature metallurgical aspects of coal conversion and utilization processes including those that burn coal and those that gasify coal by a variety of processes The similarities and differences in process environment and in material requirements of several types of combustion and gasification systems are illustrated by thermochemical stability diagrams It is shown that conditions in all the proposed conversion systems will be so aggressive that the conventional high-temperature alloys may prove inadequate and it may be desirable to change to alloys and coatings based on new compositions V L

A81-26491 **Corrosion of alloys at high temperature in coal gasification environments** D M Lloyd and M J Cooke (Coal Research Establishment, Cheltenham, Glos , England) In Behaviour of high temperature alloys in aggressive environments, Proceedings of the Petten International Conference, Petten, Netherlands, October 15-18, 1979 London, Metals Society, 1980, p 799-812 8 refs

In order to select alloys for coal gasification applications, specimens of 19 different superalloys were tested at 850 C for 250 hr in the freeboard of a 0 3 m diameter atmospheric pressure fluidized bed gasifier The ferritic base alloys MA 956 E and Fecralloy offered the best resistance to corrosion V L

A81-26492 **The performance of MCrAl alloys in complex coal conversion atmospheres** C M Packer and R A Perkins (Lockheed Research Laboratories, Palo Alto, Calif) In Behaviour of high temperature alloys in aggressive environments, Proceedings of the Petten International Conference, Petten, Netherlands, October 15-18, 1979 London, Metals Society, 1980, p 813-828 22 refs

The paper reviews the potential corrosion resistance of alumina-forming MCrAl alloys in complex coal gasification atmospheres Specifically, the performance of these alloys during exposures to complex oxidizing/sulfidizing atmospheres is summarized Attention is focused on a correlation of sulfidation resistance with composition and microstructure and how these factors affect the applicability of these materials for use in coal conversion systems In particular, conclusions are discussed as to the influence of the M element and the aluminum content on the nature and effectiveness of the protective alumina scale that forms during service In addition, the compositional and structural stability of the alloys at high temperatures is reviewed The potential applications of these materials are described in terms of their use as protective claddings or coatings for structural materials (Author)

A81-26895 **Elements of the geological structure of the western Siberian plate on the basis of the interpretation of small-scale space images, with reference to the evaluation of petroleum and natural-gas content (Elementy geologicheskogo stroeniia zapadno-Sibirskoi plity po dannym deshifrirovaniia melko masshtabnykh kosmicheskikh snimkov v sviazi s otsenkoi neftegazonosnosti).** V V Borovskii, A L Klopov, L L Podsosova, and I D Peskovskii (Zapadno-Sibirskii Nauchno Issledovatel'skii Geologorazvedochnyi Neftianoi Institut, Tyumen, USSR) *Issledovanie Zemli iz Kosmosa*, Nov -Dec 1980, p 80 86 6 refs In Russian

Ring structures and fracture systems in the western Siberian plate were identified on small-scale space imagery The complex interpretation of geological and geophysical data indicates that the ring structures are related to the geological structure of deep parts of the crust and of the pre-Jurassic basement Certain methodological problems associated with the use of magnetic and gravitational data in the present study are discussed P T H

A81-26928 **Use of weighted brines in recovery of geothermal energy from hot, dry rock.** L R Kern *Geothermal Energy,* vol 8, Feb. 1980, p. 12-24, 29-35. 14 refs

Two processes for recovering geothermal energy from hot dry rock of low permeability are studied The processes are based on connecting two or three wells with a hydraulically created fracture and circulating a weighted brine solution through the connected system to recover heat from the rock to power an electric generating plant. Data obtained in field experiments in hot rock near Los Alamos, N.M , are used to perform economic assessments of the processes The results indicate that a price of 6 to 8 cents per kWh is economical for the two-well process and a price of 2 to 3 cents is economical for the three-well process F G M

A81-27539 # **Solid-fuel combustion in fluidized beds (Szhiganie tverdogo topliva v psevdoozhizhennom sloe)** V A Borodulia and L M Vinogradov Minsk, Izdatel'stvo Nauka i Tekhnika, 1980 192 p 330 refs In Russian

Fluidized bed combustion technology is discussed as a way to control emissions from power plants The experimental and theoretical literature on the combustion of solid fuels (particularly coal) in fluidized beds is reviewed, with emphasis on engineering and chemical aspects of fluidized bed technology The removal of sulfur dioxide and the control of nitrogen oxide emissions during the low-temperature fluidized bed combustion of solid fuels are considered as an example B J

A81-27572 **Alcohols as fuels - The global picture** R F Ward (United Nations, New York, N Y) *Solar Energy,* vol 26, no 2, 1981, p 169-173 25 refs

A number of countries have programs which encourage the production and use of ethanol and methanol to extend gasoline supplies These programs are often based on food crops which are subject to wide variations in both cost and availability Some of the programs are reviewed, and the costs of alcohols are compared to world market prices of gasoline (Author)

A81-28680 **Wave-energy extraction by a submerged cylindrical resonant duct** M J Simon (Cambridge University, Cambridge, England) *Journal of Fluid Mechanics,* vol 104, Mar 1981, p 159-187 16 refs Research supported by the Science Research Council

A cylindrical duct absorbing energy from incident surface waves is considered The asymptotic properties of the scattering and radiation potentials are determined, to yield the hydrodynamic quantities on which the energy absorption characteristics of the duct can be shown to depend It is shown that it is possible to tune the resonant response of the duct to absorb the maximum theoretical energy at a given frequency. Curves are presented showing the variation of energy absorption and the amplitude of the duct response with frequency for various depths of submergence and various tuning frequencies. (Author)

A81-28690 **Head-sea diffraction by a slender raft with application to wave-power absorption.** P Haren and C C Mei (MIT, Cambridge, Mass.) *Journal of Fluid Mechanics,* vol. 104, Mar 1981, p 505-526 24 refs Contract No DE-AC02-79ET-21062. NR Project 062-228

The parabolic approximation which has recently been found to be useful in other physical contexts, is extended to head-sea diffraction of short waves by a slender raft on deep water In particular, it is a much more direct way of getting the inner approximation of the outer solution in a scheme of matched asymptotics than the original method of Faltinsen (1971). The present results are compared with a more involved integral equation method and are found to be remarkably accurate even when the raft length is comparable to the wavelength Finally, the asymptotic method is modified for a compliant raft which absorbs wave power by suitably controlled impedance Optimum efficiency and other performance characteristics are predicted (Author)

A81-28992 **Royal Society, Discussion on New Coal Chemistry, London, England, May 21, 22, 1980, Proceedings** *Royal Society (London), Philosophical Transactions, Series A,* vol 300, no. 1453, Mar 20, 1981 221 p

A discussion of new coal chemistry is presented The chemical and physical structure of coal is examined in the first section, including structural studies of coal extracts, metal and metal complexes in coal and coal microporosity The second section presents new advances in applied coal technology. The development of liquid fuels and chemicals from coal is given especial emphasis, with papers on the Sasol Synthol process, the Shell-Koppers gasification process, liquefaction and gasification in Germany, the Solvent Refined Coal process, the Exxon Donor Solvent liquefaction process and the Mobil Methanol-to-Gasoline process Finally, some developments that will be part of the future of coal chemistry in the year 2000 are examined in the third section, including coal-based chemical complexes and the use of coal as an alternative source to oil for chemical feedstocks. D.K

A81-28994 **Motor fuels and chemicals from coal via the Sasol Synthol route.** J C Hoogendoorn (Sasol, Ltd , Sasolburg, Republic of South Africa) *(Royal Society, Discussion on New Coal Chemistry, London, England, May 21, 22, 1980) Royal Society (London), Philosophical Transactions, Series A,* vol 300, no 1453, Mar 20, 1981, p 99-108, Discussion, p 108, 109

The production of synthetic motor fuels and chemicals from coal by the Sasol procedures is discussed This process is based on the Fischer-Tropsch reaction by passing hydrogen and carbon monoxide in a specific ratio over iron catalysts at elevated temperatures and pressures Two parallel reactor systems are discussed The smaller system employs fixed-bed reactors, using a precipitated iron catalyst and produces predominantly heavy hydrocarbons of an aliphatic nature with carbon chains up to 100 These straight-chain hydrocarbons yield excellent waxes and high quality diesel oil The larger system uses a powdered iron catalyst in a circulating fluid-bed reactor, a concept developed from American catalytic cracker technology This system has the advantage of high production capacity and scale-up potential, and produces light olefins which can be used either as petrochemical feedstock or refined and added to the motor fuel pool, and ethylene which is augmented by ethane cracking Analysis of product selectivities and values shows that co-production of chemicals and motor fuels from coal is profitable and efficient D K.

A81-28995 **Development of the Shell-Koppers coal gasification process** E V Vogt and M J van der Burgt (Shell Internationale Petroleum Maatschappij, The Hague, Netherlands) *(Royal Society, Discussion on New Coal Chemistry, London, England, May 21, 22, 1980) Royal Society (London), Philosophical Transactions, Series A,* vol 300, no 1453, Mar 20, 1981, p 111-120

The Shell-Koppers process for the gasification of coal under pressure is based on the principles of entrained-bed technology It is characterized by practically complete gasification of virtually all solid fuels, production of a clean gas without by-products, high throughput, high thermal efficiency, efficient heat recovery, and environmental acceptability The gas produced is 93 to 98 vol % hydrogen and carbon monoxide and is suitable for the manufacture of hydrogen or reducing gas, and, with further processing, substitute natural gas It can also be used for the synthesis of ammonia, methanol, and liquid hydrocarbons. The process can be applied as an integral part of a combined-cycle power station featuring both gas and steam turbines, which will yield electricity generation at 42 to 45% efficiency for a wide range of feed coals A 150 t/day gasifier has been put into operation successfully at Harburg, Germany, achieving a conversion of 99% for hard coal, and units of a capacity up to 2500 t/day are planned for the end of the 1980s D K

A81-28996 **Development of liquefaction and gasification in the Federal Republic of Germany** G Kolling (Bergbau-Forschung GmbH, Essen, West Germany) *(Royal Society, Discussion on New Coal Chemistry, London, England, May 21, 22, 1980) Royal Society (London), Philosophical Transactions, Series A,* vol 300, no 1453, Mar. 20, 1981, p 121-128

In the past, a variety of processes for liquefaction and gasification of coal were used on a large industrial scale in Germany. Later, as these processes became uneconomic, the plants had to be closed. But now it is again necessary to look for new sources of oil and gas, especially coal Therefore, the Federal Republic of Germany, with many other countries, is further developing known coal conversion technologies Several experimental plants for liquefaction as well as for gasification of coal are in operation, and larger plants are under construction The German federal government now intends to sponsor construction of large-scale commercial plants The state of development of all these technologies is discussed (Author)

A81-28997 **The SRC-II process.** B K Schmid and D M Jackson (Pittsburg and Midway Coal Mining Co , Englewood, Colo) *(Royal Society, Discussion on New Coal Chemistry, London, England, May 21, 22, 1980) Royal Society (London), Philosophical Transactions, Series A,* vol. 300, no 1453, Mar 20, 1981, p. 129-138, Discussion, p 138, 139 6 refs

The Solvent Refined Coal (SRC-II) process which produces low-sulfur distillate fuel oil from coal is discussed The process dissolves coal in a process-derived solvent at elevated temperature and pressure in the presence of hydrogen, separates the undissolved mineral residue, then recovers the original solvent by vacuum distillation The distillate fuel oil produced is for use largely as a nonpolluting fuel for generating electrical power and steam and is expected to be competitive with petroleum fuels during the 1980s. During this period, the SRC-II fuel oil is expected to be attractive compared with combustion of coal with flue gas desulfurization in U S East Coast oil-burning power plants, as well as in small and medium-sized industrial boilers The substantial quantities of methane, light hydrocarbons and naphtha produced by the process have value as feedstocks for preparation of pipeline gas, ethylene and high-octane unleaded gasoline, and can replace petroleum fractions in many applications The liquid and gas products from a future large-scale plant, such as the 6000 t/day plant planned for Morgantown, West Virginia, are expected to have an overall selling price of $4 25 to $4 75/GJ D K

A81-28998 **Exxon donor solvent liquefaction process.** R C Neavel (Exxon Research and Engineering Co , Baytown, Tex) *(Royal Society, Discussion on New Coal Chemistry, London, England, May 21, 22, 1980) Royal Society (London), Philosophical Transactions, Series A,* vol 300, no 1453, Mar 20, 1981, p 141-156, Discussion, p 156 11 refs Research supported by the U S Department of Energy, Electric Power Research Institute, Japan Coal Liquefaction Co., Phillips Petroleum Co , Atlantic Richfield Co , Ruhrkohle AG, and Exxon Corp

The Exxon donor solvent (EDS) coal liquefaction system is a direct liquefaction procedure Coal is chemically reacted and dissolved in a recycle solvent that is hydrogenated between passes to the liquefaction reactor More than 2 6 barrels of a synthetic crude boiling below 1000 F are produced per ton of dry, high volatile coal feed Other ranks of coal can be effectively liquefied The process development has proceeded to a 250 ton/day pilot plant stage that went into operation in June 1980 The presentation addresses the chemical reactions and process conditions that result in ease of operability and flexibility of the EDS process (Author)

A81-28999 **A new route to liquid fuels from coal.** S L Meisel (Mobil Research and Development Corp , New York, N Y) *(Royal Society, Discussion on New Coal Chemistry, London, England, May 21, 22, 1980) Royal Society (London), Philosophical Transactions, Series A,* vol 300, no 1453, Mar 20, 1981, p 157-167, Discussion, p 167-169 25 refs

The Mobil Methanol-to Gasoline (MTG) process is discussed that efficiently converts crude methanol to high-quality ,gasoline by means of a new zeolite catalyst, ZSM-5 This conversion requires a gradual rearrangement of the carbon and hydrogen atoms and the addition of hydrogen to put together the desired molecules The MTG process has been successfully demonstrated in a fixed-bed and a fluid-bed 4 barrels/day pilot unit operating under commercial conditions A fixed-bed version that will produce 13,000 barrels of gasoline a day will be a key unit in a New Zealand complex, and a fluid-bed version will be tested in a 100 barrels per day German pilot plant Modifications of the catalyst may enable it to construct basic chemical components such as light olefins, including ethylene, or BTX aromatics (benzene, toluene and xylenes) as the major product Process and catalyst modifications can yield as much as 70% light olefin products from methanol D K

A81-29267 **Combined aquatic-terrestrial biomass systems.** J R Benemann (Ecoenergetics, Inc., Vacaville, Calif) *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif , Nov 25-29, 1979) AIChE Symposium Series,* vol 76, no 198, 1980, p 144-150 20 refs

A combined aquatic agriculture and terrestrial biomass system is described which combines wastewater treatment and fuel production functions and incorporates storage for good year-round performance Considerable advantage is seen in the subsidization of the cost of fuel derived from the aquatic and terrestrial crops by the low cost of waste water treatment of such an integrated system It is concluded that although the net energy output of such systems would be below 1% of U S per capita energy consumption, they could make a significant contribution to local energy systems where yearly insolation and available land and water resources favor them O C

A81-29682 **Synfuels from coal** R A Passman (U.S Department of Energy, Office of Coal Supply Assurance and Commercial Applications, Washington, D C). In Synfuels industry opportunities, Proceedings of the Seminar, Washington, D C , November 6, 7, 1980 Seminar sponsored by the Government Institutes Washington, D C , Government Institutes, Inc , 1981, p 134-146.

Activities in the field of coal synthetics are reviewed with reference to the Federal feasibility and cooperative agreements and private sector response Commercialization of synfuels from coal and projects based on technical processes that are considered ready for commercial introduction are discussed Consideration is also given to economic, institutional, sociopolitical, and environmental issues V.L.

A81-29692 **Coal liquefaction The chemistry and technology of thermal processes.** D D Whitehurst, T O Mitchell, and M Farcasiu (Mobil Research and Development Corp , Central Research Div , Princeton, N J) New York, Academic Press, Inc , 1980 390 p 241 refs $19 50

The book treats the conversion of coal into liquids in terms of the structural and functional differences between the coal and the desired products, with particular emphasis on thermal processes for coal liquefaction The chemical and structural composition of coal and the liquids to be derived from coal are reviewed, and the significance of the physical properties and rank of coal relative to its conversion are discussed Attention is then given to the catalytic effects of minerals, and the effects of process variables including time, temperature and hydrogen gas pressure, side reactions such as char formation, and solvent composition on liquefaction behavior Finally, the intrinsic limitations of present-day processes are pointed out, and suggestions are presented for further improvements in coal liquefaction technology A L W

A81-29994 # **A UK view on future fuels.** A B Wassell (Rolls Royce, Ltd , Derby, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston,* *Tex., Mar 9-12, 1981, Paper 81-GT-87* 6 p 9 refs Members, $2 00, nonmembers, $4 00

Preliminary determinations concerning the impact of deteriorating gas turbine fuel specifications are reported, with stress on the replacing of kerosene by diesel fuel Although trends agreeing with previously published data for gaseous and black smoke emissions have been established, rig data at pressures greater than 20 bars from a tubular combustor suggest that increases in combustor liner temperatures may not have as great an impact on service life as has been supposed General consideration is also given the production of 'white smoke' at sub-idle conditions and the impact of reduced thermal stability O C

A81-30110 # **Methanol - The efficient conversion of value-less fuels into a versatile fuel and chemical feedstock.** D F Othmer (New York, Polytechnic Institute, Brooklyn, N Y) *American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, Houston, Tex , Jan 18-22, 1981, Paper 81-PID-1.* 7 p Members, $2 00; nonmembers, $4.00

The production of fuel-grade methanol and methyl chemicals is discussed with attention to production costs Natural gas and low grade solid fuels such as peat, lignite, and sub-bituminous coal combined with water or ash can be converted to methanol with a thermal efficiency of 60 to 65% Methanol can be used as a fuel for transportation engines and in electric power generation. The advantages of methanol use, such as ease and safety of transportation, are considered The projected cost is 17 to 34 cents per gallon, or $2 50 to $5.00 per million Btu L S

A81-30116 # **Engine fuels from biomass.** H W Parker (Engineering Societies Commission of Energy, Inc , Washington, D C.) *American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, Houston, Tex , Jan 18-22, 1981, Paper 81-DGP-4* 12 p 36 refs Members, $2 00, nonmembers, $4 00

Sources of biomass fuels for engines are compared to other synfuels Biomass can be converted to gaseous and liquid engine fuels by the same processes utilized for coal conversion such as gasification, direct liquefaction, and indirect liquefaction Alternatively, biomass can be converted into liquid fuels by fermentation to methane or ethanol The quantities of biomass derived engine fuels potentially available in the next decade are relatively small, and the anticipated costs are significantly greater than for liquid engine fuels made from coal or oil shale (Author)

N81-16315# Oak Ridge National Lab , Tenn Environmental Sciences Div
ENVIRONMETRICS OF SYNFUELS. II: A COMPUTER-BASED CODING SCHEME FOR COAL-CONVERSION RESEARCH DATA
R H Strand, M P Farrell, T K Birchfield, C W Gudmundson, M E Vansuch, and H N Polovino 1980 15 p refs
(Contract W-7405-eng-26)
(CONF-8010106-3, Publ-1602) Avail NTIS HC A02/MF A01

The need to reduce the complexity of data encoding and error rates in studies using multiple data bases composed of hierarchical file structures is discussed A coding scheme to represent long alphanumeric values is described The efficiency of such a scheme is indicated and error-rate reduction is discussed Several approaches are available that minimize coding errors Numeric codes with embedded information allocated to positions within the value codes are widely used, but these are unacceptable for variables with many values or levels of classification Such numeric smart codes require the full knowledge of the universe the variables describe, as well as the potential classification schemes for each variable Codes without embedded information (nonsense codes) circumvent the problems associated with smart codes With nonsense codes, alphanumeric variable values are assigned a sequential numeric code as new values are encountered in the data base, irrespective of their value in the alphanumeric sequence S F

N81-16317# Argonne National Lab , Ill Chemical Engineering Div
SAMPLING AND INSTRUMENTATION FOR FLUIDIZED-BED COMBUSTION Annual Report, Oct. 1978 - Sep. 1979
Irving Johnson, W F Posolski, K M Myles, K E Griggs (Fluor Power Services, Chicago), A A Siczek, W W Managan, R W Doering, J J Eichholz, N M Fallon, and C L Herzenberg Sep 1980 109 p refs
(Contract W-31-109-eng-38)
(ANL/CEN/FE-80-2) Avail NTIS HC A06/MF A01

Background information is presented on process control, scientific investigation, and safety, in planned and operating fluidized bed combustion systems Two prototype mass flow rate instruments installed on the solids feed lines of an existing ANL fluidized bed combustor are described Each instrument consisted of a capacitive sensor spoolpiece and an associated preamplifier and signal conditioning One channel of each instrument provides three outputs One delivers a density signal while two others deliver two signals for measuring velocity by cross correlation Operation was verified by using laboratory signal analyzers to process the signals Analytical techniques suitable for monitoring the concentration of gaseous alkali compounds in the hot gas stream from a fluidized bed combustor are described T M

N81-16318# Gulf Research and Development Co , Pittsburgh, Pa
INVESTIGATION OF MECHANISM OF HYDROGEN TRANSFER IN COAL HYDROGENATION Quarterly Progress Report, Jun. - Aug. 1980
D C Cronauer, R G Ruberto, R I McNeil, and D C Young Sep 1980 25 p refs
(Contract DE-AC22-80PC-30080)
(DOE/PC-30080-T2) Avail NTIS HC A02/MF A01

Transfer experiments using bituminous coal and deuterium labeled tetralin and described The rate of coal conversion, hydrogen transfer and site of hydrogen transfer were measured Results showed that about 3 5 g of hydrogen is transferred per 1000 g MAF coal at reactor conditions of 450 C, 30 minute and 30% feed coal in tetralin At these conditions, about 73% conversion of coal to toluene solubles was achieved Results at lower times (0 and 10 minutes) and temperatures (300, 350, and 400 C) are also discussed An evaluation of the techniques of measure hydrogen donor capacity indicated that the best instrumental approach available to us is that in which NMR is used to quantify the level of hydroaromatics Both GC/MS and group type MS techniques do not appear to be adequate for this purpose T M

N81-16322# Oak Ridge National Lab , Tenn Chemical Technology Div
RESOURCE RECOVERY FROM COAL RESIDUES
G Jones, Jr 1980 12 p refs Presented at 73rd Ann Meeting of the Am Inst Chem Engr , Chicago, 16-20 Nov 1980
(Contract W-7405-eng-26)
(CONF-801104-8) Avail NTIS HC A02/MF A01

Several processes are being developed to recover metals from coal combustion and conversion residues Methods to obtain substantial amounts of aluminum, iron, and titanium from these wastes are presented Author

N81-16324# Dynecology, Inc , Harrison, N Y
ENERGY FROM BIOMASS: THE SIMPLEX PROCESS FOR THE GASIFICATION OF COAL AND FOREST PULP Final Report, Jan. 1979 - Mar. 1980
John C Arbo and David P Glaser Apr 1980 103 p Sponsored by New York State Energy Research and Development Authority
(PB81-110512, NYSERDA-80-2) Avail NTIS HC A06/MF A01 CSCL 21D

A series of tests were performed to investigate the adaptation of simplex process to the gasification of forest pulp or wood wastes A coal and forest pulp briquette formulation, needed for the gasification process, was developed as part of the project The sample briquettes were successfully turned into gas GRA

N81-16573*# Mathtech, Inc , Princeton, N J
ADVANCED COGENERATION TECHNOLOGY ECONOMIC OPTIMIZATION STUDY (ACTEOS) Final Report
Pat Nanda, Yaw Ansu, Ernest H Manuel, Jr , and William G Price, Jr 15 Dec 1980 211 p Sponsored in part by DOE Prepared for JPL
(Contract JPL-955559)
(NASA-CR-163887, Rept-2150, JPL-9950-471) Avail NTIS HC A10/MF A01 CSCL 10B

The advanced cogeneration technology economic optimization study (ACTEOS) was undertaken to extend the results of the cogeneration technology alternatives study (CTAS) Cost comparisons were made between designs involving advanced cogeneration technologies and designs involving either conventional cogeneration technologies or not involving cogeneration For the specific equipment cost and fuel price assumptions made, it was found that (1) coal based cogeneration systems offered appreciable cost savings over the no cogeneration case, while systems using coal derived liquids offered no costs savings, and (2) the advanced cogeneration systems provided somewhat larger cost savings than the conventional systems Among the issues considered in the study included (1) temporal variations in steam and electric demands, (2) requirements for reliability/standby capacity, (3) availability of discrete equipment sizes, (4) regional variations in fuel and electricity prices, (5) off design system performance, and (6) separate demand and energy charges for purchased electricity E D K

N81-17261* National Aeronautics and Space Administration Pasadena Office, Calif
MOLTEN SALT PYROLYSIS OF LATEX Patent
Albert J Bauman, inventor (to NASA) (JPL) Issued 20 Jan 1981 5 p Filed 27 Apr 1978 Supersedes N80-10361 (18 - 01, p0050) Sponsored by NASA
(NASA-Case-NPO-14315-1, US-Patent-4,246,001, US-Patent-Appl-SN-900659, US-Patent-Class-44-62, US-Patent-Class-44-50, US-Patent-Class-201-8, US-Patent-Class-201-10, US-Patent-Class-201-25)
Avail US Patent and Trademark Office CSCL 07C

Latex-rich plants such as Guayule or extracts thereof are pyrolyzed in an inert nitrogen atmosphere inorganic salt melts such as a LiCl/KCl eutectic at a temperature of about 500 C The yield is over 60% of a highly aromatic, combustible hydrocarbon oil suitable for use as a synthetic liquid fuel
Official Gazette of the U S Patent and Trademark Office

N81-17287# Foster Associates, Inc , Washington, D C
A STATISTICAL STUDY OF COAL SULFUR VARIABILITY AND RELATED FACTORS. DOCUMENTATION FOR THE COAL SULFUR VARIABILITY DATA BASE AND ANALYTICAL PROGRAM Final Report
George R Warholic John E Morton, Yimin Ngan, James E Spearman and Yvonne Harris May 1980 254 p refs
(Contract EPA-68-02-2592)
(PB81-111593 EPA-450/5-80-008B) Avail NTIS HC A12/MF A01 CSCL 05B

The data structure and the analytical program developed for a statistical study of coal sulfur variability and related factors are described GRA

N81-17290# Katzen (Raphael) Associates, Cincinnati, Ohio
FARM AND COOPERATIVE ALCOHOL PLANT STUDY: TECHNICAL AND ECONOMIC ASSESSMENT AS A COMMERCIAL VENTURE
Oct 1980 241 p
(Contract NAFC-T-16076549)
(PB81-112641, NAFC-80-08) Avail NTIS HC A11/MF A01 CSCL 21D

The production of motor fuel grade (MFG) ethanol in small plants was evaluated Several parameters were explored as follows six agricultural locations, three plant sizes of 90,000, 300,000, and 900,000 gallons per year, five feedstocks, ethanol proof levels of 190 and 199, and by-product distillers grains either as whole stillage or prepared by various degrees of drying Plants were assumed to operate only 6000 hours per year (sugar beets only 3600 hours) because of limitations of time (or beet feedstock) Locally, available boiler fuels were chosen Simplified processing was identified so as to be realistically within the time and experience available to a farmer operator GRA

N81-17291# Institute of Gas Technology, Chicago, Ill
EVALUATION OF COAL CONVERSION CATALYSTS Annual Report
Anthony L Lee Gas Research Inst Mar 1980 16 p refs
(Contract GRI-5014-322-0139)
(PB81-111387, GRI-79/0077) Avail NTIS HC A02/MF A01 CSCL 21D

Three sulfur-resistant methanation catalysts were evaluated with feed mixtures simulating raw gasifier effluents for extended periods These catalysts were evaluated at 200, 400, and 1000 psig, 500, 700, 800, 900, 1000, 1100, and 1200F, 2000, 3000, and 4800 Scf/hr-cu ft, using feeds containing sulfurs (H_2S, COS, CH_3SH, C_2H_5SH, and C_4H_4S) up to 3 mole percent GRA

N81-17292# Institute of Gas Technology, Chicago, Ill
HYDROGASIFICATION OF OIL SHALE Final Report, Jan. 1972 - Dec. 1979
Harlan L Feldkirchner Gas Research Inst Oct 1980 495 p refs Sponsored by Gas Research Inst
(IGT Proj 30520, AGA Proj 1U-4-7)
(PB81-114092, GRI-79/0064) Avail NTIS HC A21/MF A01 CSCL 21D

The technical and economic feasibility of producing synthetic pipeline gas from oil shale using the HYTORT Process were investigated With Western shale, 95% or more of the organic carbon could be converted to useful products, and with Eastern shales organic carbon conversions up to 90% were achieved In addition to showing the overall technical and economic feasibility of the process, this study showed the technical and economic feasibility of a novel, patented method for feeding shale to and from high-pressure reactors Based on the results obtained, it now appears that the Eastern U S shale resource (largely neglected in the past because of the low yield by the conventional Fischer Assay method) is now economically recoverable GRA

N81-17293# Institute of Gas Technology, Chicago, Ill
RAPID-RATE BITUMINOUS COAL GASIFICATION Annual Report, 1 Jan. - 31 Dec. 1979
D Q Tran and A R Mikkelsen Gas Research Inst Oct 1980 27 p refs
(Contract GRI-5011-322-0082)
(PB81-114290, GRI-79/0074) Avail NTIS HC A03/MF A01 CSCL 21D

Cold flow model studies were conducted in a 91 4 cm testing tube to elucidate phenomena that cause divergence of coal particle trajectories and to define the optimum coal injector configuration Results of these studies showed that it is essential to wet screen the crushed coal and that for particles in the range of 74 to 250 microns, the particle trajectories were laminar at nozzle Reynolds numbers of up to 30 For these Reynolds numbers, the results showed that coal particles in the size range 44 to 105 micrometer (-40+325 mesh) can achieve smooth streamline flow patterns over a free fall distance greater than 76 2 cm (30 in) Large particles, up to 250 micrometer (-60 mesh), achieve even greater laminar free fall distances exceeding 91 4 cm GRA

N81-17294# Georgia Inst of Tech , Atlanta Engineering Experiment Station
PYROLYTIC OILS: CHARACTERIZATION AND DATA DEVELOPMENT FOR CONTINUOUS PROCESSING Progress Report, Jun. 1976 - Mar 1980
J A Knight, L W Elston, D R Hurst, and R J Kovac Aug 1980 199 p refs
(Grants EPA-R-804416 EPA-R-806403)
(PB81-110959, EPA-600/2-80-122) Avail NTIS HC A09/MF A01 CSCL 21D

Pyrolytic oils produced by the pyrolysis of forestry residues in a vertical bed, countercurrent flow reactor were thoroughly characterized The pyrolytic oils were produced in a 500 lb per hour pilot plant and in a 50 ton per day field development facility The overall chemical and physical properties were determined by standard analytical techniques The oils are dark brown to black with a burnt, pugent odor and have a boiling range of about 100 C to approximately 200 C at which point thermal degradation begins to occur Pyrolytic oils contained phenolics, pholythydroxy neutral compounds and volatile acidic compounds GRA

N81-17295# Dayton Univ, Ohio Research Inst.
OBTAINING IMPROVED PRODUCTS FROM THE ORGANIC FRACTION OF MUNICIPAL SOLID WASTE Final Report
N L Hecht, D S Duvall, A A Ghazee, and B L Fox Aug 1980 126 p refs
(Grant EPA-R-804421)
(PB81-110918, EPA-600/2-80-121) Avail NTIS HC A07/MF A01 CSCL 21D

Several processes for the conversion of the organic fraction of municipal solid waste to a powder were investigated The first phase was devoted to identifying processes that offer a potential for enhanced product recovery, an evaluation of chemical treatment to improve carbon recovery from pyrolysis processes, an evaluation of laboratory processes for the production of gaseous and liquid fuels, and a laboratory investigation of embrittlement processes for cellulose wastes The second phase was concerned with further laboratory studies of the embrittlement process, pilot studies of the embrittlement process with shredded newsprint and refuse derived fuel, and an engineering and economic assessment for a plant to process powered cellulose for use as fuel GRA

N81-17296# Catalytic, Inc, Philadelphia, Pa
DEVELOPMENT OF CATALYSTS FOR COAL CONVERSION Annual Report, 1979
John Happel, M A Hnatow, and Bajars Liamonis Jan 1980 24 p
(Contract GRI-5014-322-0145)
(PB81-111395, GRI-79/0115) Avail NTIS HC A02/MF A01 CSCL 21D

A major breakthrough was accomplished in the development of a new family of catalysts These formulations have such high activity in the presence of high concentrations of CO2 that they can be used in a process cycle to produce syngas with only one acid gas removal step Steam consumption was reduced from that required in conventional methanation processes Eighty-six new catalyst formulations and one hundred seventy-three reduction and evaluation tests were conducted A wide variety of potential catalytic material was tested The best catalysts were further tested at high pressure and with gas feeds simulating raw syngas from several different types of processes GRA

N81-17297# General Electric Co, Philadelphia, Pa
MARINE BIOMASS PROGRAM Annual Report for 1979
Alan N Tompkins 17 Oct 1980 115 p refs
(Contract GRI-5010-323-0014)
(PB81-113185, GRI-79/0079) Avail NTIS HC A06/MF A01 CSCL 21D

Integrated processes for production and harvesting of seaweed in the ocean and conversion of that seaweed to methane at costs competitive on a commercial scale, with other alternate energy production system are discussed Experimental data show that controlled cultivation of macroalgae is feasible, and that fuels can be derived from marine biomass feedstocks Extensive work with Macrocystis indicated that it can be grown in the open ocean when fertilized by artificially upwelled deep ocean waters Kelp thus derived was shown to be favorably suited to methane production by the process of anaerobic conversion This report expands upon this data base with emphasis of the critical parameters associated with biomass yield and overall energy balance GRA

N81-17510# Institute of Gas Technology, Chicago, Ill
ASSESSMENT OF METHANE HYDRATES Final Report, Dec. 1978 - Jun. 1980
Maurice I Scott, Philip L Randolph, and Jon B Pangborn Oct. 1980 94 p refs
(Contract GRI-5011-310-0097)
(PB81-113300, GRI-79/0070) Avail NTIS HC A05/MF A01 CSCL 08G

Prospective geological sites for gas hydrate existence, are identified to be the Arctic permafrost zones and under the ocean in deep desiments Concentrating on the permafrost zone of Alaska, a computer search of 430 wells identifies those where data was logged that might indicate hydrate interest Records of one particular well, Northwest Eileen State Number 2, strongly suggest the existence of a major natural gas hydrate deposit An estimate of gas in place for the area around this well leads to a potential resource of 68 billion cubic feet per square mile This is five times the amount of gas that would have been present if the depth interval were a conventional gas reservoir at hydrostatic pressure Developed evidence strongly supports the existence of major quantities of natural gas trapped as hydrate (and possibly trapped below hydrate layers) in various regions of North America GRA

N81-17585# California Univ, Berkeley Lawrence Berkeley Lab
CHARACTERIZATION OF SOLID WASTE CONVERSION AND COGENERATION SYSTEMS
Washington DOE Sep 1980 227 p refs
(Contract W-7405-eng-48)
(DOE/EV-0105) Avail NTIS HC A11/MF A01

Three basic technologies for recovering energy from Municipal Solid Waste (MSW) were considered direct combustion using a waterwall incinerator in which the heat from burning refuse is converted to steam by circulating water in steel tubes jacketing the interior of the incinerator, manufacture of a relatively uniform shredded, pulverized or pelleted refuse-derived fuel (RDF) for supplemental firing in a utility boiler, and pyrolysis or destructive distillation of MSW to extract a low-Btu fuel gas While resource recovery and energy recovery systems can be installed independently, the processes described include both energy and resource recovery systems as well as necessary pollution control equipment for gaseous emissions DOE

N81-17601# Midwest Research Inst, Golden, Colo Solar Energy Research Inst
COMBUSTION, PYROLYSIS, GASIFICATION, AND LIQUEFACTION OF BIOMAS
T B Reed Sep 1980 15 p refs Presented at Energy from Biomass Conf, Brighton, England, 4-7 Nov 1980
(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042)
(SERI/TP-622-893; CONF-801130) Avail NTIS HC A02/MF A01

The advantages of biomass as a feedstock are examined and biomass conversion techniques are described Combustion is the simplest method of producing heat from biomass, using either the traditional fixed bed combustion on a grate or the fluidized bed and suspended combustion techniques now being developed. Pyrolysis of biomass is a particularly attractive process if all three products gas, wood tars, and charcoal can be used. Gasification of biomass with air is perhaps the most flexible and best developed process for conversion of biomass to fuel, yielding a low energy gas that can be burned in existing gas/oil boilers or in engines Oxygen gasification yields a gas with higher energy content that can be used in pipelines or to fire turbines. In addition, this gas can be used for producing methanol, ammonia, or gasoline by indirect liquefaction. Fast pyrolysis of biomass produces a gas rich in ethylene that can be used to make alcohols or gasoline Finally, treatment of biomass with high pressure hydrogen can yield liquid fuels through direct liquefaction. DOE

N81-17603# Brookhaven National Lab, Upton, N Y. Dept. of Energy and Environment
CARBON MONOXIDE: RESOURCE OF THE FUTURE
R. S Sapienza, W A R Slegeir, R. I Goldberg, and B. Easterling 1980 9 p refs Presented at the 3rd Intern. Coal Util. Exhibition and Conf, Houston, Tex, 18-20 Nov. 1980
(Contract DE-AC02-76CH-00016)
(BNL-28576, CONF-801142-1) Avail NTIS HC A02/MF A01

Opinions and ideas under study by the Catalysis Group at Brookhaven National Laboratory (BNL) on the effective production and use of carbon monoxide and synthesis gas are described The use of carbon monoxide is important for the successful introduction of coal for fuel production and for the petrochemical industry The kinetics of fast producer reactions and slow producer reactions are described DOE

N81-17640# Southern Research Inst, Birmingham, Ala
A MANUAL FOR THE USE OF ELECTROSTATIC PRECIPITATORS TO COLLECT FLY ASH PARTICLES Final Report, Dec. 1978 - Feb. 1980
Jack R McDonald and Alan H Dean May 1980 785 p refs
(Contract EPA-68-02-2114)
(PB81-112757, SORI-EAS-80-066, Rept-3540-7, EPA-600/8-80-025) Avail NTIS HC A99/MF A01 CSCL 13B

The collection of fly ash particles (produced by the combustion of pulverized coal) by electrostatic precipitation (ESP) is considered The manual covers fundamentals of ESP, mechanical and electrical components of ESP's, factors influencing ESP performance, measurement of important parameters, advantages and disadvantages of cold-side, hot-side, and flue-gas-conditioned ESPs, safety aspects, maintenance, troubleshooting, the use of a computer model for ESP, and features of a well-equipped ESP Studies considered in this report include those, by various individuals and organizations, on comprehensive performance evaluations of full-scale ESPs, in situ and laboratory measurement of fly ash resistivity, rapping reentrainment, evaluations of the effects of flue gas conditioning agents on ESP performance, fundamental operation of hot-side ESPs, basic laboratory experiments, and development of a mathematical model of ESP GRA

N81-17642# Institute of Gas Technology, Chicago, Ill
HIGH-TEMPERATURE HIGH-PRESSURE PARTICULATE REMOVAL IN COAL GASIFICATION Final Report, 1 Sep. 1978 - 1 Jan. 1980
William F Rush, Jr and Michael Onischak Gas Research Inst Oct 1980 50 p refs Sponsored by Gas Research Inst
(PB81-113664; GRI-78/0046) Avail NTIS HC A03/MF A01 CSCL 13B

Sonic agglomeration and crossflow filtration were evaluated as techniques for removing fine particulates from high temperature, high pressure gas streams Cold flow tests provided information about the feasibility of solid membrane crossflow filtration and sonic agglomeration to remove 1 to 10 micron particulates from dust-laden gas streams Subsequent tests were conducted in high temperature high pressure equipment at operating conditions up to 265 C (509F), and 7000 kPa (1999 psia) Solid membrane crossflow filtration removed at least 98 percent of the particulates from the 95% fraction of entering gas GRA

N81-17684# Water and Power Resources Service, Denver, Colo Engineering and Research Center
WIND RESOURCE OF THE AREA SURROUNDING MEDICINE BOW, WYOMING
Aug 1980 39 p refs
(PB81-109621) Avail NTIS HC A03/MF A01 CSCL 04B

Five high wind sites were instrumented to record wind resource data, with the ultimate goal of installing a large number of wind turbine generators, i e , establishing a windfarm Integration of windpower and hydroelectric power are accomplished by tying the windfarm output into an existing hydropower electrical grid The data is presented in the form of plots of monthly mean windspeed, duration windspeed exceeded, windspeed frequency, and polar wind roses GRA

N81-18057# Michigan Univ, Ann Arbor W E Lay Automotive Lab
LIGHT AIRCRAFT ENGINES, THE POTENTIAL AND PROBLEMS FOR USE OF AUTOMOTIVE FUELS. PHASE 1 LITERATURE SEARCH Final Report, Oct. 1979 - Sep. 1980
D J Patterson, K Morrison, M Remondino, and T Slopsema Dec 1980 122 p refs
(Contract DOT-FA79NA-6083)
(AD-A094154, FAA-CT-81-150) Avail NTIS HC A06/MF A01 CSCL 21/4

A comprehensive data research and analysis for evaluating the use of automotive fuels as a substitute for aviation grade fuel by piston-type general aviation aircraft engines is presented Historically known problems and potential problems with fuels were reviewed for possible impact relative to application to an aircraft operational environment This report reviews areas such as fuel specification requirements, combustion knock, preignition, vapor lock, spark plug fouling, additives for fuel and oil, and storage stability GRA

N81-18104 Utah State Univ, Logan
AN EVALUATION OF POLYCYCLIC AROMATIC HYDROCARBONS FROM PROCESSED OIL SHALES Ph.D Thesis
David Lawrence Maase 1980 202 p
Avail Univ Microfilms Order No 8104112

The characterization of organic residue associated with processed oil shale was studied in order to aid in the evaluation of the potential impact of oil shale development A forecast of oil shale development in the White River Basin was projected and hydrological and geological parameters pertinent to estimations of polycyclic aromatic hydrocarbon (PAH) flux were presented Organic residues from processed oil shales were characterized with specific attention to PAH Processed oil shale samples were extracted by using organic solvents in a soxhlet apparatus and by mixing shale samples with water Reported organic chemistry isolation and identification regimes (applicable to gas, liquid and solid samples) are summarized in a tabular format More than 100 organic compounds from processed oil shales were identified by gas chromatography coupled with mass spectrometry Dissert Abstr

N81-18117 Washington State Univ, Pullman
THE DETECTION OF TRACE ELEMENT SPECIES IN SOLVENT REFINED COAL Ph.D. Thesis
Carl Steven Weiss 1980 132 p
Avail Univ Microfilms Order No 8104155

The separation of solvent refined coals 1 and 2 were performed using a nine step solvent gradient separation on a silica support The solvent refined coal 1 solid was subjected to solvent extraction with tetrahydrofuran before the separation The solvent refined coal 2 was filtered prior to the separation Each of the fractions generated was subjected to instrumental neutron activation analysis In addition, two of the more functional fractions from the solvent refined coal 1 silica separation were fractionated based on molecular weight using gel permeation chromatography, these fractions were also analysed by instrumental neutron activation analysis Atomic absorption spectroscopy was used to determine Ca, Mg, Fe, and Be in some of the fractions generated, as an element selective detector for the effluent of a gel permeation chromatographic column Dissert Abstr

N81-18118 Utah Univ, Salt Lake City
CATALYTIC CRACKING OF HYDROTREATED COAL LIQUIDS AND RELATED POLYCYCLIC NAPHTHENES AND NAPHTHENOAROMATICS Ph.D. Thesis
Sunder Swaminathan 1980 227 p
Avail Univ Microfilms Order No 8103900

A systematic catalytic cracking investigation of hydrotreated coal derived liquids was conducted and related model compounds found in such liquids were developed The studies were performed in a flow reactor, using REY type zeolite containing catalysts The following types of starting feedstocks were employed (1) polycyclic naphthenes viz decalin and perhydrophenanthrene (2) polycyclic naphthenoaromatics, viz tetralin, 1,2,3,4,5,6 7,8-octahydroanthracene and 9 10-dihydrophenanthrene, and (3) hydrotreated SRC-2 liquids Changes in product composition as a function of experimental variables (temperature, space velocity and catalyst type) were investigated and mechanistic aspects of the cracking reactions elucidated Dissert Abstr

N81-18149# Michigan Univ, Ann Arbor Gas Dynamics Labs
INITIATION OF DETONATION IN UNCONFINED NATURAL GAS-AIR CLOUDS Final Report
J A Nicholls and M Sichel May 1980 42 p refs
(GSRI Proj 5014-363-0132)

(PB81-113292, UMICH-320639-F, GRI-79/0068) Avail NTIS HC A03/MF A01 CSCL 21D

The possibility that an unconfined combustible cloud arising from the release of liquefied natural gas could detonate is evaluated A sector of a cylindrical cloud was modeled by a special shock tube Blast waves of variable strength were transmitted into the combustible mixture Since methane air couldn't be detonated, the critical initiation energy requirements for various stoichiometric methane oxygen nitrogen mixtures were determined and then extrapolated to determine the value for methane air Extremely high values were indicated The analysis allowed planar, cylindrical, and spherical geometries to be considered GRA

N81-18211 Stevens Inst of Tech, Hoboken, N J
KINETICS OF DONOR-SOLVENT LIQUEFACTION OF COAL IN NONISOTHERMAL EXPERIMENTS Ph.D. Thesis
Govindan Mohan 1980 203 p
Avail Univ Microfilms Order No 8100856

Coal was liquefied in a batch reactor under nonisothermal conditions from 330 to 450 C using tetrain as a hydrogen donor solvent at total pressures up to 70 atm and reaction times from 5 to 60 minutes A separation scheme was developed using liquid solid chromatography on alumina to separate the liquefied products into mixtures of classes of compounds referred to as aromatics, ethers, nitrogens, hydroxyls and multifunctionals The chemical identities of these classes of compounds were determined by infrared and nuclear magnetic resonance spectroscopy Using these classes of compounds several kinetic models were tested to fit experimental concentration time profiles using a nonisothermal, nonlinear parameter estimation technique The multifunctional compounds were considered as reaction intermediate which then decomposed reversibly into aromatics, ethers, nitrogens and hydroxyls It was found that this kinetic model predicts concentration time profiles satisfactorily Dissert Abstr

N81-18212*# BDM Corp, Huntsville, Ala
COAL GASIFICATION SYSTEMS ENGINEERING AND ANALYSIS. VOLUME 1: EXECUTIVE SUMMARY Final Report
31 Dec 1980 56 p 10 Vol
(Contract NAS8-33824)
(NASA-CR-161653, BDM/H-80-800-TR-Vol-1) Avail NTIS HC A04/MF A01 CSCL 21D

Feasibility analyses and systems engineering studies for a 20,000 tons per day medium Btu (MBG) coal gasification plant to be built by TVA in Northern Alabama were conducted Major objectives were as follows (1) provide design and cost data to support the selection of a gasifier technology and other major plant design parameters, (2) provide design and cost data to support alternate product evaluation, (3) prepare a technology development plan to address areas of high technical risk, and (4) develop schedules, PERT charts, and a work breakdown structure to aid in preliminary project planning Volume one contains a summary of gasification system characterizations Five gasification technologies were selected for evaluation Koppers-Totzek Texaco, Lurgi Dry Ash, Slagging Lurgi, and Babcock and Wilcox A summary of the trade studies and cost sensitivity analysis is included E D K

N81-18213*# BDM Corp, Huntsville, Ala
COAL GASIFICATION SYSTEMS ENGINEERING AND ANALYSIS, VOLUME 2 Final Report
31 Dec 1980 311 p 10 Vol
(Contract NAS8-33824)
(NASA-CR-161654 BDM/H-80-800-TR-Vol-2) Avail NTIS HC A14/MF A01 CSCL 21D

The major design related features of each generic plant system were characterized in a catalog Based on the catalog and requirements data approximately 17 designs and cost estimates were developed for MBG and alternate products A series of generic trade studies was conducted to support all of the design studies A set of cost and programmatic analyses were conducted to supplement the designs The cost methodology employed for the design and sensitivity studies was documented and implemented in a computer program Plant design and construction schedules were developed for the K-T, Texaco, and B&W MBG plant designs A generic work breakdown structure was prepared, based on the K-T design to coincide with TVA's planned management approach An extensive set of cost sensitivity analyses was completed for K-T, Texaco, and B&W design Product price competitiveness was evaluated for MBG and the alternate products A draft management policy and procedures manual was evaluated A supporting technology development plan was developed to address high technology risk issues The issues were identified and ranked in terms of importance and tractability and a plan developed for obtaining data or developing technology required to mitigate the risk E D K

N81-18214*# BDM Corp, Huntsville, Ala
COAL GASIFICATION SYSTEMS ENGINEERING AND ANALYSIS APPENDIX A COAL GASIFICATION CATALOG Final Report
31 Dec 1980 221 p refs 10 Vol
(Contract NAS8-33824)
(NASA-CR-161655, BDM/H-80-800-TR-App-A) Avail NTIS HC A10/MF A01 CSCL 21D

The scope of work in preparing the Coal Gasification Data Catalog included the following subtasks (1) candidate system subsystem definition (2) raw materials analysis, (3) market analysis for by-products, (4) alternate products analysis (5) preliminary integrated facility requirements Definition of candidate systems/subsystems includes the identity of and alternates for each process unit, raw material requirements and the cost and design drivers for each process design E D K

N81-18215*# BDM Corp, Huntsville Ala
COAL GASIFICATION SYSTEMS ENGINEERING AND ANALYSIS. APPENDIX B. MEDIUM Btu GAS DESIGN Final Report
31 Dec 1980 275 p 10 Vol
(Contract NAS8-33824)
(NASA-CR-161656, BDM/H-80-800-TR-App-B) Avail NTIS HC A12/MF A01 CSCL 21D

A four module 20,000 TPD, based on KT coal gasification technology was designed The plant processes Kentucky No 9 coal with provisions for up to five percent North Alabama coal Medium Btu gas with heat content of 305 Btu/SCF and not more than 200 ppm sulfur is the primary plant product Sulfur is recovered for scale as prilled sulfur Ash disposal is on site The plant is designed for zero water discharge Trade studies provided the basis for not using boiler produced steam to drive prime movers Thus process derived steam in excess of process requirements in superheated for power use in prime movers Electricity from the TVA grid is used to supply the balance of the plant prime mover power requirements A study of the effect of mine mouth coal cleaning showed that coal cleaning is not an economically preferred route The design procedure involved defining available processes to meet the requirements of each system, technical/economic trade studies to select the preferred processes, and engineering design and flow sheet development for each module Cost studies assumed a staggered construction schedule for the four modules beginning spring 1981 and a 90% on stream factor E D K

N81-18216*# BDM Corp, Huntsville Ala
COAL GASIFICATION SYSTEMS ENGINEERING AND ANALYSIS. APPENDIX C ALTERNATE PRODUCT FACILITY DESIGNS Final Report
31 Dec 1980 221 p refs 10 Vol
(Contract NAS8-33824)
(NASA-CR-161657, BDM/H-80-800-TR-APP-C) Avail NTIS HC A10/MF A01 CSCL 21D

The study of the production of methane methanol gasoline, and hydrogen by an add-on facility to a Koppers-Totzek based MBG plant is presented Applications to a Texaco facility are inferred by evaluation of delta effects from the K-T cases The production of methane from an add-on facility to a Lurgi based MBG plant and the co-production of methane and methanol from a Lurgi based system is studied Studies are included of the production of methane from up to 50 percent of the MBG produced in an integrated K-T based plant and the production of methane from up to 50 percent of the MBG produced from

an integrated plant in which module 1 is based on K-T technology and modules 2 3, and 4 are based on Texaco technology
E D K

N81-18217*# BDM Corp, Huntsville Ala
COAL GASIFICATION SYSTEMS ENGINEERING AND ANALYSIS APPENDIX D COST AND ECONOMIC STUDIES Final Report
31 Dec 1980 636 p 10 Vol
(Contract NAS8-33824)
(NASA-CR-161658, BDM/H-80-800-TR-App-D) Avail NTIS HC A99/MF A01 CSCL 21D

The detailed cost estimate documentation for the designs prepared in this study are presented The include (1) Koppers-Totzek, (2) Texaco (3) Babcock and Wilcox, (4) BGC-Lurgi, and (5) Lurgi The alternate product cost estimates include (1) Koppers-Totzek and Texaco single product facilities (methane, methanol, gasoline hydrogen) (2) Koppers-Totzek SNG and MBG, (3) Koppers-Totzek and Texaco SNG and MBG, and (4) Lurgi-methane and Lurgi-methane and methanol E D K

N81-18218*# BDM Corp Huntsville, Ala
COAL GASIFICATION SYSTEMS ENGINEERING AND ANALYSIS. APPENDIX E COST ESTIMATION AND ECONOMIC EVALUATION METHODOLOGY Final Report
31 Dec 1980 71 p refs 10 Vol
(Contract NAS8-33824)
(NASA-CR-161659, BDM/H-80-800-TR-App-E) Avail NTIS HC A04/MF A01 CSCL 21D

The cost estimation and economic evaluation methodologies presented are consistent with industry practice for assessing capital investment requirements and operating costs of coal conversion systems All values stated are based on January 1980 dollars with appropriate recognition of the time value of money Evaluation of project economic feasibility can be considered a two step process (subject to considerable refinement) First the costs of the project must be quantified and second, the price at which the product can be manufacturd must be determined These two major categories are discussed The summary of methodology is divided into five parts (1) systems costs, (2) instant plant costs, (3) annual operating costs, (4) escalation and discounting process, and (5) product pricing E D K

N81-18219*# BDM Corp Huntsville Ala
COAL GASIFICATION SYSTEMS ENGINEERING AND ANALYSIS APPENDIX F: CRITICAL TECHNOLOGY ITEMS/ISSUES Final Report
31 Dec 1980 48 p refs 10 Vol
(Contract NAS8-33824)
(NASA-CR-161660, BDM/H-80-800-TR-App-F) Avail NTIS HC A17/MF A01 CSCL 21D

Critical technology items and issues are defined in which there is a need for developmental research in order to assure technical and economic success for the state of the art of coal gasification in the United States Technology development needs for the main processing units and the supporting units are discussed While development needs are shown for a large number of systems, the most critical areas are associated with the gasifier itself and those systems which either feed the gasifier or directly receive products form the gasifier E D K

N81-18220*# BDM Corp, Huntsville, Ala
COAL GASIFICATION SYSTEMS ENGINEERING AND ANALYSIS APPENDIX G COMMERCIAL DESIGN AND TECHNOLOGY EVALUATION Final Report
31 Dec 1980 29 p 10 Vol
(Contract NAS8-33824)
(NASA-CR-161661 BDM/H-80-800-TR-App-G) Avail NTIS HC A03/MF A01 CSCL 21D

A technology evaluation of five coal gasifier systems (Koppers-Totzek, Texaco, Babcock and Wilcox, Lurgi and BGC/Lurgi) and procedures and criteria for evaluating competitive commercial coal gasification designs is presented The technology evaluation is based upon the plant designs and cost estimates developed by the BDM-Mittelhauser team E D K

N81-18221*# BDM Corp Huntsville Ala
COAL GASIFICATION SYSTEMS ENGINEERING AND ANALYSIS APPENDIX H WORK BREAKDOWN STRUCTURE Final Report
31 Dec 1980 142 p 10 Vol
(Contract NAS8-33824)
(NASA-CR-161662, BDM/H-80-800-TR-App-H) Avail NTIS HC A17/MF A01 CSCL 21D

A work breakdown structure (WBS) is presented which encompasses the multiple facets (hardware software services, and other tasks) of the coal gasification program The WBS is shown to provide the basis for the following management and control, cost estimating, budgeting and reporting scheduling activities organizational structuring, specification tree generation weight allocation and control procurement and contracting activities, and serves as a tool for program evaluation R C T

N81-18223# Royal Inst of Tech, Stockholm (Sweden)
GASIFICATION AND DESULFURIZATION OF COAL BY INJECTION INTO MOLTEN METALS
Anders Sundstroem May 1980 46 p refs
(STU-78-4560) Avail NTIS HC A03/MF A01

The desulfurization and gasification of coal was investigated on 10 resp 20 kg scale by injecting coal powder with and without oxygen into inductively heated copper melts at approximately 1300 C The variable parameters were the depth and temperature of the bath the flow of oxygen particle size and the contents of sulfur of the bath The results show that Zn, Mn, and Pb are theoretically unsuitable as gasification agents whereas the potential of Ni is considerably greater Copper seems to be more suitable for the desulfurization of coal than for the gasification especially owing to big losses of coal dust during gasification These are probably due to deficient solubility of coal the gas which was produced at gasification had very divergent CO/CO2 ratios and very low sulfur containing gases, less than 175 ppM There is a slight tendency of particle size dependent production of CO This dependence could not be confirmed when the coal powder was desulfurized DOE

N81-18224# Department of Energy, Washington, D C
GENERATOR GAS OPERATION OF MOTOR VEHICLES
1981 25 p Transl into ENGLISH from Swedish article
(DOE-TR-219) Avail NTIS HC A02/MF A01

The Swedish history development, and status of motor vehicles which operate on generator gas produced from burning wood chips are discussed These vehicles, e g passenger car trucks, buses, tractors, are modified to accommodate the attached generator gas unit and to permit combustion of the generator gas in the vehicle engine Data are included on fuel consumption for specific types of wood and for types of vehicles, the design and operation of generator gas equipment, and safety recommendations DOE

N81-18226# UOP, Inc, Des Plaines, Ill
UPGRADING OF COAL LIQUIDS: UPGRADING DISTILLATES FROM COAL LIQUEFACTION Annual Report, 31 Jan 1979 - 31 Jan 1980
A J deRossett, F J Riedl L Hilfman, and R W Johnson Oct 1980 96 p refs
(Contracts DE-AC01-77ET-10131, EF-77-C-01-2566)
(FE-2566-42) Avail NTIS HC A05/MF A01

Coal derived naphthas from the H-Coal and Exxon donor solvent (EDS) and SRC-2 processes were hydrotreated and reformed in research pilot plants to 100 research octane number (RON) gasoline Conditions for hydrotreating were relatively severe compared to those required to treat a Middle East naphtha Reforming proceeded at relatively mild conditions Hydrogen yield was greatly in excess of the amount required for hydrotreating The 400 F(+) distillates from the H-Coal and EDS processes were converted in research pilot plants by hydrotreating hydrocracking and fluid catalytic cracking (FCC) Hydrotreating alone fave high yields of environmentally acceptable No 2 fuel oil Hydrocracking to gasoline proceeded at operating conditions somewhat more severe than required for the Middle East gas oil Hydrogen consumption was high It was found that a portion of the hydrogen can be recovered by reforming the hydrocracked naphtha to 100 RON gasoline Additional hydrogen can potentially be recouped by steam reforming light gases DOE

N81-18227# Purdue Univ, Lafayette Ind School of Chemical Engineering
PHASE EQUILIBRIUM IN COAL LIQUEFACTION PROCESSES Final Report
K C Chao H M Lin G D Nageshwar, H Y Kim, J L Oliphant, H M Sebastian, and J J Simnick Oct 1980 182 p refs Sponsored by Electric Power Research Inst
(EPRI Proj 367-2)
(EPRI-AP-1593) Avail NTIS HC A09/MF A01

Gas liquid equilibria were determined in simulation of coal liquefaction process conditions in mixtures of light gases + heavy hydrocarbons (polynuclear aromatics N, S, and O containing aromatics, some paraffins, and naphthenes) The mixture systems investigated were 32 binary mixture systems of a light gas (hydrogen methane, or carbon dioxide) + a heavy hydrocarbon, 2 ternary mixture systems of hydrogen + two heavy hydrocarbons, 2 ternary mixture systems of hydrogen + methane + a heavy hydrocarbon, 5 complex mixture systems of hydrogen + a coal oil fraction and 4 complex mixture systems of methane + a coal oil fraction Equilibrium data were determined at pressures up to 250 atm and temperatures up to 460(0) C which was substantially above the upper limit of previously reported data A flow apparatus of special design made possible the attainment of the elevated temperatures at high pressures Vapor pressures were determined for eight hydrocarbons at superatmospheric pressures using the same apparatus A solubility parameter based correlation was developed for the solubility of hydrogen The hydrogen, methane and carbon dioxide data was analyzed and correlated with various degrees of success with the Soave equation of state, and Boublik-Alder-Chen-Kreglewski equation of state DOE

N81-18228# Oak Ridge National Lab, Tenn
INDIRECT CONVERSION OF COAL TO METHANOL AND GASOLINE: PRODUCT PRICE VS PRODUCT SLATE
R M Wham, D J McCracken (Fluor Engineers and Constructors, Inc, Houston, Tex), and R C Forrester III (Fluor Engineers and Constructors, Inc Irvine Calif) 1980 23 p refs Presented at Coal Technol '80, 3rd Intern Coal Utilization Exhibition and Conf, Houston, Tex, 18-20 Nov 1980
(Contract W-7405-eng-26)
(CONF-801142-3) Avail NTIS HC A02/MF A01

The technical feasibility, economic competitiveness, and environmental acceptability of selected indirect coal liquefaction processes are described Particular emphasis is placed on production of methanol as a principal product or methanol production for conversion to gasoline Potential uses for the methanol are combustion in peaking type turbines or blending with gasoline to yield motor fuel Conversion of methanol to gasoline is accomplished through the use of the Mobil methanol to gasoline (MTG) process The conceptual designs are described for the indirect conversion of a Western subbituminous coal to either methanol or gasoline The bases for the conceptual designs are given The case designations are methanol production for turbine grade fuel, methanol production for gasoline blending gasoline production with coproduction of SNG and gasoline production maximized DOE

N81-18230# Department of Energy Bartlesville Okla Energy Technology Center
FLEET TRAILS USING METHANOL/GASOLINE BLENDS
Ken R Stamper 1980 10 p refs Presented at 4th Intern Symp on Alcohol Fuels Technol Sao Paulo Brazil 5 Oct 1980
(CONF-801030-4) Avail NTIS HC A02/MF A01

Seven current production automobiles were used in a fleet study to determine the long term effects and end use influences of using 10% methanol/90% gasoline blends as automotive fuels The vehicles were operated over a course designed to accumulate mileage at a rate and duty cycle similar to automobiles used by the private sector in the US Vehicle tests were run at each 5000 mile accumulation interval to determine the fuel economy and the mass of pollutant emissions generated by the vehicles operating on the 10% methanol blend and to establish a basis for comparison on an unleaded, low octane Indolene These data showed an average reduction in carbon monoxide emissions associated with the use of the 10% methanol blend At the end of 50,000 miles of operation on the blend, the engine and fuel handling systems in four of the vehicles were disassembled for inspection and rating to identify any significant wear or materials incompatibility problems associated with long term operation on the methanol blend Other signficant observations as well as the results are reported DOE

N81-18231# Chevron Research Co Richmond, Calif
REFINING AND UPGRADING OF SYNFUELS FROM COAL AND OIL SHALES BY ADVANCED CATALYTIC PROCESSES Quarterly Report, Apr. - Jun. 1980
R F Sullivan and D J ORear Jul 1980 27 p
(Contracts DE-AC01-76ET-10532 EF-76-C-01-2315)
(FE-2315-55) Avail NTIS HC A03/MF A01

The relationship between the measured cetane number and the calculated cetane index (ASTM D 976-66) was examined for 11 coal derived diesel fuels The cetane index is consistently less than the measured cetane number Octyl nitrate was shown to be an effective cetane number improver for coal derived diesel fuels For a 40 2 cetane number base fuel which contained 2 4 vol % aromatics, 0 1 vol % octyl nitrate improved the cetane number by 3 5 and 0 3 vol % octyl nitrate improved the cetane number by 8 1 Aromatics were shown to inhibit the octyl nitrate as a cetane improver In a short test, the feasibility of refining Wyodak H-Coal cyncrude to a No 2 fuel at low pressures was examined Product made at 1000 psig total pressure (900 psia hydrogen) and 50% aromatics was stable Products made at 500 psig total pressure (about 400 psia hydrogen) was unstable Denitrified Wyodah H-Coal syncrude was hydrocracked in an extinction recycle pilot plant The yields from this plant are very similar to the yields obtained from the denitrified Illinois H-Coal on SRC-2 syncrudes This task will complete our experimental program on the Wyodak H-Coal syncrudes DOE

N81-18232# Oak Ridge National Lab, Tenn Office of Coal Research
HYDROCARBONIZATION RESEARCH COMPLETION REPORT
E L Youngblood H D Cochran, Jr P R Westmoreland C H Brown, Jr G E Oswald, and R E Barker Jan 1981 134 p refs
(Contract W-7405-eng-26)
(ORNL/TM-6693) Avail NTIS HC A07/MF A01

Hydrocarbonization is a relatively simple process used for producing oil substitute natural gas, and char by heating coal under a hydrogen rich atmosphere This report describes studies that were performed in a bench scale hydrocarbonization system at Oak Ridge National laboratory (ORNL) during the period 1975 to 1978 The results of mock up studies coal metering valve and flowmeter development, and supporting work in an atmospheric hydrocarbonization system are also described Oil, gas, and char yields were determined by hydrocarbonization of coal in a 0 1 m diam fluidized bed reactor operated at a pressure of 2170 kPa and at temperatures ranging from 694 to 854 K The nominal coal feed rate was 4 5 kg/h Wyodak subbituminous coal was used for most of the experiments A maximum oil yield of approximately 21% based on moisture and ash free (maf) coal was achieved in the temperature range of 810 to 840 K Recirculating fluidized bed, uniformly fluidized bed, and rapid hydropyrolysis reactors were used DOE

N81-18233# Oak Ridge National Lab Tenn
FUEL ALCOHOL EXTRACTION TECHNOLOGY COMMERCIALIZATION CONFERENCE
A L Compere, W L Griffith, and J M Googin 2 Dec 1980 30 p refs Presented at Fuel Alcohol Extraction (FUALEX) Method of Neutral Solvents Extraction Technol Commercialization Conf, Oak Ridge, Tenn, 2 Dec 1980
(Contract W-7405-eng-26)
(CONF-801212) Avail NTIS HC A03/MF A01

The fualex or fuel alcohol extraction process, uses a combination of hydrocarbon and surfactant to remove neutral solvents, such as butanol, ethanol, isopropanol, and acetone, from aqueous solution The hydrocarbon extractants used may be fuels such as gasoline, furnace oil, and diesel fuel Surfactant concentrations ranging from 1 to 10 g/liter and hydrocarbon ranging from 0 01 to 1 liter per liter aqueous alcohols solution were investigated The fualex process was tested on solutions which contain 5 percent total neutral solvents, since this is near maximum for the fermentation product stream The neutral solvents are removed in the form of an emulsion which is white to light bluish in the visible range The emulsion has potential for direct use in fuels or as an intermediate for obtaining purified solvents DOE

N81-18234# TRW Systems Group, McLean, Va
ENERGY BALANCES IN THE PRODUCTION AND END-USE OF METHANOL DERIVED FROM COAL
10 Dec 1980 63 p refs
(Contract DE-AC01-79PE-70151)
(DOE/PE-70151/T4) Avail NTIS HC A04/MF A01

Petroleum gain (petroleum only), net premium fuel gain (natural gas and petroleum), and net energy gain (includes all fuels, does not include free energy from Sun) The base case selected for evaluation was an energy efficient coal to methanol plant located in Montana/Wyoming and using the Lurgi conversion process The following variations of the base coal methanol case are also analyzed gasoline from coal with methanol as an intermediate step, and methanol from coal Computations are made for the product methanol as a replacement for unleaded gasoline in a conventional spark ignition engine and as a chemical feedstock Regarding mileage of methanol/gasoline compared to that of regular unleaded gasoline mileage of the two fuels equal, mileage 4 percent better with gasohol, and mileage 4 percent worse with gasohol DOE

N81-18235# Systems Science and Software, La Jolla, Calif
COMPUTER MODELING OF COAL GASIFICATION REACTORS, YEAR 4 Annual Report, Oct. 1978 - Sep. 1979
T R Blake, D H Brownell, Jr, P J Chen, J L Cook, and G P Schneyer Mar 1980 62 p refs
(Contract DE-AC21-76ET-10242)
(FE-1770-66, SSS-R-80-4416) Avail NTIS HC A04/MF A01

The application of the fluidized bed computer model to specific gasifier systems was investigated These simulations included jet penetration of bubble formation, solids mixing and product gas composition for a six-inch diameter bench scale reactor, and cold flow predictions of jet penetration and solids recirculation in two agglomerating combustor/gasifier reactors The fluidized bed coal gasifier computer model was designed to provide a description of the hydrodynamic mixing and coupled chemistry within the reactor A full description of the model is presented DOE

N81-18236# United States Steel Corp, Monroeville, Pa
USE OF COAL INJECTION AND OXYGEN IN A BLAST FURNACE TO PRODUCE FUEL GAS Final Report
Dec 1980 37 p refs
(Contract DE-AC07-76ID-01570)
(IDO-10089) Avail NTIS HC A03/MF A01

The feasibility of operating a blast furnace with coal injection and oxygen to produce fuel gas was evaluated Probable operating conditions were based on United States Steel Corporation's experience with coal injection on an experimental blast furnace It was found that the cost of the gas produced would, as expected, be sensitive to the costs of coal, coke, and oxygen used and also to the capability of the process to burn coal instead of coke To be economically viable, the medium Btu produced [270 Btu per standard cubic foot (Btu/scf)] from coal, coke, and oxygen at $30 per ton ($/T), $100/T, and $48 60/T, respectively, would have to have a selling price between $6 74 per million Btu ($/MMBtu) and $7 38/MMBtu depending on the coal-to-coke ratio assumed to be achieved in the process Because these selling prices are considerably higher than current costs for natural gas or fuel oil, it would appear that the operation of a blast furnace as a fuel gas producer would not be economically viable at this time DOE

N81-18237# Department of Energy, Bartlesville, Okla Bartlesville Energy Technology Center
COMPARISONS OF GASOHOL AND GASOLINE IN LABORATORY AND FIELD TRIALS
J R Allsup and M D Gurney 18 Dec 1980 7 p refs
Presented at the 4th Intern Symp on Alc Fuels Technol, Sao Paulo, Brazil 5-8 Oct 1980
(CONF-801030-3) Avail NTIS HC A02/MF A01

An effort was made to obtain comparative field experience with gasohol and with gasoline used in controlled tests with units of a commercial service fleet A total of 110 vehicles were involved with half of the units operated using a control gasoline and the other half operated using gasohol At an appropriate point in the tests, fuels were switched so that both gasohol and gasoline related data were obtained from all individual test units Vehicle operators observed and recorded information from the vehicles during use in normal field service Vehicle drivers rated driveability and recorded the nature and circumstances of vehicle malfunction Service records provided information on fuel economy and on fuel system problems Emissions and fuel economy data were obtained using a chassis dynamometer to run the prescribed test routines Results in comparing experience between using gasohol and using gasoline showed, on the average, regulated emissions to have been lower for vehicles fueled with gasohol Other significant results are obtained RCT

N81-18238# Rockwell International Corp, Canoga Park, Calif Energy Systems Group
COAL HYDROGASIFICATION PROCESS DEVELOPMENT. VOLUME 1: COAL STUDIES Annual Technical Progress Report
L P Combs S K Ubhayakar, L S Breese, D R Kahn, and W T Lee 20 Oct 1980 221 p refs
(Contracts DE-AC01-78ET-10328, ET-78-C-01-3125)
(FE-3125-24-Vol-1, ATPR-2-GFY-80) Avail NTIS HC A10/MF A01

Testing was concluded in a short-test-duration, engineering-scale hydrogasification test facility Test results established a data base for other program tasks Correlation of the data, using nonlinear multiple regression techniques, against a set of phenomenological hydropyrolysis reactions, leads to a powerful analytical predictive tool The design was completed and construction started on a 2/4-TPH integrated process development unit capable of continuous operation for up to 30 days DOE

N81-18239# Rockwell International Corp, Canoga Park, Calif Energy Systems Group
COAL HYDROGASIFICATION PROCESS DEVELOPMENT VOLUME 2. PEAT STUDIES Annual Technical Progress Report
K M Sprouse and J K Rosemary 20 Oct 1980 151 p refs
(Contract DE-AC01-78ET-10328)
(FE-3125-24-Vol-2, ATPR-2-GFY-80) Avail NTIS HC A08/MF A01

The effects of peat hydrogasification in an entrained flow reactor are discussed three phases peat dense-phase feed system flow studies hydrogasification entrained flow reactor testing and preliminary peat process economic evaluations The peat dense-phase feeding studies included low pressure (below 150 psig) testing at nominal solid peat flow rates of 1 ton/hr and analytical modeling efforts The hydrogasification reactor testing was performed at peat flow rates of over 1000 lb/hr and reactor temperatures to 1900(0) F in hydrogen atmospheres from 500 to 1000 psig A simple analytical kinetic model was developed to predict total carbon conversion as a function of reactor operating variables DOE

N81-18240# Exxon Research and Engineering Co, Florham Park, NJ
EDS COAL LIQUEFACTION PROCESS DEVELOPMENT, PHASE 4-5 Annual Technical Progress Report, 1 Jul. 1979 - 30 Jun 1980
Oct 1980 491 p refs
(Contracts DE-AB01-77ET-10069, EF-77-A-01-2893)
(FE-2893-53) Avail NTIS (US Sales Only) HC A21/MF A01, DOE Depository Libraries

Laboratory process research and development studies conducted in support of a donor solvent coal liquefaction process are reported Topic covered include operation of recycle units in the one ton per day pilot plant, solvent hydrogenation, catalysts, validation of the once-through unit, high pressure liquefaction, chemical structure of bottoms, coking yields, bottom solidification, hydrogen production, materials handling, erosion resistant nozzles, cost reduction, commercialization and industrial wastes, environmental engineering, value engineering, and laboratory guidance procedures A R H

N81-18241# Rockwell International Corp, Thousand Oaks, Calif Science Center
STUDIES OF THE MECHANISM OF COAL HYDROGENATION BY ELECTRON SPIN RESONANCE Quarterly Technical Progress Report, 1 Jun. - 31 Aug. 1980
Ira B Goldberg Nov 1980 17 p refs
(Contract DE-AC22-80PC-30072)
(DOE/PC-30072/T2) Avail NTIS HC A02/MF A01
This is the second quarterly report on the program Studies of Coal Hydrogenation by electron spin resonance was studied with emphasis on cell and heating rate optimization for carrying out in situ measurements Preliminary characterization of the coal to be used was carried out DOE

N81-18242# Southwest Research Inst, San Antonio, Tex
HYBRID FUELS FOR HIGHWAY TRANSPORTATION Annual Technical Progress Report, 1 Jun. 1979 - 1 Jun. 1980
T W Ryan, W Likos, and C A Moses Jun 1980 134 p refs
(Contract DE-AC04-78CS-54240)
(DOE/CS-54240/T1, ATPR-2) Avail NTIS HC A07/MF A01
A program was developed to investigate the potential of hybrid fuels for use in highway transportation Hybrids are fuels derived from combinations of readily available energetic non-conventional materials with petroleum They are generally formulated as solutions, emulsions, or slurries The underlying objective of the program is to reduce the use of petroleum derived fuels and/or to minimize the processing requirements of the finished hybrid fuels During the first year of the program, extensive work was done on the development and testing of water and alcohol emulsions and alcohol solutions In the second year, the emphasis was placed on the development and testing of hybrid fuel slurries Components evaluated included carbohydrates and various forms of carbon It was concluded that, of the slurries tested, the carbon (coke carbon black etc) slurries have the most potential for development into finished fuels The efforts during the third year will concentrate on advancing the development of the slurries (especially the carbon slurries) to the same point as the solutions and emulsions DOE

N81-18314 Houston Univ, Tex
OIL GANGLION DYNAMICS IN FLOW THROUGH POROUS MEDIA Ph.D. Thesis
Ka Ming Ng 1980 196 p
Avail Univ Microfilms Order No 8103612
A model is formulated to study the transient behavior of oil ganglion populations during immiscible displacement in oil recovery processes The model is composed of three components a suitable model for granular porous media, a stochastic simulation method capable of predicting the fate of solitary ganglia and two coupled population balance equations for studying the dynamics of oil ganglion populations The porous medium model proposed is a network of interconnected unit cells of the constricted tube type The permeability of this model is determined by both the statistical analysis the network analysis It is demonstrated that fluids in different portions of a porous medium interact with one another Two methods are used in the simulation of the motion of solitary ganglion It is found that the velocity of an oil blob decreases as its viscosity increases Dissert Abstr

N81-18343# Illinois Inst of Tech, Chicago
SOLIDS CIRCULATION AROUND A JET IN A FLUIDIZED BED GASIFIER Final Report, 1 Sep. 1978 - 30 Sep. 1980
Dimitri Gidaspow Bozorg Ettehadieh, Chungliang Lin, Anil Goyal, and Robert W Lyczkowski 1980 79 p refs
(Contract DE-FG21-78ET-12229, Grant ET-78-G-01-3381)
(DOE/ET-12229/T1) Avail NTIS HC A05/MF A01
A hydrodynamic model to predict solids circulation around a jet in a fluidized bed gasifier was developed To account for unequal velocities of solid and fluid phases, separate phase momentum balances were developed Other fluid bed models used in the scale-up of gasifiers do not employ the principles of conservation of momentum These models cannot predict fluid and particle motion In such models solids mixing is described by means of empirical transfer coefficients A two dimensional unsteady state computer code was developed to give gas and solid velocities, void fractions and pressure in a fluid bed with a jet The growth, propagation and collapse of bubbles was calculated Time-averaged void fractions were calculated that showed an agreement with void fractions measured with a gamma ray densitometer DOE

N81-18398# Department of Energy, Washington, D C
INTERNAL COMBUSTION ENGINES FOR ALCOHOL MOTOR FUELS: A COMPILATION OF BACKGROUND TECHNICAL INFORMATION
Nov 1980 362 p refs
(DOE/AF-0001) Avail NTIS HC A16/MF A01
This compilation, a draft training manual containing technical background information on internal combustion engines and alcohol motor fuel technologies, is presented in 3 parts The first is a compilation of facts from the state of the art on internal combustion engine fuels and their characteristics and requisites and provides an overview of fuel sources, fuels technology and future projections for availability and alternatives Part two compiles facts about alcohol chemistry, alcohol identification, production and use, examines ethanol as spirit and as fuel, and provides an overview of modern evaluation of alcohols as motor fuels and of the characteristics of alcohol fuels The final section compiles cross references on the handling and combustion of fuels for I C engines, presents basic evaluations of events leading to the use of alcohols as motor fuels, reviews current applications of alcohols as motor fuels, describes the formulation of alcohol fuels for engines and engine and fuel handling hardware modifications for using alcohol fuels, and introduces the multifuel engines concept DOE

N81-18476# California Univ, Los Angeles Dept of Earth and Space Sciences
RESEARCH IN THE GEOSCIENCES RELATED TO, RESOURCE ASSESSMENT Interim Progress Report
M G Kivelson 18 Jul 1980 15 p refs
(Contract DE-AT03-79ER-10119)
(DOE/IR-10119/T1) Avail NTIS HC A02/MF A01
Research progress is reported in the development of a field data acquisition and processing system for use in exploration geophysics Analysis of seismic data from Imperial Valley and Mt Etna and the genesis of uranium ore deposited are presented DOE

N81-18477# Oak Ridge National Lab, Tenn
COMMENTS ON LONG-TERM ASPECTS OF RENEWABLE VERSUS NONRENEWABLE RESOURCE SUBSTITUTION
H E Goeller 1980 15 p Presented at the Interciencia Workshop on Mater for the Future, Kingston, Jamaica, 17-21 Nov 1980
(Contract W-7405-eng-26)
(CONF-801158-1) Avail NTIS HC A02/MF A01
Advantages and limitations of renewable resources as substitutes for nonrenewable resources are discussed, with particular emphasis on the longer term when economic resources of some of the more limited chemical elements will run out or will, or least, become too expensive to use except in absolutely necessary, nonsubstitutable uses Renewable resources will continue to become available through natural processes, in some cases augmented by modern technology, but only at some maximum level For example, the amount of hydroelectric power available in the world is determined by rainfall and topograhy On the other hand, nonrenewable resources are generally regarded as being material sources that, once used, are gone forever This is true for fossil fuels, where current demands are many

orders of magnitude larger than rates of formation of new coal and petroleum It is not true, however, for some of the atmospheric gases (e g , nitrogen and argon) which are returned to the atmosphere either directly or through biological processes after use so that they are renewable resources DOE

N81-18478# Stanford Univ , Calif
GEOTHERMAL RESERVOIR ENGINEERING COMPUTER CODE COMPARISON AND VALIDATION USING THE GEONZ SIMULATOR PROGRAM
Roland N Horne, D O Ogbe, K Temeng, and H J Ramey, Jr
14 Nov 1980 67 p refs
(Contract DE-AC03-80SF-11450)
(DOE/SF-11450/1) Avail NTIS HC A04/MF A01

It was originally proposed to use the GEOTHERM geothermal simulator program to prepare solutions to the first five of the six Department of Energy computer code comparison sets Valid solutions were anticipated in all of the five problems attempted, but it was expected that problems 3 and 4 might present some difficulties A more recent version of the program, called GEONZ became available and was used successfully on problems 3 and 4 The new program, GEONZ, had additional capabilities that enabled it to handle both superheated steam and counterflows of steam and water The choice of the GEONZ code is discused, followed by an in depth description of the solutions obtained for problems 1 through 5 The five problems are 1-D Avdonin Solution, 1-D well test analysis, 2-D flow in fracture/block medium, 2-D phase system with drainage, and flow in a 2-D areal reservoir DOE

N81-18479# Utah Univ , Salt Lake City Dept of Geology and Geophysics
THERMAL STUDIES IN A GEOTHERMAL AREA. REPORT 1: THERMAL STUDIES AT ROOSEVELT HOT SPRINGS, UTAH. REPORT 2: HEAT FLOW ABOVE AN ARBITRARILY DIPPING PLANE OF HEAT SOURCES. REPORT 3: A DATUM CORRECTION FOR HEAT FLOW MEASUREMENTS MADE ON AN ARBITRARY SURFACE
W R Wilson and D S Chapman Oct 1980 151 p refs
(Contract DE-AC07-80ID-12079)
(DOE/ID-12079/19) Avail NTIS HC A08/MF A01

Interpretation of heat flow data is presented for 53 drill holes The temperature profiles are classified in three spatially consistent patterns which delineate hydrologic recharge, active convection and discharge regions DOE

N81-18480# Virginia Polytechnic Inst and State Univ , Blacksburg Dept of Geological Sciences
EVALUATION AND TARGETING OF GEOTHERMAL ENERGY RESOURCES IN THE SOUTHEASTERN UNITED STATES Progress Report, 1 Oct 1979 - 30 Jun. 1980
J K Costain Dec 1980 298 p refs
(Contract DE-AC05-78ET-27001)
(DOE/ET-27001/8) Avail NTIS HC A13/MF A01

Geological studies were conducted of the area including petrographic and stratigraphic analysis Thermal mapping was used for possible site selection of geothermal energy power plants Structural properties of the local geology are presented T M

N81-18483 California Univ , Los Angeles
MILITARY WASTES-TO-ENERGY APPLICATIONS Ph.D. Thesis
Keith Eichi Kawaoka 1980 275 p
Avail Univ Microfilms Order No 8104006

Military waste material and byproduct stream and the potential for energy recovery and utilization are discussed Feedstock material includes municipal-type solid waste, selected installation hazardous waste and biomass residue Objectives are (1) analyze the characteristics of the military waste stream, (2) identify potential energy recovery options, and (3) examine and assess the technical and economic feasibility and environmental and institutional impacts of various energy recovery approaches Benefits of waste-to-energy conversion are (1) waste is utilized as a resource, (2) nonrenewable conventional fuels are conserved, (3) waste volume is reduced, (4) there are low sulfur oxide emissions from a combusted waste, (5) waste energy is a readily available and inexhaustible resource that reduces dependence on imported energy Dissert Abstr

N81-18513# Hawaiian Dredging and Construction Co , Honolulu
ENGINEERING AND ECONOMIC STUDIES FOR DIRECT APPLICATIONS OF GEOTHERMAL ENERGY IN AN INDUSTRIAL PARK IN PAHOA, HAWAII Quarterly Technical Progress Report
15 Oct 1980 7 p
(Contract DE-AC03-79ET-27233)
(DOE/ET-27233/T2, QTPR-4) Avail NTIS HC A02/MF A01

The use of geothermal heat for industrial applications is discussed in terms of economic and technical feasibility It is concluded that a direct heat geothermal industrial park located near Pahoa, Hawaii appears feasible DOE

N81-18517# Engineering Societies Commission on Energy, Inc , Washington, D C
REGIONAL CONVERSION TO COAL Final Report
Michael L McKimmey Mar 1980 119 p refs
(Contract EF-77-C-01-2468)
(FE-2468-63) Avail NTIS HC A06/MF A01

An investigation of powerplant coal conversion is described and the options and problems confronting a group of electric utility companies in an example region were examined The region selected for the study was New England, but the analysis format is valid for other regions having different specific conditions but facing the same general conversion mandates The report concludes that because of its physical characteristics, simple conversion to coal of a utility steam boiler unit designed for oil or gas is not feasible Boiler replacement of pre boiler coal liquefaction or gasification would be required to make the conversion to coal Coal oil mixture combustion is a promising concept for the partial displacement of oil that could have significant application in New England Coal derived synthetic boiler fuels, primarily liquids, could play a significant role in the conversion of existing units, but their availability in sufficient quantities by 1990 is doubtful The region s indigenous coal and hydropower resources are not expected to impact the energy mix by 1990, if ever DOE

N81-18525# AeroChem Research Labs , Inc , Princeton, N J
RATE COEFFICIENTS OF COMBUSTION/FUEL CONVERSION REACTIONS BY HIGH-TEMPERATURE PHOTOCHEMISTRY Progress Report, 1 Sep 1979 - 31 Aug 1980
William Felder Sep 1980 17 p refs
(Contract DE-AC02-77ER-04169)
(COO-4169-5, AeroChem-TN-214) Avail NTIS HC A02/MF A01

Reliable kinetic data on isolated elementary combustion reactions spanning a broad temperature range are required for modeling and scaling studies aimed at improving the performance of, and reducing the pollutant formation from fossil fuel burning devices High temperature photochemistry was developed to provide such data It combines the technology of the high temperature fast flow reactors developed to study kinetics of metal atom/oxide reactions in the 300 to 1900 K range with the methodology of the flash photolysis technique which, although used widely for study of such combustion reactions, was limited to studies at or near room temperature DOE

N81-18526# California Univ , Livermore Lawrence Livermore Lab
WIND-POWER SITE-SCREENING METHODOLOGY Final Report
J J Walton, C A Sherman, and J B Knox Oct 1980 66 p refs
(Contract W-7405-eng-48)
(UCRL-52938) Avail NTIS HC A04/MF A01

Principal components analysis techniques for classifying types of regional flow fields and a three dimensional diagnostic flow model were blended into a rotational for screening wind sites in the presence of complex terrain Relevant contributing capabilities, the developed screening methodology the prospectors preliminary wind resource maps for the island of Oahu generated to guide the development of the observational network, and the data base developed for testing are described The use of the methodology on the island of Oahu is illustrated and two annual assessments of Oahu's wind energy potential are described DOE

N81-18547# Utah Univ, Salt Lake City Dept of Geology and Geophysics
MANAGEMENT ASSISTANCE FOR THE DEVELOPMENT OF HYDROTHERMAL ENERGY IN THE ROCKY MOUNTAIN/BASIN AND RANGE REGION Final Report, 19 Oct. 1977 - 31 Dec. 1979
John R Bowman, Ronald L Bruhn, David S Chapman, Kenneth L Cook, Stanley H Evans, Jr, Gerald W Hohmann, William P Nash, Gary R Reynolds, William R Sill, Robert B. Smith et al Sep 1980 100 p refs
(Contracts DE-AC07-78ET-28392, EG-78-C-07-1701)
(DOE/ET-28392/T2) Avail NTIS HC A05/MF A01

Abstracts of forty-six reports on this contract are presented A comprehensive list of technical reports produced an geothermal resources sponsored by US DOE is included DOE

N81-18553# Gilbert Associates, Inc, Reading, Pa
RESEARCH AND EVALUATION OF BIOMASS RESOURCES/CONVERSION/UTILIZATION SYSTEMS (MARKET/EXPERIMENTAL ANALYSIS FOR DEVELOPMENT OF A DATA BASE FOR A FUELS FROM BIOMASS MODEL VOLUME 1: BIOMASS ALLOCATION MODEL Technical Progress Report, period ending 30 Sep. 1980
Yong K Ahn, Herbert T Chen, Richard W Helm, Eric T Nelson, and Kevin J Shields 1980 131 p refs
(Contracts DE-AC02-78ET-20611, ET-78-C-02-5022)
(DOE/ET-20611/14) Avail NTIS HC A07/MF A01

A biomass allocation model was developed to show the most profitable combination of biomass feedstocks thermochemical conversion processes, and fuel products to serve the seasonal conditions in a regional market This optimization model provides a tool for quickly calculating the most profitable biomass missions from a large number of potential biomass missions Other components of the system serve as a convenient storage and retrieval mechanism for biomass marketing and thermochemical conversion processing data The system can be accessed through the use of a computer terminal, or it could be adapted to a portable microprocessor A User's Manual for the system is included The validity of any biomass allocation solution provided by the allocation model is dependent on the accuracy of the data base The initial data base was constructed from values obtained from the literature, and, consequently, as more current thermochemical conversion processing and manufacturing costs and efficiencies become available, the data base should be revised DOE

N81-19258# Gulf Research and Development Co, Pittsburgh, Pa
INVESTIGATION OF MECHANISM OF HYDROGEN TRANSFER IN COAL HYDROGENATION Quarterly Progress Report, Mar. - May 1980
D C Cronauer and R G Ruberto Jul 1980 18 p refs
(Contract DE-AC22-80PC-30080)
(DOE/PC-30080/T1) Avail NTIS HC A02/MF A01

Emphasis is upon both hydrogen transfer fundamentals, namely, observing the rate of conversion, rate of hydrogen transfer, and the site of hydrogen transfer, and upon refining the techniques to measure hydrogen donor capacity A kinetic model was prepared which correlates the data of the liquefaction of two types of coals in the presence of good and poor hydrogen donor solvents This single kinetic model, which includes the reaction of coal + solvent (oil) yields more reaction coal, adequately explains the observed phenomena of a net consumption of solvent (for poor donor solvents) at low space times TM

N81-19312# Southwest Research Inst, San Antonio, Tex Army Fuels and Lubricants Research Lab
LUBRICANTS FOR COMBATING EFFECTS OF HIGH-SULFUR FUEL Interim Report
Edwin A Frame Jul 1980 150 p refs
(Contracts DAAK70-80-C-0001, DAAK70-78-C-0001, DA Proj 1L7-62733-AH-20)
(AD-A094900, AFLRL-127) Avail NTIS HC A07/MF A01 CSCL 11/8

Six lubricants were evaluated for their effectiveness in controlling the deleterious effects of using high-sulfur diesel fuel Two lubricants were identified which have potential to substantially reduce deleterious effects when operating on high-sulfur fuel A supplemental oil additive used in preservative engine oils was evaluated in three different lubricants with high-sulfur fuel GRA

N81-19316*# Pratt and Whitney Aircraft Group, East Hartford, Conn Commercial Products Div
AN ASSESSMENT OF THE USE OF ANTIMISTING FUEL IN TURBOFAN ENGINES Final Report, Sep. 1979 - Nov. 1980
A Florentino, R DeSaro, and T Franz Nov 1980 146 p refs
(Contract NAS3-22045)
(NASA-CR-165258, PWA-5697-29) Avail. NTIS HC A07/MF A01 CSCL 21D

The effects of antimisting kerosene on the performance of the components from the fuel system and the combustor of a JT8D aircraft engine were evaluated The problems associated with antimisting kerosene were identified and the extent of shearing or degradation required to allow the engine components to achieve satisfactory operation were determined. The performance of the combustor was assessed in a high pressure facility and in an altitude relight/cold ignition facility The performance of the fuel pump and control system was evaluated in an open loop simulation RCT

N81-19317# Energy and Minerals Research Co, Exton, Pa
EFFICIENT ULTRASONIC GRINDING: A NEW TECHNOLOGY FOR MICRON-SIZED COAL Quarterly Technical Progress Report, 16 Jun. - 15 Sep. 1980
W B Tarpley, Jr, P L Howard, and G R Moulder 1 Oct 1980 19 p
(Contract DE-AC02-79ER-10466)
(DOE/ER-10466/T1, QTPR-4) Avail NTIS HC A02/MF A01

The technical feasibility and economic promise of efficiently applying ultrasonic energy to the production of -10 micron coal fines is demonstrated It is shown that such a system could overcome the inherent inefficiency and economic penalty of mechanical grinding, while producing better size uniformity in the product An additional benefit associated with the mechanism of ultrasonic effect is the possibility of selective liberation of ash and pyrite inclusions DOE

N81-19327# Institute of Gas Technology, Chicago, Ill
PREPARATION OF A COAL CONVERSION SYSTEMS TECHNICAL DATA BOOK Annual Report, May 1978 - 30 Apr. 1979
Sep 1980 664 p refs
(FE-2286-48) Avail NTIS HC A99/MF A01

Two correlations of vapor-liquid equilibria in the NH3-H2S-H2O system were tested on experimental data for the system Correlations of the salting out coefficients of ammonia, carbon dioxide, and hydrogen sulfide at 25 C were developed The basic, physical, and thermodynamic properties of xylenols and decalins are given Enthalpies of distillate fractions of various syncrudes are presented and compared with correlations The combustion characteristics of solvent refined coal are summarized A report on the viscosity of slag is presented Application of a formula for calculating the heating value of coal to coal chars to new data indicated larger standard deviations than those for the original data bank. The general fundamental design information on a fixed (moving) bed coal gasifier is reviewed and the possibility of using a computer model to generate design information is investigated The problem of carbon deposition in methanators is reviewed In gas solids transport, correlations on pressure drop in dilute phase pneumatic conveyor and vertical dense phase transport in lift line are evaluated Processes for sulfur recovery in wastewater treatment and hydrocarbon incineration are described DOE

N81-19328# Chicago Univ, Ill
COAL TRANSFORMATION CHEMISTRY Quarterly Progress Report, 1 Mar - 31 May 1980
L M Stock 1980 20 p refs
(Contracts DE-AC22-80PC-30088, DE-AS02-77ET-10487)
(DOE/PC-30088/1, QPR-1) Avail NTIS HC A02/MF A01
The development of a procedure for the alkylation of Illinois No 6 coal in liquid ammonia is discussed Work on the chemistry of the liquefaction reaction indicates that phenolic compounds participate in free radical reactions in hydrogen donor solvents Phenolic compounds and benzoic acid derivatives do not function as acid catalysts in their reactions with tetralin and other representative compounds In addition, the reaction of styrene with tetralin at 400 C is shown to be a complex process involving rather deepseated chemical transformations DOE

N81-19331# Oregon Inst of Tech, Klamath Falls Geo-Heat Utilization Center
ETHANOL: A BRIEF ECONOMIC EVALUATION
Sep 1980 12 p
(Contract DE-FG06-79ET-27256)
(DOE/ET-27256/T7) Avail NTIS HC A02/MF A01
A 10 MW geothermal flash steam power plant is described A 10 million gallon per year ethanol plant is considered The initial feed to the plant would be corn, with sugar beets as a possible alternate feed The ultimate plan is to use waste products and biomass feed stocks Geothermal water would provide the necessary process heat for the plant The following conclusions are based on an ethanol plant that produces 10 million gallons of ethanol per year Over a 20 year period, the plant using a corn feed stock would generate a rate of return of +12% present on a total equility capital investment of $33,000,00 Over a 15 year period, the plant using a corn feed stock is probably not economically feasible since it would have a rate of return less than 12 percent or a total equity capital investment of $33,000,000 A corn feed stock plant operates at a loss for the first seven years if 95 percent of the $33,000,000 cost is debt financed The plant is economically feasible only if offsetting energy income from other profitable operation permits taking advantage of investment tax credits and depletion allowances that are available If this is true, the project is highly feasible, paying back twice the 5 percent equity capital in the first year DOE

N81-19332# Oak Ridge National Lab, Tenn Environmental Sciences Div
ENVIRONMETRICS OF SYNFUELS. 2: A COMPUTER-BASED CODING SCHEME FOR COAL-CONVERSION RESEARCH DATA
R H Strand, M P Farrell (Union Carbide Corp), T K Birchfield, C W Gudmundson (Union Carbide Corp), M E Vansuch (Union Carbide Corp), and H N Polovino (Union Carbide Corp) Jan 1981 26 p refs
(Contract W-7405-eng-26)
(ORNL/TM-7525, Pub-1602) Avail NTIS HC A03/MF A01
The need to reduce the complexity of data encoding and error rates in studies using multiple data bases composed of hierarchial file structures is addressed A coding scheme to represent long alphanumeric values, the efficiency of such a scheme, and error rate reduction are discussed It is found that codes without embedded information (nonsense codes) circumvent the problems associated with smart codes In addition, experience with several large environmental data bases indicates that coding errors are less frequent using nonsense codes than using smart codes Since no information is contained in the nonsense code and classification levels are not correlated, there is no tendency for a code recorder to assume that two apparently associated values should code with approximately the same numeric code, when in fact the values are unrelated The use of the FORMAT procedure in the Statistical Analysis System and of the nonsense code approach using variable labelling is presented The increased storage efficiencies for numerical codes versus long alphanumeric strings are discussed DOE

N81-19333# CH2M/Hill, Boise, Idaho
UTILIZATION OF GEOTHERMAL ENERGY FOR METHANE PRODUCTION FOR J. A. ALBERTSOND LAND AND CATTLE COMPANY Final Report
Jul 1980 201 p refs
(Contract DE-AC51-79ET-27230)
(DOE/ET-27230/T2) Avail NTIS HC A10/MF A01
The feasibility of an integrated system to utilize a geothermal resource for a bioconversion plant was studied This integrated facility would use the manure from approximately 30,000 head of feedlot cattle as a feedstock for an anaerobic digestion plant The findings on engineering design, geological assessment, environmental, economic, and institutional requirements of the proposed project are summarized DOE

N81-19334# Battelle Columbus Labs, Ohio
DEVELOPMENT OF SWEET SORGHUM AS AN ENERGY CROP. VOLUME 3: INTEGRATION CONCEPTS
D A. Scantland, W E. Riddle, T A McClure, P G Woodford, E J. Honton, and E S Lipinsky 12 Dec 1980 147 p refs
(Contract W-7405-eng-92)
(BMI-2054-Vol-3) Avail NTIS HC A07/MF A01
For the past 3 years, Batelle's Columbus Division and several coinvestigators conducted interregional investigations related to biomass and sugar production for conversion to alcohol and other fuels. These investigations emphasized primarily the production of sweet sorghum and sugar cane due to their ability to produce high biomass and readily fermentable sugars' yields which allow a highly favorable energy balance when converted to ethanol The objectives of the research include the following (1) to conduct a prefeasibility analysis of the potential for integrating sugarcane and sugar beet production/processing with sweet sorghum, and (2) to formulate an analytical approach to estimate the economic impact of growing sweet sorghum as an energy crop upon the US agricultural system This volume is comprised of two separate investigations pertaining to potential integration of sweet sorghum into US agriculture DOE

N81-19335# Conoco Coal Development Co, Library, Pa
ZINC HALIDE HYDROCRACKING PROCESS FOR DISTILLATE FUELS FROM COAL. VOLUME 1: SUMMARY AND CONTINUOUS BENCH STUDIES Final Report, Jan. 1975 - Nov. 1979
R. T Struck, C W Zielke, M Pell, J T Maskew, F Sim, W A Rosenhoover, and W E Clark 1 Dec 1980 337 p refs
(Contracts DE-AC01-76ET-10489, EX-76-C-01-1743)
(FE-1743-80-Vol-1) Avail NTIS HC A15/MF A01
The development of the Conoco process for liquefaction of coal using a pool of molten zinc chloride as catalyst is discussed Continuous bench-scale hydrocracking and regeneration units (1 kg/h) showed that both bituminous and subbituminous coals are operable and convert to high yields of gasoline and other distillates with unusually low nitrogen and sulfur contents A data base and a rate model were developed for Rosebud Seam subbituminous coal allowing conversions and product distributions to be predicted as functions of temperature, pressure, and residence time. Regeneration of the used catalyst was demonstrated giving 97(+)% removal of C, N, O, S and ash A secondary zinc recovery step was developed increasing the recovery to 99.7%. DOE

N81-19336# Mueller Associates, Inc., Baltimore, Md
ALTERNATIVE FUELS UTILIZATION AND THE AUTOMOTIVE EMISSION CERTIFICATION PROCESS
Washington DOE Mar 1980 43 p refs
(Contract DE-AC05-79CS-56051)
(DOE/CS-56051/T1) Avail. NTIS HC A03/MF A01
The Clean Air Act of 1977 requires that commercially offered automotive fuels and fuel additives be substantially similar to fuels used in certifying model year 1975 and later vehicles. Procedures for certifying that vehicles perform with emissions that meet the Clean Air Act specifications and the impact of this emissions certification process on the use of alternative fuels, such as alcohols, alcohol-gasoline blends and synthetic fuels in highway vehicles is discussed. DOE

N81-19337# PRC Energy Analysis Co., McLean, Va
BIOMASS ENERGY SYSTEMS PROGRAM SUMMARY, INFORMATION CURRENT AS OF SEPTEMBER 30, 1979
Oct. 1980 189 p
(Contract DE-AC01-77ET-21059)
(DOE/CS-21059/01) Avail. NTIS HC A09/MF A01

This program summary describes each of the DOE's Biomass Energy System's projects funded or in existence during fiscal year 1979 and reflects their status as of September 30, 1979 The summary provides an overview of the ongoing research, development, and demonstration efforts of the preceding fiscal year as well. DOE

N81-19340# NEUS, Inc, Santa Monica, Calif
BIOSOURCES DIGEST, A JOURNAL ON BIOMASS UTILIZATION, VOLUME 2, NUMBER 3, JULY 1980 Quarterly Report
Harry Sobel, ed Jul 1980 63 p refs
(Grant NSF PFR-77-12500)
(PB81-123952, NSF/RA-800222-VOL-2) Avail NTIS HC A04/MF A01 CSCL 21D

Grant awards listed in this issue include the following: lignocellulose-transforming microorganisms, pyrolytic conversion of lignocellulosic materials, lipids from microalgae, rubber analysis and guayule seed selection, regulation of rubber formation in guayule plants, chemical stimulation and breeding improvement of rubber yield in guayule hydrocarbon-producing plants as potential multi-use crops, and an animal waste management system for the 1980's GRA

N81-19342# TRW, Inc, McLean, Va Energy Systems Planning Div
ENERGY BALANCES IN THE PRODUCTION AND END-USE OF ALCOHOLS DERIVED FROM BIOMASS
Oct 1980 141 p refs Sponsored in part by DOE Washington, D C
(PB81-125585, NAFC-80-10) Avail NTIS HC A07/MF A01 CSCL 21D

The utility of converting one form of energy into another more valuable form is considered Net fuel gain is defined, for the purpose of the savings in fuels (with special attention to premium fuel) obtained by substituting biomass derived ethanol (grain, woody-biomass, MSW, etc) for a given end-use of a premium fuel Six cases, encompassing three feedstocks five process fuels, and three process variations are examined For each case, two end-uses (automotive fuel use and replacement of petrochemical feedstocks) are scrutinized Energy requirements calculated for the six process cycles accounted for fuels used in all stages of alcohol production, from agriculture through distribution of products to the end-user GRA

N81-19539# Sandia Labs, Albuquerque, N Mex
STRATEGIC PETROLEUM RESERVE DATA ACQUISITION SYSTEM
P D Merillat and A G Bauer Oct 1980 180 p
(Contract DE-AC04-76DP-00789)
(SAND-80-2143) Avail NTIS HC A09/MF A01

The Strategic Petroleum Reserve Data Acquisition System is a general purpose, digital data acquisition system designed for field use in DOE's Strategic Petroleum Reserve testing and monitoring program The system is computer driven, under the control of an operator The system is designed to allow the operator to perform pre-test system configuration, test monitoring and control and post test analysis This document is a system description and an operator users manual Topics covered include configuration and running on-line tests, software documentation, and maintenance programming information DOE

N81-19540# Science Applications, Inc, McLean, Va
HEAVY OIL RESERVOIRS RECOVERABLE BY THERMAL TECHNOLOGY Annual Report
Patrick Kujawa Feb 1981 339 p refs Prepared in cooperation with DOE, Oakland, Calif
(Contract DE-AC03-78ET-12380)
(DOE/ET-12380/1-Vol-3) Avail NTIS HC A15/MF A01

Reservoir, production, and project data are presented for target reservoirs thermally recoverable by steam drive which are equal to or greater than 2500 feet deep and contain heavy oil in the 8 to 25(0) API gravity range Data were sought depicting and characterizing individual reservoirs as opposed to data covering an entire field with more than one producing interval or reservoir DOE

N81-19541# North Carolina Univ, Chapel Hill Dept of Geology
PEAT RESOURCES OF NORTH CAROLINA Annual Report
Lee J Otte and Ray L Ingram Nov 1980 65 p
(Contract DE-AC01-79ET-146933)
(DOE/ET-14693/T1) Avail NTIS HC A04/MF A01

Peat deposits of North Carolina are of three main geological types representing the accumulation of organic matter in pocosins - broad shallow depressions on an uplifted sea floor, river flood plains, and Carolina Bays - elliptical depressions of unknown origin Pocosin deposits normally range in thickness from 1 to 8 feet River flood plain peats are of unknown extent They occur as lenses in alluvial sands and clays and may attain thickness of 20 feet The ash content usually exceeds 10 percent Five to six hundred Carolina Bays from 0 2 to 3 miles in length are scattered over the Coastal Plain DOE

N81-19553# Institute of Gas Technology Chicago, Ill
ANALYSIS OF GEOPRESSURED AQUIFERS Annual Report, 1979
Mark G Doherty Jun 1980 64 p refs
(PB81-123416, GRI-79/0040) Avail NTIS HC A04/MF A01 CSCL 08I

The purpose of this project is to assemble data to analyze the possibility of natural gas production from watered-out geopressured gas cap wells and hydropressured aquifers The technical and economic feasibility of hydraulically fracturing a tight geopressured aquifer to increase reservoir permeability as well as gas production were examined GRA

N81-19563# Aeronautical Research Labs, Melbourne (Australia)
WIND ENERGY - HOW RELIABLE
Douglas J Sherman Jan 1980 36 p refs
(AD-A094988, ARL/STRUC-380) Avail NTIS HC A03/MF A01 CSCL 04/2

The reliability of a wind energy system depends on the size of the propeller and the size of the back-up energy storage Design of the optimum system for a given reliability level can be performed if a time series of wind speed data is available However, a design based on conventional meteorological records, which sample the wind speed with a ten minute averaging time at three-hourly intervals, will over-estimate the storage by a factor of approximately 2, and if the wind speed is only available on a daily basis the storage will be over-estimated by a factor of 2 5 to 4 0 This is because a propeller can respond to wind speed changes in much less than ten minutes and also because three-hourly sampling does not often pick up the brief high-speed incidents which generate a significant part of the wind energy A nomogram is presented, based on some continuous wind speed measurements, which enables storages calculated from three-hourly or daily data to be appropriately reduced because of these two effects GRA

N81-19588# Oak Ridge National Lab, Tenn Fossil Energy Program
FOSSIL ENERGY PROGRAM Quarterly Progress Report, period ending 30 Sep. 1980
L E McNeese Jan 1981 348 p refs
(Contract W-7405-eng-26)
(ORNL-5702) Avail NTIS HC A15/MF A01

Progress is reported for the period July 1 through September 30 for the Oak Ridge National Laboratory research and development projects that are carried out in support of the increased utilization of coal and other fossil fuels as sources of clean energy These projects are supported by various parts of DOE including Fossil Energy, Basic Energy Sciences, Office of Health and Environmental Research, Office of Environmental Compliance and Overview, Economic Regulatory Administration, Power Research Institute, and by the Tennessee Valley Authority and the EPA Office of Research and Development through interagency agreements DOE

N81-19597# Oregon Inst of Tech., Klamath Falls Geo-Heat Utilization Center
ALASKA: A GUIDE TO GEOTHERMAL ENERGY DEVELOPMENT
N Basescu, R Gordon Bloomquist, Charles Higbee, Debra Justus, and Stuart Simpson Jun 1980 117 p refs Prepared in cooperation with Alaska State Div of Energy and Power Development
(Contract DE-AS06-77ET-28476)
(DOE/ET-28476/T12) Avail NTIS HC A06/MF A01
Alaska's geothermal potential, exploration, drilling, utilization, and legal and institutional setting are covered. Economic factors of direct use projects are discussed. DOE

N81-19598# Oregon Inst of Tech, Klamath Falls Geo-Heat Utilization Center
OREGON: A GUIDE TO GEOTHERMAL ENERGY DEVELOPMENT
Debra Justus, Neil Basescu, R Gordon Bloomquist, Charles Higbee, and Stuart Simpson Jun 1980 121 p refs
(Contract DE-AS06-77ET-28476)
(DOE/ET-28476/T11) Avail NTIS HC A06/MF A01
Oregon's geothermal potential exploration, drilling, utilization, legal and institutional setting are covered Economic factors of direct use projects are discussed DOE

N81-19616# Science Applications, Inc, McLean, Va
HEAVY OIL RESERVOIRS RECOVERABLE BY THERMAL TECHNOLOGY Annual Report
Patrick Kujawa Feb 1981 178 p Prepared in cooperation with DOE, Oakland, Calif
(Contract DE-AC03-78ET-12380)
(DOE/ET-12380/1-Vol-1) Avail NTIS HC A09/MF A01
Data are presented on reservoirs that contain heavy oil in the 8 to 25(0) API gravity range, contain at least ten million barrels of oil currently in place, and are noncarbonate in lithology The reservoirs within these constraints were analyzed in light of applicable recovery technology, either steam drive or in situ combustion, and then ranked hierarchically as candidate reservoirs An extensive basis for heavy oil development is provided, however, it is recommended that data on carbonate reservoirs, and tar sands be compiled It was discovered that operators, and industrial and government analysts will lump heavy oil reservoirs as poor producers, however, it was found that upon detailed analysis, a large number, so categorized, were producing very well A big problem in producing heavy oil is that of regulation, specifically, it was found that the regulatory constraints are so fluid and changing that one cannot settle on a favorable recovery and production plan with enough confidence in the regulatory requirements to commit capital to the project DOE

N81-19617# Science Applications, Inc, McLean, Va
HEAVY OIL RESERVOIRS RECOVERABLE BY THERMAL TECHNOLOGY Annual Report
P Kujawa Feb 1981 529 p refs
(Contract DE-AC03-78ET-12380)
(DOE/ET-12380/1-Vol-2) Avail NTIS HC A23/MF A01
Reservoir, production, and project data for target reservoirs which contain heavy oil in the 8 to 25(0) API gravity range and are susceptible to recovery by in situ combustion and steam drive are presented The reservoirs for steam recovery are less than 2500 feet deep to comply with state of the art technology In cases where one reservoir would be a target for in situ combustion or steam drive, that reservoir is reported in both sections Data were collected from three source types hands-on, once removed, and twice removed In all cases, data were sought depicting and characterizing individual reservoirs as opposed to data covering an entire field with more than one producing interval or reservoir The data sources are listed at the end of each case A complete listing of operators and projects is included as well as a bibliography of source material DOE

N81-19699# Sandia Labs, Albuquerque, N Mex Geothermal Research Div
KILAUEA IKI LAVA LAKE EXPERIMENT PLANS
J C Dunn and R G Hills Jan 1981 64 p refs
(SAND-80-1653) Avail NTIS HC A04/MF A01
Twelve experimental studies are proposed to complete field laboratory work at Kilauea Iki lava lake Of these twelve experiments, eleven do not require the presence of melt Some studies are designed to use proven techniques in order to expand our existing knowledge, while others are designed to test new concepts Experiments are grouped into three main categories geophysics, energy extraction, and drilling technology Each experiment is described in terms of its location, purpose, background, configuration, operation, and feasibility DOE

N81-20202 Pennsylvania State Univ, University Park
CLASSIFICATION OF PETROLEUM SAMPLES FROM GAS CHROMATOGRAPHIC DATA BY PATTERN RECOGNITION TECHNIQUES AND SIMULATION OF MASS SPECTRA BY REGRESSION ANALYSIS OF STRUCTURAL DESCRIPTORS Ph.D. Thesis
Hayden Adams Clark 1980 148 p
Avail Univ Microfilms Order No 8105709
A study of the classification of petroleum samples using pattern recognition analysis of gas chromatographic data was performed A set of 42 gas chromatograms of petroleum samples was voded using 19 descriptors peak heights above unresolved background of the normal alkanes from nC14 through nC25 peak heights of the branched alkanes pristane and phytane and five ratios of these 14 raw descriptors A linear learning machine, a heuristic method of finding a discriminant function, was trained to recognize samples and predict unknowns Predictive abilities of 87 to 100 percent were obtained K nearest neighbor classifications were made for comparison Further study, using data from both weathered and unweathered samples confirmed that samples could be recognized correctly when the samples were of like origin and weathering history Four types of oil were represented by gas chromatograms taken before and after artificial weathering Dissert Abstr

N81-20226# Castle Technology Corp, Lexington, Mass
SURVEY OF ELECTROCHEMICAL PRODUCTION OF INORGANIC COMPOUNDS Final Report
J Paul Pemsler and Robert A Spitz Oct 1980 145 p refs
(Contract W-31-109-eng-38)
(ANL/OEPM-80-3) Avail. NTIS HC A07/MF A01
The electrochemical generation of inorganic compounds, excluding chlorine/caustic, was critically reviewed About 60 x 10 to the 12th power Btu/y fossil fuel equivalent will be used in the year 2000 for the electrosynthesis of inorganic compounds Significant energy savings in chlorate production results from the development of suitable electrocatalysts for lowering the cathodic overpotential Perchlorates, electrolytic hypochlorite, electrolytic manganese dioxide, fluorine and other miscellaneous compounds use relatively small amounts of electrical energy Implementation of caustic scrubber technology for stack gas cleanup results in appreciable amounts of sodium sulfate which are electrolyzed to regenerate caustic Hydrogen peroxide, now produced by the alkyl anthraquinone process, is made electrolytically by coupling anodic oxidation of sulfate with cathodic reduction of oxygen in alkaline solution A novel energy efficient approach which uses an oxygen enhanced anodic reaction is examined DOE

N81-20227# Duquesne Light Co, Pittsburgh, Pa Dept of Chemistry
HYDROGEN BONDING IN ASPHALTENES AND COAL LIQUIDS Quarterly Report, 1 Aug. - 31 Oct. 1980
N. C Li, L Jones, and N F Yaggi 1980 37 p refs
(Contract DE-AC22-80PC-30252, Grant PHS-RR-00292)
(DOE/PC-30252/T1) Avail NTIS HC A03/MF A01
A coal derived liquid (SRC-2) and its fractions were characterized by 600 MHz(1)H NMR spectrometer The saturate fraction, being 8.1% by weight of unfractionated coal-liquid, is mainly composed of n-alkanes of high carbon numbers and the content of cycloalkanes is negligible The aromatic fraction (49 0%) contains a considerable amount of partially hydrogenated polynuclear compounds Double resonance techniques were used for chemical shift identification of beta-CH2 and alpha-CH2

protons attached to aromatic ring structures The decoupled signals may be used for quantitative analysis of donor hydrogens, which are known to be effective in hydrogen transfer phenomenon in coal liquefaction processes The aromatic fraction contains larger amounts of CH3 groups attached to condensed aromatic ring structures, which appear as singlets in the region of 2 4 to 2 7 ppM, whereas in acidic fractions almost all benzylic CH3 groups are attached to mono-aromatic ring structures DOE

N81-20290# Logistics Management Inst, Washington, D C
THE DEVELOPMENT OF SYNTHETIC FUELS: DEPARTMENT OF DEFENSE LOGISTICS IMPLICATIONS Final Report
Connelly D Stevenson Nov 1980 35 p
(Contract MDA903-77-C-0370)
(AD-A095713, LMI-ML010) Avail NTIS HC A03/MF A01
CSCL 21/4

The Department of Defense (DoD) has been testing synthetic fuels, especially shale oil, since 1970 The DoD regards synthetic fuels as potential alternative liquid hydrocarbon energy source, especially for mobility applications The Energy Security Act (ESA) requires the DoD to consume a substantial portion of the initial output of synthetic fuels in order to provide a guaranteed market for the new industry It is impossible to predict the synthetic fuel production rate growth The DoD should make incremental flexible projections of synthetic fuel use rates, both for testing and for operational applications, in order to carry out its ESA responsibilities and simultaneously to exploit the synthetic fuels potential GRA

N81-20292# Utah Univ, Salt Lake City Dept of Mining and Fuels Engineering
APPLIED RESEARCH AND EVALUATION OF PROCESS CONCEPTS FOR LIQUEFACTION AND GASIFICATION OF WESTERN COALS Final Report, 1 Jun. 1975 - 31 Jul. 1980
W H Wiser Sep 1980 311 p refs
(Contracts DE-AC01-76ET-10527, E(49-18)-2006)
(DOE/ET-10527/T1) Avail NTIS HC A14/MF A01

An attempt was made to conduct the process of converting coal to methane at temperatures below 500 C in a single reactor The various parameters and factors are investigated, including commercially available catalysts, which might make such a process possible The results from the single stage gasification process with nickel-moly on alumina as a catalyst, a reactor temperature of 500 C, and a hydrogen pressure of 1000 psi are gases 41 3%, liquids 39 4%, and char 19 3% The overall conversion of liquids and gases is comparable to the conversion in two stages, however, the liquid yields are higher in the single stage process and yields of ethane are slightly higher than the yields of methane RCT

N81-20293# Computer Sciences Corp, Washington, D C
OFFICE OF ALCOHOL FUELS PROGRAM PLAN, FY 1981
Oct 1980 122 p
(Contract DE-AC01-79CR-10001)
(DOE/AF-10001/T2) Avail NTIS HC A06/MF A01

The goal of the Office of Alcohol Fuels is to promote the production, distribution, and use of alcohol fuels The program objectives are defined and the strategy for implementation is described An organizational model of the operation is included The roles of the 3 program offices and various field offices are described DOE

N81-20296# Rockwell International Corp, Canoga Park, Calif Energy Systems Group
***MOLTEN SALT COAL GASIFICATION PROCESS DEVELOPMENT UNIT, PHASE 1. VOLUME 1. PDU OPERATIONS* Final Report**
A L Kohl May 1980 244 p
(Contract DE-AC03-77ET-10296)
(DOE/ET-10296/66-VOL-1) Avail NTIS HC A11/MF A01

Five extended test runs were made The observed product gas composition was quite close to that predicted on the basis of earlier small scale tests and thermodynamic considerations All plant systems were operated in an integrated manner during one of the runs The principal problem encountered during the five test runs was maintaining a continuous flow of melt from the gasifier to the quench tank Test data and discussions regarding plant equipment and process performance are presented The program also included a commercial plant study which showed the process to be attractive for use in a combined cycle, electric power plant DOE

N81-20297# Department of Energy, Washington, D C Div of Fossil Fuel Processing
COAL CONVERSION 1979 TECHNICAL REPORT
Sep 1980 179 p refs
(DOE/FE-0010) Avail NTIS HC A09/MF A01

Individual reports are made on research programs which are being conducted by various organizations and institutions for the commercial development of processes for converting coal into products that substitute for those derived from oil and natural gas Gasification, liquefaction, and demonstration processes and plants are covered DOE

N81-20301# Brookhaven National Lab, Upton, N Y Dept of Energy and Environment
FLASH PYROLYSIS AND HYDROPYROLYSIS OF COAL
Meyer Steinberg and Bharat Bhatt Oct 1980 22 p refs
Presented at the Specialist Workshop on Fast Pyrolysis of Biomass, Copper Mountain, Colo, 20 Oct 1980
(Contract DE-AC02-76CH-00016)
(BNL-28577, CONF-8010126-1) Avail NTIS HC A02/MF A01

Rapid pyrolysis of coal usually produces larger yields of volatile matter including liquid and gaseous hydrocarbons than slow pyrolysis Rapid pyrolysis in vacuum or with an inert atmosphere yields lower conversions of coal to liquid and gaseous hydrocarbons than hydropyrolysis in a hydrogen atmosphere Pyrolysis in a higher pressure inert atmosphere tends to decrease overall yields Rapid pyrolysis in an inert atmosphere produces larger amounts of heavier liquids and tars than hydropyrolysis Hydropyrolysis at higher hydrogen pressures produces higher overall yields Rapid pyrolysis at higher temperatures tends to decrease yields and produce lower molecular weight species Rapid hydropyrolysis at higher temperatures produces more gaseous hydrocarbons and lower liquid yields There are optimum residence times for maximizing either liquid or gaseous yields Pyrolysis in an inert atmosphere at longer residence times tend to increase coversions but then becomes constant after devolatilization is complete DOE

N81-20302# Bechtel National, Inc, San Francisco, Calif
COAL PREPARATION USING MAGNETIC SEPARATION. VOLUME 5: EVALUATION OF MAGNETIC COAL DESULFURIZATION CONCEPTS Final Report
F V Karlson, H Huettenhain, M Epstein, O N Degiovanni, and P J Chassagne Jul 1980 187 p refs
(EPRI Proj 980-5)
(EPRI-CS-1517-Vol-5) Avail NTIS HC A09/MF A01

Magnetic separator designs performed by four contractions were reviewed A complete plant conceptual design was developed, based on high gradient magnetic separator (HGMS) designs proposed by Sala Magnetics, Inc, and the Magnetic Corporation of America (MCA) A design for a conventional heavy medium plant was also developed and costed to establish a point of comparison for the HGMS designs The HGMS design provided by Sala is based on their commercial operating experience in the iron ore concentration industry and operation of a one ton/hour continuous pilot plant, while the superconducting HGMS proposed by MCA represents a conceptual design based on bench scale data The three plants were designed to clean 2 64 million tons/year of feed and produce approximately 2 2 million tons/year of clean coal Also, a technical review of the Magnex process as developed by Nedlog Technology Group/Hazen Research, Inc, was performed DOE

N81-20304# Rockwell International Corp, Canoga Park, Calif Energy Systems Group
COAL HYDROGASIFICATION PROCESS DEVELOPMENT Quarterly Technical Progress Report, 1 Oct. - 31 Dec. 1980

L P Combs, L S Breese, D R Kahn, M D Schuman, C W Adamson, and W T Lee Jan 1981 41 p refs
(Contracts DE-AC01-78ET-10328, ET-78-C-01-3125)
(DOE/ET-10328/27) Avail· NTIS HC A03/MF A01

A program schedule delineating the breakdown of the overall program into tasks and logical subtasks and time-phased relationships among them is shown The major tasks are summarized Task I is concerned with the engineering-scale testing Task II is concerned with design, construction, and testing Task III provides for process optimization studies and for preliminary design of a commerical plant DOE

N81-20305# Oak Ridge National Lab, Tenn Environmental Sciences Div
ENVIRONMETRICS OF SYNFUELS. 1: PROCESSING THE AUTOMATED PDP-11 DATA COMPONENTS FOR THE UMD GASIFIER FACILITY
R H Strand, M. P Farrell, C W Gudmundson (Union Carbide Corp), T K Birchfield (Union Carbide Corp), S S Casada (Union Carbide Corp), and M E Vansuch (Union Carbide Corp) Jan 1981 34 p
(Contract W-7405-eng-26)
(ORNL/TM-7428) Avail NTIS HC A03/MF A01

This report summarizes the techniques and procedures used to handle automated data collected at the University of Minnesota-Duluth (UMD) campus coal gasification facility This facility, which is partially funded by the Department of Energy, is being evaluated by scientists at Oak Ridge National Laboratory (ORNL) for its potential health and environmental effects Automatic data collections and manually collected and sample results data are used for this assessment A data management project at ORNL handles these and other UMD data for the Gasifiers in Industry Program The procedures developed within the data management project for handling two categories of automated data are documented The examples use actual data from the first one and a half years of gasifier operation DOE

N81-20306# Arizona State Univ, Tempe Coll of Engineering and Applied Sciences
CONVERSION OF CELLULOSIC WASTES TO LIQUID FUELS Interim Report
J L Kuester Sep 1980 74 p refs
(Contracts DE-AS02-76CS-40202, EY-76-S-02-2982)
(COO-2982-57) Avail NTIS HC A04/MF A01

A project to convert waste cellulosic (biomass) materials to quality liquid hydrocarbon fuels is described The basic approach is indirect liquefaction, i e, thermal gasification followed by catalytic liquefaction The indirect approach results in separation of the oxygen in the biomass feedstock, i e, oxygenated compounds do not appear in the liquid hydrocarbon fuel product The process is capable of accepting a wide variety of feedstocks Potential products include medium quality gas, normal propanol, diesel fuel and/or high octane gasoline A fluidized bed pyrolysis system is used for gasification The pyrolyzer can be fluidized with recycle pyrolysis gas, steam or recycle liquefaction system of gas or some combination thereof The tasks specified were (1) feedstock studies, (2) gasification system optimization, (3) waste stream characterization, and (4) liquid fuels synthesis DOE

N81-20525# Sandia Labs, Albuquerque, N Mex
COMPARATIVE ASSESSMENT OF FIVE POTENTIAL SITES FOR HYDROTHERMAL-MAGMA SYSTEMS: SUMMARY
W C Luth and H C Hardee Nov 1980 54 p
(Contract DE-AC04-76DP-00789)
(DOE/TIC-11303) Avail NTIS HC A04/MF A01

Five potential hydrothermalmagma sites were assessed the Geysers-Clear Lake, Ca; Long Valley, Ca, Rio Grande Rift, NM, Roosevelt Hot Springs, Ut, and Salton Trough, Ca Background information (geology, geochemistry, geophysics, and energy transport) was gathered on the five sites as a preliminary stage to site selection Criteria for site selection are that potential sites have identifiable, or likely, hydrothermal systems and associated magma sources, and the important scientific questions can be identified and answered by deep scientific holes Recommendations were made DOE

N81-20562# New Zealand Energy Research and Development Committee, Auckland
ENGINEERING STUDY OF PELLETING WASTE PAPER FOR ENERGY RECOVERY Final Report
1980 11 p refs
(NZERDC-53, ISSN-0110-1692) Avail NTIS HC A02/MF A01

Scientific work completed by the Environmental Ethics Trust is reported As the production of pellets, the source of raw material, and the burning characteristics were already established by the Trust, the report concentrates on the economics of production as being one of the two critical factors not yet established These costs are given for various throughputs to determine the most economic production rate and to establish likely production costs with a given source of raw material The other critical factor discussed is the possible market for the pellets, for without a market, the economics of the process are meaningless DOE

N81-20565# VIAK A.B, Vaellingby (Sweden).
ENERGY OUT OF GROUNDWATER
Torgny Agerstrand and Lars O Eriksson Mar 1980 42 p refs In SWEDISH
(NE/HETV-80/9) Avail NTIS HC A03/MF A01

The purpose of this inventory is to estimate those energy resources of the built-up area which are stored in aquifers with good tapping facilities It is presumed that the energy is extracted by conventional heat pump technique in a relatively big scale The following conditions have to be met (1) adequate access to ground water having ample and stable temperature, (2) facilities to exploit the ground water at a lower temperature, (3) a well built-up residential area, and (4) access to reasonably priced momentum power for the heat pump The total power requirement per tenement will be 5 kW Thus 295,000 tenements in build-up areas can be supplied with heat to 90 percent of their yearly requirement by means of energy from ground water and the heat pump Conflict of interests reduce the coverage to 184,000 tenements DOE

N81-20571# Toledo Metropolitan Area Council of Governments, Ohio
GROUNDWATER AS AN ALTERNATIVE ENERGY SOURCE FOR SPACE HEATING AND COOLING, GEOTHERMAL HEAT EXTRACTION
Jul 1980 37 p refs
(Contract W-31-109-eng-38)
(DOE/TIC-11367, INFORMATION-5) Avail NTIS HC A03/MF A01

The technology of the groundwater heat pump (GWHP), its applicability to the Toledo metropolitan area council of governments region, and relative economics of its use are addressed The operation of the GWHP in both the heating and cooling modes is discussed as well as its advantages and disadvantages A comparison is made between GWHP and other heating and cooling systems both in operation and cost A detailed analysis is given to the legal implications of direct groundwater use and its related impacts RCT

N81-20580# Los Alamos Scientific Lab, N Mex
BASIC RESEARCH NEEDED FOR THE DEVELOPMENT OF GEOTHERMAL ENERGY
R. L Aamodt and R E Riecker Oct 1980 22 p refs
(Contract W-7405-eng-36)
(LA-8562-MS) Avail NTIS HC A02/MF A01

Basic research needed to facilitate development of geothermal energy is identified The present state of knowledge of geothermal energy is presented and specific recommendations for further research, with status and priorities are listed Discussion is limited to a small number of applicable concepts, namely origin of geothermal flux, transport of geothermal energy, geothermal reservoirs, rock water interactions, and geophysical and geochemical exploration DOE

N81-20581# Lund Univ (Sweden)
MARINE BIOMASS: ALGAE AS SOURCE OF ENERGY
Lars Edler, Torgny vonWachenfeldt, and Lars Emmelin Apr 1980

115 p refs In SWEDISH
(NE/BIO-80/12) Avail NTIS (US Sales only) HC A06/MF A01

Calculations based on data from laboratory and field measurements indicate that a production of as much as 115 tons of algae (dry matter) per hectare and year could be achieved Culture of marine algae along the Swedish coast would probably take place in shallow, sheltered waters Using a succession of naturally occuring species a growing season of 240 days could be achieved With a production of 115 tons dm ha/1 year/1 an output of approximately 110 MWhT ha/1 year/1 of methane gas would be feasible using anaerobic fermentation The area of the Baltic inside the 5 m depth curve is 19,000 sq km If 10% of this area were available, a production of around 20 TWhT of gas annually would be the maximum potential of the system A system is described for growing algae in the shallow marine environment Energy analysis of the system indicates that approximately 5% of the energy output from an algae based methane plant would be required for growth, harvesting and conversion to methane DOE

N81-20592# GEOMET, Inc, Gaithersburg, Md
WIND ENERGY RESOURCE ATLAS. VOLUME 4: THE NORTHEAST REGION
K E Pickering, J M Vilardo, J T Schakenbach, D L Elliott (Pacific Northwest Lab), W R Barchet (Pacific Northwest Lab), and R L George (Pacific Northwest Lab) Sep 1980 228 p refs
(Contract DE-AC06-76RL-01830)
(PNL-3195-WERA-4) Avail NTIS HC A11/MF A01

This atlas is composed of introductory and background information, a regional summary of the wind resource, and assessments of the wind resource in each state of the region Background is presented on how the wind resource is assessed and on how the results of the assessment should be interpreted A description of the wind resource on a regional scale is then given The results of the wind energy assessments for each state are assembled in this chapter into an overview and summary of the various features of the regional wind energy resource An introduction and outline are provided for in the descriptions of the wind resource given for each state Assessments for individual states are presented The state wind energy resources are described in greater detail than is the regional wind energy resource, and features of selected stations are discussed DOE

N81-21153# State Univ of New York, Buffalo Dept of Chemical Engineering
HYDROGEN-METHANE SEPARATION PROCESSES AND RELATED PHENOMENA
J T Saunders, S S Wang, and R T Yang Jan 1981 50 p refs
(Contract DE-AC21-80MC-14386)
(DOE/METC-14386/106) Avail NTIS HC A03/MF A01

A literature survey on processes for separating hydrogen and methane is presented This was done in conjunction with work developing a more energy efficient and lower cost process based on cyclic, fixed bed processes using coal chars as the sorbents Although the review has covered all hydrocarbon separation processes, the focuses were on physical adsorption phenomena and theories (for both single and mixed gases), surface and pore characteristics of coals and heat-treated coals, and the continous or semi continuous chromatographic separation methods Processes of hydrocarbon separation based on absorption/desorption competitive adsorption, the cyclic (including parametric pumping) processes, absorption on coal chars, and absorption on raw coals are investigated J D H

N81-21154# State Univ of New York, Buffalo School of Engineering and Applied Science
CATALYTIC COMBUSTION OF SYNTHETIC FUELS Semiannual Report, 1 Aug. 1980 - 31 Jan. 1981
L A Kennedy and Eli Ruckenstein 1981 6 p
(Contract DE-FG22-80PC-30220)
(DOE/PC-30220/T1) Avail NTIS HC A02/MF A01

The efforts on this project were directed towards three goals (1) catalyst development (2) preliminary measurements of fuel bound nitrogen conversion, and (3) design of a droplet injector and vaporization section for use with SRC-II liquids An experimental apparatus was designed to examine NO conversion in a catalytic combustor Argon-oxygen is the oxidizing gas Minimizing conversion of fuel nitrogen to nitrogen oxides is the aim of this task A multiport injector for coal derived liquid fuels is being designed J D H

N81-21179# Oak Ridge National Lab, Tenn
STRESS CORROSION STUDIES IN SOLVENT REFINED COAL LIQUEFACTION PILOT PLANTS
V B Baylor, J R Keiser, M D Allen, and E J Lawrence Dec 1980 48 p refs
(Contract W-7405-eng-26)
(ORNL/TM-7513) Avail NTIS HC A03/MF A01

The causes of stress corrosion cracking in solvent refined coal (SRC) reactor materials are examined To screen candidate materials of construction for resistance to stress corrosion cracking, racks of stressed U bend specimens in welded and as wrought conditions were exposed at the Wilsonville and Fort Lewis SRC pilot plants Alloys that are suitable for critical plant applications were identified DOE

N81-21217# Department of Energy, Grand Forks, N Dak Grand Forks Energy Technology Center
OBSERVATIONS ON TEST STOCKPILES OF DRIED LIGNITE AND SUBBITUMINOUS COALS
S. A Cooley, L E Paulson, and R C Ellman 1981 14 p refs
(DOE/GFETC/RI-80/5) Avail NTIS HC A02/MF A01

Dried low rank coal stockpiles were monitored from 1974 to 1980 Moisture content, heating value, and pile temperature showed little changes since compaction Indications are that dried coal can be stockpiled for extended periods DOE

N81-21218# Air Products and Chemicals, Inc, Allentown, Pa
CRYOGENIC METHANE SEPARATION/CATALYTIC HYDROGASIFICATION PROCESS ANALYSIS Quarterly Report
J. Klosek 2 Dec. 1980 17 p
(Contract DE-AC01-78ET-10325)
(DOE/ET-10325/T3) Avail. NTIS HC A02/MF A01

Trade-off and optimization studies are reported for the Short Residence Time Hydrogasification (SRTH) and the Catalytic Coal Gasification (CCG) processes in the acid gas removal and cryogenic separation areas Subtasks include block flow sheet, overall heat and material balance, utility summary, four-line equipment description, investment and treatment cost summaries and final report writing in addition to monthly and quarterly reports DOE

N81-21220# Department of Energy, Washington, D C
ALTERNATIVE FUELS PRODUCTION PROGRAM Semiannual Report
Nov 1980 188 p
(DOE/RA-0058/2) Avail NTIS HC A09/MF A01

The provisions of Public Law 96-126 and subsequent legislation by Congress, applicable to the alternative fuels production program are described Emphasis is placed on program strategies and objectives as well as specific implementation approaches Results of several feasibility studies conducted under the program are presented R.C T

N81-21222# Gulf Research and Development Co, Pittsburgh, Pa
INVESTIGATION OF THE LIQUEFACTION OF PARTIALLY DRIED AND OXIDIZED COALS Final Report
D C Cronauer, R G Ruberto, R S Silver, R J Jenkins (Pennsylvania State Univ), and A Davis (Pennsylvania State Univ) Nov 1980 177 p refs Sponsored by Electric Power Research Inst
(EPRI Proj 779-25)
(EPRI-AP-1625) Avail NTIS HC A09/MF A01

The effect of predrying and partial oxidation on the liquefaction behavior of subbituminous coal was examined It was found from both micro and bench scale experiments that the drying of

Belle Ayr subbituminous coal, even in nitrogen, results in a significant reduction of product yields when a comparison is made to similar runs using as-received coal A further reduction occurs when the drying gas contains oxygen As observed from a microscopic study of the reaction product residues, the yield reduction is due in part to a prepolymerization of coal liquid products resulting in a sizable portion of coke-like solids Samples of both Belle Ayr subbituminous and Powhatan bituminous coals were dried in various gases in three scales of equipment, namely, TGA and laboratory and bench-scale fluid bed units. The rates and maximum levels of coal oxidation are discussed It is noted that the lower rank coal oxidizes more readily, but the maximum up-take of oxygen is only about 4 wt % while that of the higher rank coal is about 8 wt %
DOE

N81-21223# Oak Ridge National Lab., Tenn Chemical Technology Div
LIQUEFACTION TECHNOLOGY ASSESSMENT. PHASE 1: INDIRECT LIQUEFACTION OF COAL TO METHANOL AND GASOLINE USING AVAILABLE TECHNOLOGY
R M Wham J F Fisher, R C Forrester, III, A R Irvine, R Salmon, S P N Singh, and W C Ulrich Feb 1981 403 p refs
(Contract W-7405-eng-26)
(ORNL-5664) Avail NTIS HC A18/MF A01
Major liquefaction technologies employed were ICI low pressure methanol synthesis and Mobil-MTG conversion of methanol to gasoline Four major cases were studied, representing different product slates In each case, the economic study was based on the detailed process design of a conceptual, self sufficient, commercial facility using a coal feed rate to the gasifiers of 16 000 tons per stream day on a moisture and ash-free basis This corresponds to a total as-received coal feed rate of about 30,000 TPSD to the facility Process designs, equipment summaries, cost estimates, and operating requirements were prepared Economic sensitivity studies showed that the two factors having the greatest influence on product price were the method of financing and the inclusion of escalation of inflation Depending on the financing assumptions, the initial gasoline selling price in 1979 dollars varied from $0 78 to $1 25/gallon This price must be escalated at 6%/yr to obtain the price in the start-up year, or in any other year of operation DOE

N81-21224# Battelle Pacific Northwest Labs., Richland, Wash
METHANOL PRODUCTION WITH ELEMENTAL PHOSPHORUS BYPRODUCT GAS: TECHNICAL AND ECONOMIC FEASIBILITY
S. E. Lyke Jan 1981 200 p refs
(Contract DE-AC06-76RL-01830)
(PNL-3694) Avail. NTIS HC A09/MF A01
The technical and economic feasibility of using a phosphorus byproduct stream as a substitute for part of the natural gas in methanol production is assessed Economic tradeoffs between several alternative methods of supplying the necessary hydrogen gas for methanol production are established A preliminary basic design of a plant to clean and compress the off gas, return recovered phosphorus to the phosphorus plant, and produce methanol by using the phosphorus off gases is presented Detailed economic analyses of the production of elemental phosphorus and methanol, a methanol plant feasibility study, and methanol market study are presented J D H

N81-21228# Argonne National Lab., Ill Materials Science Div
MATERIALS TECHNOLOGY FOR COAL-CONVERSION PROCESSES Progress Report, Apr. - Jun. 1980
William A Ellingson Oct 1980 70 p refs
(Contract W-31-109-eng-38)
(ANL-80-93) Avail NTIS HC A04/MF A01
High chromia content and high density were identified as important factors in minimizing corrosion of refractories Results from the high temperature nondestructive erosion scanner revealed the presence of a hard film composed of Cr, Fe, S, and O2 which reduced erosive wear which is acoustically transparent Further improvements in the erosion scanner data acquisition system through employment of a correction for through wall thermal gradients reduced data scatter Qualitative detection of internal liquid leaks past critical valves in coal liquefication plants seems possible through use of low velocity ultrasonic or strain sensitive flowmeters together with passive acoustic systems Studies of high temperature gaseous corrosion of low Btu environments show that the potential exists for sulfide attack even in high chromium alloys such as 310 SS Failure analysis activities included analysis of a failed internal transfer line and a thermocouple sheath
DOE

N81-21229# Fluor Engineers and Constructors, Inc., Irvine, Calif
ECONOMIC COMPARISON OF MOLTEN CARBONATE FUEL CELLS AND GAS TURBINES IN COAL GASIFICATION BASED POWER PLANTS Final Report
C D Crawford, R P Dawkins, and J R Joiner Sep 1980 444 p
(EPRI Proj 239-2)
(EPRI-AP-1543) Avail NTIS HC A19/MF A01
The results of screening type process evaluation for heat integration of coal gasification processes with two alternate advanced combined cycle power generation systems are presented One system was composed of a molten carbonate fuel cell prime cycle and a steam bottoming cycle The second system contained a 2600 F gas turbine prime cycle and a steam bottoming cycle The three coal gasification processes utilized included the oxygen blown entrained gasifier, the air blown entrained gasifier, and the slagging gasifier DOE

N81-21230# RANN, Inc., Palo Alto, Calif
COMPARATIVE ANALYSIS OF COAL USE OPTIONS FOR REDUCING THE DEPENDENCE OF UTILITIES ON IMPORTED OIL
A J Eggers, Jr 3 Jan 1980 54 p refs
(Contract DE-AC01-78RA-12301)
(DOE/RA-12301-T1) Avail NTIS HC A04/MF A01
The conversion of utilities from oil-fired to coal-fired to yield an import reduction of 0 75 MBD by 1990 It is indicated therefore that the program development and management techniques employed in the Apollo Polaris, and Minuteman programs may have useful application to the utility conversion program These techniques include comparative systems and mission mode analysis, and the application of these techniques to the utility conversion program is discussed It is suggested that DOE/RA initiate an in-house task force effort to make a comparative analysis of conversion alternatives to meet this goal This analysis is discussed in some detail and it should consider the coal delivery as well as the conversion elements of the overall coal use system with a view to focusing on problems which must be addressed DOE

N81-21231# Sandia Labs., Albuquerque N Mex
CATALYTIC EFFECTS IN COAL GASIFICATION Quarterly Report, Apr - Jun. 1980
T D Padrick Nov 1980 18 p refs
(Contract DE-AC04-76DP-00789)
(SAND-80-2151) Avail NTIS HC A02/MF A01
The effects of mineral matter on the devolatilization of coal and on the subsequent char gasification were determined Eastern bituminous coals whose mineral matter content, as determined by X-ray analysis of low temperature ash, ranged from less than 5% to more than 20% were selected for study Chemical and physical characterization revealed that these coals had similar rank and petrographic content Baseline thermal gravimetric experiments in which the coals were heated from ambient to 1000 C at 5 C/min under nitrogen or hydrogen were completed Also the composition of the gas evolved during both the devolatization regime and the subsequent period of slower char gasification was measured J M S

N81-21232# General Accounting Office Washington, D C Energy and Minerals Div
LIQUEFYING COAL FOR FUTURE ENERGY NEEDS
12 Aug 1980 43 p refs
(PB81-135956 EMD-80-84) Avail NTIS HC A03/MF A01 CSCL 07A

Coal liquefaction is a technology which can augment petroleum derived products such as gasoline and boiler fuels There are no commercial plants operating or under construction in the United States for either of the two types of coal liquefaction direct and indirect If any portion of the national goals for synthetic fuels is to be met with coal liquefaction, the bulk of the production is likely to come from the indirect processes GRA

N81-21233# Office of Technology Assessment, Washington, D C

ENERGY FROM BIOLOGICAL PROCESSES. VOLUME 2: TECHNICAL AND ENVIRONMENTAL ANALYSES

Jul. 1980 228 p refs

(PB81-134769, OTA-E-128, LC-80-600118) Avail NTIS HC A11/MF A01 CSCL 21D

Forestry, agriculture, processing wastes, and various unconventional energy sources including oil-bearing and aquatic plants are considered Energy conversion technologies discussed include thermochemical conversions, fermentation by ethanol production, anaerobic digestion, use of alcohol fuels, select energy balances, and chemicals from biomass Technical, economic, and environmental details are presented and analyzed GRA

N81-21234# Washington Univ, Seattle Coll of Forest Resources

ENERGY FROM BIOLOGICAL PROCESSES. VOLUME 3: APPENDIXES. PART A: ENERGY FROM WOOD

James S Bethel, David G Briggs, Lorenzo Garay, Stanley P Gessel, William D Kitto, Warren F Lake, Amadeo J Rossi, Gerald F Schreuder, David A Tillman, and Larry G Zuller Jul 1980 387 p refs

(PB81-134777, OTA-C-78-339) Avail NTIS HC A17/MF A01 CSCL 21D

The feasibility of fostering further substitution of wood for fossil fuels was assessed It is concluded that there is a surplus of wood that could be used for fuel in substitution for fossil fuels, and, on a renewable basis, this supply could be very substantially increased if it were national policy to do so GRA

N81-21235# Office of Technology Assessment, Washington, D. C.

ENERGY FROM BIOLOGICAL PROCESSES. VOLUME 3: APPENDIXES. PART B: AGRICULTURE, UNCONVENTIONAL CROPS, AND SELECTED BIOMASS WASTES Final Report

Jul. 1980 856 p refs 3 Vol

(PB81-134785) Avail NTIS HC A99/MF A01 CSCL 21D

Working papers presented include The Potential of Producing Energy From Agriculture, Cropland Availability for Biomass Production, Energy From Agriculture, Unconventional Crops, Energy From Aquaculture Biomass Systems, Fresh and Brackish Water Aquatic Plants, Energy From Agriculture, Animal Wastes, and Energy From Agriculture, Agricultural Processing Wastes GRA

N81-21236# Office of Technology Assessment, Washington, D. C.

ENERGY FROM BIOLOGICAL PROCESSES. VOLUME 3: APPENDIXES. PART C: SELECTED CONVERSION TECHNOLOGIES AND END USE

Sep 1980 719 p refs 3 Vol

(PB81-134793) Avail NTIS HC A99/MF A01 CSCL 21D

Contents End Use of Fluids from Biomass as Energy Resources in Both Transportation and Nontransportation Sectors, Thermochemical Conversion of Biomass The Scientific Aspects, Engineering Aspects of Thermochemical Conversion, and Biological Production of Gas GRA

N81-21237# Textron, Inc, Buffalo, N Y

COAL GASIFIER WALL PROTECTION SYSTEM Report, 15 Jan. 1979 - May 1980

Dale M Slaughter Apr 1980 132 p refs Sponsored by New York State Energy Research and Development Authority

(PB81-141921, NYSERDA-80-5) Avail NTIS HC A07/MF A01 CSCL 21D

When coal is converted to other forms, as much as 5 to 30 percent of it is left as ash That ash can foul the interior of the conversion system, cutting efficiency, and sometimes causing total shut down Molten or solidified ash (slag) build up occurs in coal gasifiers where temperatures are so high that the ash melts Finding materials and developing designs to eliminate slag accumulation are emphasized GRA

N81-21381# Department of Energy, Morgantown, W Va Energy Systems Planning Div

EVERLASTING SLIDING-DISC VALVE METC SOA TEST VALVE NO. B-3, STATE-OF-THE-ART LOCKHOPPER VALVE TESTING AND DEVELOPMENT PROJECT

J F Gardner, R C Hall, R G Hornbeck, R A Griffith, T M Yost, D M Harvey, W E Galvin (EG/G, Morgantown, W Va), T R Gayheart (EG/G, Morgantown, W Va), and S K Kapur (TRW, Denver) Aug 1980 42 p refs

(Contracts DE-AM21-80MC-15422, DE-AT21-80MC-14689) (DOE/METC-SP-80/17) Avail NTIS HC A03/MF A01

The Everlasting Sliding-Disc Value accumulated 740 valve cycles in the valve static test unit and over 16,000 valve cycles in the valve dynamic test unit Only minor operating problems, primarily erratic motion and some scoring of the seating surface, were encountered with coarse limestone (5/16 x 1/8 in) particles Operation with fine solids (100 mesh limestone) showed excellent performance The actuator level arm failed twice but a change in clearances solved the problem Based on its performance in testing, the sliding disc valve, with minor modifications, is a very promising choice for feedside lockhopper service in coal conversion and utilization DOE

N81-21423*# Instituto Geografico Nacional, Madrid (Spain)

THERMAL MAPPING, GEOTHERMAL SOURCE LOCATION, NATURAL EFFLUENTS AND PLANT STRESS IN THE MEDITERRANEAN COAST OF SPAIN Progress Report

Rodolfo Nunez delasCuevas, D Fernando Lopez deSagredo (Univ Politecnica de Madrid), D Joaquin Melia Miralles (Valencia Univ), D Pedro Herranz Araujo (Univ Complutense), D Jesus Paredes Perlado (Centro de Estudios Hidrograficos, Madrid), D Gregorio Parrilla (Inst Espanol de Oceanografia, Madrid), D J Luis Picon (Centro de Investigacion, Madrid), and D J Luis Labrandero, Principal Investigators (Consejo Superior de Investigaciones Cientificas, Madrid) 30 Jun 1980 3 p Sponsored by NASA HCMM

(E81-10119, NASA-CR-164113, PR-3) Avail NTIS HC A02/MF A01 CSCL 13B

Although no significant results were achieved during the report period, research continues A sample of imagery showing thermal inertia and temperature differences over the northeastern United States and Europe was received The project coordinator attended a TELLUS Project meeting in Ispra, Italy at which general guidelines for the future were established and the quality of the data received was discussed A R H

N81-21463# California Univ, Berkeley Lawrence Berkeley Lab. Earth Sciences Div

UPDATED PLAN FOR SUPPORT OF RESEARCH RELATED TO GEOTHERMAL RESERVOIR ENGINEERING

J. H. Howard, N E Goldstein, and A N Graf Sep 1980 59 p refs

(Contract W-7405-eng-48)

(LBL-10807) Avail NTIS HC A04/MF A01

The original plan for support of research in geothermal reservoir engineering, GREMP, was reviewed and compared with accomplishments to date A commentary on the comparison and an updated plan are presented Also included are a justification of the updated plan and a reviewed management plan DOE

N81-21464# Department of Energy, Washington, D C Office of Coal Supply Development

WESTERN COAL SURVEY: A SURVEY OF COAL MINING CAPACITY IN THE WEST

Jan 1981 60 p

(DOE/RA-0045/1) Avail NTIS HC A04/MF A01

The purpose of the survey is to track progress and changes in productive capacity Specifically, the survey seeks estimates of current and future productive capacity, of amounts of coal currently under contract, and of potential constraints to higher production The report identifies 116 western mines producing 200,000 tons or more in 1980, 209 such mines in 1985 and 221 in 1990 All but 29 of the future operations are expected to be producing by the end of 1985 Of these 29, 12 begin production in 1986 and 9 in 1987 Six existing mines are expected to be mined out or abandoned by 1990 DOE

N81-21468# Sandia Labs, Albuquerque, N Mex SPR Geotechnical Div

STRATEGIC PETROLEUM RESERVE (SPR) GEOLOGICAL SUMMARY. WEEKS ISLAND SALT DOME

Terri Smith Ortiz Oct 1980 54 p refs

(Contract DE-AC04-76DP-00789)

(SAND-80-1323) Avail NTIS HC A04/MF A01

A portion of the Weeks Island Salt Dome in southern Louisiana was purchased for use as a crude oil storage facility, mine Geotechnical investigations of the conventional underground salt mine are summarized Topics cover site geology, material properties of the salt, the condition of the oil storage area, the status of other activities in the salt dome, and recommendations DOE

N81-21550# Delegationen foer Energiforskning, Stockholm (Sweden)

PRODUCTION OF A RAW MATERIAL FOR ENERGY PRODUCTION IN AGRICULTURE

Goeran Hellstroem Apr 1980 48 p refs In SWEDISH

(DFE-31) Avail NTIS (US Sales Only) HC A03/MF A01, DOE Depository Libraries

The total amount of energy in products produced by Swedish agriculture was estimated to 80 TWH 30 TWh for cereals, 15 TWh for grass and leguminosae, and 35 TWh for straw and other agricultural wastes Of this production a large part will be used as food even in the future New plants that would produce more energy than the ones traditionally grown in Sweden are discussed Also other types of energy from agriculture are discussed such as methane from manure, methanol from gasification processes, and ethanol from fermentative processes Costs were estimated from different alternatives DOE

N81-21562# New Mexico State Univ, Las Cruces

REGIONAL OPERATIONS RESEARCH PROGRAM FOR COMMERCIALIZATION OF GEOTHERMAL ENERGY IN THE ROCKY MOUNTAIN BASIN AND RANGE Final Report, 1 Aug. 1978 - 28 Feb. 1980

J M Marlin, Roy Cunniff, Paul McDevitt, Kenneth Nowotny, and Patrick ODea Jan 1981 126 p Sponsored in part by New Mexico Energy and Minerals Dept and Four Corners Regional Commission

(Contract DE-AS07-78ID-01756)

(DOE/ID-01756/T1, EMD-78-2236) Avail NTIS HC A07/MF A01

The work accomplished from August 1978 to February 1980 in the Regional Operations Research efforts for the Rocky Mountain Basin and Range Geothermal Commercialization Program is described The work included continued data acquisition and extension of the data base, enhancement and refinement of the economic models for electric and direct use applications, site-specific and aggregated analyses in support of the state teams and special analyses in support of several federal agencies DOE

N81-21573# Los Alamos Scientific Lab, N Mex

HEAT-FLOW MEASUREMENTS IN THE STATE OF ARKANSAS Final Report

R F Roy, Bruce Taylor, Arthur J Pyron, and James C Maxwell Oct 1980 16 p refs

(Contract W-7405-eng-36)

(LA-8569-MS) Avail NTIS HC A02/MF A01

The pertinent holes are located in the four major geological divisions of the state Despite the presence of hot springs in the Ouachita region, these figures are not especially encouraging as indicators of the a possible geothermal resource, and the low heat-flow in the syenite intrusion at Little Rock is certainly disappointing in terms of hot dry rock exploitation The most promising area geothermally is in the southern counties (in the Gulf coastal plain), where a compilation of geothermal gradient estimates, made from published well-temperature data, shows a trend towards higher than average gradients DOE

N81-21585# Denver Univ, Colo Denver Research Inst

MUNICIPAL GEOTHERMAL HEAT UTILIZATION PLAN FOR GLENWOOD SPRINGS, COLORADO Final Technical Report

31 Dec 1980 276 p refs

(Contract DE-AS07-79ID-12049)

(DOE/ID-12049-3) Avail NTIS HC A13/MF A01

The results show that the use of geothermal heat is indeed feasible when compared to the cost of natural gas The proposed system is composed of a wellhead plate heat exchanger which feeds a closed distribution loop of treated water circulated to the buildings which form the load The base case system was designed to supply twice the demand created by the seven public buildings in order to take advantage of some economies of scale To increase the utilization factor of the available geothermal energy, a peaking boiler which burns natural gas is recommended Disposal of the cooled brine would be via underground injection DOE

N81-21604# Battelle Pacific Northwest Labs, Richland, Wash

INVESTIGATIONS ON CATALYZED STEAM GASIFICATION OF BIOMASS. APPENDIX B: FEASIBILITY STUDY OF METHANOL PRODUCTION VIA CATALYTIC GASIFICATION OF 2000 TONS OF WOOD PER DAY

L K Mudge, S L Weber, D H Mitchell, L J Sealock, Jr, R J Robertus, and Davy McKee Jan 1981 124 p

(Contract DE-AC06-76RL-01830)

(PNL-3695-App-B) Avail NTIS HC A06/MF A01

The plant design in this study was developed from information on gasifier operation supplied by the Pacific Northwest Laboratory (PNL), operated by Battelle PNL obtained this information from laboratory and process development unit testing The plant is designed to process 2000 tons per day of dry wood to methanol Plant production is 997 tons per day of methanol with a HHV of 9784 Btu per pound All process and support facilities necessary to convert wood to methanol are included in this study DOE

N81-21610# Department of Energy, Washington, D C Energy Information Administration

PERFORMANCE PROFILES OF MAJOR ENERGY PRODUCERS

Dec 1980 111 p refs

(DOE/EIA-0206/78) Avail NTIS HC A06/MF A01

Data for 26 major energy producing companies (coal, oil, gas, nuclear) for 1977 and 1978 are presented Data were collected using the Financial Reporting System (FRS) reporting Form EIA-28 which collects disaggregated financial data on revenues and expenses, assets and liabilities, and sources and uses of funds The overall corporate financial performance of 26 FRS companies are compared with the other major industrial companies Differences in relative commitment and profitability associated with alternative lines of corporate activity are examined The size composition and international character of FRS companies are examined Oil and gas resource development efforts in 1978 are traced Data on resource development expenditures are complemented by information on reserve holdings, changes in reserves, and characteristics of exploration and development efforts Foreign activity is compared with domestic DOE

N81-21615# California Univ, Livermore Lawrence Livermore Lab

SYNOPSES OF R AND D IN GEOTHERMAL-GEOCHEMICAL ENGINEERING AT THE LAWRENCE LIVERMORE NATIONAL LABORATORY, 1976 - 1980

J E Harrar, comp Dec 1980 23 p refs

(Contract W-7405-eng-48)

(UCID-18863) Avail NTIS HC A02/MF A01

Research is summarized on geothermal field test apparatus, brine acidification as a means of scale control at the Salton

Sea Geothermal Field, tests of seeding and other chemical methods for the control of scale at the Salton Sea Geothermal Field, tests of proprietary organic additives for the control of scale at the Salton Sea Geothermal Field, tests of generic organic compounds for control of scale at Salton Sea Geothermal Field, studies of the dissolution of geothermal scale, chemical measurement developments, chemical modeling of geothermal systems, processing of geothermal brine effluents for injection, hydrogen sulfide abatement using geothermal brine effluents, use of surface waters to supplement injection at the Salton Sea Geothermal Field, and measurement of injectability of geothermal brines DOE

N81-21616# Los Alamos Scientific Lab, N Mex Systems Analysis and Assessment Div
MICRO-LEVEL LAND USE IMPACTS OF BIOCONVERSION M.S. Thesis
Virginia Kay Barber Parsons Nov 1980 94 p refs
(Contract W-7405-eng-36)
(LA-8599-T) Avail NTIS HC A05/MF A01

Implementation of the land intensive bioenergy technologies involves actions that impact existing land use at the local level Due to the differences in crop type, yield per acre, existing land use conditions, and agricultural practices throughout the U S, microlevel information is necessary The local biomass potential is examined based on existing land use in seven countries in different agricultural regions throughout the U S These case studies serve as a basis for identifying the microlevel land use impacts of the bioconversion technologies DOE

N81-21623# Los Alamos Scientific Lab, N Mex
GEOTHERMAL ENERGY ENHANCEMENT BY THERMAL FRACTURE
Ruth B Demuth and Francis H Harlow 1980 70 p ref
Sponsored by DOE
(LA-8428) Avail NTIS HC A04/MF A01

A large, vertical, circular fracture created deep within hot rock is connected to the surface through two holes The inlet provides a source of cold water and the outlet extracts heated water Cooling of the rock produces thermal stresses that fracture the rock adjacent to the primary crack, thereby enhancing the heat extraction rate by means of convective transport The properties of the thermal fracture network vary with position and time The REX code for high-speed computer was written and used to study the coupled processes of primary-crack flow and lateral thermal fracture heat transport Calculations for elapsed times of 100 yr show that thermal fracture enhancement can double the heat extraction rate over the results from conduction alone SF

N81-21712# Nuclear Utility Services, Inc, Rockville, Md
WIND ENERGY RESOURCE ATLAS. VOLUME 5: THE EAST CENTRAL REGION
R Brode, R Stoner, D L Elliott (Pacific Northwest Lab), W R Barchet (Pacific Northwest Lab), and R L George (Pacific Northwest Lab.) 1980 214 p refs
(Contract DE-AC06-76RL-01830)
(PNL-3195-Vol-5) Avail NTIS HC A10/MF A01

This atlas of the wind energy resource is composed of introductory and background information, a regional summary of the wind resource, and assessments of the wind resource in each state of the region. Background is presented on how the wind resource is assessed and on how the results of the assessment should be interpreted A description of the wind resource on a regional scale is given The results of the wind energy assessments for each state are assembled into an overview and summary of the various features of the regional wind energy resource Assessments for individual states are presented The state wind energy resources are described in greater detail than is the regional wind energy resource, and features of selected stations are discussed States include Delaware, Maryland, Kentucky, North Carolina, Tennessee, Virginia, and West Virginia DOE

N81-21876# Argonne National Lab, Ill Components Technology Div
MONITORING TEMPERATURES IN COAL CONVERSION AND COMBUSTION PROCESSES VIA ULTRASOUND
N Gopalsami (Illinois Univ at Chicago Circle), A C Raptis, and T P Mulcahey Feb 1980 48 p refs
(Contract W-31-109-eng-38)
(ANL-FE-49622-TM09, TM-9) Avail NTIS HC A03/MF A01

The state of the art of instrumentation for monitoring temperatures in coal conversion and combustion systems is examined The instrumentation types studied include thermocouples, radiation pyrometers, and acoustical thermometers The capabilities and limitations of each type are reviewed A feasibility study of the ultrasonic thermometry is described A mathematical model of a pulse-echo ultrasonic temperature measurement system is developed using linear system theory The mathematical model lends itself to the adaptation of generalized correlation techniques for the estimation of propagation delays Computer simulations are made to test the efficacy of the signal processing techniques for noise-free as well as noisy signals Based on the theoretical study, acoustic techniques to measure temperature in reactors and combustors are feasible DOE

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ENERGY CONVERSION

Includes photovoltaic, thermoelectric, geothermal, ocean thermal, and wind energy conversion Also includes nuclear reactors and magnetohydrodynamic generators

A81-19810 **Two-phase liquid-metal MHD generator experiments and pressure-gradient correlations** P F Dunn, G Fabris, E S Pierson, and M Petrick (Argonne National Laboratory, Argonne, Ill) In MHD-flows and turbulence II Jerusalem, Israel Universities Press, 1980, p 145-155 16 refs Research supported by the U.S Navy and U S Department of Energy

Experimental results of single and two-phase liquid-metal MHD investigations using circular and rectangular test-section geometries are presented Single-phase pressure gradient data for the circular geometry are compared with the existing MHD theory, the two-phase results for both geometries agree with a two-phase MHD correlation developed here Tests were conducted in a 10-cm diameter circular stainless-steel pipe with sodium and nitrogen over the range of liquid mean velocities of 2-4 2 m/s, mixture qualities from zero to 0 0053, and magnetic flux densities from zero to 0 9 T, at 530-810 K A T

A81-19812 **Liquid metal MHD generators with shunt layer.** P S Lykoudis (Argonne National Laboratory, Argonne, Ill , Purdue University, West Lafayette, Ind) In MHD-flows and turbulence II Jerusalem, Israel Universities Press, 1980, p 183-191 ERDA-Navy-sponsored research

An analysis of the shunt layer in a liquid metal magnetohydrodynamic generator was performed in a closed form assuming a two-dimensional duct with a uniform two-phase core with walls wetted by liquid An expression is derived for the generator efficiency as a function of the load factor using standard Hartmann layer approximations The efficiency has the same expression with a uniform working fluid at an effective Hartmann number in terms of ratios of viscosity and electrical conductivity for the two-phase to the liquid phase value It was concluded that the high Hartmann number at which generators operate the shunt layer does not significantly decrease generator efficiency A T

A81-19814 **Pulsed self-excited MHD power generation at large energy densities.** B Zauderer and E Tate (General Electric Co , King of Prussia, Pa) In MHD-flows and turbulence II Jerusalem, Israel Universities Press, 1980, p 207-221 6 refs

An experimental investigation of the physical, electromagnetic, and gas dynamic processes in the production of pulsed, self-excited MHD power is presented The MHD channel is inserted into the electrically driven shock-tunnel section so that its front face provides a reflecting end wall for the shock, the plasma flows from the reflected region through a converging-diverging nozzle to achieve supersonic velocity in the active region of the generator The voltage losses at the electrodes were independent of current, the plasma conductivity was equivalent to a 13,000 K argon plasma, with temperatures above 18,000 K expected in the reflected region A T

A81-20022 # **Approximate three-dimensional electric solution for a frame-type MHD generator** W Unkel (MIT, Cambridge, Mass) *Journal of Energy,* vol 4, Nov -Dec 1980, p 245-251 14 refs Contract No E(49-18) 2215

An approximate technique to determine the potential distribution and integral performance characteristics of a frame-type MHD channel is presented In addition to including the effect of the conducting sideframes, the model considers the effects of finite segmentation and the effects of variable plasma conductivity Hall parameter, and velocity In its simplest form, the approximate technique effects results for the three-dimensional potential distribution by solution of an ordinary differential equation The accuracy of the technique is demonstrated by comparison with results of more detailed calculations and by comparison with experimental results These comparisons show good agreement both for the integrated generator performance and for the current distribution to the electrode frame In contrast to the detailed calculation procedure, the approximate technique has modest solution times and can be incorporated in a MHD generator design and prediction code (Author)

A81-20025 # **Performance assessment of a Flettner wind turbine** P Crimi *Journal of Energy,* vol 4, Nov Dec 1980, p 281-283 8 refs

A study undertaken to provide a preliminary assessment of a wind turbine developed in the early 20th century by Flettner is discussed It is noted that with the Magnus effect providing lift, the turbine functions aerodynamically in the same way as a propeller-type device Significant factors affecting the overall cost of power production with a Flettner turbine are identified, including the relatively low power coefficient which arises from the low section lift-drag ratio, and the relatively low tip speed, also deriving from this ratio It is concluded that the aerodynamic performance of a hybrid configuration with constant-chord, fixed-pitch conventional blading at the tips would lie roughly midway between that of a Flettner and a propeller-type wind turbine C R

A81-20225 # **The rebirth of the Rankine cycle** B Sternlicht and D D Colosimo (Mechanical Technology, Inc , Latham, N Y) *Mechanical Engineering,* vol 103, Jan. 1981, p 41-47 6 refs

With fossil fuels diminishing and increasingly expensive, the need for alternate energy sources becomes imperative In the combined industrial, utility, and federal sectors, there are close to 25 quads of thermal wastes that could be profitably tapped for such a purpose and heat engine cycles such as the Rankine cycle could be effective in converting such flows to useful power The Rankine cycle operates at a 40 percent efficiency at the top end of its peak cycle temperature range, which is roughly 200-1000 F, a range lower than other cycles but well within that of many thermal waste streams Installation costs for waste heat recovery systems are comparable to those of coal-fired electrical plants ($800-$1000/kW) and those of nuclear plants ($1200/kW and up) Waste heat recovery, however, is based on systems whose operating energy costs are zero Economic and investment analyses are included R S

A81-20548 # **Preliminary Faraday performance of a large MHD generator at high magnetic field** R F Starr, L S Christensen, G W Garrison, and G L Whitehead (ARO, Inc , Arnold Engineering Development Center, Arnold Air Force Station, Tenn) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan 12-15, 1981, Paper 81-0028* 12 p 7 refs Research sponsored by the U S Department of Energy

The High Performance Demonstration Experiment showed that an MHD generator simulating a commercial scale device can convert 16 to 18% of the available thermal energy into electrical power Results have been obtained with the channel in the Faraday configuration and magnetic field strengths ranging from 1 5 to 3 5 Tesla, a maximum Faraday power of 23 MW was produced representing an enthalpy extraction of 9% An analysis is presented of the electrical and aerodynamic characteristics of the channel including the voltage drop in the cold plasma layers near the electrode walls A T

A81-20549 # **Comparison of analytical and experimental studies of the HPDE MHD generator performance** Z El Derini, E Doss, and C Lenzo (Argonne National Laboratory, Argonne, Ill) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan 12-15, 1981, Paper 81-0029* 11 p 6 refs

The MHD generator performance of the High Performance Demonstration Experiment (HPDE) has been analyzed using the ANL quasi-three-dimensional computer model Computations performed for the operating conditions of tests No 10 and 14 indicate that, for both tests, the trends and magnitudes of the experimental data for various electrical and gasdynamic variables are in good agreement with the analytical predictions. The variation of the channel performance as a function of the channel wall temperature, surface roughness, load factor, and magnetic field strength is examined, and numerical examples are given Performance maps, showing channel enthalpy extraction versus isentropic efficiency, are generated for range of magnetic field strengths, loading parameters, and electrode surface temperatures A 'diagnostic data analysis' (DDA) procedure has been developed for further verification of the accuracy of the predictions of the quasi-three-dimensional model. In this procedure, the experimental data are used to compute the gasdynamic flow parameters and the boundary layer voltage drop characteristics in terms of average electrical conductivity and average electrical resistance. The results of this DDA procedure and those of the quasi-three-dimensional model are in good agreement. (Author)

A81-20550 # **Experimental results of the UTSI coal-fired MHD generator and investigations of various power take-off schemes.** F L. Galanga, J T. Lineberry, Y. C. L. Wu, M. H. Scott, W. E Baucum, and R. W Clemons (Tennessee, University, Tullahoma, Tenn) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan 12-15, 1981, Paper 81-0030.* 14 p. 13 refs Contract No. DE-AC02-79ET-10815

Tests were conducted at the University of Tennessee Space Institute, Energy Conversion Division, in support of technology development of coal-fired MHD generator systems The primary objectives of the test series were to evaluate the overall electrical performance of the 60 deg DCW generator with vitiation heated oxidizer, to study the thermal behavior of capped versus solid frame electrodes, and to investigate various power take-off schemes Results from the above-mentioned areas of investigation are presented and discussed. (Author)

A81-20551 # **A comparison of experimental results from the UTSI coal-fired MHD generator to theoretical predictions.** J. T. Lineberry, F L Galanga, B. Liu, Y. C L. Wu, M. H. Scott (Tennessee, University, Tullahoma, Tenn), Y C Pan, and E D Doss (Argonne National Laboratory, Argonne, Ill) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan. 12-15, 1981, Paper 81-0031* 16 p. 19 refs Contract No DE-AC02-79T-10815

Experimental data collected from recent coal-fired MHD generator tests are compared to theoretical predictions Three independent numerical models are employed for this comparison; a one-dimensional model, a two-dimensional model which includes modeling of the slag layer, and a quasi-three-dimensional model Comparisons are made between measured gas dynamic and generator electrical performance parameters to those predicted by each method These comparisons are drawn for a fixed set of generator operating conditions which include an experimentally inferred entrance temperature The analyses illustrate the effects of flow field dimensionality on generator performance predictions. Discussions on the applications and limitations of each code are included along with suggestions for refinements to achieve an improved modeling of real MHD phenomena. (Author)

A81-20552 # **U-25B MHD generator performance.** E. Doss, B F Picologlou, Y Pan (Argonne National Laboratory, Argonne, Ill), and T Petrie (Southern Illinois University, Carbondale, Ill) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St. Louis, Mo., Jan 12-15, 1981, Paper 81-0032* 10 p 9 refs. Contract No W-31-109-eng-38.

The performance of the U-25B MHD generator is analyzed with theoretical predictive models developed at Argonne National Laboratory Modifications and improvements of the computer codes, motivated from study of the experimental results, are outlined and discussed The theoretical predictions are compared to experimental results and good agreement is found. Sensitivity studies involving a number of input parameters are used to identify those parameters that have a strong impact on generator performance (Author)

A81-20601 # **Plasma diagnostics of MHD generators.** A M Demirjian (Avco Everett Research Laboratory, Inc , Everett, Mass.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo ; Jan. 12-15, 1981, Paper 81-0099* 6 p 5 refs. Contract No DE-AC01-80ET-15614

Average measurements of conductivities and Hall parameters in a Faraday MHD generator are presented The measurement scheme is simple and requires no special probes other than peg walls that provide the two-dimensional voltage fields in the generator No corrections are made for the conductivity profiles at the generator walls The use of this scheme for the estimation of average flow velocities is described which may provide a valuable tool to diagnose the generator performance in real time (Author)

A81-20602 # **Diagnostic instrumentation development program for the heat recovery/seed recovery system of the open-cycle, coal-fired magnetohydrodynamic power plant.** D L Murphree, R L Cook, L E. Bauman, R D. Benton (Mississippi State University, Mississippi State, Miss), P. B. Probert (Babcock and Wilcox Co , Fossil Power Generation Div., Barberton, Ohio), and R C. Selby (U S. Department of Energy, Chicago Operations and Regional Office, Argonne, Ill) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan 12-15, 1981, Paper 81-0110* 12 p 14 refs. Contract No DE-AC02-80ET-15601

Highly efficient and environmentally acceptable, the coal-fired MHD power plant is an attractive facility for producing electricity. The design of its downstream system, however, presents technological risks which must be corrected if such a plant is to be commercially viable before the end of the century The heat recovery/seed recovery system (HRSR) at its present stage is vulnerable to corrosion on the gas side of the radiant furnace, the secondary superheater, and the intermediate temperature air heater Slagging and fouling of the heat transfer surface have yet to be eliminated. Gas chemistry, radiant heat transfer, and particulate removal are other problematic areas which are being researched in a DOE development program whose test activities at three facilities are contributing to an MHD/HRSR data base. In addition, a 20 MWt system to study HRSR design, is being now assembled in Tennessee. R S

A81-20603 # **Utilization of staged combustion for controlling NO/x/ emissions from a test facility simulating a coal-fired MHD power plant.** A G. Wehr and R. Tang (Mississippi State University, Mississippi State, Miss). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan 12-15, 1981, Paper 81-0101* 7 p. 9 refs. Contract No DE-AC02-80ET-15601.

The MHD Energy Center has constructed a test stand that will simulate the conditions that are present at any point in a coal-fired MHD power plant. This test stand was used to examine the effect of primary combustion stoichiometry and various secondary combustion parameters on the generation of nitrogen oxides The secondary combustion air was injected at eight different locations along the length of the test stand, and the gas stream was sampled at four different locations during each series of tests The results are also reported for a study of the role of char in the decomposition of NO(x). (Author)

A81-20604 # **The effect of secondary combustion on nitric oxide concentrations in a MHD combustion gas.** P F. Dunn, T R Johnson, C B. Reed, M G Chasanov, and M A. Inbody (Argonne National Laboratory, Argonne, Ill) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo., Jan 12-15, 1981, Paper 81-0102.* 10 p 23 refs Contract No W-31-109-eng-38.

Results are presented of recent investigations of the effect of secondary combustion on nitric oxide concentrations in an MHD combustion gas Forty-one experiments, in which NO concentration measurements were made, were conducted. In 16 of those experiments, secondary combustion of the MHD combustion gas was achieved over two temperature ranges (1500-1800 K and 1700-2000 K) A model assuming instantaneous mixing, and using a modification of the NASA chemical kinetics code, predicted to within 10% for all clean-fuel experiments conducted the measured changes in NO concentrations that resulted from secondary combustion This model was extended to estimate changes in NO concentrations that would occur during secondary combustion in a larger MHD facility. It is established that, in addition to other parameters including mixing, the heat loss from the secondary combustion zone strongly influences the amount of NO reformed during secondary combustion (Author)

A81-20649 * # **The STD/MHD codes - Comparison of analyses with experiments at AEDC/HPDE, Reynolds Metal Co., and Hercules, Inc.** A A Vetter, C D Maxwell, T. F Swean, Jr., S T Demetriades, D A Oliver, and C D. Bangerter (STD Research Corp, Arcadia, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St. Louis, Mo , Jan 12-15, 1981, Paper 81-0173* 16 p. 39 refs. Research supported by the Reynolds Metal Co. and U S. Department of Energy, NSF Grant No C-727, Contracts No DEN3-179, No DEN3-202

Data from sufficiently well-instrumented, short-duration experiments at AEDC/HPDE, Reynolds Metal Co , and Hercules, Inc , are compared to analyses with multidimensional and time-dependent simulations with the STD/MHD computer codes. These analyses reveal detailed features of major transient events, severe loss mechanisms, and anomalous MHD behavior In particular, these analyses predicted higher-than-design voltage drops, Hall voltage overshoots, and asymmetric voltage drops before the experimental data were available The predictions obtained with these analyses are in excellent agreement with the experimental data and the failure predictions are consistent with the experiments The design of large, high-interaction or advanced MHD experiments will require application of sophisticated, detailed and comprehensive computational procedures in order to account for the critical mechanisms which led to the observed behavior in these experiments (Author)

A81-20650 # **Three-dimensional analysis of MHD generators - Development of electrical solution.** R K Ahluwalia, S P Vanka, K H Im, and S A Zwick (Argonne National Laboratory, Argonne, Ill) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan 12-15, 1981, Paper 81-0175* 11 p 14 refs Contract No W-31-109-eng-38

A model for calculating three-dimensional current and electric field distributions in MHD generator channels is formulated and numerically solved The chief advantage of this model is that its solution can be implemented on the digital computer in less than one CPU second, and thus the model can be conveniently coupled to a full three-dimensional gas dynamic analysis The model is equally valid for Faraday, diagonal insulating-side-wall, and diagonal conducting-sidewall channels Accuracy of the model is calibrated by comparing its predictions with the results of three-dimensional finite segmentation analyses The model is found to perform best for channels with low wall temperatures and low electrode pitch-to-height ratios, and when the boundary layers are thick The effects of the nonuniformity in normal current density, as predicted by the model, leading to velocity overshoots in the boundary layers, and of the transverse nonuniformity in Hall current density, generating secondary flows, are discussed (Author)

A81-20651 # **Electrical effects of coal slag in a diffuse mode MHD generator.** R M Nelson (Stanford University, Stanford, Calif , Iowa State University of Science and Technology, Ames, Iowa) and J K Koester (Stanford University, Stanford, Calif). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan 12-15, 1981, Paper 81-0176* 12 p. 8 refs. Research supported by the Electric Power Research Institute

Ten high-temperature (1700-2000 K) platinum-rhodium capped magnesia electrodes were successfully tested in a slagging MHD generator with diffuse mode (non-arcing) current transport at 3 amps/sq cm occurring for electrode temperatures over 1800 K. A diffuse mode, two-dimensional model for current density and potential distributions was developed which includes the effects of slag layer hydrodynamics, slag layer energy transport, and assumed plasma boundary layers Numerical and experimental results are compared and the effects of slag, current density, generator size, wall temperature, and cathode shorting on generator performance are numerically determined (Author)

A81-20652 # **Preliminary results of analytical modeling of subsonic MHD diffusers.** C C P Pian, R Kessler, and A Solbes (Avco Everett Research Laboratory, Inc , Everett, Mass) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan 12-15, 1981, Paper 81-0177* 9 p 10 refs. Contract No DE-AC01-80ET-15614

An integral technique is described which models the subsonic MHD diffuser The diffuser flow is assumed fully developed and with overshoots in the sidewall velocity profiles A power law relationship is assumed for the enthalpy distribution and a modified classical profile is proposed for the velocity distribution The governing equations are derived, along with a discussion of the procedure for their solution Preliminary results simulating a low-speed subsonic diffuser are also presented (Author)

A81-20653 # **Investigative data analysis technique for MHD generators** W Unkel, J Schwoerer, J D Teare, and J F Louis (MIT, Cambridge, Mass) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo , Jan 12-15, 1981, Paper 81-0174* 15 p Research supported by the U S Department of Energy

A method of data analysis is developed for MHD generators The axial distributions of core properties are accurately determined without a detailed boundary layer calculation and without accurate knowledge of wall temperature, wall roughness, absolute conductivity level, or inlet conditions In addition to the inputs required for a direct (i e , design mode) calculation of channel characteristics, the method requires axial distributions of static pressure and, for a diagonal generator, requires axial distributions of Hall voltage at several levels of generator loading The technique also determines the distribution of the plasma resistance parameter and with additional assumptions, evaluates the interframe leakage resistance and local boundary layer size and shape Data from the sixth and seventh joint US/USSR tests with the U25-B facility are analyzed with the technique The technique establishes the degree to which a code can be validated by comparison with overall generator data The technique is shown to be a useful supplement to the usual design mode computer codes and the technique is ideally suited to onsite data analysis (Author)

A81-20683 * # **Radiatively coupled thermionic and thermoelectric power system concept.** K Shimada and R. Ewell (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St. Louis, Mo., Jan. 12-15, 1981, Paper 81-0217.* 7 p Contract No. NAS7-100.

The study presented showed that the large power systems (about 100 kW) utilizing radiatively coupled thermionic or thermoelectric converters could be designed so that the power subsystem could be contained in a Space Shuttle bay as a part of an electrically propelled spacecraft The radiatively coupled system requires a large number of individual converters since the transferred heat is smaller than with the conductively coupled system, but the advantages of the new system indicates merit for further study The advantages are (1) good electrical isolation between converters and the heat source, (2) physical separation of converters from the heat source (making the system fabrication manageable), and (3) elimination of radiator heat pipes, which are required in an all-heat-pipe power system In addition, the specific weight of the radiatively coupled power systems favorably compares with that of the all-heat-pipe systems (Author)

A81-20696 # **Power conditioning and control requirements of coal fired MHD generators.** A M Demirjian and I M. Quijano (Avco Everett Research Laboratory, Inc, Everett, Mass) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo, Jan. 12-15, 1981, Paper 81-0246* 9 p 5 refs Contract No DE-AC01-80ET-15614

The operational characteristics of coal fired open-cycle linear MHD generators are presented The salient features of loading and control requirements of Faraday and diagonal generators are analyzed and circuits that meet these requirements are presented Consolidation and current control circuits are discussed elaborating on the design considerations for operating them with MHD generators Such circuits are shown to have relatively low losses reflecting in higher than 98-99% efficiencies (Author)

A81-20698 * # **On the magnetoaerothermal instability.** S T Demetriades, D A Oliver, T F Swean, Jr, and C D Maxwell (STD Research Corp, Arcadia, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St. Louis, Mo, Jan 12-15, 1981, Paper 81-0248* 14 p 18 refs Research supported by the Northrop Corp, U S Department of the Interior, U S Department of Energy, and ERDA, NSF Grant No C-727, Contracts No AF-49(638)-1160, No DEN3-179, No DEN3-202

A fundamental instability in MHD channel flow, hitherto unknown or unappreciated, is described Lorentz force-driven secondary flow cells preferentially couple core temperature gradient modes into the near fields of the anode wall leading to a locally growing Lorentz force which eventually separates the anode boundary layer The instability is described with both heuristic order-of-magnitude analyses and detailed three-dimensional, turbulent, MHD flow computations This magnetoaerothermal instability will be manifested in commercial scale MHD generators of moderate MHD interaction parameter Methods of control and prevention of the magnetoaerothermal instability exist (Author)

A81-20699 # **Performance of MHD generators with electrode current control** A M Demirjian and C. C P Pian (Avco Everett Research Laboratory, Inc, Everett, Mass) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo., Jan 12-15, 1981, Paper 81-0249* 7 p Contract No DE-AC01-80ET-15614

Current controllers developed for regulating the electrode currents of the diagonal generator against the effect of slag driven cathode wall nonuniformities can also be used as power shufflers that force the electrode currents to be proportional to the generator load current Power shufflers eliminate axial currents in the plasma, driven by the mismatches between the isopotentials of the uncontrolled diagonal generator and its load current requirements The generator performance with shuffle power is shown to be identical to a uniform electrode current Faraday generator under all loading conditions Analysis shows that diagonal generators with current control and power shufflers may embody the advantages of both Faraday and diagonal configurations with reduced control and power conditioning requirements (Author)

A81-20700 # **Feasibility of the inflow disk generator for open-cycle MHD power generation.** T Nakamura, W E Lear, and R H Eustis (Stanford University, Stanford, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St. Louis, Mo., Jan 12-15, 1981, Paper 81-0250* 18 p 51 refs Research supported by the Electric Power Research Institute

A feasibility study of the inflow disk MHD generator for baseload applications was performed Each design element, i e, the combustor, the inlet flow path, the generator channel, the diffuser and the magnet, was studied in detail in order to provide a comprehensive assessment of the inflow disk generator Based on these results, the performance of the inflow disk generator was calculated for two different thermal inputs 1250 MW(th) and 2500 MW(th) It was shown that the performance of the inflow disk generator is similar to that of the diagonal generator within the uncertainty of the analysis (Author)

A81-20747 # **Heat transfer in slagging MHD radiant boilers.** K H Im, R K Ahluwalia, and G Berry (Argonne National Laboratory, Argonne, Ill) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo, Jan 12-15, 1981, Paper 81-0316* 13 p 14 refs Contract No W-31-109-eng-38

A combined convection-radiation model is formulated to study heat transfer characteristics of slagging MHD radiant boilers The model includes the contributions of carbon dioxide, water vapor, potassium atoms, and slag particles to gas radiation, it also accounts for the presence of slag layer on the wall of the radiant boiler In order to determine the slag layer dynamics, the mechanism of slag particle deposition by thermophoresis and by fluid turbulence is investigated The role of a slag layer in moderating the influence of refractory thickness on heat transfer is illustrated The calculations indicate that an adequately slow cooling rate of the combustion gas can be realized in the radiant boiler (Author)

A81-20748 # **Off-design study of an open cycle MHD power plant with oxygen enrichment.** H K Geyer and G. F Berry (Argonne National Laboratory, Argonne, Ill) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo, Jan 12-15, 1981, Paper 81-0319* 9 p 12 refs

Some of the more important aspects of off-design operation for a magnetohydrodynamic (MHD) power plant are discussed It is noted that the plant must be designed to meet part-load and overload conditions and that the optimal design should be subject to a specified load demand curve. An analysis is made for off-design regimes to determine the compatible joint operating conditions for an MHD topping cycle, a steam bottoming plant, a turbine train, a compressor, and an oxygen separation plant The analysis is subject to such constraints as metal temperatures, second law violations, component performance requirements, and environmental considerations C R

A81-20802 # **Pressurized fluidized bed - A technology for combined cycle power generation.** S Moskowitz (Curtiss-Wright Corp, Wood-Ridge, N J) and J Geffken (U S Department of Energy, Germantown, Md). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo, Jan 12-15, 1981, Paper 81-0392* 9 p

The production of electric power using high sulfur coal in an environmentally clean and efficient manner is a major element in this country's goal for energy independence One coal combustion technique which has had demonstrable progress toward accomplishing this goal is the pressurized fluidized bed process A pilot plant program sponsored by the Department of Energy to design a power generation system of 13 MWe size has been instrumental in developing the PFB technology The paper describes the technology test programs that have been conducted to establish the design criteria and to select the design configurations and materials for the pilot plant Over 10,000 hours of tests have demonstrated adequate fluid bed combustion characteristics, gaseous emissions levels at one-third the level permitted by EPA for NO(x) and SO2, and durability for the in-bed heat exchanger and the turbine blade materials (Author)

A81-20805 * # **Status of commercial phosphoric acid fuel cell system development.** M Warshay, P R Prokopius, S N Simons, and R B King (NASA, Lewis Research Center, Phosphoric Acid Fuel Cell Program Load Center Office, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 19th, St Louis, Mo, Jan 12-15, 1981, Paper 81-0396* 9 p 12 refs

A review of the current commercial phosphoric acid fuel cell system development efforts is presented In both the electric utility and on-site integrated energy system applications, reducing cost and increasing reliability are important The barrier to the attainment of these goals has been materials The differences in approach among the three major participants are their technological features, including electrodes, matrices, intercell cooling, bipolar/separator plates, electrolyte management, fuel selection and system design philosophy (Author)

A81-21062 # **Theory of a conducting MHD motor with a free field (K teorii konduktsionnogo MGD-dvizhitelia so svobodnym polem)** V I Khonichev and V I Iakovlev *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki,* Sept-Oct 1980, p 109-118 6 refs In Russian

An analysis was made of the effectiveness of a conducting MHD motor with a free field using a flat plate finite width model. The variational problem of determining the optimal potential distribution on the plate with maximum efficiency was solved It was shown that the consideration of the end effects determines some of the unknown characteristics of the system A T.

A81-21064 # **MK-generators using the transition of a semiconductor material into a conducting state (MK-generatory s ispol'zovaniem perekhoda poluprovodnikovogo materiala v provodiashchee sostoianie)** E I Bichenkov, S D. Gilev, and A M. Trubachev *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki,* Sept-Oct 1980, p 125-129 9 refs In Russian

Experimental results are presented on plane and coaxial MK-generators with cavities filled with powdered Si. An evaluation of the coefficients of current amplification is made in the framework of an electrotechnical model A significant dependence of the generator parameters on the ratio of mass velocity to the velocity of the shock wave in Si is demonstrated A T

A81-21065 # **Magnetohydrodynamic generator of electrical energy using gasification products of lignite coal (Magnitogidrodinamicheskii generator elektroenergii na produktakh gazifikatsii burykh uglei)** V A Derevianko, V S Slavin, and V S Sokolov *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki,* Sept-Oct. 1980, p 129-138 14 refs In Russian

An investigation is presented of an MHD generator of electrical energy fueled by gasification products of lignite coals using the T-layer effect which eliminates caustic additives A quasi-one-dimensional theory of linear MHD processes is constructed on the basis of MHD equations, a design of an industrial generator is discussed A.T

A81-21096 # **Operational, control and protective system transient analyses of the closed-cycle GT-HTGR power plant.** F L Openshaw and T W Chan (General Atomic Co, San Diego, Calif.) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/GT-1* 11 p. 10 refs. Members, $2 00, nonmembers, $4 00 Contract No DE-AT03-76SF-70046

This paper presents a description of the analyses of the control/protective system preliminary designs for the gas turbine high-temperature gas-cooled reactor (GT-HTGR) power plant. The purpose of these systems is the control and safe operation of the plant in accordance with utility practice for large nuclear generation stations, and in the event of an abnormal or accident condition to shut the plant down in an orderly manner and maintain it in a safe shutdown condition Several unique characteristics inherent in the operation of the closed-cycle multiple-loop GT-HTGR design have presented special modeling and/or control design requirements or resulted in unusual conditions The GT-HTGR dynamic modeling, control/protective system design, and transient analyses are illustrated in this paper through discussion of a few selected transient events and the special modeling and control operation for these events (Author)

A81-21103 # **Electrical conductivity and Hall parameter measurements in Faraday MHD generators.** A M Demirjian (Avco Everett Research Laboratory, Inc, Everett, Mass) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/HT-9* 6 p 5 refs Members, $2 00, nonmembers, $4 00

An experimental technique to measure the axial distribution of plasma electrical conductivities and Hall parameter, is described Basic discussion of the underlying assumptions and their justification is presented, the data show that the electrical conductivity measurements agree with other experimental results In the absence of other experimental data, confidence in the Hall parameter measurements was reinforced by agreements with analytical results (Author)

A81-21104 # **MHD electrode performance - Heat transfer and voltage drops** A M Demirjian (Avco Everett Research Laboratory, Inc, Everett, Mass) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/HT-10.* 7 p 6 refs Members, $2 00, nonmembers, $4 00

The electrical and thermal performance of arc mode electrodes was investigated in environments typical of large scale coal fired MHD generators by measuring electrode voltage drops and heat fluxes The electrode metal temperatures were about 260 C, while plasma interface temperatures were controlled by a flowing slag layer at 1800 K The measurements show that the cathode voltage drops correlate with the normalized current density parameter modified by the Hall effect concentration factor An increased heat flux on the anode wall coincided with reduced anode voltage drop indicating increased current leakage in the boundary layers A T

A81-21105 # **On heat balance in coal-fired MHD systems, channel heat transfer and electrode temperature distribution.** G D Roy and L W Crawford (Tennessee, University, Tullahoma, Tenn) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/HT-11* 10 p 9 refs Members, $2 00, nonmembers, $4 00 Contract No DE-AC02-79ET-10815

This paper presents results from heat transfer studies performed in 7.5 MWt and 15 MWt direct coal-fired magnetohydrodynamic systems for electrical power generation Heat transfer from the various components is measured to determine system heat balance and the influence of parameters related to coal combustion on heat transfer The measured heat flux from electrode walls is compared with a quasi-one-dimensional model and extended for off-design operation The heat flux values are used in a computer model to evaluate temperature distributions in electrode frames and caps and are compared with measurements taken during power runs (Author)

A81-21138 # **Torque ripple in a Darrieus, vertical axis wind turbine.** R C Reuter, Jr (Sandia Laboratories, Albuquerque, N Mex) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/Sol-13* 7 p 9 refs. Members, $2 00, nonmembers, $4 00 Contract No AT(29-1) 789

Interaction between a steady wind and a rotating, Darrieus, vertical axis wind turbine produces time periodic aerodynamic loads which cause time dependent torque variations, referred to as torque ripple, to occur in the mechanical link between the turbine and the electrical generator There is concern for the effect of torque ripple upon fatigue life of drive train components and upon power quality An analytical solution characterizing the phenomenon of torque ripple has been obtained which is based upon a Fourier expansion of the time dependent features of the problem Numerical results for torque ripple, some experimental data, determination of acceptable levels and methods of controlling it, are presented and discussed (Author)

A81-21142 # **VAWTDYN - A numerical package for the dynamic analysis of vertical axis wind turbines** D W Lobitz and W N. Sullivan (Sandia Laboratories, Albuquerque, N Mex) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill., Nov 16-21, 1980, Paper 80-WA/Sol-18* 7 p 10 refs Members, $2 00; nonmembers, $4 00 Contract No DE AC04-76DP-00789

The dynamic behavior of wind turbines is a major factor governing their overall fatigue life and reliability This paper describes a package developed for the dynamic analysis of the Darrieus vertical axis wind turbine The model on which the package is based includes the major rotor elastic degrees of freedom, gyroscopic effects, and structural damping. The equations of motion are discussed and several example solutions are presented Comparisons are made between model predictions and data from operational rotors (Author)

A81-21143 # **Binary Rankine-cycle engines for solar-thermal power systems.** J P Abbin, Jr (Sandia Laboratories, Albuquerque, N Mex) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill, Nov 16-21, 1980, Paper 80-WA/Sol-19* 6 p 10 refs Members, $2 00, nonmembers, $4 00 Contract No. DE-AC04-76DP-00789

Binary Rankine-cycle engines have the potential to provide thermal-to-electric conversion efficiencies of 40 percent or more at relatively moderate temperatures and pressures, e g , 1000 F (538 C) and 180 psia (1200 kPa) Even though moderate-temperature binary Rankine engines have been operated successfully in commercial service for many years, none are presently operated or under development The reasons are discussed in this paper In addition, projected performance for a new binary Rankine engine is compared with that of other moderate and high temperature engines The argument is made that even relatively small binary Rankine engines have a high potential for providing efficient energy conversion at conditions that are readily achievable with two-axis tracking, point-focusing, solar-collector systems currently under development (Author)

A81-21162 # **The nuclear closed-cycle gas turbine /HTGR-GT/ - Dry cooled commercial power plant studies** C F McDonald and C R Boland (General Atomic Co , San Diego, Calif) *(American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La , Mar 10-13, 1980, Paper 80-GT-82) ASME, Transactions, Journal of Engineering for Power,* vol 103, Jan 1981, p 89-100 29 refs Contract No DE-AT03-76SF-70046

Combining the modern and proven power conversion system of the closed-cycle gas turbine (CCGT) with an advanced high-temperature gas-cooled reactor (HTGR) results in a power plant well suited to projected utility needs into the twenty-first century The gas turbine HTGR (HTGR-GT) power plant benefits are consistent with national energy goals, and the high power conversion efficiency potential satisfies increasingly important resource conservation demands Established technology bases for the HTGR-GT are outlined, together with the extensive design and development program necessary to commercialize the nuclear CCGT plant for utility service in the 1990s The most recent design studies for a dry-cooled commercial plant of 800 to 1200 MW(e) power based on both nonintercooled and intercooled cycles are outlined and various primary system aspects are discussed Details are given of the reactor turbine system and on integrating the major power conversion components in the prestressed concrete reactor vessel (Author)

A81-21163 # **The nutating traction drive** Y Kemper (Vadetec Corp , Troy, Mich) *(American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La , Mar 10-13, 1980, Paper 80-GT-99) ASME, Transactions, Journal of Engineering for Power,* vol 103, Jan 1981, p 154-157

The unique torque speed characteristic of the single-shaft gas turbine requires that it have a continuously variable-ratio transmission for successful application to automotive use This paper discusses the development of a novel mechanical transmission which has the power density required for highway vehicles Cost and efficiency are competitive with conventional automatic transmissions. (Author)

A81-21466 **Nonlinear evolution of ablation-driven Rayleigh-Taylor instability.** R L McCrory (Rochester, University, Rochester, N Y.), L Montierth, R L Morse (Arizona, University, Tucson, Ariz), and C P Verdon (Arizona, University, Tucson, Ariz , Rochester, University, Rochester, N Y). *Physical Review Letters,* vol 46, Feb 2, 1981, p 336-339 14 refs Contract No DE-AC08-80DP-40124

Simulations of the Rayleigh-Taylor instability of ablatively accelerated thin-shell fusion targets show that the nonlinear evolution exhibits spike amplitude saturation due to ablative mass removal, the shell anterior surface evolves to a laminar (nonturbulent) quasistationary distorted state The perturbed flow causes a significant departure from spherically symmetric behavior, but the laminar shell interior structure makes it appear possible to retain some of the advantages of larger-aspect-ratio fusion targets (Author)

A81-21480 **Effects of toroidal coupling on the stability of tearing modes** B Carreras (Institute for Advanced Study, Princeton, N J), H R Hicks, and D K Lee (Oak Ridge National Laboratory, Oak Ridge, Tenn) *Physics of Fluids,* vol 24, Jan 1981, p 66-77 17 refs Contracts No W-7405-eng-26, No DE-AC02-76ET

The time evolution of tearing modes in toroidal geometry is studied in the low-beta and large-aspect-ratio limit An initial value three-dimensional computer code which numerically advances the reduced set of resistive magnetohydrodynamic equations is employed Toroidicity has, in general, a destabilizing effect on tearing modes in this limit A generalization of Delta-prime formalism can be used to study the linear regime The results obtained in this way are in very good agreement with the results from the initial value code The nonlinear phase of the evolution is also followed numerically In the case of strong interaction of different helicities, a larger region of stochastic magnetic field lines results than in the cylindrical geometry case (Author)

A81-21494 **Corrosion behavior of metallic materials in the reducing environments characteristic of a coal-fired MHD generator** R N Singh and K Natesan (Argonne National Laboratory, Argonne, Ill). *Corrosion,* vol 36, May 1980, p 230-241 11 refs Research supported by the U S Department of Energy

Metallic materials selected for the balance of plant construction of an open cycle coal fired magnetohydrodynamic (MHD) generator must withstand the corrosive-erosive conditions in these systems. The corrosion behavior of carbon steel, chromium-molybdenum ferritic steel, austenitic stainless steels, and nickel base alloys, has been evaluated after exposure to complex gas mixtures that simulate a coal fired MHD environment with substoichiometric combustion The results show that sulfidation was the predominant mode of interaction for the alloys in this environment Carbon steel and Cr-Mo steels suffered significant sulfidation attack, while the austenitic stainless steels exhibited superior resistance to corrosion It is concluded that low cost ferritic steels with a stainless steel cladding or a ramming refractory coating can be used for protection of the radiant boiler components of a typical coal fired MHD generator system (Author)

A81-21640 **Selective fast neutron detector** R. E Chrien and J D Strachan (Princeton University, Princeton, N J) *Review of Scientific Instruments,* vol 51, Dec 1980, p 1638-1640 7 refs Contract No DE-AC02-76CH-03073

A ZnO(Ga) scintillator has been developed which selectively detects 14 MeV neutrons in a large 2 5 MeV neutron and hard X-ray background The detector will be useful in measuring the 14 MeV neutron emission with trace concentrations of tritium in a predominately deuterium plasma during early experiments in the Tokamak Fusion Test Reactor (TFTR) or the Joint European Torus (JET) (Author)

A81-21641 **Voltage and current sensors for a high-density z-pinch experiment.** C A Ekdahl (California, University, Los Alamos, N. Mex) *Review of Scientific Instruments,* vol 51, Dec 1980, p 1645-1648 7 refs Research sponsored by the U S Department of Energy

Capacitively-coupled transmission-line voltage sensors and inductive-shunt current sensors used in experiments with a high-density gas-embedded z pinch have provided accurate and reliable measurements Design and construction of these sensors is described, and their calibration is discussed in detail (Author)

A81-22176 # **Investigation of dynamics of a waterwave power plant (Issledovanie dinamiki tipovoi volnovoi energeticheskoi ustanovki)** G I Denisenko, A S. Tsybenko, and S. A Lavrikov (Kievskii Politekhnicheskii Institut, Kiev, Ukrainian SSR) *Problemy Prochnosti*, Jan 1981, p 27-31 5 refs In Russian

Waterwave power plant dynamic processes are examined Equations of motion are derived for such a system, a computation algorithm is constructed illustrated by an example of utilization of sea wave energy A T

A81-22400 **Fuel cells - A survey. I.** M A Parrish (Lambson, Ltd , Castleford, Yorks., England) *Materials in Engineering*, vol 2, Dec 1980, p 68-72 36 refs

The nature, history and types of fuel cells are outlined with attention to the contributions of Davy, Grove, Mond and Langer, Ostwald, Jacques, Haber, and Brunner, and Bacon Advantages and applications of the fuel cell as an energy converter are noted. Fuels and oxidants are surveyed and types of electrolyte are described L S

A81-22526 * # **Stability of large horizontal-axis axisymmetric wind turbines** M S Hirschbein (NASA, Lewis Research Center, Cleveland, Ohio) and M I Young (Delaware, University, Newark, Del) *Miami International Conference on Alternative Energy Sources, 3rd, Miami, Fla , Dec 15-17, 1980, Paper* 35 p 19 refs

The stability of large horizontal-axis, axisymmetric, power producing wind turbines is examined within the framework of an analytical model which includes dynamic coupling of the rotor, tower, and power generating system The aerodynamic loading is derived from blade element theory Stability is determined by the eigenvalues of a set of linearized constant-coefficient differential equations All results presented are based on a 3-bladed, 300-ft diameter, 2 0-MW wind turbine It is shown that unstable or weakly stable behavior can be caused by aerodynamic forces due to motion of the rotor blades and tower in the plane of rotation or by mechanical coupling between the rotor system and the tower V L

A81-22659 **The development of advanced structural materials for fusion power** J L Scott (Oak Ridge National Laboratory, Oak Ridge, Tenn) In The 1980's - Payoff decade for advanced materials, Proceedings of the Twenty-fifth National Symposium and Exhibition, San Diego, Calif, May 6-8, 1980
Azusa, Calif , Society for the Advancement of Material and Process Engineering, 1980, p 330-339. 11 refs Contract No W-7405-eng-26

It is noted that once physics questions are resolved limitations imposed by the nature of the materials under consideration for fusion reactor first walls and blankets will pose a major problem The development of fusion reactor materials is seen as being hampered by the lack of a large-volume, high-flux source of neutrons of appropriate energies The environment in which the first wall and blanket must exist is described, and properties of the alloys being considered are presented It is noted that while preliminary data on austenitic stainless steel (type 316) show some encouraging trends, the properties of this material are not particularly favorable in terms of thermal stress resistance It is concluded that the alloy eventually selected will probably be developed specifically for the fusion application C.R

A81-22775 **HGP-A wellhead generator feasibility project.** *Geothermal Energy*, vol 8, Mar. 1980, p 33-38 Research sponsored by the U S Department of Energy, University of Hawaii, and Hawaii Electric Light Co

The geothermal power plant to be built over the Kapoho geothermal reservoir in Hawaii is discussed Attention is given to the organization and financing of the project It is noted that because there is a risk of volcanic eruption occurring near or at the site, the plant is designed so that specific pieces of equipment will be easily removable and transportable to avoid lava flows The electrical output of the plant's generator will be 2 8 MW. A description is given of the various systems of the plant, namely the steam supply system, cooling water system, and system for hydrogen sulfide abatement. It is noted that geoscientists have estimated that this reservoir may have the capacity of 500,000 kW for 100 years The contribution that the plant can make to the state's economy is assessed C R

A81-22876 **Limits to plasma science.** T W Johnston (Québec Université, Varennes, Canada) *IEEE, Proceedings*, vol 69, Feb 1981, p 149-158 70 refs

Since fundamental limits to plasma science are the well-known ones of relativity and quantum mechanics, various practical limits are discussed for plasma science in several domains of current interest applications (mainly controlled thermonuclear fusion, both magnetic confinement and ablative compression) investigation of natural plasma (in space near earth and solar system and in astrophysics) Some historical flavor is imparted by also considering the effect of limits on three domains of interest since the 1945 plasma frequency devices for microwave applications at millimeter wavelengths, solid-state plasmas, and reentry vehicle plasmas In general, while one can identify the nature of the limits, refining their 'values' or making firm predictions in view of possible 'breakthroughs' is seen to be unlikely to be worth doing (Author)

A81-22900 **Contribution of ocean thermal energy conversion to world energy needs.** W H Avery and G L Dugger (Johns Hopkins University, Laurel, Md) *International Journal of Ambient Energy*, vol 1, July 1980, p 177-190 46 refs

Ocean Thermal Energy Conversion (OTEC) can provide energy to all countries It can deliver the energy (1) to regions bordered by warm ocean waters via direct electric-power transmission or (2) to other areas not bordered by warm ocean waters, via an energy-intensive material produced on OTEC plantships cruising on the high seas in the tropics Ammonia is an outstanding choice for an energy-intensive material because it can (a) replace ammonia now made from natural gas to conserve fuel, (b) serve as a synthetic fuel, or (c) provide an easily transported, storable source of hydrogen for fuel cells to generate electric power where needed anywhere in the world Costs of OTEC ammonia and of electricity delivered directly or via fuel cells are projected to be competitive with costs of electricity from coal or nuclear plants by 1990, if rapid OTEC development is pursued (Author)

A81-23063 **Optical spectrum of a closed cycle MHD generator plasma.** M Zlatanovic (Beograd, Univerzitet, Belgrade, Yugoslavia) and A F C Sens (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands) *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol 25, Mar 1981, p 291-294 5 refs

The spectra of argon-cesium plasmas, used as working fluids of closed-cycle MHD generators, were investigated in the visible and near-i r regions by using a Hilger-Watts medium quartz spectrograph A number of argon and cesium lines was observed, as well as some lines originating from the impurities present in the cesium capsule. The molecular bands of aluminum monoxide have also been detected The population temperatures estimated from relative intensities of cesium lines lie below those obtained by using either the line-reversal method or recombination-radiation measurements The intensities of some neutral cesium lines follow the Boltzmann population relation at the population temperature The Zeeman effect and reversed profiles of cesium resonance lines were not observed because of low resolution of the spectrograph used and because of light scattering on the film (Author)

A81-23066 # **A review of the icing problem for aerogenerators** A R. Mortimer (Science Research Council, Rutherford and Appleton Laboratories, Didcot, Oxon, England) *Wind Engineering*, vol 4, no 4, 1980, p 183-191 15 refs

A81-23067 # **A performance analysis for horizontal axis wind turbines applicable to variable pitch or airbrake control** R I Lewis and K Y Cheng (Newcastle-upon-Tyne, University, Newcastle-upon-Tyne, England) *Wind Engineering*, vol 4, no. 4, 1980, p 192-210 6 refs

A theoretical analysis is developed for predicting the performance of horizontal axis wind turbines of prescribed geometry and of known profile aerodynamics The solution is based upon the matching of axial thrust according to momentum control volume analysis to that corresponding to the aerodynamic blade forces, and unlike most theories allows for the division of stagnation pressure loss in the wake between shaft power and frictional losses The theory also predicts the influence of air brakes upon the system characteristic, and makes it possible to compute characteristics with variable pitch control applied to the whole blade or parts of it A design method is also presented for selection of blade geometry to suit prescribed radial distribution of blade loading (Author)

A81-23068 # **Integration of wind power into Australian electricity grids without storage - A computer simulation.** M Diesendorf (Commonwealth Scientific and Industrial Research Organization, Div of Mathematics and Statistics, Canberra, Australia) and B Martin (Australian National University, Canberra, Australia) *Wind Engineering,* vol 4, no 4, 1980, p. 211-226 10 refs. Research supported by the National Energy Research, Development and Demonstration Council of Australia

A computer simulation is performed of the operation of two fuel-based Australian State electricity grids (WA and SA) with zero storage and added hypothetical wind power capacity. It is found that wind energy contributions of 20 percent (WA) and 30 percent (SA) of the annual grid energy output can be achieved before the losses of unutilized wind energy increase to 20 percent of wind energy generation The results are sensitive to the extent to which the output of conventional units can be regulated or 'cycled' Small modifications to the grid operating strategy can affect the extent to which wind energy substitutes for a mixture of peak, intermediate and base load fuel or mainly for base load fuel The most economical operation strategy is not necessarily the one which places wind at the top of the merit order (Author)

A81-23426 **Applied Superconductivity Conference, Santa Fe, N. Mex., September 29-October 2, 1980, Proceedings.** Conference sponsored by APS, IEEE, DOE, et al. Edited by S J S. Lorant (Stanford University, Stanford, Calif.) *IEEE Transactions on Magnetics,* vol. MAG-17, Jan. 1981 1180 p

The conference focused on magnets for fusion technology, Ni-Ti conductors and critical current standards, microbridges and arrays, rotating machinery, discontinuous filament A15 superconductors, materials for tunnel junctions, magnets for energy storage and MHD, magnet technology, multifilamentary Nb3Sn conductors, and cavities and resonators Papers included superconducting magnets for toroidal fusion reactors, the circular form of the linear superconducting machine for marine propulsion, elastic buckling of superconducting Yin-Yang magnets for fusion, and magnetic energy storage A T.

A81-23436 **Flux pump excited brushless alternator.** A M Ferendeci, O K. Mawardi (Case Western Reserve University, Cleveland, Ohio), M J Melfi (Reliance Electric Co., Cleveland, Ohio), and H Laquer *(Applied Superconductivity Conference, Santa Fe, N. Mex , Sept. 29-Oct 2, 1980) IEEE Transactions on Magnetics,* vol MAG-17, Jan. 1981, p. 146-148 Contract No. F33615-79-C-2038

Experimental measurements obtained for a novel brushless superconducting alternator that makes use of a flux pump of the rotating spot type are presented The flux pump, used to provide the excitation current of the field coils incorporates several features of a machine studied theoretically and reported in an earlier paper The flux pumping is achieved with six electromagnets having pole pieces of special configurations to yield high efficiency and rapid pumping rates. The maximum design values for the current in the pump is 1,300 amps, and for the rotational speed, 500 rpm. Sensors installed on the generator yield information on the spatial and temporal behavior of the magnetic field in the flux spot and on the operational characteristics of the pump. The preliminary observations are compared with the theoretical predictions (Author)

A81-23441 **A superconducting magnet for Stanford University.** J F Parmer, G D Magnuson, R G Jones, W D Taylor, S. D Peck, J P Waszczak (General Dynamics Corp , Convair Div , San Diego, Calif.), J. E C. Williams, and E S Bobrov (MIT, Cambridge, Mass.). *(Applied Superconductivity Conference, Santa Fe, N. Mex., Sept 29-Oct. 2, 1980) IEEE Transactions on Magnetics,* vol. MAG-17, Jan. 1981, p 344-347 5 refs.

Three MHD superconducting magnets are being developed for coal power generation A rectangular saddle magnet uses a nonmetallic substructure for conductor support, a circular magnet contains the radial Lorentz forces by interlayer bands instead of a superstructure, and a circular saddle magnet supports conductors with a metallic substructure A substructure support provides conductor movement within the winding controlled by the limits of frictional heating of the conductor and reacts with a significant part of the magnetically induced loads During a seismic event or MHD channel-induced vibration of the winding, eddy currents induced in the vacuum vessel provide damping for the controls of resonant amplitude A.T

A81-23442 **The design of a tapered bore superconducting MHD magnet system.** Z J J Stekly, R D Pillsbury, Jr., W F B Punchard, and S Mushnick (Magnetic Corporation of America, Waltham, Mass.). *(Applied Superconductivity Conference, Santa Fe, N. Mex., Sept. 29-Oct. 2, 1980.) IEEE Transactions on Magnetics,* vol. MAG-17, Jan. 1981, p 348-351. USAF-supported research.

A superconducting MHD magnet will produce a magnetic field on axis which tapers from 4 T to 2 75 T over an active field length of 1 04 m The warm bore has a minimum ID of 0 29 m at the inlet and 0.53' m at the outlet, the magnet windings, structure, and helium vessel are 1.77 m long weighing 818 kg A 24 strand Rutherford cable with a Kapton and B-stage epoxy-glass wrap is wound onto a cold bore tube in the shape of an annular saddle with arched end turns, the windings are separated by an internal structure to transmit the Lorentz body forces to the superstructure (Author)

A81-23443 **ETF magnet design alternatives for the national MHD program.** P. G. Marston, R J Thome, A M Dawson, E S Bobrov, and A M Hatch (MIT, Cambridge, Mass) *(Applied Superconductivity Conference, Santa Fe, N Mex , Sept 29-Oct. 2, 1980.) IEEE Transactions on Magnetics,* vol MAG-17, Jan 1981, p 352-355 6 refs Research supported by the U S Department of Energy and NSF

Five superconducting magnet designs are evaluated for a 200 MWe test facility requiring a magnet with an on-axis field of 6 T, an inlet bore area of 4 sq m, storing 6 x 10 to the 9th J. The designs include a straightforward rectangular saddle coil set, a 'Cask' configuration based on staves and corner blocks as the main support structure, and an internally cooled, cabled superconductor to minimize the substructure and eliminate the helium vessel. Also, a modular design using six coils with individual helium vessels and an integrated structure produces a simplest configuration which utilizes a natural rectangular interface for packaging the MHD channel and its connections, and results in a lower capital cost. A T

A81-23447 **A computer circuit analysis investigation into stray subplate capacitance effects during the discharge of an MHD magnet.** G D. Magnuson and E L Woods (General Dynamics Corp , Convair Div , San Diego, Calif) *(Applied Superconductivity Conference, Santa Fe, N Mex., Sept 29-Oct 2, 1980) IEEE Transactions on Magnetics,* vol MAG-17, Jan 1981, p. 456-459 Research sponsored by the U S Department of Energy

A81-23451 **Construction program for a large superconducting MHD magnet system at the Coal-Fired Flow Facility.** S -T. Wang, L Genens, J Gonczy, H Ludwig, M Lieberg, E Kraft, D Gacek, Y.-C Huang, and C -J Chen (Argonne National Laboratory, Argonne, Ill) *(Applied Superconductivity Conference, Santa Fe, N Mex , Sept 29-Oct 2, 1980) IEEE Transactions on Magnetics,* vol MAG 17, Jan 1981, p 529-532 Research supported by the U S Department of Energy

The Argonne National Laboratory has designed and is constructing a 6 T large aperture superconducting MHD magnet for use in the Coal-Fired Flow Facility (CFFF) at the University of Tennessee Space Institute (UTSI) at Tullahoma, Tennessee The magnet system consists of the superconducting magnet, a magnet power supply, an integrated instrumentation for operation, control and protection, and a complete cryogenic facility including a CTI Model 2800 helium refrigerator/liquefier with two compressors, helium gas handling system and a 7500 liter liquid helium dewar The complete system will be tested at Argonne, IL in 1981 This paper first briefly reviews the magnet design Second, the coil fabrication programs are described in detail (Author)

A81-23452 **Reliability of large superconducting magnets through design** C D Henning (California, University, Livermore, Calif). *(Applied Superconductivity Conference, Santa Fe, N Mex , Sept 29-Oct 2, 1980) IEEE Transactions on Magnetics,* vol MAG-17, Jan 1981, p 618-625 17 refs Contract No W-7405-eng-48.

Design and quality control of large superconducting magnets for reliability comparable to pressure vessels are discussed The failure modes are analyzed including thermoelectric instabilities, electrical shorts, cryogenic/vacuum defects, and mechanical malfunctions. Design must take into consideration conductor stability, insulation based on the Paschen curves, and the possible burnout of cryogenic transition leads if the He flow is interrupted The final stage of the metal drawing process should stress the superconductor material to a stress value higher than the magnet design stress, cabled conductors should be used to achieve mechanical redundancy, and ground-plane insulation must be multilayered for arc prevention A T.

A81-23466 **Superconducting generators - Economics, technical considerations and ancillary technology** J J Bzura, F Abtahi, and L J Stratton (Arthur D Little, Inc , Cambridge, Mass) *(Applied Superconductivity Conference, Santa Fe, N Mex , Sept 29-Oct 2, 1980) IEEE Transactions on Magnetics,* vol MAG 17, Jan 1981, p 880-883 6 refs Research supported by the U S Department of Energy

An economic analysis of superconducting generators was performed and compared with analyses by Westinghouse and General Electric Superconducting generators were compared with conventional generators over a 30-year operating life using three energy sources (nuclear fuel, coal and oil), and including the effects of inflation on fuel and operating costs The ADL analysis shows that operating cost savings of a 1200 MVA superconducting unit can be approximately 70% of the capital cost of a conventional generator driven by a coal-fired steam turbine Principal R&D needs for superconducting generators and the limitations of ancillary technology are also discussed (Author)

A81-23515 **Lifting hydro's potential.** N Lihach *EPRI Journal,* vol 5, Dec 1980, p 6-13

The advantages of hydroelectric power, in terms of capital, operating and maintenance costs and in terms of fuel and environmental considerations, are causing an upgrading of existing installations to provide more generating capacity Hydrocapacity supplies 1/8 of the U S electric energy and will probably increase from 50 to 100% by the early 2000's as the price of other forms of energy rises Ways of increasing output are better water control, uprating of hydrogenerators, standardization of turbines, and methods of pumped hydro, an energy storage technique An obstacle to this aim is the cumbersome licensing process of competing federal agencies which places a particular burden on small projects. D.K

A81-23694 * **Large wind-turbine projects in the United States wind energy program.** R L Thomas and W H Robbins (NASA, Lewis Research Center, Cleveland, Ohio) *Journal of Industrial Aerodynamics,* vol 5, May 1980, p 323-335

The technological development of large, horizontal-axis wind turbines (100 kW-2500 kW) is surveyed with attention to prototype projects managed by NASA Technical feasibility has been demonstrated in utility service for systems with a rated power of up to 200 kW and a rotor diameter of 125 ft (Mod-OA) Current designs of large wind turbines such as the 2500 kW Mod-2 are projected to be cost competitive for utility applications when produced in quantity, with capital costs of 600 to 700 dollars per kW (in 1977 dollars) L S

A81-23695 **Current developments in small wind energy conversion systems** A C Hansen and C P Butterfield (Rockwell International Corp , Energy Systems Group, Golden, Colo) *Journal of Industrial Aerodynamics,* vol 5, May 1980, p 337-356 23 refs

The development of Small Wind Energy Conversion Systems (SWECS) with capacities under 100 kW and rotor diameters of approximately 30 meters is surveyed with a view to current prototypes, design programs, cost factors and wind systems testing The characteristics of development SWECS and the projected cost of energy from the new prototypes are given A primary objective of the Rocky Flats Test Center is the determination of the SWECS power output as a function of average wind speed One-second average values of wind speed and power output are continuously recorded for each wind turbine and the data are analyzed using the Method of Bins Areas of research discussed include rotor/wind dynamic interaction, and measurements of power output and blade root bending moments It is noted that a reliable method of load spectrum prediction would be invaluable in designing for fatigue L S

A81-23696 **Wind-turbine aerodynamics** R E Wilson (Oregon State University, Corvallis, Ore) *Journal of Industrial Aerodynamics,* vol 5, May 1980, p 357-372 16 refs

The aerodynamics of wind turbines is reviewed starting with effects of lift and drag on translating devices and proceeding through the performance aerodynamics of the horizontal-axis and vertical axis machines currently in service Horizontal-axis rotor aerodynamics is outlined and the performance limits are presented along with key assumptions and problem areas The Darrieus rotor multiple streamtube analysis is developed and compared with fixed and free wake analyses for an idealized case (Author)

A81-23697 **Aeroelastic stability and response analysis of large horizontal-axis wind turbines** P P Friedmann (California, University, Los Angeles, Calif) *Journal of Industrial Aerodynamics,* vol 5, May 1980, p 373-401 36 refs

The purpose of this review is to present recent research on aeroelastic and structural dynamic aspects of large horizontal-axis wind turbines in a unified manner The literature available in the field is reviewed with considerable detail and the fundamental differences between helicopter rotor aeroelastic problems and the wind turbine aeroelastic problem are carefully outlined Formulation of the isolated blade aeroelastic problem, as well as the coupled rotor/tower system, are treated with considerable detail Results illustrating the characteristics of the isolated blade behavior are presented Coupled rotor/tower behavior is also illustrated with an emphasis on rotor-tower-yaw drive interaction and rotor/tower interaction Various other structural dynamic and aeroelastic problems occurring in wind turbines are also briefly discussed (Author)

A81-23698 **The performance of arrays of wind turbines.** D J Milborrow (Central Electricity Generating Board, Central Electricity Research Laboratories, Leatherhead, Surrey, England) *Journal of Industrial Aerodynamics,* vol 5, May 1980, p 403-430 32 refs.

To assess the amount of power available in the wind, interactions between wind turbines in an array, or cluster, have been studied using a number of experimental techniques, and methods of mathematical analysis These studies have included wake measurements behind wind turbine rotors and wind tunnel tests of model clusters, together with analyses using wake mixing and boundary-layer theories. The results from these studies are reviewed and compared and it is shown that there is reasonable agreement between the estimates for the power loss due to interactive effects in a cluster generating 1000 MW (about 25% is lost, if the rotors are spaced 10 diameters apart) Estimates of the output from larger arrays show some variation and there are conflicting views on the effects of certain parameters - such as rotor height Other topics requiring further study - such as the influence of machine design - are also identified and discussed. (Author)

A81-23711 **Trends and developments in magnetic confinement fusion reactor concepts.** C. C Baker (Argonne National Laboratory, Argonne, Ill), G. A Carlson (California, University, Livermore, Calif), and R A. Krakowski (California, University, Los Alamos, N Mex.). *Nuclear Technology/Fusion,* vol 1, Jan. 1981, p. 5-78. 214 refs.

An overview is presented of recent design trends and developments in reactor concepts for magnetic confinement fusion The paper emphasizes the engineering and technology considerations of commercial fusion reactor concepts. Emphasis is placed on reactors that operate on the deuterium/tritium/lithium fuel cycle. Recent developments in tokamak, mirror, and Elmo Bumpy Torus reactor concepts are described, as well as a survey of recent developments on a wide variety of alternate magnetic fusion reactor concepts. The paper emphasizes recent developments of these concepts within the last two to three years. (Author)

A81-23712 **Contribution of activation products to fusion accident risk. I - A preliminary investigation.** J P Holdren (California, University, Berkeley and Livermore, Calif.). *Nuclear Technology/Fusion,* vol 1, Jan. 1981, p. 79-89. 25 refs. Research sponsored by the U S. Department of Energy

The health hazards of activation products from fusion-reactor accidents are dealt with in a study on an early conceptual tokamak reactor, using a simple consequence model based on that of the Nuclear Regulatory Commission's Reactor Safety Study (the Rasmussen Report) in order to determine conceivable radiation doses near the plant boundary Though tritium releases appear to result in fewer casualties than those predicted for the most severe accidents in fission reactors of similar electrical-generating capacity, the boundary doses of stainless-steel and molybdenum structures subject to massive lithium fires are comparable to the doses similarly calculated for 'worst case' light water reactor accidents. Calculations and tables are given for major activation products, their stored energy and their boundary doses in severe fusion and fission accidents Remedies are suggested for greatly reducing the potential for activation product release from fusion reactors, such as the use of low activation materials, the reduction of stored energy by putting lithium in relatively non-reactive form and the use of deuterium-deuterium instead of D-T reactions. D.K.

A81-23713 **Preliminary skyshine calculations for the Poloidal Diverter Tokamak Experiment.** D W. Nigg and F. J. Wheeler (EG & G Idaho, Inc., Idaho Falls, Idaho). *Nuclear Technology/Fusion,* vol. 1, Jan 1981, p 90-98. 10 refs Research supported by the U.S. Department of Energy

A calculational model is presented to estimate the radiation dose, due to the skyshine effect, in the control room and at the site boundary of the Poloidal Diverter Experiment (PDX) facility at Princeton University which requires substantial radiation shielding The required composition and thickness of a water-filled roof shield that would reduce this effect to an acceptable level is computed, using an efficient one-dimensional model with an Sn calculation in slab geometry. The actual neutron skyshine dose is computed using a Monte Carlo model with the neutron source at the roof surface obtained from the slab Sn calculation, and the capture gamma dose is computed using a simple point-kernel single-scatter method. It is maintained that the slab model provides the exact probability of leakage out the top surface of the roof and that it is nearly as accurate as and much less costly than multi-dimensional techniques. D.K.

A81-23714 **Neutronics shielding analysis of the last mirror-beam duct system for a laser fusion power reactor** M M. H. Ragheb (Illinois, University, Urbana, Ill), A C. Klein, and C. W Maynard (Wisconsin, University, Madison, Wis). *Nuclear Technology/Fusion,* vol. 1, Jan 1981, p. 99-119. 33 refs Research supported by the Electric Power Research Institute

A Monte Carlo three-dimensional neutronics analysis for the last mirror-beam duct system for the SOLASE conceptual laser-driven fusion power reactor design is presented Detailed geometric configurations including the reactor cavity, the two last mirrors, and the three-section two-right-angle bends duct are modeled. Measurements are given of the dimensions and compositions of the reactor components, and of neutron scalar fluxes, spatial dependencies and neutron volumetric heating rates for the cases of aluminum or Boral as laser beam duct liners, and ordinary concrete or lead mortar as shield material. A three-dimensional modeling of laser-driven reactor penetrations is employed. The particle leakage is found to be excessively high for the configuration of the conceptual design considered and the advantages and disadvantages of various solutions, such as the use of Boral as a duct liner and the use of lead mortar instead of ordinary concrete as a shield material, are considered. D.K

A81-23716 **An economics method for symbiotic fusion-fission electricity generation systems.** D H. Berwald and J. A Maniscalco (TRW, Inc., Redondo Beach, Calif) *Nuclear Technology/Fusion,* vol. 1, Jan 1981, p 128-136. 15 refs. Research supported by the Exxon Research and Engineering Co. and University of Rochester

A self-consistent analytical methodology for evaluating the economic incentives for symbiotic electricity generation systems that consist of fusion breeder reactors and supported fission converter reactors is developed This methodology employs a discounted cash flow analysis of breeder and converter direct operating costs and indirect capital costs, as well as a novel treatment of fissile inventory charges. Three figures of merit are emphasized (1) the levelized cost of electricity generated by the symbiotic system, (2) the levelized cost of fuel exchanged by the breeder and converter reactors in the system, and (3) the equivalent cost of fuel to produce the same levelized electricity cost in an alternatively fueled converter reactor A fission converter operating on the current once-through fuel cycle is a special case of the above The method is equally applicable to symbiotic systems that utilize spallation accelerator breeder reactors. (Author)

A81-23717 **Performance and economics analysis of several laser fusion breeder fueled electricity generation systems.** D. H. Berwald and J A Maniscalco (TRW, Inc., Redondo Beach, Calif) *Nuclear Technology/Fusion,* vol 1, Jan 1981, p 137-159 32 refs Research supported by the Exxon Research and Engineering Co

The paper evaluates the potential of several future electricity generating systems composed of laser fusion-driven breeder reactors that provide fissile fuel for current technology light water fission power reactors (LWRs) The performance and economic feasibility of four fusion breeder blanket technologies for laser fusion drivers, namely uranium fast fission (UFF) blankets, uranium-thorium fast fission (UTFF) blankets, thorium fast fission (TFF) blankets and thorium-suppressed fission (TSF) blankets, are considered, including design and costs of two kinds, fixed (indirect) costs associated with plant capital and variable (direct) costs associated with fuel processing and operation and maintenance Results indicate that the UTFF and TFF systems produce electricity most inexpensively and that any of the four breeder blanket concepts, including the TSF and UFF systems, can produce electricity for about 25 to 33% above the cost of electricity produced by a new LWR operating on the current once-through cycle It is suggested that fusion breeders could supply most or all of our fissile fuel makeup requirements within about 20 years after commercial introduction D K

A81-23719 **Tides and turbines** R H Charlier *Sea Frontiers,* vol 26, Nov-Dec 1980, p 355-362

Tidal power plants are examined with attention to potential sites worldwide and to existing projects in France, the Soviet Union, and China It is noted that maximum power cannot always be made available during peak demand periods because of the continuous variation of the daily tidal cycle throughout the year However, this can be alleviated if a two-pool design or pumping are used The economic impact of tidal power has been favorable, with the use of cellular units reducing construction costs substantially. L S

A81-23747 # **Electrical characteristics of MHD generators with solid electrodes and linear distribution of potential at the end strips (Elektricheskie kharakteristiki MGD-generatorov so sploshnymi elektrodami i lineinym raspredeleniem potentsiala na kontsevykh prostavkakh).** G. P. Bazarov, V A. Bitiurin, E. N. Kufa, and S. A. Medin. *Magnitnaia Gidrodinamika,* Oct-Dec 1980, p. 107-114. 9 refs. In Russian.

A numerical analysis is used to study the local and integral characteristics of the end sections of Faraday-type MHD generators with solid electrodes and sectioned metallic end strips The characteristics are investigated in relation to the length of the strips, their position relative to the decreasing magnetic field, and the mode of channel loading for a linear distribution of potential on the strips It is shown that there exist optimal dimensions of end strips and optimal positions relative to the magnetic field The characteristics of channels with different end configurations are examined. B.J

A81-23848 **The fusion-supported decentralized nuclear energy system.** D. L Jassby (Princeton University, Princeton, N J.) *Journal of Fusion Energy,* vol 1, Jan 1981, p. 59-67. 21 refs Contract No. EY-76-C-02-3073.

A decentralized nuclear energy system is proposed comprising mass-produced pressurized water reactors in the size range 10 to 300 MW (thermal), to be used for the production of process heat, space heat, and electricity in applications where petroleum and natural gas are presently used Special attention is given to maximizing the refueling interval with no interim batch shuffling in order to minimize fuel transport, reactor downtime, and opportunity for fissile diversion The smallest reactors could be deployed as 'nuclear batteries', kept in the equivalent of spent-fuel shipping casks and returned to nuclear fuel centers for refueling These objectives demand a substantial fissile enrichment (7 to 15%) The preferred fissile fuel is U-233, which offers an order of magnitude savings in ore requirements (compared with U-235 fuel), and whose higher conversion ratio in thermal reactors serves to extend the period of useful reactivity and relieve demand on the fissile breeding plants (compared with Pu-239 fuel) Application of the neutral-beam-driven tokamak fusion-neutron source to a U-233 breeding pilot plant is examined This scheme can be extended in part to a decentralized fusion energy system, wherein remotely located large fusion reactors supply excess tritium to a distributed system of relatively small nonbreeding D-T reactors (Author)

A81-23901 # **Direct conversion of chemical energy to electrical energy (Priamoe prevrashchenie khimicheskoi energii v elektricheskuiu)** N S. Lidorenko and G G Muchnik (Moskovskii Fiziko-Tekhnicheskii Institut, Moscow, USSR) *Priroda,* Jan 1981, p 8-19 7 refs In Russian

Various aspects of the development of direct electrochemical conversion are reviewed. The principles of operation of electrochemical generators are described, along with approaches to the analysis of such generators and the problem of catalysis The basic engineering problems in the fabrication of electrochemical generators are considered, and the prospects of their utilization in electric automobiles and electric power stations are discussed B.J.

A81-23955 **Power from water waves.** D V Evans (Bristol, University, Bristol, England) In Annual review of fluid mechanics Volume 13. Palo Alto, Calif, Annual Reviews, Inc, 1981, p. 157-187. 75 refs.

A review is presented of wave-energy devices and hydrodynamic properties of idealized equipment for extracting power from waves The governing equations involve the fluid hydrodynamic theory applied to machines with zero forward speed which can absorb energy from the neighboring wave field. A mixture of waves of different amplitudes, periods, wavelengths, and directions with randomly distributed phases coexist at a given time, a mathematical model of the sea surface assumes it to be an infinite superposition of wave trains of various amplitudes and frequencies A theory was developed for the oscillation of two-dimensional energy-absorbing cylindrical sections which can be utilized for estimating hydrodynamic characteristics of fully three-dimensional ship hulls. Finally, three-dimensional wave-energy absorbers are represented by expressions in terms of the force amplitude, direction of motion, and the damping coefficient A T.

A81-24209 **Low-temperature thermal emission rectifier with an oxidized titanium collector.** V. K. Tskhakaia and V. I. Iarygin. *(Zhurnal Tekhnicheskoi Fiziki,* vol 50, May 1980, p. 957-962.) *Soviet Physics - Technical Physics,* vol 25, May 1980, p. 577-580. 11 refs. Translation

Experimental results are presented on the operation of a thermionic converter with a W(110) emitter and an oxidized-titanium collector. It is shown that the output and emission characteristics of the converter are stable for times not less than 1800 hours. The minimum work function of the collector was 1.35 eV at a collector temperature of 823 C, the barrier index was 1.95 eV It is suggested that the surface of the collector was a stable film of titanium suboxide. B J

A81-24433 **An analytical expression for the average output power of a wind machine.** W R Powell (Johns Hopkins University, Laurel, Md) *Solar Energy,* vol 26, no 1, 1981, p. 77-80. 7 refs. Research supported by the U.S Coast Guard, Contract No N00017-72-C-4401.

A81-24447 **Submarine hydro-electro-osmotic power plants for an efficient exploitation of salinity gradients.** M Reali (Ente Nazionale per l'Energia Elettrica, Milan, Italy) *Energy* (UK), vol 6, Mar 1981, p 227-231 12 refs

An energy-conversion scheme, which allows efficient exploitation of salinity gradients, is proposed This is a submarine hydro-electro-osmotic power plant in which fresh surface water is conveyed through a penstock to a submerged hydraulic turbine for the generation of electric power The water leaves the turbine outlet depressurized and finally diffuses out in the sea, by osmosis, through a semipermeable barrier (Author)

A81-24617 **Performance calculation of a vertical-axis wind power converter (Leistungsberechnung fur einen Windenergiekonverter mit vertikaler Achse).** M Fallen and J Ziegler (Kaiserslautern, Universitat, Kaiserslautern, West Germany) *Brennstoff-Warme-Kraft,* vol 33, Feb 1981, p 54-59 8 refs In German

The performance calculation of a vertical-axis wind power converter is carried out by Strickland's DART model, modified for the H-Darrieus rotor The basic equations are solved by an iterative method. The influence of blade number, wheel geometry, and profile shape on the performance is determined, and results are compared with those for other windmill designs B.J.

A81-24811 **On the flow of an ionized gas in a MHD generator with segmented electrodes.** L. Brinzanescu (Bucuresti, Institutul Politehnic, Bucharest, Rumania) and L Dragos (Bucuresti, Universitatea, Bucharest, Rumania). *Acta Mechanica,* vol. 38, no 3-4, 1981, p 131-141.

A mathematical model is given for the flow of ionized gases in an MHD channel on the hypothesis that the external magnetic field is applied only in the zone of the electrodes. The rectangular cross-section channel carries N pairs of segmented electrodes The solution is expressed in terms of Fourier series distinct in the electrode zones from those in the insulator zones The coefficients are determined by the matching conditions at the ends of the electrodes The characteristics of the generator are determined and a computing program for N = 2 is given D K

A81-24975 **The sea trial of the wave power generator 'Kaimei'** Y Masuda and T Miyazaki (Japan Marine Science and Technology Center, Japan) *Energy Developments in Japan,* vol 3, Oct 1980, p 165-179

An experimental Japanese prototype of a wave-power electricity generator system is examined Construction details and experimental data are presented The ship-type floating structure, 80 meters in length and 500 tons dead weight, used a non-valve Wells turbine of 0 6 m diameter with four wings, whose energy conversion efficiency was found to be greater than 60% with very small waves, and whose safety factor was found to be greater than that of the impulse turbine The 'Kaimei' is concluded to be promising, but some technical problems, including increasing and smoothing the output power, remain to be solved D K

A81-25067 **New developments in wind systems technology.** R L Moment and C. P Butterfield (Rockwell International Corp., Golden, Colo) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 4 Washington, D C., Hemisphere Publishing Corp , 1981, p 1519-1530.

The design details of the prototype 1-2 kW, 8 kW, and 40 kW wind power systems are presented The prototypes are either nearing completion or currently undergoing tests at the Rocky Flats Test Center The 1-2 kW is a high-reliability system for remote applications in severe weather environments with a dc output for charging batteries The 8 kW is intended for farm residence use with an output of 60 Hz for tie-in with a utility The 40 kW will be used for irrigation or small community applications and is being designed for both 60 Hz ac electrical utility tie-in and mechanical output formats. Emphasis was placed on developing designs suitable for near-term commercialization and for potential cost-effectiveness L S

A81-25068 **An analysis for aerodynamic performance of the vertical axis 'phi' type rotor wind turbine** D -J Ye (Tsinghua University, Peking, Communist China) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 4. Washington, D C , Hemisphere Publishing Corp., 1981, p 1531-1542 9 refs

A method of calculating the aerodynamic performance of the vertical axis phi-type rotor wind turbine is proposed Two integral equations determining the work output of the turbine are derived from a stream sheet taken on a differential length of the rotor along the vertical axis Given the equality of the equations, the factor of influence and the wind energy efficiency of the stream sheet are obtained By the summation of the efficiencies of all the stream sheets, the aerodynamic performance of the wind turbine is determined regardless of differences in shape or the shear effects of the wind L.S.

A81-25069 **The flow field about a vertical axis wind turbine** T E Base and L. J Russell (Western Ontario, University, London, Canada) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 4 Washington, D C , Hemisphere Publishing Corp , 1981, p 1543-1560 5 refs.

An approach to determine the performance of a straight bladed vertical axis wind turbine is introduced, and an expression is derived for the blockage factor of a vertical shaft straight bladed turbine A comparison of the two types of vertical axis turbines is made The effect of solidity on the power output of a vertical axis straight bladed machine is studied It is shown that higher maximum power coefficients are attainable at lower solidities up to an optimum solidity value A vortex model describing the flow field about a vertical axis wind turbine is outlined The flow field consisted of a regular intermittent coherent singular pattern of finite vortex filaments shed from the blade every half revolution The computed vortex models will improve the determination of the aerodynamics associated with critical blade vibrations L S.

A81-25070 **The characteristics of two, simple, automatic speed-control devices for horizontal axis wind-turbines.** J A C Kentfield (Calgary, University, Calgary, Alberta, Canada) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 4 Washington, D.C , Hemisphere Publishing Corp , 1981, p 1561-1580 6 refs

A81-25071 **A new concept in horizontal axis wind turbine rotors.** V P Roan (Florida, University, Gainesville, Fla). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 4 Washington, D C , Hemisphere Publishing Corp , 1981, p 1581-1586

A new concept for horizontal axis wind turbine rotors was developed at the University of Florida The main feature of this concept is a 'segmented' blade design using uniform airfoil sections separated by thin aerodynamic fences. The fences allow the individual segments to have different orientations to provide desired twist and pitch. Several prototypes have been built and tested and a wind machine using this concept was the overall winner in the wind division of the ERA II SCORE competition in 1977 (Author)

A81-25072 **An unconventional wind machine** J R Sheff (Lowell, University, Lowell, Mass) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 4 Washington, D C , Hemisphere Publishing Corp , 1981, p 1587-1598 10 refs.

The installation of natural draft cooling towers in 1000 MWE nuclear, oil, gas, peat or wood plants is discussed It is estimated that up to 17 MWE could be saved for other uses such as sale by this method The examples of a coal fired power plant in New Mexico and the Catawba and Seabrook Nuclear Stations are used to derive a cost analysis of the natural draft towers It is concluded that these towers are generally competitive with nuclear power and other projected wind machine costs L S

A81-25073 **Commercial, or usable, size Campbell Chinese type windmill** J S Campbell In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 4 Washington, D C , Hemisphere Publishing Corp , 1981, p 1599-1621 5 refs.

An adequately large, home-use size, model of the Campbell Chinese type windmill has been designed, built, debugged and partially tested Two basic windmills, operating side by side and assembled on one supporting structure, constitute the complete windmill This complete windmill can be readily tilted down to a horizontal position to provide protection from destructive winds or to make upper parts accessible for maintenance Minimum feasible weight was a design aim, and some important weight reduction features are included in the descriptions. The testing of only one basic windmill on the supporting structure has been started (Author)

A81-25074 **Estimating the wind's potential for small scale energy generation using available local climatological data** D L Miller (Pennsylvania State University, Middletown, Pa) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13 1979 Volume 4 Washington, D C., Hemisphere Publishing Corp., 1981, p. 1623-1633

A81-25075 **Wind energy utilization possibilities in Turkey.** S. Oney, T Yarman, and B Tekes (Istanbul, Technical University, Istanbul, Turkey) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979. Volume 4 Washington, D C , Hemisphere Publishing Corp , 1981, p 1635-1656 5 refs

An analysis of the wind energy utilization possibilities in Turkey is presented Monthly wind speed maps based on data of the last twenty to thirty years are provided The minimum wind energy speed of nine meters per second is found to be satisfied in approximately 25 percent of the country It is concluded that the installation of several small (1-10 kW) wind generators in the southeastern part of the country may be fruitful, particularly during the summer months when wind energy may be coupled with solar power L S.

A81-25076 **Wind energy conversion in the MW range.** L Lois (Maryland, University, College Park, Md) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 4 Washington, D C , Hemisphere Publishing Corp , 1981, p 1659-1667 14 refs

The purpose of this paper is threefold (1) to show that certain wind patterns above the continental United States are particularly suited for wind energy conversion utilizing wind powered stations in the MWe range, (2) to describe a system specifically designed for such stations, and (3) to present calculations which show that such a system is within the range of existing technology The proposed system is based on the existence of a wind pattern called the low level jet in which (a) the average wind speed is 2 0 to 3.0 times higher than at the 300 ft level, and (b) the diurnal and seasonal variations are smaller than at 300 ft The higher specific power and utilization factor which result from the characteristics of the low level jet contribute to higher power level per installation and power cost per unit energy produced (Author)

A81-25077 **Dynamic response of power generating wind turbines.** D W Adkins and M I Young (Delaware, University, Newark, Del). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 4 Washington, D C., Hemisphere Publishing Corp , 1981, p 1669-1681 5 refs

A model is presented of the rotational dynamics of a large wind turbine driving synchronous and nonsynchronous electric generators The rotor is assumed rigid with constant-chord blades and is modeled by aerodynamic strip theory The loads include a dc generator with either field current control or blade pitch control and a synchronous alternator with blade pitch control These models are used to evaluate rotational response of the wind turbine to step-changes in wind speed (Author)

A81-25078 **Reliability, energy, and cost effects of wind integration with conventional electrical generating systems** W A Buehring, K A Hub, C C- Huber, J C Vankuiken (Argonne National Laboratory, Argonne, Ill), and J G Gros (U S Department of Energy, Washington, D C) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 4 Washington, D C , Hemisphere Publishing Corp , 1981, p 1683-1695 11 refs

The potential impacts of incorporating wind turbines, without the aid of storage devices, into a conventional electrical generating system is investigated A description of the methods and assumptions used to model the integrated operation of wind turbines in a utility system is given Limitations of the methods and qualifications for the results are identified and discussed It is concluded that, with both energy and reliability benefits, there is a reasonable potential for wind generators to be competitive, in limited penetrations, with conventional capacity (Author)

A81-25079 **Sources and potential uses of wave energy.** D D. Woodbridge (Hittman Associates, Inc., Columbia, Md) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 4 Washington, D C , Hemisphere Publishing Corp., 1981, p 1727-1742 11 refs

An analysis of ocean wave energy and its uses is presented The ocean energy conversion systems surveyed include the ocean valve, the spherical vane, the hinged raft and the oscillating water column systems The configuration of the Ocean Swell and Wave Energy Converter (OSWEC) is detailed, and its potential power output is discussed It is noted that the utilization of a single OSWEC system of 20 MW would result in a savings of nearly 25,000 barrels of oil a month. L S.

A81-25080 **Small scale power generation utilizing wave energy.** G N Nurick and R K Dutkiewicz (Cape Town, University, Cape Town, Republic of South Africa) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 4. Washington, D.C , Hemisphere Publishing Corp , 1981, p 1751-1760 15 refs.

The Differential Area Piston Compressor (DAPC) small wave power generator is described The DAPC has two moving parts, a vertical moving float, and a turbo-alternator A large float connected to a piston which has a smaller area moves in a vertical direction under the impulse from the vertical movement of the wave so that the piston compresses air The air passes through the turbo-alternator via a storage accumulator Each unit would have to be designed according to the wave characteristics of the considered area of application The dimensions, power output, and efficiency of the unit and the relationship between these and the wave characteristics are discussed L S

A81-25081 **The design and analysis of a vertical axis ocean current power plant** C C Richard, J R Hartzog, R V Sorge, J V. Quigley, and G R Adams (U S Naval Academy, Annapolis, Md) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 4 Washington, D C , Hemisphere Publishing Corp , 1981, p 1761-1768

This paper discusses a calculation of the power generated by a *vertical axis ocean current power plant An analytical model* is presented and a computer solution described Results of the calculation show the optimum angles of the blades about the vertical axis to maximize power output, as well as the total extractable power of the plant for various ocean current velocities Tow tank tests are described for a scale model of the plant Additionally, the advantages and economics of the proposed design are discussed (Author)

A81-25082 **Some new conceptions in the approach to harnessing tidal energy.** A. M Gorlov (Northeastern University, Boston, Mass) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 4 Washington, D C , Hemisphere Publishing Corp , 1981, p 1771-1795 10 refs Research sponsored by the U S Department of Energy

A method of converting ocean tide energy into compressed air energy for subsequent conversion to electrical and other forms of industrial energy is presented The tidal energy is converted to compressed air energy by means of specialized chambers which are put on the ocean bed Ocean water from the dammed region passes through the chamber where it works as a natural piston compressing air in the upper part of the closure The compressed air can be expanded through high speed compact gas turbines or any type of reciprocating engine The flexible reinforced plastic barrier should be substantially cheaper than a conventional rigid dam and can be designed so that by means of special floats it becomes a self-supported and self-regulated weightless structural system which can dam a large shallow space of ocean without having to be connected to special bays L S

A81-25083 **The utilization of the free and at present dissipated gravitational force inherent in tidal motion by conversion to electrical energy, using compressed air as the active intermediary** A W Baber (Technical College of Smethwick, Warley, Worcs , England) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 4 Washington, D.C, Hemisphere Publishing Corp, 1981, p 1797-1811

A81-25084 **Korea tidal power and beyond** W O Song (Korea Ocean Research and Development Institute, Seoul, South Korea) and E van Walsum (Shawinigan Engineering Co, Ltd, Montreal, Canada) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 4 Washington, D C., Hemisphere Publishing Corp, 1981, p 1813-1832 10 refs United Nations Contract No ROK/72/027

A study evaluating the tidal power potential on the west coast of Korea is presented. The tidal power plant concept applied to all sites features prefabricated caissons from which the powerhouse and the sluice sections of the plant are built up In the screening process, all 13 potential sites were compared on the basis of a single basin and single effect schemes operated to produce the maximum amount of energy The four sites identified as having potential for development (the inner Asan Bay, the outer Asan Bay, the Incheon Bay, and the Garorim Bay) are economically evaluated It is noted that harbor development and land reclamation can proceed in conjunction with tidal power development L S

A81-25085 **A perspective on OTEC plants** L W Zelby (Oklahoma, University, Norman, Okla) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 4 Washington, D C, Hemisphere Publishing Corp, 1981, p 1835-1842 25 refs

An ocean thermal energy conversion plant (OTEC) concept is analyzed with a view to economic and environmental constraints, positive net energy yield, and the quantities of construction materials used It is noted that many such materials are not renewable The plant discussed is a 240 MWe plant consisting of a partially submerged floating platform housing four power modules, each containing two 30 MWe generators The plant is expected to have a lifespan of 100 years for the platform and 35 years for the power modules and to deliver 1 13 billion kWhe per year The projected OTEC plant seems to satisfy environmental, net energy, and economic criteria but requires very large quantities of concrete, steel and titanium It is concluded that OTEC expansion should be deferred until more information can be gathered by a small pilot plant L S

A81-25086 **A bottom fixed OTEC plant on the edge of a continental /or island/ shelf.** J C Daidola, N S. Basar (M. Rosenblatt and Son, Inc, New York, N Y), and D. S Sasscer (University of Puerto Rico, Mayaguez, P R) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 4 Washington, D C, Hemisphere Publishing Corp., 1981, p 1843-1857. 12 refs.

A generic type of shallow water bottom fixed ocean thermal energy conversion plant (SBF-OTEC) is considered The SBF-OTEC consists of a platform structure rigidly attached to the seabed at the edge of a continental or island shelf It is noted that the cold water, warm water and combined discharge pipes to be used in connection with this plant are not subject to the very large hydrodynamic forces acting on a pipe attached to a floating platform The characteristics of the platform and the SBF-OTEC systems are given and the costs, prospects for commercialization and potential island location sites are discussed L.S.

A81-25087 **Coupling Ocean Thermal Energy Conversion technology /OTEC/ with nuclear power plants** M K Goldstein (JGC Corp, Yokohama, Japan), D Rezachek, and C. S Chen (Hawaii, University, Honolulu, Hawaii) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 4 Washington, D C, Hemisphere Publishing Corp, 1981, p 1875-1892 12 refs

The use of an Ocean Thermal Energy Conversion Related Bottoming Cycle (ORBC) to recover the waste heat generated by a large nuclear or fossil power plant is considered To take advantage of an ORBC, a plant must be located close to cold, deep ocean water, either open-ocean or shore-based The ORBC can also be retrofitted to existing shore-based nuclear plants or it can be a part of the design of future plants The increased efficiency of a nuclear floating system due to the ammonia bottoming cycle and ORBC systems is shown for the example of the proposed facility in Murata, Japan It is noted that the size of the heat exchangers and the diameter of the cold water pipe would be relatively smaller for an ORBC than for a conventional ocean thermal energy conversion system. L.S.

A81-25092 **Making geothermal power competitive.** L L. Fassbender and C H. Bloomster (Battelle Pacific Northwest Laboratories, Richland, Wash) In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 5 Washington, D.C., Hemisphere Publishing Corp, 1981, p 2009-2021. 6 refs Contract No EY-76-C-06-1830

The near-term supply curve for the electrical applications of geothermal energy is presented, and the impacts of technological improvements are illustrated. The curve is derived using the subsurface temperature, reservoir thickness, and heat content estimates made by the U S Geological Survey for the identified high-temperature and intermediate-temperature hydrothermal resources of the western U S Each step in the curve is composed of one or more geothermal resources identified by the USGS Both high- and intermediate-temperature resources were included up to an arbitrary cost ceiling of 100 mills/kWh Curves are drawn to show the impacts of combinations of technological advances expected to be achieved by 1982 and 1985. It is shown that most of the identified hydrothermal resources could become competitive with conventional energy sources for electrical power production by 1985 L.S.

A81-25095 **The utilization of geothermal energy in the Philippines.** L U Rivero (De La Salle University, Manila, Philippines). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979. Volume 5. Washington, D C, Hemisphere Publishing Corp, 1981, p 2071-2075 15 refs

A history of the exploration of the geothermal resources as well as the construction of the geothermal power plants in the Philippines is given The cost and the viability of such plants under Philippine conditions are presented The necessity of a planned development around the geothermal plant - such as heat-consuming industries - is stressed (Author)

A81-25097 **An evaluation of alternate energy sources for the Guyana energy crisis.** M Sankies (University of Guyana, Turkeyen, Guyana) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 5 Washington, D C, Hemisphere Publishing Corp., 1981, p 2125-2153. 11 refs

Hydropower, tidal power, and Ocean Thermal Energy Conversion (OTEC) are evaluated as energy sources for the economic development of Guyana The realization of a 3000 MW hydropower scheme is expected to promote industries such as an aluminum smelting plant and an ammonium nitrate plant in the hinterland A proposal is made for a tidal power plant on the Saint John River with a million kW capacity Although Guyana's geological location and atmospheric conditions make it a favorable site for solar seapower, OTEC cannot be considered as a current alternative It is concluded that hydropower will play an important role as an inexpensive source of energy for industry, and that tidal power will supply coastal areas and function as part of the sea-defense system L.S

A81-25099 **Alternative energy source II, Proceedings of the Second Miami International Conference, Miami Beach, Fla.,**

December 10-13, 1979 Volume 6 - Nuclear energy Conference supported by the International Association for Hydrogen Energy, IAEA, ISES, Florida International University, and University of Miami Edited by T N. Veziroglu (Miami, University, Coral Gables, Fla) Washington, D C , Hemisphere Publishing Corp , 1981 438 p Price of nine volumes, $595

This volume examines conventional nuclear energy, breeder reactors, and thermonuclear energy The particular papers presented consider current developments in nuclear breeder technology, fusion-driven fissile fuel breeder systems, and the fusion fission hybrid reactor The implications of nuclear energy utilization in the Phillipines and the internationally safeguarded atomic fuel exchanger center for the Asian-Pacific basin are also discussed L S

A81-25101 **The future of fusion power comes into focus.** W B Briggs (McDonnell Douglas Astronautics Co , St Louis, Mo) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 6 Washington, D C , Hemisphere Publishing Corp , 1981, p 2523-2533

Experimental studies of plasma behavior from the five large tokamaks and one mirror which began operations in 1978-79 are briefly surveyed, and the progress of the Mirror Fusion Test Facility and the Tokamak Fusion Test Reactor is noted as part of an outline of the U.S fusion power program The advanced designs described include the Engineering Test Facility, The International Tokamak Reactor, and the Commercial Tokamak study Department of Energy policies and recent changes in government fusion organization are discussed, and industry participation and the economics of fusion are addressed Experimental facilities and projects under development which do not utilize a research reactor are also discussed L S.

A81-25102 **Concept evaluation of nuclear fusion driven symbiotic energy systems.** J P Renier and T J Hoffman (Oak Ridge National Laboratory, Oak Ridge, Tenn). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 6 Washington, D C , Hemisphere Publishing Corp , 1981, p 2539-2577 18 refs

An analysis of systems based on D-T and semi-catalyzed D-D fusion-powered U233 breeders is presented Metallic thorium pebble-bed blankets with a batch reprocessing mode and a molten salt blanket with on-line continuous or batch reprocessing were used Neutronics depletion calculations are coupled with a scenario optimization and a cost analysis code The fusion-driven symbiotes are compared with LMFBR-driven energy systems The analyses of the symbiotic energy systems were performed at equilibrium, at the maximum rate of grid expansion and for a given nuclear power demand. Attractive schemes are identified based on D-T driven fusion-drivers operated with low plasma performance parameters L S

A81-25103 **The fusion fission hybrid - Roles in the energy economy.** R T. Perry (Wisconsin, University, Madison, Wis), B R Leonard, Jr , and V L Teofilo (Battelle Pacific Northwest Laboratories, Richland, Wash) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 6 Washington, D C , Hemisphere Publishing Corp , 1981, p 2579-2584. 8 refs

The fusion-fission hybrid reactor is characterized and its roles in the U S power economy are defined The hybrid can be utilized as a fuel factory, as a stand-alone power producer, in the production of hydrogen for use in the manufacture of synthetic fuels, as an alternative to the fast breeder reactor, and as a technological base for pure fusion. It is noted that because of its prolific fissile fuel production, there are economic windows in which the hybrids could feed the light water reactor industry until the fast breeder becomes established. L S

A81-25104 **Overview of nonelectrical applications of fusion.** G H. Miley (Illinois, University, Urbana, Ill.). In: Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 6. Washington, D C , Hemisphere Publishing Corp , 1981, p 2585-2613 64 refs

The potential for, and importance of, nonelectrical applications of fusion energy is discussed. Three possibilities are reviewed in some detail fusion-fission hybrids for fissile fuel production, high-temperature electrolysis and thermochemical processes for hydrogen production, and high-temperature steam for coal gasification The hybrid could be an early application of fusion if this route is identified as a desirable goal Hydrogen production and coal gasification processes appear feasible and could be developed as a part of the conventional fusion blanket research and development The question of economics, particularly in view of the high capital cost of fusion plants, remains an open issue requiring more study (Author)

A81-25105 **Fusion reactors as high-temperature process heat sources.** J H Pendergrass and L A Booth (California, University, Los Alamos, N Mex) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 6 Washington, D C , Hemisphere Publishing Corp , 1981, p 2615-2642 33 refs

The reasons for interest in fusion process heat sources, the present United States requirements for process heat, and process industry criteria for selection of thermal energy sources are reviewed Constraints on process heat fusion reactor design, conceptual solutions to design problems, and energy delivery characteristics of present process heat fusion reactor concepts are described Projections of the time frame and potential for commercialization of fusion process heat sources are presented (Author)

A81-25106 **Laser fusion systems for process heat** K D Kok, W H Goldthwaite, R S Denning, H I Avci, F J Bates, R C Dykhuizen, J C Skelton, and C T Walters (Battelle Columbus Laboratories, Columbus, Ohio) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 6 Washington, D C , Hemisphere Publishing Corp , 1981, p 2643-2658 17 refs

The suitability of laser fusion power plants as sources of process heat for industry is investigated Process heat requirements are tabulated according to process temperature and unit size for 19 energy intensive industries Specifications based on this tabulation were determined for five conceptual plant designs The industry criteria having the greatest effect on the design and the evaluation of the concepts were the needs for high availability, minimal energy production costs, and compatibility with process heat requirements The principal variations in design related to the differences in the blanket materials and coolant requirements The analysis of the designs indicates that an acceptable level of plant availability can be achieved by the use of redundant components L S

A81-25119 **Combined gas-steam turbine cycle using coal derived liquid fuel - A viable alternative to direct combustion of coal** R Tabi (New York Institute of Technology, Old Westbury, N Y.) and J E Mesko (Pope, Evans and Robbins, Inc , New York, N Y). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla , December 10-13, 1979 Volume 7 Washington, D.C , Hemisphere Publishing Corp , 1981, p 2837-2846 Research supported by the Institute of Gas Technology.

An alternative to direct coal-combustion for electric power generation is liquefaction of coal prior to combustion in a combined gas-steam turbine plant For optimization of the overall efficiency of the power plant, individual subsystem efficiencies must be analyzed, but the prevailing energy analysis based on the first law of thermodynamics is insufficient for this purpose and can be misleading. The paper presents a complete thermodynamic analysis of an 873 MWe combined gas-steam turbine cycle, which utilizes semiclean fuel from the H-Coal process (Author)

A81-25123 **Thermodynamic calculations for Otto cycle engines using methanol as a fuel.** M F Bardon (Royal Military College of Canada, Kingston, Ontario, Canada) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp, 1981, p 2887-2908 14 refs

Equations are derived to permit calculation of the work required for the isentropic compression of a two phase fuel-air mixture Methanol evaporation during compression is shown to substantially reduce compression work and thereby improve cycle efficiency and maximum power Effects of evaporative cooling in the intake manifold are calculated Energy density of methanol and gasoline fuel-air charges are compared. Both phase equilibrium and evaporation rate are shown to be causes of the poor cold starting performance of methanol (Author)

A81-25131 **The development of a free-piston Stirling engine power conversion system for multiple applications utilizing alternative fuel sources** T J Marusak (Mechanical Technology, Inc, Latham, N Y) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp, 1981, p 3007-3013

The thermodynamic and mechanical advantages of free-piston Stirling engines developed to date by NASA, and their future potential as small powerplants, are discussed Applications include heat-pumps, mobile electric power systems, solar thermal electric power generation and multiple heat source-capability power systems Existing prototypes have demonstrated engine efficiencies of 33% even at low output levels, and an advanced design capable of 40% efficiency and an output power of more than 3 kW is currently undergoing extensive testing O.C

A81-25132 **An experimental investigation of manned vehicle utilizing CDE /concentration difference energy/ engine.** J Kamoshida (Shibaura Institute of Technology, Tokyo, Japan) and N Isshiki (Tokyo Institute of Technology, Tokyo, Japan) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 7 Washington, D C, Hemisphere Publishing Corp, 1981, p 3015-3029

The thermodynamics and corrosive chemistry of a lithium salt solution thermal energy storage device under various heat pump operation and vehicle propulsion conditions are discussed Propulsion system theoretical efficiencies are compared with figures obtained from an experimental vehicle's operation, and it is determined that storage capacity is comparable with that of lead-acid batteries, with about 40% of theoretical capacity being liberated Extensive charts and figures are provided of salt solution conditions encountered in the course of the experimental vehicle's testing O C

A81-25325 **Tetrathiafulvalenes as catalysts for the reduction of oxygen in acid electrolytes** E Fanghanel, G Schukat (Leuna-Merseburg, Technische Hochschule, Merseburg, East Germany), K. Wiesener, and A Fuhrmann (Dresden, Technische Universitat, Dresden, East Germany) *Journal of Power Sources,* vol 6, Apr 1981, p 193-197 10 refs

Tetrathiafulvalenes have been examined as metal-free electrocatalysts for the cathodic reduction of oxygen at monolayer carbon diffusion electrodes in sulphuric acid The polarizability of the electrodes increases in the following order conjugatively-connected polymeric tetrathiafulvalenes, catalyst-free electrodes, non-conjugatively-connected polymeric tetrathiafulvalenes, and monomeric tetrathiafulvalenes Only electrodes that are covered by conjugatively polymeric tetrathiafulvalenes exhibit a better performance than the active carbon P 33 used as carrier, this fact is discussed in terms of the increased electronic catalyst conductivity (Author)

A81-25381 **A study of a commercial MHD power plant scheme.** S A Pashkov and E V Shishkov (Akademiia Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR) *Indian Academy of Sciences, Proceedings (Engineering Sciences),* vol 3, July 1980, p 81-87 12 refs

Power engineering specialists are currently interested in electrical power stations with magnetohydrodynamic generators This paper is devoted to an investigation of one of the possible process flow diagrams of MHD electrical power plants The structure of MHD electrical power plants, the interrelation between the aggregates, issues concerning the starting of the plant and the working of the power unit under various partial load conditions are discussed With the availability of new theoretical and experimental data, the process flow diagrams of industrial MHD electrical power plants will naturally undergo changes However, the methodical approach and the investigation described in this paper should retain their validity for all process flow diagrams of electrical power plants with MHD generators (Author)

A81-25480 # **Metal hydrides in energy conversion systems** G Alefeld (Munchen, Technische Universitat, Garching, West Germany) In Hydrogen in metals, Proceedings of the Second International Symposium, Minakami, Gumma, Japan, November 26-29, 1979 Sendai, Japan, Japan Institute of Metals, 1980, p 25-32 28 refs

The properties of metal hydrides and the interaction of hydrogen with metals are important parameters needed for many technical applications A short review is given with emphasis on fusion reactor technology, hydrogen storage, metal hydride power cycles and Stirling engines (Author)

A81-25492 # **HVEM in situ hydriding of hydrogen storage materials.** E A Kenik (Oak Ridge National Laboratory, Oak Ridge, Tenn), J Mullins, S Spooner, and B R Livesay (Georgia Institute of Technology, Atlanta, Ga) In Hydrogen in metals, Proceedings of the Second International Symposium, Minakami, Gumma, Japan, November 26-29, 1979 Sendai, Japan, Japan Institute of Metals, 1980, p 321-324 Contract No W-7405-eng-26

The microstructural changes induced during hydriding have been investigated by high-voltage electron microscopy and in situ hydriding studies of LaCo5 and LaNi2Co3 thin foil specimens There appears to be an activation barrier to hydriding at low hydrogen pressures which may be reduced or eliminated by heating to 200 C under a low partial pressure of hydrogen Internal stresses generated by hydriding result in cracking and ultimately in fracturing, due to some dislocation mechanism such as slip or twinning or the generation of internal stresses itself O.C

A81-25602 **Development of advanced electrocatalysts for phosphoric acid fuel cells.** P Stonehart (Stonehart Associates, Inc, Madison, Conn) In Progress in batteries and solar cells Volume 3 Cleveland, Ohio, JEC Press, Inc, 1980, p 34-37 Research supported by the Electric Power Research Institute, Contract No DE-AC03-78ET 15365

The role of the carbon support for platinum electrocatalysts is discussed with a view to the process of carbon corrosion The relationships between decrease in surface area, platinum utilization, and carbon corrosion is discussed It appears that catalysts deposited on graphitic supports are more stable than electrocatalysts deposited on ungraphitized supports Future electrocatalysts will be designed on new high surface area materials so that platinum surface areas will be maintained above 60 sq m/g after 40,000 hours at 200 g L S

A81-25608 **The oxygen electrode - A major problem in energy conversion.** Ch Fabjan (Wien, Technische Universitat, Vienna, Austria) In Progress in batteries and solar cells Volume 3 Cleveland, Ohio, JEC Press, Inc, 1980, p 233-237 27 refs

The electrode reactions of oxygen are examined with a view to the evaluation of the cathodic reaction orders The oxygen electrode in phosphoric acid and alkaline electrolytes is reviewed A consideration of the presented data indicates that long-term development should favor oxygen electrodes for alkaline electrolytes, particularly in batteries for electric vehicles L S

A81-25609 **Electrochemistry of oxygen** E Yeager (Case Western Reserve University, Cleveland, Ohio) In Progress in batteries and solar cells Volume 3 Cleveland, Ohio, JEC Press, Inc, 1980, p 238-241

The factors which control the performance of O2 cathodes and anodes for metal-air batteries and fuel cells are discussed with a view toward the production of O2 electrocatalysts of reasonable cost and life The general features of air cathodes are noted, and the reaction pathways for O2 electroreduction in acid electrolytes are examined O2 generation electrocatalysts are reviewed Some of the mixed transition metal oxides including the perovskites are particularly promising as O2 generation catalysts L S

A81-25611 **Tungsten carbide/platinum fuel cell with phosphoric acid electrolyte** R Fleischmann, J Heffler, and H Boehm (Telefunken AG, Frankfurt am Main, West Germany) In Progress in batteries and solar cells Volume 3 Cleveland, Ohio, JEC Press, Inc, 1980, p 245-247

A fuel cell system operating with tungsten carbide anodes and platinum supported cathodes in a phosphoric acid electrolyte for crude gas conversion is examined The converter consists of a cracking reactor, control and starting unit, fuel cell stack, dc/ac converter, methanol tank, pump, valves, and air fan The automatically working system is controlled by temperature sensors in the cracking reactor and the fuel cell The fuel cell stack consists of bipolar contact cells by means of which the whole cross-section is pressed on ribbed graphite plates The plates contact the electrodes, assure gas separation, and provide the porous electrodes with fuel and oxidant gases The cell components and the results of battery tests are given L S

A81-25625 **Calculation of the internal heat exchange cycle of a Stirling engine (Raschet parametrov vnutrennego teploobmennogo kontura dvigatelia Stirlinga)** V S Trukhov, I A Tursunbaev, and G Ia Umarov Tashkent, Izdatel'stvo Fan, 1979 80 p 62 refs In Russian

The current status of research and development on Stirling engines is reviewed, and the technical and economic feasibility of the utilization of such engines in energy systems (e g, solar systems) is considered Engineering methods for the calculation and optimization of heat exchangers are presented with allowance for consideration of thermal and hydraulic losses Recommendations are given on the optimization of pistons and drive for a single-cylinder Stirling engine B J

A81-26006 **Gas turbine combustor design problems** Edited by A H Lefebvre (Purdue University, West Lafayette, Ind) Washington, D C, Hemisphere Publishing Corp, 1980 447 p $45

The book focuses on gas turbine combustor problems, fuels and combustion, pattern factors and wall temperatures, relighting, emissions, modeling, and diagnostics Papers were presented on vortex-controlled diffusers in annular combustor flowpaths, residual fuel combustion in industrial gas turbines, combustor cooling, combustion of coal-derived liquids and shale oil in gas turbines, and spray diagnostics A T

A81-26007 **Problems and promises in gas turbine combustor design development** D A Hudson (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) In Gas turbine combustor design problems Washington, D C, Hemisphere Publishing Corp, 1980, p 3-9, Discussion, p 9, 10

Current design emphasis for gas turbine engine combustion systems is in part durability The development of combustion systems which meet durability goals has required concentration on solving the problems of accurate duty cycle definition and high temperature maldistributions Recent improvements in the understanding of aircraft utilization has allowed accurate duty cycle descriptions which, in turn, has improved our capability to design more durable combustion systems Maldistribution of high temperature regions in the combustor continues to be the greatest causal factor of distress to the combustion system These maldistributions of high temperature are caused primarily by ill-defined and poorly controlled flow fields in the dome of the combustion system The most challenging and beneficial research facing the combustor designer today is an improved understanding of the flow field in the combustor dome region Future combustion systems will be facing many problems from new fuels effects, advanced aerodynamics, reduced wall cooling, and combustion instabilities To meet the challenges of current and future problems, promising new techniques such as combustion modelling, variable geometry and new non metallic materials are being developed (Author)

A81-26009 **Problems due to multifuel operation of gas turbine combustors** J Odgers (Calgary, University, Calgary, Alberta, Canada) In Gas turbine combustor design problems Washington, D C, Hemisphere Publishing Corp, 1980, p 71-84, Discussion, p 84, 85 11 refs

The effects of fuel changes in gas turbine operation are examined Costly refinery treatment will be needed for aircraft and industrial applications unless the current NO(x) specifications are relaxed, the greater C/H ratios (aromatics) can be alleviated by assuming that the flame emissivity of all fuels is unity Improved conditions could also result from airblast atomizers used as a partial premixed system. A dual gas/liquid injection system is practical when the gas is a pure hydrocarbon of high calorific content (such as methane or propane), but cannot be utilized with a low Btu gas due to a possible compressor mismatch It is concluded that the major problem in multifuel applications is expensive refinery processing due to the bound nitrogen A T

A81-26010 **Residual fuel combustion in industrial gas turbines** C Wilkes (General Electric Co, Schenectady, N Y) In Gas turbine combustor design problems Washington, D C, Hemisphere Publishing Corp, 1980, p 87-109, Discussion, p 109, 110 17 refs

The problems of combustion of residual fuels in industrial gas turbines due to strict emission rules and increases in pressure ratios and inlet temperatures require greater efforts from combustion engineers Computer data acquisition methods, online information processing, and better instrumentation provide increased testing rates to determine combustor dimensions, fuel properties, and hydrogen distribution, the effects of H content on specific gravity, heating values, and flame temperatures are computed to compare combustor performances. Corrosion caused by Na, K, and V is serious for hot metal components downstream of the combustor, tests are time-consuming and costly, but the effects of residual fuel impurities and inhibitors on particulates will be estimated in the future A T

A81-26016 **Combustion of coal-derived liquids and shale oil in gas turbine combustors** J M Beer and S Hanson (MIT, Cambridge, Mass) In Gas turbine combustor design problems Washington, D C, Hemisphere Publishing Corp, 1980, p 225-244, Discussion, p 244 17 refs

It can be expected that high nitrogen content coal derived fuels and shale oil will play an increasing role as gas turbine fuels during the 1980s A thermodynamic and kinetic analysis implies that high temperature fuel rich conditions in the first stage of a combustor may be favorable for converting most of the fuel nitrogen into N2 rather than NO These conditions, however, are also conducive to soot formation in the first stage of the combustion process While soot will further reduce NO to CO2, CO, and N2 the carbon may not be fully burned in the second, fuel-lean stage on the combustor with the result of particulate emission Fuel-nitrogen transformations at gas turbine combustion conditions are discussed, with special reference to these new fuels Reactions between NO and gaseous hydrocarbons, and soot respectively are considered and the relevance of some of the results of pyrolysis and combustion studies carried out with bituminous coals is discussed. A theoretical and experimental program which can yield information on the nitrogeneous product distribution of pyrolyzing and burning of droplet arrays of coal liquids and shale oil is outlined (Author)

A81-26018 **Coalescence/dispersion modeling of gas turbine combustors.** D T Pratt (Utah, University, Salt Lake City, Utah) In Gas turbine combustor design problems

Washington, D C, Hemisphere Publishing Corp., 1980, p 315-330 18 refs Research supported by the University of Utah and Avco Corp, NSF Grant No ENG-76-84533

The Mellor turbulent mixing time theory (1976) indicates that this parameter is the most significant characteristic of gas turbine combustors However, the classical reactor theoretic and finite-difference solutions of the governing differential equations considered the turbulent mixing time as either zero or infinite Stochastic and Monte Carlo techniques can include the mixing time for simple chemistries, preliminary analyses of a new algorithm for integrating the batch-reaction chemical equations show a possibility of practical combined modeling of finite-rate micromixing and complex finite rate chemistry required for the determination of pollutant formation and combustor stability A T

A81-26062 **Theory of an induction MHD propeller with a free field** V I Iakovlev *(PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki,* May-June 1980, p 105-116) *Journal of Applied Mechanics and Technical Physics,* vol 21, no 3, Nov 1980, p 376-384. 9 refs Translation

From the present analysis it can be seen that allowance for the longitudinal edge effect in the evaluation of the energetic characteristics of MHD propulsion reduces markedly the values predicted by Phillips (1962) for a given magnetic field intensity At the same time, the magnetic field required to obtain a given efficiency value is higher than the predicted value. A method of improving propulsion efficiency by 'amplitude modulation' is proposed. V.P

A81-26552 **Self-magnetically insulated ion diode** J P VanDevender, J P Quintenz, R J Leeper, D J Johnson, and J T Crow (Sandia Laboratories, Albuquerque, N Mex) *Journal of Applied Physics,* vol 52, Jan 1981, p 4-12 19 refs Contract No DE-AC04-76DP-00789

Light ion diodes for producing 1-100 TW ion beams are required for inertial confinement fusion The theory, numerical simulations, and experiments on a self-magnetically insulated ion diode are presented The treatment is from the point of view of a self-magnetically insulated transmission line with an ion loss current and differs from the usual treatment of the pinched electron beam diode The simulations show that the ratio V/IZ(0) = 0 25 in such a structure with voltage V, local total current I, and local vacuum wave impedance Z(0) The ion current density is enhanced by a factor of approximately 2 over the simple space-charge limited value The simulation results are verified in an experiment An analytical theory is then presented for scaling the results to produce a focused beam of protons with a power of up to 10 to the 13th W (Author)

A81-26570 **Charge exchange and energy loss of carbon ions in air-plasma channels** T P Wright, T A. Green, and T A Mehlhorn (Sandia Laboratories, Albuquerque, N. Mex) *Journal of Applied Physics,* vol 52, Jan 1981, p. 147-150 17 refs

A model is developed to study two loss mechanisms during the propagation of high-power beams of carbon ions in current-carrying air-plasma channels Such channels can provide the necessary standoff between the diodes and the target in light-ion-driven inertial confinement fusion Particle losses due to radial charge exchange diffusion across the channel magnetic field as well as collisional energy losses are studied Semiempirical charge exchange cross sections are derived from literature sources and used in a Monte Carlo transport code with the energy loss modeled in the continuous slowing down approximation We conclude that charge exchange losses are probably not of major concern for light ion beam inertial confinement fusion reactor configurations using channel transport, whereas collisional energy loss can be detrimental if the plasma channel density is too large (Author)

A81-26571 **Anode plasma behavior in a magnetically insulated ion diode** D J Johnson, E J T Burns, J P Quintenz, K W Bieg, A V. Farnsworth, Jr, L P. Mix, and M. A. Palmer (Sandia Laboratories, Albuquerque, N Mex) *Journal of Applied Physics,* vol 52, Jan 1981, p 168-174. 17 refs Contract No. DE-AC04-76DP-00789

The nature and time evolution of the 'surface flashover' anode plasma in a magnetically insulated ion diode is studied Holographic interferometric and spectrographic measurements indicate a plasma with an electron density of 5 x 10 to the 16th per cu cm and a temperature of approximately 5 eV which is created by electric breakdown along a surface parallel to the imposed pulsed electric field. The divergence of the ion beam accelerated from this plasma is governed by the spatial nonuniformities of the plasma The beam is composed primarily of protons for the experiments studied Contrary to expectations, a substantial C(4+) beam component was not observed (Author)

A81-26851 **Advances in cryogenic engineering. Volume 25 - Proceedings of the Cryogenic Engineering Conference, University of Wisconsin, Madison, Wis, August 21-24, 1979.** Conference supported by the Aerospace Corp, General Electric Co, NBS, et al Edited by K D Timmerhaus and H A Snyder (Colorado, University, Boulder, Colo) New York, Plenum Press, 1980. 866 p $59 50

A number of superconductivity applications are discussed including MHD and fusion magnets, energy transfer and storage, rotating machinery, magnet technology, and cryogenic techniques Attention is also given to cooling superconducting systems, heat transfer in helium, liquefaction and refrigeration, and cryogenic applications in space technology and resource utilization P T H

A81-26852 **Superconducting MHD magnet engineering program.** P G Marston, A M Dawson, D B Montgomery, and J E C Williams (MIT, Cambridge, Mass) In Advances in cryogenic engineering Volume 25 - Proceedings of the Cryogenic Engineering Conference, Madison, Wis, August 21-24, 1979.
New York, Plenum Press, 1980, p 1-11 5 refs

The MIT Francis Bitter National Magnet Laboratory has been designated as the DOE magnet program field office to assist with the creation and management of a national program of superconducting MHD magnet technology development This activity will include conceptual design and subsequent contract management for a number of large magnets destined for use in a variety of MHD experimental facilities The technology development program is dynamically integrated with the magnet construction management in order to identify design and manufacturing techniques for commercial scale units, identify failure modes, and safety and risk configurations, define evaluation and success criteria, predict costs, provide the fundamental engineering data base and design tools, and perform verification testing and modeling P T H

A81-26853 **Impact of high-current operation on the cost of superconducting magnet systems for large-scale MHD applications.** R J Thome, R D Pillsbury, H R Segal, and B O Pederson (Magnetic Corporation of America, Waltham, Mass) In Advances in cryogenic engineering Volume 25 - Proceedings of the Cryogenic Engineering Conference, Madison, Wis, August 21-24, 1979

New York, Plenum Press, 1980, p 12-18 Contract No EX-77-A-01 2295

The method used in the present study involved the development of a set of cost factors in the general areas of system components, fabrication, and assembly Components with features expected to be strongly dependent on the current level were studied in sufficient detail to allow their characteristics to be determined for cost-estimating purposes, these included conductor, substructure, the power supply subsystem, and the refrigerator/liquifier subsystem

Cost estimates for magnet fabrication and system assembly were developed by generating hypothetical manufacturing flow diagrams, assigning cost elements to the individual steps, and integrating these elements into cost factors dependent on current level and cost factors assumed to be independent of current level Preliminary results appear to imply that future reference designs for large-scale MHD magnets should consider operating levels somewhat higher than the 10 to 20 kA typically used to date P T H

A81-26854 **Final design of a superconducting MHD magnet for the coal-fired flow facility at the University of Tennessee Space Institute** S -T Wang, L R Turner, L Genens, W Pelczarski, J Hoffman, J Gonczy, H Ludwig, R. C Niemann, K F Mataya, and E Kraft (Argonne National Laboratory, Argonne, Ill) In Advances in cryogenic engineering. Volume 25 - Proceedings of the Cryogenic Engineering Conference, Madison, Wis , August 21-24, 1979 New York, Plenum Press, 1980, p. 19-29 Research supported by the U S Department of Energy.

The superconducting magnet system of the coal-fired flow facility at the University of Tennessee Space Institute consists of a superconducting magnet, a magnet cryostat, a helium refrigerator/liquefier facility, a helium gas-handling system, apparatus for cryogenic transfer and storage, a magnet power supply, an integrated instrumentation and control system including a computer for magnet operation, data acquisition, system status and diagnosis, and magnet protection For a given conductor design, cooling provisions, and given coil structure, it is possible to compute the minimum propagating energy and perform verification experiments This paper describes the coil configurations, conductor design, coil structure, cryostability, electromagnetic forces and pressure, structural support and stress analysis, and power supply, instrumentation, and magnet protection P T H

A81-26855 **Cryogenic aspects of the UTSI-CFFF superconducting dipole magnet for MHD research** R C Niemann, S -T Wang, J W Dawson, L Genens, R P Smith, L R Turner, J D Gonczy, J Hoffman, K F Mataya (Argonne National Laboratory, Argonne, Ill), and P Smelser In Advances in cryogenic engineering Volume 25 - Proceedings of the Cryogenic Engineering Conference, Madison, Wis , August 21-24, 1979 New York, Plenum Press, 1980, p 30-38 Research supported by the U S Department of Energy

The Argonne National Laboratory has designed and is constructing a 6-T 0 8-m minimum warm bore superconducting dipole magnet system for MHD research The system will be installed and operated at the University of Tennessee Space Institute Coal Fired Fuel Facility The system will consist of a coil assembly contained in a liquid helium cryostat, a helium refrigerator/liquefier system, and controls and instrumentation for cooldown and steady-state operation P T H

A81-26856 **Safety analysis of the UTSI-CFFF superconducting magnet** L R Turner, S -T Wang, R P Smith (Argonne National Laboratory, Argonne, Ill), P C Vander Arend (Cryogenic Consultants, Inc , Allentown, Pa), and Y -H Hsu (General Atomic Co , San Diego, Calif) In Advances in cryogenic engineering Volume 25 - Proceedings of the Cryogenic Engineering Conference, Madison, Wis , August 21-24, 1979 New York, Plenum Press, 1980, p 39-48 5 refs Research supported by the U S Department of Energy

The paper presents a safety analysis of the University of Tennessee Space Institute-Coal Fired Flow Facility Attention is given to the quench analysis, followed by the cryostat fault condition analysis Two analyses of exposed turns are also discussed the first shows that gas cooling protects uncovered turns, and the second shows that the cryostat pressure relief system protects them. Finally, the failure mode and safety analysis is presented P T H.

A81-26857 **Engineering aspects of cryogenic laser-fusion targets.** D L Musinski, T M Henderson, R J. Simms, T R Pattinson (KMS Fusion, Inc., Ann Arbor, Mich.), and R B. Jacobs (R B. Jacobs Associates, Inc , Boulder, Colo.). In Advances in cryogenic engineering Volume 25 - Proceedings of the Cryogenic Engineering Conference, Madison, Wis , August 21-24, 1979 New York, Plenum Press, 1980, p. 49-60 13 refs. Contracts No EY-76-C-02-2709, No ES-77-C-02-4149, No ED-78-C-08-1598, No DE-AC08-78DP-40030.

Experiments with cryogenic liquid-layer targets, using point-contact conduction cooling, have opened the way to experiments with solid-layer targets The engineering and integration of successively more complex systems have identified the critical design features and procedures needed to obtain uniformity of the fuel layer The technology has been refined and extended in several iterative steps to eliminate the major causes of nonuniformity and to provide an interferometric viewing system that enables an operator to observe and evaluate the layer formation The gaseous helium shroud and retraction system were shown to be capable of producing and presenting to the laser a satisfactorily uniform (not greater than 20% WNU) solid-fuel-layer target. P T.H

A81-26881 **Liquid nitrogen as an energy source for an automotive vehicle.** M. V Sussman (Tufts University, Medford, Mass.). In Advances in cryogenic engineering. Volume 25 - Proceedings of the Cryogenic Engineering Conference, Madison, Wis., August 21-24, 1979. New York, Plenum Press, 1980, p. 831-837. 8 refs

It is suggested that liquid nitrogen can serve as a portable, safe, benign, inexhaustible, nonpolluting energy storage means. Emphasis is placed on the application of liquid nitrogen to Rankine-cycle-powered automotive vehicles. The cost of operation has been found to be three to six times the current cost of gasoline and about the same as that of lead-acid battery operation. P.T.H

A81-26975 **Aeroelastic stability of wind turbine rotors.** P. C. Hensing (Delft, Technische Hogeschool, Delft, Netherlands) In Recent advances in structural dynamics, Proceedings of the International Conference, Southampton, England, July 7-11, 1980 Volume 2. Southampton, University of Southampton, 1980, p 631-639 5 refs.

The paper deals with the aeroelastic instability of wind turbine rotors with low blade torsional frequency such as tipvane rotors. The types of instabilities discussed include two-degrees-of-freedom flutter, stall-flutter, and torsional divergence Theoretical flutter boundaries are compared with experimental data. V.L.

A81-27551 # **Overview of wind energy systems - Issues in development and application.** P M Moretti (Oklahoma State University, Stillwater, Okla) and R W Thresher (Oregon State University, Corvallis, Ore) *ASME, Transactions, Journal of Solar Energy Engineering,* vol 103, Feb 1981, p 3-10 32 refs.

An overview of the current status of wind energy technology and system development is presented with major emphasis placed on the key issues which face the commercialization of wind technology The basic fundamentals of the technology are reviewed and the direction of current development is outlined. Economic considerations are discussed both from a machine development point of view and the utility-industry cost-of-service approach In addition, the problems associated with wind turbine performance testing are discussed and a short review of operational experience is provided These topics are all considered in the context of providing the reader with an understanding of wind system technology, a general knowledge of current problems, and the expected trends for the future. (Author)

A81-27553 # **Flow field analysis and performance of wind turbines employing slotted diffusers** A L Loeffler, Jr (Grumman Aerospace Corp , Research Dept , Bethpage, N Y) *ASME, Transactions, Journal of Solar Energy Engineering,* vol 103, Feb 1981, p 17-22 8 refs

Operation of diffuser-augmented wind turbines (DAWTs) utilizing slotted walls for tangential blowing as a boundary layer control measure has been analyzed using the method of singularities (MOS)

The diffuser wall and the drop in total pressure through the turbine are represented by a series of ring vortices along the diffuser surface and along the wake boundary Diffuser included angles of 60 to 80 deg are considered, in contrast to the conventional range of 7 to 10 deg Agreement with Grumman Research Department experimental data with respect to overall performance and pressure and velocity distributions is reasonably good In particular, the existence of the observed large pressure reduction at the diffuser exit plate is predicted A consequence of this agreement is that Reynolds number scaling effects are small for slotted DAWTs, so that MOS analyses hold promise for other innovative diffuser designs and flow problems (Author)

A81-27966 # **Linear induction-type MHD machine with a winding connected to the voltage source (Lineinaia induktsionnaia MGD-mashina s obmotkoi, nodkliuchennoi k istochniku napriazheniia)** S A Bugianis and V I Chesonis *Magnitnaia Gidrodinamika,* Jan -Mar 1981, p 87-92 In Russian

A81-27967 # **A numerical study of the nonuniform loading of a segmented MHD channel (Chislennoe issledovanie neodnorodnogo nagruzheniia sektsionirovannogo MGD-kanala)** V A Bitiurin, B M Burakhanov, and S A Medin *Magnitnaia Gidrodinamika,* Jan -Mar 1981, p 93-100 6 refs In Russian

The characteristics of an MHD generator are analyzed given nonuniform loading of various segments In making the analysis, the numerical solution to the two-dimensional problem of the distribution of the current and potential in a segmented MHD channel having a nonuniform flow of an anisotropically conducting plasma is used Two cases are considered In the first, the load parameters in one of the segments of the channel's working section vary while the other segments are subjected to fixed equilibrium loading In the other, the external load parameters in a uniform section of the channel vary synchronously, here, each of the loads is connected to two segments the adjacent electrodes of which are joined through equal ballast resistors The results of the numerical experiment are used in constructing volt-ampere characteristics for channel segments subjected to nonuniform loading Attention is given to certain features of the various methods used in regulating external loads C R

A81-27968 # **Transient processes and self-excited oscillations in the electrical circuit of an MHD generator (Perekhodnye protsessy i avtokolebaniia v elektricheskoi tsepi MGD-generatora)** A V Gubarev and S. A. Laptev *Magnitnaia Gidrodinamika,* Jan -Mar 1981, p 101-106 In Russian

Transient processes in the circuit of an MHD generator having diagonal electrode switching are considered The existence of limiting values for the angle of inclination of the coils is established, at this value, the system becomes self-excited The characteristics of the diagonal design are compared with those of the Hall and Faraday MHD generators For an MHD generator having an inductive external load, the stability of an infinitely distant point on the phase plane I(1)-I(2) is investigated In this way, the plausibility of limiting cycles in the system is established, that is, the possibility of obtaining an alternating current in the load circuit C R

A81-28217 # **Electron and positive ion measurements in MHD combustion plasmas with phosphorous addition** K D Annen, P J Kuzmenko, R Keating, and S A Self (Stanford University, Stanford, Calif) *(International Conference on MHD Electrical Power Generation, 7th, MIT, Cambridge, Mass, June 16-20, 1980) Journal of Energy,* vol 5, Jan -Feb 1981, p 31-38 20 refs NSF Grant No ENG-77-23932, Contract No DE-AC01-80ET-15611

Simultaneous measurements of the electron concentration by submillimeter interferometry and of the positive ion concentration by a swept electric probe have been made in an ethanol-fueled, potassium-seeded combustion plasma Phosphorous was added to the reactants to match the maximum phosphorous concentration anticipated in coal-fired MHD plasmas The electric probe was calibrated against the interferometer to check the probe theory, it is concluded that because of theory limitations the absolute accuracy of the probe is no better than 50% However, the discrepancy is systematic over the range of interest to MHD, enabling the probe to provide reliable relative measurement having good temporal and spatial resolution The effect of the phosphorous on the electron concentration was found to be much smaller than previously predicted The results indicate that the reduction in the electron concentration is no more than 15% for conditions appropriate to the downstream end of a coal-fired MHD generator (Author)

A81-28219 * # **Radiatively coupled thermionic power system concept** K Shimada (California Institute of Technology, Jet Propulsion Laboratory, Electric Propulsion and Power Section, Pasadena, Calif) *Journal of Energy,* vol 5, Jan -Feb 1981, p 60, 61 Contract No NAS7-100

It is shown that thermionic converters at moderate emitter temperatures of about 1600 K can be designed for a radiatively coupled 100 kWe device A nuclear reactor is a primary heat source, with heat pipes extracting heat from the reactor and distributing it over a large surface opposite an array of thermionic energy converters The radiative heat transfer across the vacuum gap heats up the thermionic emitters, and excess heat from the converters is radiated from the collector electrodes to the vacuum of space, the heat transfer is controlled by the energy density to be transferred, and by the temperature differential between the heat source and the heat receiver It is concluded that this system achieves isolation of power converter modules from the heat source, elimination of additional radiators, and reduction of converter dimensions A T

A81-28395 **Theoretical advantages of pn/+/-type Cu_2S-ZnO solar cell** M Burgelman and H J Pauwels (Gent, Rijksuniversiteit, Ghent, Belgium) *Electronics Letters,* vol 17, Mar 19, 1981, p 224-226 10 refs

A81-28550 **A primer on economic feasibility for direct-users.** W B Eastlake (Idaho State Office of Energy, Boise, Idaho) *Geothermal Energy,* vol 8, Oct -Nov 1980, p 29-32

An economic feasibility analysis of building a geothermal direct-use system to replace conventional fuel is presented Future savings are evaluated in terms of present worth and a hypothetical space-heating system is used as an example to compare the cost of geothermal heat with conventional fuel, and to calculate the internal rate of return It is shown that the system pays for itself in less than three years, due to lower operational costs A flow diagram is provided to explain the process K S

A81-28614 # **The possibilities of improving the efficiency of gas turbines (Die Moglichkeiten zur Verbesserung des Wirkungsgrades der Gasturbinen)** F Toth *Acta Technica,* vol 89, no 3-4, 1979, p 347-352 In German

Advantages of multistage chamber turbines over traditional blade turbines are discussed Possible improvements in efficiency fall into three areas gains in the maximal amount of mechanical energy from the thermal energy of the gas, transformation of mechanical energy of gas into useful work, and utilization of the energy of the consumed gas as useful work The advantages of the chamber turbines are that the gas does double work in all expansions except the last and that the pressure energy of the gas can be utilized during combustion as well as at the outflow from the chamber. Multistage chamber turbines utilize, at optimal speed of rotation, only 40% of the kinetic energy of the gas, the outer 60% results from the pressure energy of the gas The major advantage of chamber over blade turbines is that they incur fewer aerodynamic losses in their utilization of pressure energy D K

A81-29031 **Energy analysis of four geothermal technologies** R A Herendeen and R L Plant (Illinois, University, Urbana, Ill) *Energy* (UK), vol 6, Jan 1981, p 73-82 31 refs Contract No ET 78-S-02-5085

Detailed comparisons of energy inputs and outputs are presented for four geothermal electric technologies liquid-dominated, hot dry rock, geopressure and vapor dominated The standard energy analysis is used which involves the energy costing of the inputs to the energy systems including the total energy needed for manufacturing and delivery as well as support, operation and maintenance activities, and the output electricity Ratios of net electrical energy outputs over plant lifetimes to energy inputs are found to exceed unity in all cases, even in view of the necessary uncertainties in the calculations The highest energy ratio, amounting to 13 + or - 4, is obtained for vapor-dominated (dry-steam systems), which are currently in commercial use for energy production in the United States The values obtained are noted to be either equal to or less than those obtained by others, primarily due to considerations of the cost of environmental controls for the liquid-dominated systems A L W

A81-29070 # **A new breed of an air breathing engine** M Berchtold (Zurich, Eidgenossische Technische Hochschule, Zurich, Switzerland) In International Symposium on Air Breathing Engines, 5th, Bangalore, India, February 16-22, 1981, Proceedings Bangalore, National Aeronautical Laboratory, 1981, p 29-1 to 29-6 6 refs

Small shaft power gas turbines of less than 200 HP are presently unavailable for light aircraft propulsion The use of recuperators, as proposed for improving the efficiency in automotive small gas turbines, is not feasible for aircraft installation The wave pressure exchanger 'Comprex', used in connection with conventional turbomachines, promises to become an efficient and compact powerplant Its low weight and the absence of vibrations makes it well suited for the propulsion of light aircrafts The 'Comprex' is capable to utilize high peak cycle temperatures due to the fact that the rotor is exposed to both the air to be compressed and the hot gas to be expanded Theoretical and experimental experience accumulated with wave pressure exchangers applied to Diesel engines supercharging, allows to predict the performance of this new turbine engine The expected efficiency of 27 is competitive with present aircraft piston engines (Author)

A81-29115 # **Transpiration air cooled turbine blade - A technology for future generation aircraft and industrial gas turbine engines using coal or coal derived fuels** R Raj (City College, New York, N Y) In International Symposium on Air Breathing Engines, 5th, Bangalore, India, February 16-22, 1981, Proceedings Symposium sponsored by ICAS, AIAA, UNESCO, et al Bangalore, India, National Aeronautical Laboratory, 1981 25 p 34 refs

An insight to the design and development of the transpiration air cooled turbine blade concept is presented in this paper The technology considerations include a discussion of the blade concept, heat transfer effectiveness, thermo-aerodynamics, erosion-corrosion-deposition resistance characteristics and technology status In recent developments the transpiration cooling concept achieved operation at high temperatures of 3000 F (1650 C) while offering protection for the turbine blades from damage due to particulate emission from a combustion process simulating the use of coal or coal-derivatives The technology achieved in this field is at a stage where nations dependent on importation of oil and natural gas can consider the shift to coal or other forms of fossil fuels for operating highly efficient gas turbines in a combined cycle for electric power generation (Author)

A81-29199 **Osmo-power - Theory and performance of an osmo-power pilot plant** H H G Jellinek (Clarkson College of Technology, Potsdam, N Y) and H Masuda (Clarkson College of Technology, Potsdam, N Y , National Chemistry Laboratory for Industry, Tokyo, Japan) *Ocean Engineering*, vol 8, no 2, 1981, p 103-128 8 refs Contract No EG-77-S-05-5440

A theoretical and experimental study of the production of useful energy by the natural process of osmosis is presented Using the results of the study a conceptual design of an osmotic pilot plant is performed The power produced by a 1 6 MW/sq km plant has a competitive cost with that produced by both fossil power plants and nuclear power plants (Author)

A81-29200 **OTEC cold water pipe design for problems caused by vortex-excited oscillations** O M Griffin (U S Navy, Naval Research Laboratory, Washington, D C) *Ocean Engineering*, vol. 8, no. 2, 1981, p 129-181, 183-209 84 refs

The objective of this paper is to survey recent results pertaining to the vortex-excited oscillations of structures in general and to consider the application of these findings to the design of the OTEC Ocean Thermal Energy Conversion cold water pipe Practical design calculations are given as examples throughout the various sections of the report This paper is limited in scope to the problems of vortex shedding from bluff, flexible structures in steady currents and the resulting vortex-excited oscillations The effects of flow non-uniformities, surface roughness of the cylinder, and inclination to the incident flow are considered in addition to the case of a smooth cylinder in a uniform stream Emphasis is placed upon design procedures, hydrodynamic coefficients applicable in practice, and the specification of structural response parameters relevant to the OTEC cold water pipe. (Author)

A81-29243 **Solid-state power conversion - A Fourier analysis approach to generalized transformer synthesis** A Alesina (Sassari, Università, Sassari, Italy) and M G B Venturini (Texas Instruments, Ltd , Bedford, England) *IEEE Transactions on Circuits and Systems*, vol CAS-28, Apr 1981, p 319-330 13 refs

Consideration is given to the design and Fourier analysis of a family of solid-state power converters which synthesize the assigned slow-varying waveforms by means of high-frequency switching, thereby requiring a minimum of reactive elements The basic structure of this type of power converter is analyzed in terms of a switching matrix model of the electronic switches, and a general waveform synthesis technique is presented which makes little use of reactive elements A general condition is presented for the applicability of this type of conversion in a given situation, and a method is proposed which allows a straight-forward design of a converter if the condition is met A general model is introduced in which the converter is represented as a two-port multipole time-varying linear circuit element consisting of a matrix of linear modulators Finally, an example is presented of the design of an ac-ac converter capable of sinusoidal waveform, frequency, amplitude, phase and power factor conversion, which can be regarded as a generalized transformer A L W

A81-29958 * # **Ultra-lean combustion at high inlet temperatures** D N Anderson (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-44* 9 p 13 refs Members, $2 00, nonmembers, $4 00

Combustion at inlet-air temperatures of 1100 to 1250 K was studied for application to advanced automotive gas turbine engines Combustion was initiated by the hot environment, and therefore no external ignition source was used Combustion was stabilized without a flameholder The tests were performed in a 12-cm-diameter test section at a pressure of 250,000 Pa, with reference velocities of 32 to 60 m/s and at maximum combustion temperatures of 1350 to 1850 K Number 2 diesel fuel was injected by means of a multiple source fuel injector Unburned hydrocarbon emissions were negligible for all test conditions Nitrogen oxide emissions were less than 1 9 g NO2/kg fuel for combustion temperatures below 1680 K Carbon monoxide emissions were less than 16 g CO/kg fuel for combustion temperatures greater than 1600 K, inlet air temperatures higher than 1150 K, and residence times greater than 4 3 ms (Author)

A81-29959 # **Economics of heavy fuels in gas turbines and combined cycles** L O Tomlinson and R K Alff (General Electric Co., Schenectady, N Y) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-45* 11 p 6 refs Members, $2 00, nonmembers, $4 00

Operating experience has established the ability of gas turbines and combined cycles to utilize heavy fuel oils for power generation economically and reliably The technical factors related to operation of gas turbines on heavy oils are discussed and installation and operating costs are developed for each of these factors for economic evaluation Factors influencing heavy oil use include fuel specifications and treatment to prevent corrosion of hot parts, the effects of ash deposition on turbine nozzles and buckets and on boiler heat transfer surface, turbine and boiler cleaning techniques and their use for maintaining capability, and downtime for cleaning (Author)

A81-29963 # **Combustion of methanol and liquefied butane in a gas turbine combustor.** S Kajita, J Kitajima, and T Kimura (Kawasaki Heavy Industries, Ltd, Akashi, Japan) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex, Mar 9-12, 1981, Paper 81-GT-50.* 8 p. Members, $2 00, nonmembers, $4 00

Combustion tests with a gas turbine combustor were carried out to clarify the technical problems caused when liquefied butane was supplied and burned in the liquid phase in addition to evaluating methanol and liquefied butane as an alternative fuel. For methanol, a conventional dual-orifice type fuel injector, and for liquefied butane, the same dual-orifice type injector and two types of multi-hole injectors were tested The results of combustion tests with both fuels were compared with those of conventional gas turbine fuels - kerosene and natural gas with respect to combustion performances and exhaust emissions It was found that both fuels had some advantages over conventional fuels (Author)

A81-29964 # **Effect of water injection for NOx reduction with synthetic liquid fuels containing high fuel-bound nitrogen in a gas turbine combustor.** P R Mulik, P. P Singh (Westinghouse Electric Corp, Pittsburgh, Pa), and A. Cohn (Electric Power Research Institute, Palo Alto, Calif) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex, Mar. 9-12, 1981, Paper 81-GT-51* 9 p 11 refs Members, $2 00, nonmembers, $4 00. Research supported by the Electric Power Research Institute

A total of five combustion tests utilizing water injection for control of NOx emissions have been conducted on three types of coal-derived liquid (CDL) fuels from the H-Coal and SRC II processes along with a shale-derived liquid (SDL) fuel Actual testing was performed in a 0 14 m diameter gas-turbine-type combustor For comparative purposes, each run with a synthetic liquid fuel was preceded by a baseline run utilizing No 2 distillate oil The effectiveness of water injection was found to decrease as the fuel-bound nitrogen (FBN) content of the synthetic liquids increased (Author)

A81-29974 # **Methanol combustion in a 26-MW gas turbine.** W H von KleinSmid (Southern California Edison Co., Rosemead, Calif), H Schreiber (Electric Power Research Institute, Palo Alto, Calif), and R D Klapatch (United Technologies Corp., Farmington, Conn). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex, Mar 9-12, 1981, Paper 81-GT-64* 6 p. Members, $2.00, nonmembers, $4 00.

Combustion tests of methanol were conducted on a 26-MW gas turbine for a period of 523 total hours. The methanol fueled gas turbine was operated in tandem with an identical gas turbine fueled with distillate (Jet A). Emissions and performance data were recorded and hot section inspections were carried out on both machines periodically during the test program. A comparison of data recorded during the test program clearly indicates that methanol is a superior fuel for gas turbines. (Author)

A81-29975 # **Gas turbine materials evaluation program utilizing coal derived gaseous fuel.** M L Williams, C C Yates (Pittsburgh, University, Pittsburgh, Pa), G B Manning (U.S Department of Energy, Washington, D C), and R R. Peterson (Mitre Corp, McLean, Va) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex, Mar 9-12, 1981, Paper 81-GT-65* 3 p Members, $2.00, nonmembers, $4 00

A gas turbine materials evaluation test facility under the sponsorship of the U S Department of Energy is described. The objective of the mobile test facility is to obtain dynamic and static test data on the erosion/corrosion characteristics of materials exposed to the hot products of the combustion of coal-derived fuels The engine being utilized for the tests is the WR 24-7 aircraft turbojet unit reconfigurated to burn coke oven gas Approximately 100 hours of engine operating time have been logged to date L S

A81-29978 # **Comparison of the HTTT reheat-gas-turbine combined cycle with the HTTT nonreheat gas-turbine combined cycle.** I G. Rice and P. E Jenkins (Texas A & M University, College Station, Tex) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar 9-12, 1981, Paper 81-GT-69* 13 p. 16 refs Members, $2 00, nonmembers, $4.00.

High-temperature turbine technology (HTTT) when applied to the reheat-gas-turbine combined cycle offers distinct advantages over the presently contemplated HTTT simple-cycle gas-turbine combined cycle being developed for gaseous fuel derived from coal Specific improvements are (1) higher combined-cycle efficiency, (2) higher specific output per unit of air flow, (3) less critical high-temperature nozzle-vane and rotating-blade surface area to be cooled, (4) less strategic high temperature metal material to be used, and (5) less overall cycle-cooling degradation allowing growth potential New cooling techniques employing steam are required to accomplish these projections, which necessitate advanced research and development and presently unavailable analytical approaches (Author)

A81-30008 # **Combined gas and steam cycle for a gas-cooled solar tower power plant** B. Becker, H. H. Finckh, and R. Meyer-Pittroff (Kraftwerk Union AG, Mulheim, West Germany) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar 9-12, 1981, Paper 81-GT-102.* 14 p 6 refs. Members, $2 00, nonmembers, $4 00 Research sponsored by the Bundesministerium fur Forschung und Technologie, Internationale Reaktorbau Gesellschaft GmbH, and Maschinenfabrik Augsburg-Nurnberg AG.

The design and optimization of a combined gas and steam turbine cycle incorporating both solar heating and a waste heat steam generator are investigated Several variants of the combined cycle are considered and efficiency-enhancing features introduced It is demonstrated that both straight solar and fossil-fueled constant load requirements are met, for a system with 800 C solar receiver temperature and 20 MWe capacity. O C

A81-30009 # **Modified Brayton cycles utilizing alcohol fuels.** M. F. Bardon (Royal Military College of Canada, Kingston, Ontario, Canada) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar 9-12, 1981, Paper 81-GT-103.* 8 p. 14 refs Members, $2 00, nonmembers, $4.00

It is already well known that alcohols can be burned in open cycle gas turbines by direct firing in the combustor. This paper demonstrates however that there are significant improvements in thermal efficiency possible by modifying the manner in which alcohols are used in Brayton cycle engines. It is shown that injection of the alcohol during the compression process can materially improve both thermal efficiency and specific work because of the intercooling effect of evaporation. Calculations are given which demonstrate the improvement theoretically possible at representative values of peak turbine inlet temperature. It is also shown that the optimum pressure ratio for both regenerated and unregenerated cycles is different when such compressor evaporative intercooling is used rather than simply injecting the fuel into the combustor. (Author)

A81-30014 * # **Low NO/x/ combustion systems for burning heavy residual fuels and high-fuel-bound nitrogen fuels.** D. J White, A. Batakis, R. T LeCren (Solar Turbines International, San Diego, Calif.), and H. G. Yacobucci (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 9-12, 1981, Paper 81-GT-109.* 11 p. Members, $2.00, nonmembers, $4.00.

Research supported by the U S Department of Energy

Design concepts are presented for lean-lean and staged rich-lean combustors. The combustors are designed for the dry reduction of thermal NO(x), control of NO(x) from fuels containing high levels of organic nitrogen, and control of smoke from low hydrogen content fuels The combustor concepts are tested with a wide variety of fuels including a middle distillate, a petroleum based heavy residual, a coal derived synthetic, and ratios of blends of these fuels The configurations of the lean-lean and rich-lean combustion systems are provided along with a description of the test rig and test procedure. L.S.

A81-30029 * # Evaluation of advanced combustors for dry NO/x/ suppression with nitrogen bearing fuels in utility and industrial gas turbines. M B. Cutrone, M B. Hilt (General Electric Co., Schenectady, N.Y), A Goyal, E E. Ekstedt (General Electric Co , Evendale, Ohio), and J. Notardonato (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-125* 10 p Members, $2 00, nonmembers, $4 00 Research supported by the U S Department of Energy

A81-30031 # A baseload gas turbine to meet utility requirements for reliability and availability. P E Grevstad, M J. Smith (United Technologies Corp., Power Systems Div , South Windsor, Conn), and R. L. Duncan (Electric Power Research Institute, Palo Alto, Calif) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 9-12, 1981, Paper 81-GT-127.* 8 p. 10 refs. Members, $2.00, nonmembers, $4.00. Research supported by the Electric Power Research Institute.

The development of a new, 120 MW gas turbine, designed specifically for baseload service and incorporating a coal gasifier-fueled combined cycle, is described. The goals of the development program were the high reliability and availability and low maintenance costs typical of steam turbines It is estimated that the introduction of air-cooled turbine airfoils and new combustor liner technology will allow the design output to rise to 165 MW. Rigorous emissions requirements are met by the gasifier combined cycle, despite the use of ordinary coal stocks. O.C.

A81-30034 # Design analysis of high-efficiency low-stress ceramic gas turbines D G Wilson (MIT, Cambridge, Mass) and L Wood *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-130* 8 p 14 refs Members, $2 00, nonmembers, $4 00

The gains which can be realized in gas-turbine cycles by lowering the pressure ratio, increasing the degree of regeneration, and utilizing multistage compressors and turbines, are much increased design-point thermal efficiency, very much higher part-load efficiency, and much reduced centrifugal stress, attachment stress, and foreign-object-damage stress These gains, and the size penalty associated with this approach, are evaluated to a first approximation The net benefits should be substantial for many applications where size limits are not stringent, for instance trucks and boats, and where reduced fuel consumption is of paramount importance (Author)

A81-30051 # ITI GT601 - A new approach to vehicular gas turbine power unit design G D Woodhouse (Garrett Corp , Phoenix, Ariz) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-152* 16 p Members, $2 00, nonmembers, $4 00

The design and development of the GT601 336 to 485 kW gas turbine power plant for highway trucks are outlined The GT601 is a medium-pressure ratio, recuperated-cycle, free-turbine engine The engine comprises a two-stage centrifugal compressor, a single-can combustor, a radial-inflow gas generator turbine, and a two-stage power turbine utilizing variable geometry stators The engine is controlled by a hydromechanical fuel-metering system Start-sequencing and control-trimming are handled by an electronic control module The GT601 is economically competitive with the diesel engine developments projected for the late 1980's and meets emission and noise environmental goals L.S.

A81-30080 # Progress in the development of the Marine Spey, SM1A D E Williams (Rolls-Royce, Ltd , Coventry, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-186* 8 p Members, $2 00, nonmembers, $4 00

A81-30083 # A market research effort leading to the development of a high efficiency 10,000 shp gas turbine system. K Frankfort (Thomassen Holland, Rheden, Netherlands) and J Rich (Fern Engineering, Bourne, Mass) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-190* 8 p Members, $2 00, nonmembers, $4 00

Results of two market research surveys are presented to establish design criteria, performance parameters, and product specification for a 10,000 shp flange-to-flange gas turbine system The design of the turbine, designated as the TF-10, consists basically of a two stage centrifugal compressor driven by a single stage axial turbine, an annular combustor and a two stage axial load turbine An optimization study was carried out to achieve the highest level of performance attainable Performance parameters, which include rated power, rated speed, gas generator speed, thermal efficiency, heat rate, rotor inlet temperature, turbine exhaust temperature, regenerator exhaust temperature, and compressor pressure ratio, were established for operation at ISO conditions The major potential market was identified as gas transmission and distribution The survey also indicated a growing interest in cogeneration of power and heat The research identified the requirements of the market place and integrated those requirements with the product development program K S

A81-30084 # Engine cycle selection for advanced technology engine studies C L Lehman and V J Crafa (Grumman Aerospace Corp , Air Breathing Propulsion Section, Bethpage, N Y) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-191* 8 p 6 refs Members, $2 00, nonmembers, $4 00

The Installed Propulsion Performance (IPP) and Propulsion Selection and Integration (PSI) programs are discussed The IPP program interfaces with the source performance deck from the engine manufacturer to derive installed performance in a representative installation Installation correction factors are selected from a large data bank with appropriate inlet, nozzle, engine air bleed, and horsepower extraction data selected from existing system designs and modified to the needs of the particular configuration The PSI program is used to analyze propulsion system and mission performance The internal design data routines of PSI are configured to generate an aircraft design consistent with engine dimensional, weight, and center of gravity characteristics The program has several specialized subroutines to account for unique engine installations such as V/STOL The results of studies using the IPP-PSI methodology are given for several high performance aircraft L S

A81-30091 # Small gas turbine with large parabolic dish collectors K Bammert (Hannover, Universitat, Hanover, West Germany), A Sutsch (Institute for Computer Assisted Research in Astronomy, Alterswil, Switzerland), M Simon (Maschinenfabrik Augsburg-Nürnberg AG, Munich, West Germany), and A Mobarak (Cairo, University, Cairo, Egypt) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-201* 13 p 26 refs Members, $2 00, nonmembers, $4 00

A cost and efficiency comparison of different solar power plants demonstrates that the large parabolic dish system with a turbo converter is superior to other solar thermal power plants in the power range of 50 to 2000 kW Selection and design criteria for the dish, the gas turbine set, and the receiver are provided and discussed When not in power conversion mode, the proposed dish system can be used for various kinds of communication and data transmission An advanced layout for a 250 kW gas turbo converter with recuperator is presented in detail L S

A81-30101 # **Coal-fired heaters for CCGT cogeneration service** J Campbell, Jr , G A Hastings (Rockwell International Corp , Rocketdyne Div , Canoga Park, Calif), and C E Holt (Battelle Columbus Laboratories, Columbus, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-212* 10 p 7 refs Members, $2 00, nonmembers, $4 00

This paper discusses a current research and development program whose object is to advance the technical readiness of large, coal-fired heaters to supply the input to closed-cycle gas turbine cogeneration systems Such closed-cycle systems become increasingly attractive as energy costs increase The gas turbine working fluid is completely isolated from the products of coal combustion, thus avoiding corrosion and erosion of the gas turbine system. Additionally, the nature of the thermodynamic cycles is frequently such as to afford substantial savings in coal input requirements as compared to steam turbine based systems producing equivalent process heat and power This paper describes three fired heater concepts that are under development for CCGT service The organization of the research and development program, and the development needs of the fired heaters that are to be satisfied by the R&D program, are discussed (Author)

A81-30102 # **Cooled radial in-flow turbines for advanced gas turbine engines** J M Lane (U.S Army, Applied Technology Laboratory, Fort Eustis, Va) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9-12, 1981, Paper 81-GT-213* 9 p 9 refs Members, $2 00, nonmembers, $4 00

It is noted that while the radial in-flow turbine has consistently demonstrated its capability as a high-performance component for small gas turbine engines, its use has been restricted to lower turbine-inlet-temperature cycles This is because of insurmountable problems regarding the manufacture of radial turbine rotors having internal cooling passages It is pointed out that these cycle temperature limitations are inconsistent with modern trends toward higher-performance, fuel-conservative engines The results of several Army-sponsored programs are presented, the first of which deals with the performance potential for the high-temperature radial turbine The results of two successful programs for developing fabrication techniques for internally cooled radial turbines, including mechanical integrity testing, are also discussed C R.

A81-30106 # **Analytical consideration of fuel economy and dynamic response of a regenerative high temperature automobile gas turbine II** T Takeuchi, T Itoh, and T Ishida (Nissan Motor Co., Ltd , Central Engineering Laboratories, Yokosuka, Japan). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex , Mar 9 12, 1981, Paper 81-GT-218*. 8 p Members, $2 00, nonmembers, $4 00

A81-30112 # **Wellbore flow characteristics for optimal energy recovery from Gulf Coast geopressured geothermal sources.** J P Lamb and C L Hamburger (Texas, University, Austin, Tex). *American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, Houston, Tex , Jan 18-22, 1981, Paper 81-Pet-18* 6 p 15 refs Members, $2 00, nonmembers, $4 00.

Geopressured geothermal brines contain potential energy in three forms dissolved methane, high pressure, and high temperature For optimal resource utilization one must separate the natural gas while simultaneously maximizing the conversion processes required for the liquid phase The present paper discusses some basic thermodynamic concepts which determine the conversion effectiveness of hydraulic and thermal energy components. Using realistic resource data for Texas and Louisiana, it is shown that there is a range of well flow rates which maximizes the brine energy recovery The effects of salinity levels on various flow parameters are also illustrated, in general, salinity is found to have a minor effect on theoretical performance Hence, the major influence of dissolved solids would be on equipment performance (Author)

A81-30114 # **Gas-turbine-topped hybrid power plants for the utilization of geopressured geothermal resources** H E Khalifa (United Technologies Research Center, East Hartford, Conn) *American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, Houston, Tex , Jan 18 22, 1981, Paper 81-Pet-5* 6 p 16 refs Members, $2 00, nonmembers, $4 00

The paper presents an analysis of the performance and economics of a novel hybrid energy conversion system that would efficiently utilize the methane, hydraulic and thermal energy produced by geopressured-geothermal resources The novel system comprises a methane-fueled gas turbine whose waste heat is used to superheat the vapor generated from the geopressured brine in an otherwise-conventional double-flash power plant The analysis indicates that, compared to a conventional double-flash system, the hybrid system can generate nearly 44 percent more work from the thermal energy of the brine, in addition to the outputs of the gas and hydraulic turbines Conservative preliminary economic estimates indicate that the unit installed cost of the hybrid plant would be about 25 percent lower than that of a conventional system constructed at the same geopressured resource site. (Author)

N81-16056*# Jet Propulsion Lab., California Inst of Tech., Pasadena
TWO-STAGE COMBUSTION FOR REDUCING POLLUTANT EMISSIONS FROM GAS TURBINE COMBUSTORS
Richard M Clayton and David H Lewis 1 Feb 1981 86 p refs
(Contract NAS7-100)
(NASA-CR-163877, JPL-Pub-80-63) Avail NTIS HC A05/MF A01 CSCL 21E

Combustion and emission results are presented for a premix combustor fueled with admixtures of JP5 with neat H2 and of JP5 with simulated partial-oxidation product gas The combustor was operated with inlet-air state conditions typical of cruise power for high performance aviation engines Ultralow NOx, CO and HC emissions and extended lean burning limits were achieved simultaneously Laboratory scale studies of the non-catalyzed rich-burning characteristics of several paraffin-series hydrocarbon fuels and of JP5 showed sooting limits at equivalence ratios of about 2 0 and that in order to achieve very rich sootless burning it is necessary to premix the reactants thoroughly and to use high levels of air preheat The application of two-stage combustion for the reduction of fuel NOx was reviewed An experimental combustor designed and constructed for two-stage combustion experiments is described T M

N81-16061# Purdue Univ , Lafayette, Ind Combustion Lab
AGT-1500 COMBUSTOR AND FUEL ELLECTS MODELING Final Technical Report, 1 Sep. 1978 - 31 Aug. 1980
P. A Leonard, J E Peters, and A M Mellor 1 Oct 1980 72 p refs
(Contract DAAG29-79-C-0169, Grant DAAG29-78-G-0092)
(AD-A092255, PURDU-CL-80-03, ARO-15642 5-E) Avail NTIS HC A04/MF A01 CSCL 21/5

The influence of alternative fuels on gas turbine engine performance is considered analytically Broad specification or alternative fuels may have viscosities and wider boiling point temperature distributions which adversely affect atomization and vaporization processes within gas turbine combustors, leading to performance penalties in ignition, lean blowoff and combustion efficiency These performance measures have been modeled by considering ratios of characteristic times which describe the controlling physical processes of fluid mechanic mixing, kinetics and fuel evaporation Semi-empirical models are developed which describe lean blowoff, ignition and combustion efficiency of the AVCO-Lycoming AGT-1500 combustor and other combustors These expressions can be used to assist design of fuel tolerant combustors, and to assess impacts associated with fuel type selection GRA

N81-16456# KMS Fusion, Inc , Ann Arbor, Mich
THE CHEMICALLY PUMPED IODINE LASER AS A FUSION DRIVER

George E Busch 1980 4 p refs
(Contract DE-AC08-78DP-40030)
(KMSF-U-944, CONF-800208-19) Avail NTIS HC A02/MF A01

A chemically pumped iodine laser is evaluated for fusion requirements Efficiencies greater than 8 percent and long energy storage times are predicted, with high repetition rates and elimination of pulsed power supplies Author

N81-16570*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
PERFORMANCE CALCULATIONS FOR 1000 MWe MHD/STEAM POWER PLANTS
C C P Pian 1981 15 p refs Presented at the 19th Aerospace Sci Meeting, St Louis, 12-15 Jan 1981, sponsored by AIAA
(Contract DE-A101-77ET-10769)
(NASA-TM-81667, DOE/NASA/10769-13, E-688) Avail NTIS HC A02/MF A01 CSCL 10B

The effects of MHD generator operating conditions and constraints on the performance of MHD/steam power plants are investigated Power plants using high temperature combustion air preheat (2500 F) and plants using intermediate temperature preheat (1100 F) with oxygen enrichment are considered Variations of these two types of power plants are compared on the basis of fixed total electrical output (1000 MWe) Results are presented to show the effects of generator plant length and level of oxygen enrichment on the plant thermodynamic efficiency and on the required generator mass flow rate Factors affecting the optimum levels of oxygen enrichment are analyzed It is shown that oxygen enrichment can reduce magnet stored energy requirement Author

N81-16571*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
OFF-DESIGN ANALYSIS OF A GAS TURBINE POWER-PLANT AUGMENTED BY STEAM INJECTION USING VARIOUS FUELS
Robert J Stochl Nov 1980 29 p refs
(NASA-TM-81611, E-609) Avail NTIS HC A03/MF A01 CSCL 10B

Results are compared using coal derived low and intermediate heating valve fuel gases and a conventional distillate The results indicate that steam injection provides substantial increases in both power and efficiency within the available compressor surge margin The results also indicate that these performance gains are relatively insensitive as to the type of fuel Also, in a cogeneration application, steam injection could provide some degree of flexibility by varying the split between power and process steam T M

N81-16579*# Westinghouse Electric Corp, Pittsburgh, Pa
CELL MODULE AND FUEL CONDITIONER DEVELOPMENT Quarterly Report, Jul. - Sep. 1980
D Q Hoover, Jr Oct 1980 68 p
(Contracts DEN3-161, DE-AI03-79ET-11272)
(NASA-CR-165189, DOE/NASA/0161-5, Rept-80-9E6-MARED-R4, QR-4) Avail NTIS HC A04/MF A01 CSCL 10A

Measurements of stack height changes with temperature and cell material characteristics were made Stack 559 was assembled and components were fabricated for 560, 561, and 562. Stack 425 was transferred from the parallel DOE program and installed in the OS/IES simulation loop for mechanical and electrical testing Construction and preliminary checkout of the 2 kW test facility was completed and design and procurement of the 8 kW test facility was initiated The fuel conditioning subsystem design continued to evolve, and the state points for the current design were calculated at full and part load conditions Steam reforming catalyst activity tests were essentially completed and aging tests and CO shift converter tests were initiated Author

N81-16589# Energy Research Corp, Danbury, Conn
IMPROVEMENT OF PHOSPHORIC ACID FUEL CELL STACKS Final Technical Report, Aug. 1977 - Jun. 9180
S G Abens, F J Ascenzo, B S Baker, G Garretson, and M Lambrech Jul 1980 88 p
(Contract DAAK70-77-C-0174 DA Proj 1L2-63702-DG-10)
(AD-A092814) Avail NTIS HC A05/MF A01 CSCL 10/2

Phosphoric acid fuel cell components and stack assembly methods were evaluated Electrodes with Pt loading between 0 3 and 0 9 g/sq ft were employed Matrix materials were phenolic (Kynol) fibers and SiC A new ERC proprietary matrix was used also Graphite bipolar plates with 33% phenolic resin binder were used Stacks were tested on hydrogen and simulated reformed methanol for up to 18,000 hours Two 80 cell (2 1 kW) stacks and a methanol reformer were built and delivered to MERADCOM GRA

N81-16597# Oak Ridge National Lab, Tenn Operations Div
RADIOISOTOPE POWERED LIGHT SOURCES
F N Case and W C Remini 1980 14 p Sponsored in part by USAF
(Contract W-7405-eng-26)
(CONF-801157-1) Avail NTIS HC A02/MF A01

The background and current status of the use of radioisotopes to excite phosphors to produce visible light are discussed Current energy conservation needs provided the incentive for the development of illuminators for air field markers using both byproduct krypton-85 and processed tritium L F M

N81-16598# United Technologies Corp, South Windsor, Conn Power Systems Div
IMPROVED FCG-1 CELL TECHNOLOGY Final Report, 1 Mar. - 31 Dec. 1979
R D Breault, J V Congdon, R D Coykendall, and W L Luoma Oct 1980 49 p Sponsored in part by Electric Power Research Inst
(Contract DE-AC03-76ET-11301, EPRI Proj 842-5)
(EPRI-EM-1566) Avail NTIS HC A03/MF A01

Fuel cell performance in the ribbed substrate cell configuration consistent with tha5 projected for a commercial power plant is demonstrated Tests were conducted on subscale cells and on two 20 cell stacks of 4 8 MW demonstrator size cell components These tests evaluated cell stack materials, processes, components, and assembly configurations The first task was to conduct a component development effort to introduce improvements in 3 7 square foot, ribbed substrate acid cell repeating parts which represented advances in performance, function, life, and lower cost for application in higher pressure and temperature power plants Specific areas of change were the electrode substrate, catalyst, matrix, seals, separator plates, and coolers Full sized ribbed substrate stack components incorporating more stable materials were evaluated at increased pressure (93 psia) and temperature (405 F) conditions Two 20 cell stacks with a 3 7 square feet, ribbed substrate cell configuration were tested S F

N81-16602# Westinghouse Electric Corp, Pittsburgh, Pa Research and Development Center
AIR/GAS SYSTEM DYNAMICS OF FOSSIL FUEL POWER PLANTS. VOLUME 4: EXPERIMENTAL VIBRATION AND ACOUSTIC TEST DATA OF A 500-MW UNIT Interim Report
F R Goldschmied, D N Wormley, and D Rowell Oct 1980 174 p refs Prepared in cooperation with MIT, Cambridge
(EPRI Proj 1651)
(EPRI-CS-1444-Vol-4) Avail NTIS HC A08/MF A01

Vibration and acoustic tests were made in a 500 MW oil fired unit, in conjunction to system dynamics pressure data The test data were taken on one forced draft fan, on one induced draft fan and on the gas recirculation fan Both cold tests and hot tests were taken for all fans Identical fans were used for forced draft and for induced draft installation but the acoustic characteristics were different A total of 145 spectrum plots are presented Twenty five vibration spectrums are given, where acceleration level, g, is plotted against frequency, two frequency ranges are used, 0-20 Hz and 0-200 Hz One hundred and twenty acoustic spectrums are given, where sound level is plotted against frequency, three frequency ranges are used, 0-20 Hz, 0-200 Hz, and 0-2000 Hz The test data are presented for future reference without concomitant analysis at this time Author

N81-16609# Stanford Linear Accelerator Center, Calif
ULTRA HEADLESS HYDRO POWER
F F Hall Sep 1980 4 p refs Presented at 3rd Intern Conf on Alternative Sources, Miami Beach, Fla, 15-17 Dec 1980
(Contract DE-AC03-76SF-00515)
(SLAC-Pub-2613, CONF-801210-3) Avail NTIS HC A02/MF A01

Site selection considerations were reviewed for hydroelectric power stations. Design factors influencing energy conversion efficiency are presented Electric energy storage technology was reviewed. Principles for the ultimate attainment of hydropower from the least head are discussed T M

N81-16615# National Technical Information Service, Springfield, Va.
HYDROCARBON FUEL CELLS. CITATIONS FROM THE AMERICAN PETROLEUM INSTITUTE DATA BASE Progress Report, 1967 - Jul. 1980
Diane M Cavagnaro Oct. 1980 135 p Supersedes NTIS/PS-79/0718 and NTIS/PS-78/0651
(PB81-800021; NTIS/PS-79/0718, NTIS/PS-78/0651) Avail NTIS HC $30 00/MF $30 00 CSCL 10B

This bibliography cites worldwide research on hydrocarbon fuel cells. The citations cover applications, design, performance, fabrication, catalysts, and electrochemistry This updated bibliography contains 130 citations, 2 of which are new entries to the previous edition GRA

N81-16898# Committee on Science and Technology (U S House)
FUSION ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION ACT OF 1980
Washington GPO 1980 26 p Rept to accompany H. R 6308 presented by the Comm on Sci and Technol at the 96th Congr, 2nd Sess, 17 Jun 1980
(H-Rept-96-1096) Avail US Capitol, House Document Room

An accelerated program for development of magnetic fusion energy leading to commercialization of the technology is described The fusion technology will provide energy for the generation of electricity and production of heat, hydrogen and synthetic fuels S F

N81-16899# Massachusetts Inst of Tech, Cambridge
MHD EFFECTS ON VISCOUS AND THERMAL WAKES AND THEIR INFLUENCE ON THE PERFORMANCE OF MHD GENERATORS
Steven J Schneider (Westinghouse Research and Development Center, Pittsburgh, Pa) and Jean F Louis 8 Jan 1979 38 p refs Backup Document for AIAA Synoptic Scheduled for Publication in the Journal of Aircraft, Jan/Mar 1981
(LOG-E281) Avail NTIS HC A03/MF A01

The development of velocity and thermal wakes induced by inlet vanes are analyzed separately and their influence on the performance of magnetohydrodynamic (MHD) generators is evaluated The velocity wake has uniform conductivity, a magnetic field parallel to the vorticity and uniform current passed through the channel An analytical solution is determined for the wake as a function of the MHD interaction parameter where the rising interaction parameter causes a greater velocity defect and the greater velocity defect decreases the electrical efficiency The thermal wake has uniform velocity at any cross section of the channel, a magnetic field parallel to the vorticity and uniform current passed through the channel An analytical solution for the conductivity wake as a function of the MHD interaction parameter is presented This solution is exact only for the case of maximum power delivered to the load but is also accurate for a channel with loading factor less than 0 7 Increasing the interaction parameter decreases the thermal defect and the decreased thermal defect increases the electrical efficiency M G

N81-16906# Brookhaven National Lab, Upton, N Y Dept of Nuclear Energy
HYFIRE: A TOKAMAK HIGH TEMPERATURE ELECTROLYSIS SYSTEM
J A Fillo, J R Powell, M Steinberg, R Benenati, F Horn, H Isaacs, O W Lazareth, H Makowitz, and J Usher 1980 10 p refs Presented at the 3rd Miami Intern Conf on Alternative Energy Sources, Miami Beach, Fla, 15-17 Dec 1980 Sponsored in part by DOE
(BNL-28679, CONF-801210-9) Avail. NTIS HC A02/MF A01

The conceptual design HYFIRE, a commercial fusion Tokamak reactor, high temperature electrolysis system, is discussed with emphasis on the adaptability of the STARFIRE power reactor to a synfuel application The HYFIRE blanket must perform three functions: (1) provide high temperature (approximately 1400 C) process steam at moderate pressures (in the range of 10 to 30 atm) to the high temperature electrolysis (HTE) units, (2) provide high temperature (approximately 700 to 800 C) heat to a thermal power cycle for generation of electricity to the HTE units; and (3) breed enough tritium to sustain the D-T fuel cycle In addition to thermal energy for the decomposition of steam into its constituents, H2 and O2, electrical input is required Fourteen hundred degree steam coupled with 40% power cycle efficiency results in a process efficiency (conversion of fusion energy to hydrogen chemical energy) of 50% A R H

N81-16909# Westinghouse Electric Corp, Pittsburgh, Pa Research Labs
OPERATIONAL ANALYSIS OF OPEN-CYCLE MHD Final Report
T E Lippert and D A McCutchan Jul 1980 268 p refs
(EPRI Proj 639-1)
(EPRI-AP-1463) Avail NTIS HC A12/MF A01

Open cycle magnetohydrodynamic (OCMHD) conceptual power plant designs are studied in the context of a utility system to form a better basis for understanding their design, design requirements, and market possibilities Based on assumed or projected plant costs and performance characteristics, assumed economics and escalation factors, and one coal supply and delivery scenario, overall and regional OCMHD utility market possibilities are reviewed Additionally, for one hypothetical utility system a generation expansion plan is developed that includes OCMHD as a baseload power generating station The impact on generation system economics and operation of alternating selected MHD plant cost and performance characteristics is reviewed Baseload plant availability is shown as an important plant design consideration, and a general methodology and data base is developed to assess the impact on design and cost of various reliability decisions. An overall plant availability goal is set and the required availabilities of various MHD high technology components are derived to meet the plant goal. The approach is then extended to projecting channel life goals for various plant design configurations and assumptions Author

N81-17527*# Stonehart Associates, Inc, Madison, Conn
PREPARATION AND EVALUATION OF ADVANCED ELECTROCATALYSTS FOR PHOSPHORIC ACID FUEL CELLS Quarterly Report, Jul. - Sep. 1980
Paul Stonehart, John Baris, and Peter Pagliaro Sep 1980 30 p refs
(Contract DEN3-176)
(NASA-CR-165179, DOE/NASA/0176-80/3, QR-3) Avail NTIS HC A03/MF A01 CSCL 10A

Results are presented for hydrogen oxidation and hydrogen oxidation poisoned by carbon monoxide at levels between 0 and 30% Due to the high activities that are now being observed for our platinum based electrocatalysts, the hydrogen concentrations were reduced to 10% levels in the gas supplies Perturbation techniques were used to determine that a mechanism for the efficient operation of our porous gas diffusion electrodes is diffusion of the carbon monoxide out of the electrode structure through the electrolyte film on the electro-catalyst A survey of the literature on platinum group materials (PGM) was carried out so that an identification of successful electrocatalysts could be made Two PGM electrocatalysts were prepared and performance data for hydrogen oxidation in hot phosphoric acid in the presence of high carbon monoxide concentrations showed that they matched the best platinum on carbon electrocatalysts but with an electrocatalyst cost that was half of the platinum catalyst cost Author

N81-17594# Westinghouse Electric Corp, Lester, Pa. Power Systems Co
OCEAN THERMAL ENERGY CONVERSION POWER SYSTEM DEVELOPMENT: PSD-I, PHASE 2 Final Design Report
30 Jun 1980 515 p refs
(Contract DE-AC03-79ET-21039)
(DOE/ET-21039/1) Avail NTIS HC A22/MF A01
The PSD-1 program provides a heat exchanger system consisting of an evaporator, condenser and various ancillaries with ammonia used as a working fluid in a closed simulated Rankine cycle Primary design concerns include control of biofouling corrosion and erosion of aluminum tubes, selection of materials, and the development of a basis for scale up to large heat exchangers so as to ultimately demonstrate economic feasibility on a commercial scale The PSD-1 test article was devised to verify thermodynamic, environmental and mechanical performance of basic design concepts The detailed design, development, fabrication, checklist, delivery, installation support, and operation support for the Test Article Heat Exchangers are described DOE

N81-17606# Babcock and Wilcox Co, Alliance, Ohio
STUDY OF SEED-REPROCESSING SYSTEMS FOR OPEN-CYCLE COAL-FIRED MHD POWER PLANTS.
A Sheth (Argonne National Lab) Jul 1980 63 p refs Prepared in cooperation with J E Sirrine Co
(Contract DE-AC02-79ET-15613)
(DOE/ET-15613-T1-App) Avail NTIS HC A04/MF A01
Of the several processes that are capable of separating sulfur from potassium sulfate, the process developed by Pittsburgh Energy Research Center (PERC), and the Formate process were selected for the detailed mass and energy balance calculations As a basis for the calculations, an MHD power plant of 450 Mwt size and burning Illinois no 6 coal was selected In the mass balance calculations, the role played by various trace impurities was included to the extent of current knowledge about such impurities and their impacts on process chemistry The results given should be considered as preliminary values because various simplifying assumptions were made and factors such as heat losses and component efficiencies were excluded On the basis of net energy requirements, the Formate process showed a slight advantage, however, it produced a potentially unacceptable sludge as the sulfur containing waste DOE

N81-17619# Institute of Gas Technology, Chicago, Ill
FUEL CELL SUPPORT STUDIES: ON-SITE MOLTEN CARBONATE SYSTEMS Final Report, 1 Dec. 1978 - 30 Nov. 1979
Ronald M Bowman, Bassam J Jody, Kuang C Lu, and Keith F Blurton Gas Research Inst Oct 1980 214 p refs Sponsored by Gas Research Inst
(PB81-113672, GRI-79/0067) Avail NTIS HC A10/MF A01 CSCL 10B
The potential energy savings which could be obtained from industrial cogeneration using molten carbonate fuel cells are, assesses A natural gas-fueled molten carbonate fuel cell system was configured, and its efficiency and the quantity and quality of its rejected heat were calculated Potential energy savings, environmental benefits, and impact on overall gas consumption from using the system in a cogenerative mode in 13 selected energy-intensive industries were determined General equations were derived for the calculation of potential energy savings using any cogeneration system GRA

N81-17883# Sandia Labs, Albuquerque, N Mex
DRIVERS FOR LIGHT ION FUSION
J P VanDenvender 1980 12 p refs Presented at the 4th ANS Topical Meeting on the Technol. of Controlled Fusion, King of Prussia, Pa, 14-17 Oct 1980
(Contract DE-AC04-76DP-00789)
(SAND-80-2432C, CONF-801011-20) Avail NTIS HC A02/MF A01
The light ion approach to inertial confinement fusion requires the production of 10 to the 13th power to 10 to the 14th power watt and 10 to the 6th power to 10 to the 7th power joule pulses The accelerator technology developed in the particle beam fusion program is capable of fulfilling these requirements DOE

N81-17910# Los Alamos Scientific Lab, N Mex
POSSIBLE APPLICATION OF ELECTROMAGNETIC GUNS TO IMPACT FUSION
R. N Kostoff (DOE), F L Ribe (Washington Univ), and A T Peaslee 1980 9 p refs Presented at the Electromagnetic Guns and Launchers Conf, San Diego, Calif, 4-6 Nov 1980
(Contract W-7405-eng-36)
(LA-UR-80-3137, CONF-801138-4) Avail NTIS HC A02/MF A01
The concept of impact fusion is discussed in terms of application to generation of electric power Target interactions and acceleration systems are addressed The potential of the rail gun as an impact fusion macroparticle accelerator is assessed including the relative advantages of the rail gun J M S

N81-17911# Edgerton, Germeshausen and Grier, Inc, Idaho Falls, Idaho
ENVIRONMENTAL AND SAFETY ISSUES OF THE FUSION FUEL CYCLE
J G Crocker 1980 13 p refs Presented at the 4th ANS Topical Meeting on the Technol of Controlled Nucl Fusion, King of Prussia, Pa, 14 Oct 1980
(Contract DE-AC07-76ID-01570)
(CONF-801011-66) Avail NTIS HC A02/MF A01
The environmental and safety concerns inherent in the development of fusion energy are discussed Specific topics covered include: (1) safe and reliable techniques for tritium control, (2) reduce the quantity of activation products produced, and (3) provide designs to limit the potential for accidents that could result in release of radioactive materials Because of the inherent safety features of fusion and the early start that has been made in safety problem recognition and solution, fusion should be among the lower risk technologies for generation of commercial power DOE

N81-18153 Stanford Univ, Calif
OPTICAL DIAGNOSTIC MEASUREMENTS OF COAL SLAG PARAMETERS IN COMBUSTION MHD SYSTEMS Ph.D. Thesis
Peter Carl Anessohn 1980 183 p
Avail Univ Microfilms Order No 8103481
A diagnostic technique capable of making continuous, in situ measurements of slag layer thickness was developed This technique was then applied in a magnetohydrodynamic (MHD) system for comparison with the predictions of one of the existing hydrodynamic models A diagnostic technique capable of making in situ measurements of ash droplet size and concentration at the exit of an MHD combustor was also developed and the sensitivity of these quantities was studied with respect to various combustion parameters A slag layer surface position monitor employing a laser triangulation method was developed and used to measure variations in slag layer thickness as a function of substrate temperature for a variety of ash loadings and total reactant flowrates These measurements, on both eastern and western coals, were in excellent agreement with theoretical predictions based on estimated properties of these slags Slag layer thickness is shown to decrease with increasing substrate temperature and plasma velocity Increased deposition rate, slag viscosity and thermal conductivity all led to increased slag layer thickness Dissert Abstr

N81-18247# Office National d'Etudes et de Recherches Aerospatiales, Paris (France)
CLOSED-CYCLE HELIUM GAS TURBINE FOR SOLAR TOWER POWER PLANT
Pierre Duran *In its* La Rech Aerospatiale, Bimonthly Bull No 1980-2 (ESA-TT-652) 1980 p 35-50 refs Transl into ENGLISH from La Rech Aerospatiale, Bull Bimestriel (Paris), no 1980-2, Mar - Apr 1980 p 109-122 Original report in FRENCH previously announced as A80-46228

Avail NTIS HC A05/MF A01

Closed-cycle helium gas turbines with an atmospheric cold heat source, currently under development for very high temperature nuclear power plants, are discussed for use in solar energy conversion systems not requiring long term thermal storage In the 10 MW-el range, and with a turbine inlet temperature of 900 C, the thermal efficiency of a complex gas turbine, including cooling between low pressure and high pressure compressors as well as reheating between high pressure and low pressure turbine and regenerative heat exhangers, lies between 41 and 43% The efficiency is constant in time and is sustained even at off-design operation, it is equivalent to the efficiency achieved by a thermal power plant, which allows running the solar plant with an auxiliary fossil fuel combustor Author (ESA)

N81-18484 Virginia Polytechnic Inst and State Univ Blacksburg
THE AERODYNAMIC ANALYSIS OF A 10 KW HORIZONTAL-AXIS WINDMILL Ph D. Thesis
Reginald Lee Figard 1980 154 p
Avail Univ Microfilms Order No 8101878

An aerodynamic study of the performance and the flowfield in the vicinity of the rotor of a three bladed 10kW horizontal-axis windmill is presented The windmill has a 6 38 m (20 92 ft) diameter rotor and is rated at 10kW in a 13 41m/s(44 0 fps) wnd Three basic approaches are utilized First, field measurements of the performance and the axial velocity and turbulence behind the rotor were conducted Second wind tunnel tests of a 1 5 scale model were performed Third, theoretical analyses of the windmill were made This included performance predictions with a computerized, modified blade element (vortex theory) analysis and the development and utilization of a numerical procedure employing the full Navier-Stokes equations in axisymmetric form to examine the wake development in detail The results of each of the three approaches shows agreement within 10 to 15% with the other two approaches The theoretical performance analysis underpredicts both the field and wind tunnel results while scaled-up wind tunnel results overpredicted the field results The axial velocities immediately behind the rotor are compared for all three cases and the results correspond to the performance results Dissert Abstr

N81-18491*# Westinghouse Electric Corp, Pittsburgh, Pa Advanced Energy Systems Div
DISK MHD GENERATOR STUDY Final Report
F D Retallick et al Oct 1980 424 p refs
(Contract DEN3-139 DE-A101-77ET-10769)
(NASA-CR-159872, DOE/NASA/0139-1, AESD-TME-3064) Avail NTIS HC A18/MF A01 CSCL 10A

Directly-fired separately-fired and oxygen-augmented MHD power plants incorporating a disk geometry for the MHD generator were studied The base parameters defined for four near-optimum-performance MHD steam power systems of various types are presented The finally selected systems consisted of (1) two directly fired cases one at 1920 K (2996F) preheat and the other at 1650 K (2500 F) preheat, (2) a separately-fired case where the air is preheated to the same level as the higher temperature directly-fired cases and (3) an oxygen augmented case with the same generator inlet temperature of 2839 (4650F) as the high temperature directly-fired and separately-fired cases Supersonic Mach numbers at the generator inlet, gas inlet swirl, and constant Hall field operation were specified based on disk generator optimization System pressures were based on optimization of MHD net power Supercritical reheat stream plants were used in all cases Open and closed cycle component costs are summarized and compared A R H

N81-18494*# Westinghouse Research and Development Center, Pittsburgh, Pa
CELL MODULE AND FUEL CONDITIONER Quarterly Report, Jul - Sep 1980
D Q Hoover, Jr Oct 1980 72 p
(Contracts DEN3-161, DE-AI03-79ET-11272)
(NASA-CR-165189, DOE/NASA/0161-5, Rept-80-9E6-MARED-R4, QR-4) Avail NTIS HC A04/MF A01 CSCL 10A

Measurements of stack height changes with temperature and cell material characteristics were made Stack 559 was assembled and components were fabricated for 560 561, and 562 Stack 425 was transferred from the parallel DOE program and installed in the OS/IES simulation loop for mechanical and electrical testing Construction and preliminary checkout of the 2 kW test facility was completed and design and procurement of the 8 kW test facility was initiated The fuel conditioning subsystem design continued to evolve and the state points for the current design were calculated at full and part load conditions Steam reforming catalyst activity tests were essentially completed and aging tests and CO shift converter tests were initiated Author

N81-18496*# Stonehart Associates, Inc, Madison, Conn
PREPARATION AND EVALUATION OF ADVANCED ELECTROCATALYSTS FOR PHOSPHORIC ACID FUEL CELLS Quarterly Report, Oct - Dec. 1980
Paul Stonehart, John Baris, John Hochmutt, and Peter Pagliaro 31 Dec 1980 35 p
(Contracts DEN3-176 DE-AL01-80ET-17088)
(NASA-CR-165245, DOE/NASA/0176-80/4, GR-4) Avail NTIS HC A03/MF A01 CSCL 10A

Alloy electrocatalysts on carbon supports were developed for hydrogen oxidation in the presence of carbon monoxide These electrocatalysts match the best platinum on carbon catalysts for performance yet cost half as much The results demonstrate that a significant reduction in anode electrocatalyst material cost can be achieved by replacing the platinum Since surface characterization of this catalyst is important to explain its performance, several approaches and pitfalls to the elucidation of the surface characterization are presented T M

N81-18497*# National Bureau of Standards, Washington, D C Metallurgy Div
NON-NOBLE CATALYSTS AND CATALYST SUPPORTS FOR PHOSPHORIC ACID FUEL CELLS Quarterly Report, Aug. - Nov. 1980
A J McAlister Nov 1980 13 p refs
(NASA Order C-46229D, Contract DE-AL01-80ET-17088)
(NASA-CR-165221 DOE/NASA/6229-1 QR-1) Avail NTIS HC A02/MF A01 CSCL 10A

Tungsten carbide which is known to be active for hydrogen oxidation and CO tolerant has a hexagonal structure Titanium carbide is inactive and has a cubic structure Four different samples of the cubic alloys Wx-1TixC were prepared and found to be active and CO tolerant These alloys are of interest as possible phosphoric acid fuel cell catalysts They also are of interest as opportunities to study the activity of W in a different crystalline environment and to correlate the activities of the surface sites with surface composition Author

N81-18518# Brookhaven National Lab, Upton, N Y
FUEL-CELLS FOR ELECTRIC UTILITY AND TRANSPORTATION APPLICATIONS
S Srinivasan 1980 22 p refs Presented at 5th Australian Electrochem Conf Perth Australia, 18 Aug 1980
(Contract DE-AC02-76CH-00016)
(BNL-28696, CONF-800883-1) Avail NTIS HC A02/MF A01

The current status and expected progress status of the fuel cell research and development programs in the USA electrochemical problem areas techno-economic assessments of fuel cells for electric and/or gas utilities and for transportation and other candidate fuel cells and their applications are presented For electric and/or gas utility applications the most likely candidates are phosphoric, molten carbonate and solid electrolyte fuel cells The first will be coupled with a reformer (to convert natural gas, petroleum-derived, or biomass fuels to hydrogen) while the second and third will be linked with a coal gasifier A fuel cell/battery hybrid power source is an attractive option for electric vehicles with projected performance characteristics approaching those for internal combustion or diesel engine powered vehicles For this application, with coal-derived methanol as the fuel a fuel cell with an acid electrolyte is essential with pure hydrogen, alkaline fuel cells show promise DOE

N81-18529# Physical Sciences, Inc Woburn Mass
TASK REPORT NO 3 SYSTEMS ANALYSIS OF ORGANIC

RANKINE BOTTOMING CYCLES
D Bloomfield and S Fried Dec 1980 62 p refs
(Contract DE-AC21-80MC-14361)
(PSI-TR-245) Avail NTIS HC A04/MF A01

A model was developed that predicts the design performance and cost of a Fuel Cell/Rankine cycle powerplant The Rankine cycle utilizes the rejected heat of an 11 3 MW phosphoric acid fuel cell powerplant Improvements in the total plant heat rate and efficiency of up to 10% were attainable, using ammonia as the working fluid The increase in total plant cost divided by the increase in total plant power ranged from $296/kW to $1069/kW for the cases run, and was a strong function of ambient temperature The concept appears to be capable of producing substantial energy savings in large fuel cell powerplants, at reasonable costs However, a much more detailed study that includes such factors as duty cycle, future cost of fuel and site meteorology needs to be done to prove the design for any potential site DOE

N81-18536# Lockheed Missiles and Space Co, Palo Alto, Calif Metallurgy and Composites Lab
ELECTRODE MATERIALS FOR COAL-FIRED MHD GENERATORS Final Report, 1 Mar. 1977 - 31 May 1978
R A Perkins Oct 1980 163 p refs
(Contract EPRI Proj 468-2)
(EPRI-AP-1562) Avail NTIS HC A08/MF A01

Metallic materials are evaluated as electrodes for coal fired MHD generators A laboratory test that simulates the electrochemical and corrosive environment was developed and used to characterize electrode behavior in a diffuse current flow (nonarcing) mode of operation High current density requires that an electron transport mechanism of current flow be maintained With inert, stable electrodes, anode polarization occurs and ionic conduction prevails, limiting current to low values The nature of this behavior and approaches to overcoming anodic polarization are studied as a function of electrode material, slag composition, and temperature By operating at high temperatures and with controlled slag chemistries to produce a very fluid slag, depolarization may be achieved by mechanical mixing Interrupted current flow are required to aid in breaking down anodic polarization DOE

N81-18546# Texas A&M Univ, College Station Dept of Mechanical Engineering
TECHNICAL AND ECONOMIC FEASIBILITY OF A THERMAL GRADIENT UTILIZATION CYCLE (TGUC) POWER PLANT Final Report
Ashok M Raiji, David A Renfroe, and Thomas R Lalk 1980 115 p refs
(Contract DE-FG01-78CS-56604)
(DOE/CS-56604/T1) Avail NTIS HC A06/MF A01

Power is generated by exploiting the natural atmospheric temperature gradient A low grade energy source is used to vaporize a fluid which rises in a pipe to a higher elevation where it is condensed The cycle is completed by passing the condensed liquid through a turbine as it returns to the lower elevation A digital computer model was developed and used to simulate the operation of the cycle and to conduct a parametric study Life cycle cost analysis and energy analyses were conducted for the specific case of a TGUC using the ambient air at the lower elevation as an energy source Although the cycle has a low thermal efficiency and is site specific, it is technically feasible Variations in mass flow rate of the working fluid and elevation were found to affect the cycle power output to a large extent The investment cost of a hypothetical 10 megawatt TGUC power plant was determined to be $3,080 per kilowatt, with life cycle busbar costs of electricity ranging from 47 to 55 Mills per kilowatt hour depending on the method of financing DOE

N81-18550# Sandia Labs, Albuquerque, N Mex
PROCEEDINGS OF THE VERTICAL AXIS WIND TURBINE (VAWT) DESIGN TECHNOLOGY SEMINAR FOR INDUSTRY
Sidney F Johnston, ed Aug 1980 339 p refs
(Contract DE-AC04-76DP-00789)
(SAND-80-0984, CONF-8004128) Avail NTIS HC A15/MF A01

The objective of the program is to develop technology that results in economical, industry produced, and commercially marketable wind energy systems The purpose of the VAWT Design Technology Seminar for Industry was to provide for the exchange of the current state of the art and predictions for future VAWT technology Emphasis was placed on technology transfer on Sandia's technical developments and on defining the available analytic and design tools DOE

N81-18558# Water and Power Resources Service Denver, Colo Engineering and Research Center
SOLAR/HYDRO INTEGRATION STUDY Technical Progress Report, Feb. - Jul. 1980
1980 47 p refs
(Contract DE-AI03-79SF-10505)
(DOE/SF-10505/4) Avail NTIS HC A03/MF A01

The Water and Power Resources Service in cooperation with the Department of Energy (DOE) is investigating the technical and economic feasibility of integrating solar central receiver powerplants with the Federal hydroelectric power system in the southwest United States The principal hydro facility in this region is Hoover Dam Typical meteorological year data were obtained for Las Vegas from the Solar Energy Research Institute Plots of available solar energy at Yuma and Mormon Mesa are presented for several operational threshold levels The data show that a solar plant's operational time can be reduced by 20% and still utilize more than 97% of the available solar energy The Mormon Mesa site has slightly more solar energy available than the Yuma site A meteorological surface observation network (MESONET) weather station is being prepared for installation at the Yuma site The MESONET station which normally measures temperature, relative humidity, barometric pressure, wind speed, and wind direction will be retrofitted to measure direct beam and global radiation The radiation data will be used in dynamic simulations of solar power systems DOE

N81-18562# Foster-Miller Associates, Inc, Waltham Mass
DESIGN AND DEVELOPMENT OF STIRLING ENGINES FOR STATIONARY POWER GENERATION APPLICATIONS IN THE 500 TO 3000 HORSEPOWER RANGE Quarterly Report
Feb 1980 61 p refs
(Contracts DE-AC02-79ET-15208, W-31-109-eng-38)
(DOE/ET-15208/1, QR-1) Avail NTIS HC A04/MF A01

Initial work on the design and development of Stirling engines for stationary integrated energy systems is reported Information is included on a market assessment design methodology, evaluation of engine thermodynamic performance and preliminary system design It is concluded that Stirling engines employing clean fossil fuels cannot compete with diesel engines However, combustion technology exists for the successful burning of coal derived fuels in a large stationary Stirling engine High efficiency is predicted for such an engine and further development work is recommended DOE

N81-18565 Colorado Univ at Boulder
AERODYNAMIC ANALYSIS OF PROPELLER-TYPE WINDMILLS WITH HELICAL TRAILING VORTICES Ph D Thesis
Ta-Ching Shiao 1980 75 p
Avail Univ Microfilms Order No 8103137

To improve the strip theory for computing the performance of a propeller type windmill a realistic analysis is formulated to include the wake effect The finite-wing theory is applied to a rotor blade to find its circulation distribution with the downwash determined from a direct integration of Biot-Savart's law based on the entire helical trailing vortex system An iterative procedure was developed to determine the sectional properties at some selected stations A computer program is constructed for the computation in which the empirical lift and drag data of the blade airfoil section are programmed The torque, thrust and power output of the windmill are obtained by integrating the sectional aerodynamic properties from hub to tip along the blades Two windmills, one with twisted and tapered blades and the other with uniform blades, are used as examples in predicting the performances Dissert Abstr

N81-18877 Stanford Univ, Calif
FLUCTUATIONS IN COMBUSTION-DRIVEN MHD GENERATORS Ph.D. Thesis
John Paul Barton 1980 414 p
Avail Univ Microfilms Order No 8103483
The results of an experimental and theoretical investigation of the inherent fluctuations that occur within combustion driven magnetohydrodynamic generators are presented The primary concern was to determine the presence and effects of axially propagating linear hydrodynamic traveling waves of the magnetoacoustic and magnetoentropic types The possible development of large fluctuations in high magnetic interaction MHD generators caused by hydrodynamic traveling waves propagating with increasing amplitude was considered Experimentally time resolved measurements of pressures, electrode currents, and internal differential voltages within a laboratory scale, combustion driven MHD generator facility were analyzed to determine the nature of the inherent fluctuations A special probe tube microphone provided a sensitive measurement of the pressure fluctuations within a combustion driven MHD generator duct Dissert Abstr

N81-18998*# Jet Propulsion Lab, California Inst of Tech, Pasadena
FUEL CELLS FEASIBILITY
D Schonfeld and T Charng *In its* The Telecommun and Data Acquisition 15 Feb 1981 p 154-168 refs

Avail NTIS HC A09/MF A01 CSCL 10A
The technical and economic status of fuel cells is assessed with emphasis on their potential benefits to the Deep Space Network The fuel cell, what it is, how it operates, and what its outputs are, is reviewed Major technical problems of the fuel cell and its components are highlighted Due to these problems and economic considerations it is concluded that fuel cells will not become commercially viable until the early 1990s J M S

N81-19257# Western Reserve Univ, Cleveland, Ohio Dept of Chemistry
RECENT ADVANCES IN THE SCIENCES OF ELECTROCATALYSIS
Ernest Yedger 1 Nov 1980 60 p refs Presented at the Acheson Natl Meeting of the Electrochem Soc, Cleveland, Oct 1980
(Contract N00014-75-C-0953, NR Proj 359-451)
(AD-A095095, TR-52) Avail NTIS HC A04/MF A01 CSCL 07/4
This paper was presented as the Acheson Award lecture at the national meeting of the Electrochemical Society in October 1980 and surveys recent developments in the field of electrocatalysis, including work in the author's laboratory, most of which was carried out with the support of ONR The first part surveys techniques for obtaining information concerning electrode surfaces and particularly species adsorbed on such surfaces Special attention is focused on in-situ optical techniques (ultraviolet, visible, infrared, Raman) and the use of ex-situ surface physics techniques, the latter in conjunction with electrochemical studies of single crystal electrode surfaces The second part of the paper summarizes the present state of understanding of hydrogen and oxygen electrocatalysis GRA

N81-19259# Westinghouse Electric Corp, Concordville, Pa Combustion Turbine Systems Div
GAS TURBINE COMBUSTOR PERFORMANCE ON SYNTHETIC FUELS, VOLUME 1 Final Report
S M DeCorso, P W Pillsbury, G Bauserman, P R Mulik, and T. R Stein Nov 1980 68 p Sponsored by Electric Power Research Inst
(EPRI Proj. 989-1)
(EPRI-AP-1623-Vol-1) Avail NTIS HC A04/MF A01
The effects of burning coal and shale derived synthetic liquid in state of the art gas turbine combustors were determined Ten types of coal derived liquid fuels from the SRC-I, SRC-II, EDS, and H-Coal processes, and three hydrogenated shale oil fuels were utilized The combustion and emission performance of fuels other than petroleum was obtained Synthetic fuels burned approximately as expected from extrapolation of the combustion results obtained with petroleum fuels It was concluded that synthetic fuels with hydrogen content approximately 0 2% should be satisfactory for engines of current design All fuels were landled acceptably by standard fuel forwarding systems Emissions of CO, UHC and particulates were at about the same low levels as for petroleum distillate No. 2 analysis and correlation of NO sub x emissions and wall temperatures versus fuel properties were developed for prediction of these effects over a range of operating conditions DOE

N81-19266# Tennessee Univ, Tullahoma Energy Conversion Div
INVESTIGATION OF SWIRLING FLOW MIXING FOR APPLICATION IN AN MHD PULVERIZED COAL COMBUSTOR USING ISOTHERMAL MODELING M.S. Thesis Interim Report
William H Power May 1980 81 p refs
(Contract DE-AC02-79ET-10815)
(DOE/ET-10815/39) Avail NTIS HC A05/MF A01
A one fourth dimensionally scaled combustor model was developed for isothermal flow testing A comparison was made of cold flow tests using 3 swirler designs with a base case oxidizer injector design of perforated plated which demonstrated acceptable performance in the 4 lbm/sec MHD combustor The three swirlers that were evaluated were designed to allow a wide range of swirl intensity to be investigated The design criterion of the swirler was the swirl number which has been related to swirler geometry The results of the study showed that the swirlers that were tested fell short of the mixing characteristics displayed with the perforated plate base case oxidizer injector The data obtained with the cold flow model established that the actual swirl numbers of two of the swirlers were much lower than the design swirl numbers Recirculation zones were defined for all configurations that were tested, and a comparison of velocity profiles was made for the configurations DOE

N81-19402# Westinghouse Electric Corp, Athens Ga Distribution Transformer Div
OPTIMIZATION OF DISTIBUTION TRANSFORMER EFFICIENCY CHARACTERISTICS Final Report
H Braunstein 4 Dec 1979 428 p refs
(Contract DE-AC01-78ET-29298)
(DOE/ET-29298/T1) Avail NTIS HC A19/MF A01
A method for distribution transformer loss evaluation was derived The total levelized annual cost method was used and was extended to account properly for conditions of energy cost inflation, peak load growth and transformer changeout during the evaluation period The loss costs included were the no-load and load power losses, no-load and load reactive losses, and the energy cost of regulation The demand and energy components of loss costs were treated separately to account correctly for the diversity of load losses and energy cost inflation An analysis was performed to find what level of transformer loss yields the minimum total levelized annual cost for a given kVA rating and a given set of load and cost parameters Initial transformer costs as a function of no-load loss, load loss, and kVA were generated and used in the evaluation Both single and multiple efficiency designs were considered The total levelized annual costs of the two designs were compared In each case the multiple efficiency design was less costly A sensitivity analysis was performed to find the change in total levelized annual cost due to changes in the input parameters DOE

N81-19464# Department of Energy, Washington, D C Office of Transportation Programs
AUTOMOTIVE TECHNOLOGY DEVELOPMENT PROGRAM Annual Report to Congress, 30 Sep. 1980
30 Sep 1980 30 p
(DOE/CS-0069/1, AR-2) Avail NTIS HC A03/MF A01
Advanced gas turbine (AGT) engines, advanced Stirling

engines (ASE), vehicles and vehicle components to use with advanced, energy conserving automotive propulsion systems are described For the AGT, accomplishments included awarded contracts for AGT development, completed reference powertrain design, initiated design and fabrication of testing facilities, and testing of components For the ASE, components were tested up to 4000 h A turbocompound diesel engine completed 54,000 miles of road testing and showed a 5 percent fuel economy improvement Ten thousand miles of road testing a prototype Diesel Organic Rankine Bottoming Cycle in a heavy truck engine showed a 10 percent fuel economy gain Three hundred standard GSA vehicles, operated with a Controlled Speed Accessory Drive showed, a 6 to 8 percent fuel economy gain
DOE

N81-19466# United Technologies Corp, South Windsor, Conn Power Systems Div
HIGH-RELIABILITY GAS TURBINE COMBINED-CYCLE DEVELOPMENT PROGRAM, PHASE 1 Interim Report
F H Boenig and J H Lewis Oct 1980 544 p
(EPRI Proj 1187-1)
(EPRI-AP-1599-Vol-1) Avail' NTIS HC A23/MF A01

Phase 1 of a multiphase program leading to the development of a High Reliability Gas Turbine is described The engine would be used for base load, combined cycle applications Phase 1 was a conceptual design study of both the gas turbine itself and the full plant High reliability was reflected in a concept that features ruggedness and simplicity Ease of maintenance was provided through structural simplicity and modularization Component designs for the gas turbine were selected on the basis of a review of past operational experience and an in depth statistical reliability analysis Design details were then determined using trade off and parametric studies Reliability in the auxiliary and balance of plant waste heat recovery equipment was provided by redundancy of critical components as well as the use of proven equipment The final gas turbine design is a 107 MW, single shaft engine Projected availability for the final engine installed in a combined cycle plant is 92 percent DOE

N81-19495# Rockwell International Corp, Golden, Colo
WIND MACHINE FATIGUE ANALYSIS AND LIFE PREDICTION
C A Waldon Apr 1980 66 p refs
(Contract DE-AC04-76DP-03533)
(RFP-3135/3533/80-19) Avail NTIS HC A04/MF A01

A technique for measuring fatigue and predicting fatigue life for different wind regimes is described Presented are the techniques for locating high stress measuring points, obtaining data, using computer programs for calculating fatigue reduction, and finally predicting fatigue life DOE

N81-19497# Atomic Energy Commission Research Establishment, Riso (Denmark) Engineering Dept
STATIC DEFLECTION AND EIGENFREQUENCY ANALYSIS OF THE NIBE WIND TURBINE ROTORS. THEORETICAL BACKGROUND
Per Lundsager Feb 1980 31 p refs
(RISOE-M-2199, ISBN-87-550-0627-2, ISSN-0418-6435) Avail NTIS HC A03/MF A01

The theory of thin-walled multicell structures is used to calculate the cross-sectional properties of rotor blades The theory is developed for beams of inhomogeneous materials The blade is then modeled using the finite element method A stayed and a cantilevered blade, each consisting of a steel part and a glass fiber part, were analyzed Static deflection caused by extreme wind load along with the five to ten lowest eigenfrequencies were calculated Results deviated less than 15 percent from theoretical predictions Author (ESA)

N81-19561*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
IMPROVED THERMIONIC ENERGY CONVERTERS Patent Application
James F Morris, inventor (to NASA) Filed 19 Feb 1981 11 p
(NASA-Case-LEW-12443-1, US-Patent-Appl-SN-235797) Avail NTIS HC A02/MF A01 CSCL 10A

The efficiency of thermionic energy converters is improved by reducing plasma losses This is achieved by internal distribution of tiny shorted cesium diodes driven by the thermal gradient between the primary emitter and the collector The tiny, shorted diode distribution comprises protrusions of the emitter material from the main emitter face which contact the main collector face thermally but not electrically The main collector ends of the protrusions are separated from the main collector by a thin layer of insulation, such as aluminum oxide The diode effect will increase with the use of metals that adsorb cesium less readily for the main emitter ends of the tiny protrusions and metals that adsorb cesium more readily for the main collector ends of the protrusions Author

N81-19573*# Westinghouse Research and Development Center, Pittsburgh, Pa Research and Development Center
CELL MODULE AND FUEL CONDITIONER DEVELOPMENT Quarterly Report, Oct. - Dec. 1980
D Q Hoover, Jr Jan 1981 72 p refs
(Contracts DEN3-161, DE-AI01-80ET-17088)
(NASA-CR-165190, DOE/NASA/0161-6, Rept-80-9E6-MARED-R5, QR-5) Avail NTIS HC A04/MF A01 CSCL 10A

The test results of and post test analysis of Stack 559 are reported The design features and construction status of Stacks 560, 561, 562 and 563 are described The measurements of cell materials compressibility are rationalized and summarized and an explanation of their uses is given Preliminary results of a manifold material/coating survey are given The results of shift converter catalyst performance tests and reforming catalyst aging tests are reported State points for full load and part load operation of the fuel conditioning subsystem tabulated Work on the data base for the fuel conditioner ancillary subsystems is summarized T M

N81-19579# United Technologies Corp, South Windsor, Conn Power Systems Div
OPTIMIZATION OF CARBON-SUPPORTED PLATINUM CATALYSTS FOR FUEL CELL ELECTRODES Final Technical Report, Oct. 1979 - Oct. 1980
H R Kunz, F J Luczak, and G A Gruver Dec, 1980 51 p
(Contract DAAK70-79-C-0151, DA Proj 1L1-62733-AH-20)
(AD-A094714, PSD/UTC-FCR-2834) Avail NTIS HC A04/MF A01 CSCL 09/1

The objective of this program was to optimize electrodes using the carbon supported platinum catalysts at the operating conditions required for use in methanol air, phosphoric acid electrolyte, fuel cell power plants for U S Army applications Cathodes using proprietary, supported platinum catalyst, GSA-6, were fabricated with various degrees of hydrophobicity by adjusting the Teflon content in the catalyst layer and by changing the Teflon sintering cycle These cathodes were tested with supported platinum anodes in eighteen subscale cells at the Army power plant operating conditions for periods exceeding 5000 hours The optimum structure, on the basis of peak cell voltage, endurance stability, and manufacturing reproducibility was found to be one containing 47 5% Teflon A standard United proprietary anode catalyst showed satisfactory peak performance and endurance stability The cells with optimized electrodes exceeded the program 500 hour performance goal of 0 620V at 200 mA/cubic centimeters by 0 020V The 8000 hour performance goal of 0 590 V at 200 mA/cubic centimeters was projected to be exceeded by 0 036 to 0 038 V (based on over 4000 hours of operation GRA

N81-19581# Grumman Energy Systems, Inc, Bohemia, N Y
DEVELOPMENT OF AN 8 KILOWATT WIND TURBINE GENERATOR FOR RESIDENTIAL TYPE APPLICATIONS. PHASE 1: DESIGN AND ANALYSIS. VOLUME 2: TECHNICAL REPORT
F M Adler, L G Angeloff, P Henton, and P W King Mar 1980 92 p refs
(Contract DE-AC04-76DP-03533)

(RFP-3007-Vol-2) Avail NTIS HC A05/MF A01

The Windstream 25 (WS-25) WTG showed a good match with the requirements for the 8kW WTG The configuration overview, cost analysis, and design criteria are presented The parametric and trade off studies, as well as supporting analysis are included It was concluded that the WTG fell short of the original statement in only one area, that of achieving the target capital cost goal of $750/kW (1977 dollars) E D K

N81-19583# Catalytica Associates, Inc, Santa Clara, Calif

DISTILLATE FUEL-OIL PROCESSING FOR PHOSPHORIC ACID FUEL CELL POWER PLANTS

Feb 1980 141 p refs

(Contract DE-AC03-77ET-13323)

(DOE/ET-13323/2) Avail NTIS HC A07/MF A01

Efforts to develop distillate oil steam reforming processes are reviewed, and the applicability of these processes for integration with the fuel cell are discussed The development efforts can be grouped into the following processing approaches high temperature steam reforming, autothermal reforming, autothermal gasification, and ultra desulfurization followed by steam reforming Sulfur in the feed is a problem in the process development DOE

N81-19585# Zaininger Engineering Co, San Jose, Calif

WIND POWER GENERATION DYNAMIC IMPACTS ON ELECTRIC UTILITY SYSTEMS Final Report

H W Zaininger Nov 1980 88 p refs Sponsored by Electric Power Research Inst

(EPRI-AP-1614) Avail NTIS HC A05/MF A01

A primary application of windpower generation on utility systems is expected to be large clusters of megawatt scale wind turbine (WT) units connected to the utility transmission network and operated as part of the overall utility generation mix Wind fluctuations will result in minute to minute WT output variations Large penetrations of wind turbines may cause dynamic impacts such as severe system swings, excessive frequency excursions, or system instability These potential dynamic impacts, considering the integrated wind power plants, utility conventional generation, and transmission system, may limit the potential WT penetration and/or cause significant system operating restrictions An initial assessment of potential wind power generation dynamic impacts on utility systems from a global utility perspective was made Dynamic study of minute to minute ramping, frequency excursion, and short term transient stability was performed DOE

N81-19600# Rockwell International Corp, Golden, Colo Rocky Flats Wind System Program

SMALL WIND SYSTEMS TECHNOLOGY ASSESSMENT. STATE OF THE ART AND NEAR TERM GOALS

W S Bollmeier, C P Butterfield, R P Cingo, A C Hansen, D C Shepherd, and J L Tangler Feb 1980 84 p refs

(Contract DE-AC04-76DP-03533)

(RFP-3136/3533/80/18) Avail NTIS HC A05/MF A01

Commercially available small wind conversion systems (SWECS), DOE funded prototype SWECS, and possible second generation advanced concepts are assessed from the standpoint of several key Figures-of-Merit including cost of energy, dollars per pound, kilowatt hours per year per pound, and kilowatt hours per year per square meter of rotor area The reliability, performance, and installation and maintenance costs of these systems are also assessed It is concluded that current SWECS, while nearing the threshold of competitiveness with conventional energy sources, are inhibited from reaching their lowest cost potential by the use of off-the-shelf components, less than optimum rotor designs, and (in some cases) overly complicated control systems The comparisons of improved DOE prototypes and possible advanced concept SWECS shows that, in many size ranges, considerable reductions in energy cost can be achieved DOE

N81-19601# Rockwell International Corp, Golden, Colo

DUNLITE MODEL 81/002550 WIND TURBINE GENERATOR Final Test Report

K K Higashi Feb 1980 24 p refs

(Contract DE-AC04-76DP-03533)

(RFP-3149/3533/80-17) Avail NTIS HC A02/MF A01

The Dunlite Model 81/002550 Wind Turbine Generator has met all manufacturer claims of performance and reliability The machine operated satisfactorily in wind up to the manufacturer rated survival speed of 36 m/s (80 mph) In addition, the Dunlite operated in winds exceeding 22 5 m/s (50 mph) for eight hours without incurring damage Major damage to the machine occurred when wind speeds exceeded 40 3 m/s (90 mph) If winds of this velocity are expected, the manufacturer offers a high speed model of this wind turbine designed to withstand winds of 49 5 m/s (110 mph) Testing of the Dunlite designed to withstand winds of 49 5 m/s (110 mph) Testing of the Dunlight indicated that the machine is capable of producing its rated output of 2 kw at 11 m/s (25 mpj) DOE

N81-19604# California Univ, Livermore Lawrence Livermore Lab

CHARACTERISTICS OF ACIDIC ELECTROLYTE HYDROGEN-AIR FUEL BATTERIES (3)

H Tajima, M Sakurai, K Mizukami, and R Endo Dec 1980 11 p refs Transl into ENGLISH from a Japanese source

(Contract W-7405-eng-48)

(UCRL-Trans-11655) Avail NTIS HC A02/MF A01

The electrode characteristics of hydrogen air fuel batteries using phosphoric acid as the electrolyte using hydrogen reformed from natural gas were studied The effects of the impurities, particularly CO, contained in the gas were examined The effects of the carrier on poisoning of platinum by CO were studied using porous hydrogen electrodes in which carbon was used as the carrier and platform as the catalyst Also, the effects of the carrier on poisoning in cases where the catalyst used was a compound catalyst consisting of platinum and ruthenium, an oxidation catalyst of CO, are reported Results are presented and discussed DOE

N81-19619# Midwest Research Inst, Golden, Colo

MOD 2 WIND TURBINE DEVELOPMENT PROJECT

Oct 1980 24 p refs

(Contract DE-AC02-77CG-00178)

(SERI/SP-732-728) Avail NTIS HC A02/MF A01

A wind turbine to produce energy for less than 5 cents/kWh based on 1980 cost forecasts was designed The pricing method used to project the Mod 2 energy costs is the levelized fixed charge rate approach, generally accepted in the electric utility industry as a basis for relative ranking of energy alternatives This method derives a levelized energy price necessary to recover utility's purchasing, installing, owning, operating, and maintenance costs DOE

N81-19632# Westinghouse Electric Corp, Concordville, Pa Combustion Turbine Systems Div

HIGH-RELIABILITY GAS TURBINE COMBINED-CYCLE DEVELOPMENT PROGRAM, PHASE 1 Final Report

R E Strong, D J Amos, K H Eagle, and G L Francois Nov 1980 362 p

(EPRI Proj 1187-2)

(EPRI-AP-1598) Avail NTIS HC A16/MF A01

The development of a conceptual centerline design of a highly reliable combustion turbine combined cycle (CTCC) electric power generating plant having the twin design availability goals of 0.95 for the combustion turbine (CT) engine and 0 90 for the combined cycle (CC) plant, together with a CT engine starting reliability of 0 99 is described The work and results of six interrelated tasks are described (1) reliability analyses of current CT engines/plants, (2) eight CT unit/CC plant reliability design trade off studies, (3) high reliability CT unit and CC plant conceptual designs, (4) definition of technology research projects required to complete development of the conceptual CTCC plant, (5) analyses of the conceptual designs to determine what modifications are required for peaking duty application and use of lower grade petroleum and coal derived fuels, and (6) analyses of installed and current design CT engines/CC plants to determine what retrofit modifications and design changes can be made to economically improve their availability DOE

N81-19636# Aeronautical Research Inst of Sweden, Stockholm Structures Dept
STUDY OF WIND ENERGY CONVERSION SYSTEMS (WECS) IN A FARM AREA AND WECS SAFETY LIMIT REQUIREMENTS. MINUTES FROM EXPERT MEETING IEA, RESEARCH AND DEVELOPMENT WECS, ANNEX ONE, SUBTASK A1
Sigge Eggwertz Jun 1980 114 p refs Partly in ENGLISH and DUTCH Proceedings of IEA WECS Sub-Task A1 Meeting, Stockholm, 25 Feb 1980
(Contract SWEDBESD-5060-601)
(FFA-TN-HU-2218) Avail NTIS HC A06/MF A01

The proceedings include the description of two 2500 kW windmill prototypes, safety studies performed in several countries, and a contribution concerning fault tree analysis and load case recommendations The introduction of safe zone, the crack detection system, and operation during icing conditions are discussed Author (ESA)

N81-19637# Atomic Energy Commission Research Establishment, Riso (Denmark) Physics Dept
ANALYSIS OF DATA FROM THE GEDSER WIND TURBINE 1977 TO 1979
P Lundsager, S Frandsen, and C J Christensen Aug 1980 137 p refs Sponsored by Danish Ministry of Energy, Danish Electric Utilities and Danish Ship Research Lab
(RISOE-M-2242, ISBN-87-550-0693-0, ISSN-0418-6435) Avail NTIS HC A07/MF A01

Power characteristics based on 10 min averages, coherence between measurements of wind and electric power based on high speed scanning, drive train oscillations and structural response of the rotor on a 200 kW windmill are analyzed Theoretical models are developed and evaluated The measurements are summarized and a Gedser Wind turbine on Easter Island is compared to other Danish, Swedish and American experimental wind turbines Author (ESA)

N81-19639# Bonn Univ (West Germany) Inst fuer Physikalische Chemie
ELECTRODES AND DIAPHRAGMS FOR FUEL CELLS Final Report
Wolf Vielstich, Hermann Schladitz, and Ernst Knauf (Physikalische-Chemie Forschungslabor) Bundesministerium fuer Forschung und Technologie Dec 1979 50 p refs In GERMAN, ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-79-140, ISSN-0340-7608) Avail NTIS HC A03/MF A01

Polycrystalline electrodes made up of iron whiskers or nickel whiskers were investigated for application in water electrolysis and supporting material in fuel cells For fuel cell studies an asbestos polymer separator was used. Electrodes of different thickness and having layers of different catalysts were studied The best results were obtained with the nickel-whisker electrode which was used as an anode and a cathode in half cells The nickel-whisker electrode was sintered in an H2 atmosphere at 800 C, in 2mm thick, and has a porous volume of 70% Whisker electrodes had to be covered by platings when they were used in a glycol-air fuel cell The activity of these electrodes is strongly dependent on platinum layer formation and on the nature of the supporting material Author (ESA)

N81-19888# California Univ Berkeley Lawrence Berkeley Lab Accelerator and Fusion Research Div
TRANSPORT OF LOW ENERGY POSITIVE AND NEGATIVE ION BEAM BY PERMANENT MAGNETS
K N Leung, K W Ehlers and E B Hooper Jr Oct 1980 7 p refs Presented at the 2d Intern Symp on the Prod and Neutralization of Negative Hydrogen Ions and Beams, Upton N Y, 6-10 Oct 1980
(Contract W-7405-eng-48)
(LBL-11636) Avail NTIS HC A02/MF A01

An experimental investigation of low energy ion beam guiding by a surface magnetic field generated by samarium cobalt magnets has been performed It was found that magnets arranged in a multi-ring cusp configuration produced the best beam transport efficiency in agreement with calculation of the charged particle trajectories for this particular magnet arrangement This geometry is predicted to yield no distortion in the phase space of the beam The effect is proportional to charge squared and is therefore independent of the sign of the charge of the particle being transported DOE

N81-19920*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
THERMIONIC ENERGY CONVERSION (TEC) TOPPING THERMOELECTRICS
James F Morris 1981 16 p refs Proposed for presentation at Intern Conf on Plasma Sci, Sante Fe, N Mex, 18-20 May 1981, sponsored by IEEE
(Contract EC-77-A-31-1062)
(NASA-TM-81677, E-702, DOE/NASA/1062-8) Avail NTIS HC A02/MF A01 CSCL 20I

Performance expectations for thermionic and thermoelectric energy conversion systems are reviewed It is noted that internal radiation effects diminish thermoelectric figures of merit significantly at 1000 K and substantially at 2000 K, the effective thermal conductivity contribution of intrathermoelectric radiative dissipation increases with the third power of temperature It is argued that a consideration of thermoelectric power generation with high temperature heat sources should include utilization of thermionic energy conversion (TEC) topping thermoelectrics However TEC alone or TEC topping more efficient conversion systems like steam or gas turbines, combined cycles, or Stirling engines would be more desirable generally M G

N81-19932# Argonne National Lab Ill Engineering Div
TWO-DIMENSIONAL MHD GENERATOR MODEL
H K Geyer, R K Ahluwalia, and E D Doss Sep 1980 103 p refs
(Contract W-31-109-eng-38)
(ANL/MHD-80-11) Avail NTIS HC A06/MF A01

A steady state two dimensional MHD generator code, GEN, is presented The code solves the equations of conservation of mass, momentum and energy, using a Von Mises transformation and a local linearization of the equations By splitting the source terms into a part proportional to the axial pressure gradient and a part independent of the gradient the pressure distribution along the channel is easily obtained to satisfy various criteria Thus the code can run effectively in both design modes where the channel geometry is determined and analysis modes where the geometry is previously known The code also employs a mixing length concept for turbulent flows Cebeci and Chang's wall roughness model, and an extension of that model to the effective thermal diffusivities Results on code validation as well as comparisons of skin friction and Stanton number calculations with experimental results are presented DOE

N81-20037# Aeronautical Research Inst of Sweden, Stockholm
THE VELOCITY INDUCED BY THE WAKE OF A WIND TURBINE IN A SHEAR LAYER, INCLUDING GROUND EFFECT
Bo C A Johansson Jun 1980 42 p refs
(FFA-133, ISSN-SW-0081-5640) Avail NTIS HC A03/MF A01

A theory for the calculation of the velocity field induced by the wake of a horizontal axis wind turbine in a wind shear layer and in the vicinity of a plane ground surface, when the force distribution of the turbine is known, is developed The turbine is approximated by a disk area of continuous distributions of thrust and force parallel to the disk plane. Its wake is represented by a semi-infinite cylinder of distributed vorticity. A numerical example is calculated and distributions of velocity normal to the disk plane and ground effect influences are shown. The theory is based on assumptions strictly valid only for small perturbations of the undisturbed flow. Author (ESA)

N81-20356 Iowa State Univ of Science and Technology, Ames
WIND GENERATOR NETWORK METHODOLOGY AND ANALYSIS Ph.D. Thesis

James Neils Peterson 1980 115 p
Avail Univ. Microfilms Order No 8106042

The methodology of optimal allocation of wind generators was developed and was applied to actual hourly wind speed data from six known windy sites in the Pacific Northwest The problem of selecting the best combination of n wind generator sites out of a possible N sites (for n less than N) was also examined A hypothetical network consisting of three wind generator sites was investigated prior to analyzing the actual wind speed data By allocating unequal numbers of wind generators to the different sites, the total network power variance was minimized The number allocated to each site was determined as a function of the wind power mean values and variances at each site as well as the site to site correlations in wind power fluctuations Network power variances were given as a function of the correlation coefficient between two of the sites. A comparison was made of the network variances for both equal and optimal allocations of the wind generators at the three sites Dissert. Abstr

N81-20427# Westinghouse Electric Corp, Philadelphia, Pa
STEAM TURBINES FOR LARGE POWER OUTPUTS
W G Steltz *In* Von Karman Inst for Fluid Dyn Steam Turbines for Large Power Outputs 1980 70 p refs (For primary document see N81-20426 11-37)
Avail NTIS HC A25/MF A01

An historical perspective on steam turbine development is presented, then design considerations specific to steam turbine blade paths are reviewed Thermal to mechanical energy conversion in turbomachinery is described in terms of the force developed on the blading The magnitude of the force developed is determined by application of Newton laws Turbine stage designs and stage performance characteristics are given Low pressure turbine design is also addressed, including comparison of turbine flow field solutions using the matrix and streamline curvature techniques Physical chemistry turbine design aspects are discussed and blade to blade flow analysis techniques are summarized, emphasizing the conservation equations of mass and momentum Author (ESA)

N81-20434# United Technologies Corp, South Windsor, Conn Power Systems Div
HIGH-RELIABILITY GAS TURBINE COMBINED-CYCLE DEVELOPMENT PROGRAM, PHASE 1. VOLUME 2: APPENDIXES Interim Report
F H Boenig and J H Lewis Oct 1980 124 p refs Sponsored by Electric Power Research Inst
(EPRI Proj 1187-1)
(EPRI-AP-1599-Vol-2) Avail NTIS HC A06/MF A01

Results are presented of Phase 1 of a multiphase program leading to the development of a High Reliability Gas Turbine The engine would be used for the base load, combined cycle application starting in the mid-1980's The design, with primary emphasis on reliability, recognizes the need on the part of the electric utility user for high operating availability together with low maintenance cost to take full advantage of the capital cost and efficiency advantage offered by the combined cycle plant. Phase 1 was a conceptual design study of both the gas turbine itself and the full plant Component designs for the gas turbine were selected on the basis of a review of past operational experience and an in-depth statistical reliability analysis. Reliability in the auxiliary and balance of plant waste heat recovery equipment was provided by redundancy of critical components as well as the use of proven equipment DOE

N81-20440# General Electric Co, Schenectady, N Y. Gas Turbine Div
DEVELOPMENT OF HIGH-TEMPERATURE TURBINE SUBSYSTEM TECHNOLOGY TO A TECHNOLOGY READINESS STATUS, PHASE 2 Quarterly Report, Jul. - Sep. 1980
M W Horner Oct 1980 89 p
(Contracts DE-AC01-76ET-1034, EX-76-C-01-1806)
(FE-1806-96) Avail. NTIS HC A05/MF A01

Progress is reported in the design, development and testing of a high-temperature gas turbine for use in a combined-cycle power plant, with coal-derived fuel, at a firing temperature of 2600 F and with growth capability to 3000 F Topics covered include hot gas path development test, turbine simulation tests, shock tunnel tests, low-temperature, low Btu gas cleanup system tests, aerodynamics tests, motorized rig tests, and air turbine tests An update of gas-fueled and liquid-fueled combined power plant design is included DOE

N81-20543*# National Aeronautics and Space Administration, Washington, D C.
LARGE WIND ENERGY CONVERTER: GROWIAN 3 MW Final Report
J. E. Feustel, S. Helm, and F Koerber Nov. 1980 90 p Transl into ENGLISH of "Grosse Windenergieanlage Growian 3 MW. Baureife Unterlagen fuer Grosse Windenergieanlage" Rept. ET 4088A Nuremberg, Nov. 1979 92 p Transl. by Kanner (Leo) Associates, Redwood City, Calif Original doc. prep by Maschinenfabrik Augsburg-Nuernberg A.G., Nuremberg
(Contract NASw-3199)
(NASA-TM-75404) Avail: NTIS HC A05/MF A01 CSCL 10A

The final report on the projected application of larger-scale wind turbine on the northern German coast is summarized. The designs of the tower, machinery housing, rotor, and rotor blades are described accompanied various construction materials are examined Rotor blade adjustment devices auxiliary and accessory equipment are examined A R H

N81-20564# Acres Shawinigan Ltd., Toronto (Ontario)
STUDY OF THE POTENTIAL FOR COGENERATION IN CANADA: INDUSTRIAL STEAM TURBINES. VOLUME 2: ECONOMIC POTENTIAL
Dec 1979 254 p
(NP-25187-Vol-2) Avail. NTIS (US Sales Only) HC A12/MF A01, DOE Depository Libraries

The economic potential, with the identification of the technical possibilities that could prove to be economically viable, for industrial cogeneration is discussed Emphasis is placed on the point of view of society as a whole and as well as on what may be thought of as the direct production costs of electric power generation. These are the elements of cost that would fall within the purview of an accountant and it omits the opportunity costs of non-market elements. Calculation methods and results of the social savings and price scenarios are presented. Specifically, information on the economic potential of cogeneration in Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia is detailed DOE

N81-20590# Fluidyne Engineering Corp, Minneapolis, Minn
MHD AIR HEATER DEVELOPMENT TECHNOLOGY Technical Progress Report, 1 Apr. - 30 Jun. 1980
Jul 1980 58 p refs
(Contract DE-AC01-80ET-15602)
(DOE/ET-15602/T2) Avail. NTIS HC A04/MF A01

Technology development for the directly-fired high temperature air heater (HTAH) for MHD power plants is described Three tasks are described (1) Materials selection, evaluation, and development the objective of this task is to continue development of ceramic materials technology for the directly fired HTAH, including compilation of materials data, materials selection for testing and design studies, materials property determination (2) Operability, performance, and materials testing the objectives are to demonstrate the technical feasibility of operating a directly fired HTAH (including both the heater matrix and valves), to continue obtaining information on life and corrosion resistance of HTAH materials, and to obtain design information for full scale studies and future design work. (3) Full scale design concepts DOE

N81-20901# Los Alamos Scientific Lab., N. Mex Laser Fusion Program Sect
INERTIAL FUSION PROGRAM Progress Report, 1 Jul. - 31 Dec. 1978

Roger B Perkins and Frederick Skoberne, comp Nov 1980 135 p refs
(Contract W-7405-eng-36)
(LA-7755-PR) Avail. NTIS HC A07/MF A01

Progress in the development of high energy short pulse CO2 laser systems for fusion research is reported. Improvements to a two-beam system, Gemini, are outlined and experimental results discussed. An eight-beam system, Helios, was fired successfully on target for the first time, and became the world's most powerful gas laser for laser fusion studies Work on Antares, a 100 to 200 TW target irradiation system, is summarized A baseline design for automatic centering of laser beams onto the various relay mirrors and the optical design of the Antares front end are discussed. The results of various fusion reactor studies are summarized, as well as investigations of synthetic-fuel production through application of fusion energy to hydrogen production by thermochemical water splitting. Studies on increased efficiency of energy extraction in CO2 lasers and on lifetimes of cryogenic pellets in a reactor environment are summarized, as well as the results of studies on pellet injection, tracking, and beam synchronization. DOE

N81-20958*# Garrett Corp., Phoenix, Ariz. Turbine Engine Co.
ANALYTICAL DESIGN OF AN ADVANCED RADIAL TURBINE Final Report, 1 Feb. 1979 - 1 Aug. 1980
Gerald D. Large, David G. Finger, and Charles G. Linder Feb. 1981 156 p refs
(Contracts DEN3-106; DE-AI01-77CS-51040)
(NASA-CR-165170; DOE/NASA/0106-1; Rept-31-1653) Avail: NTIS HC A08/MF A01 CSCL 13F

The aerodynamic and mechanical potential of a single stage ceramic radial inflow turbine was evaluated for a high temperature single stage automotive engine. The aerodynamic analysis utilizes a turbine system optimization technique to evaluate both radial and nonradial rotor blading. Selected turbine rotor configurations were evaluated mechanically with three dimensional finite element techniques. Results indicate that exceptionally high rotor tip speeds (2300 ft/sec) and performance potential are feasible with radial bladed rotors if the projected ceramic material properties are realized. Nonradial rotors reduced tip speed requirements (at constant turbine efficiency) but resulted in a lower cumulative probability of success due to higher blade and disk stresses. R.C.T.

N81-21080# AiResearch Mfg Co, Phoenix, Ariz
REGENEATIVE ENGINE ANALYSIS PROGRAM (REAP) Final Report, Oct. 1979 - May 1980
R W Heldenbrand and W S Miller Jan 1981 143 p
(Contract DAAK51-79-C-0057, DA Proj 1L1-62209-AH-76)
(AD-A096113, Rept-21-3668, USAAVRADCOM-TR-81-D-2) Avail NTIS HC A07/MF A01 CSCL 21/5

This report presents the results of a 7-month program to conduct a preliminary design analysis of a 500-SHP fuel-efficient regenerative turboshaft engine and to identify promising heat exchanger concepts for such engines A technology level consistent with that available in a 1980 demonstrator engine is assumed Ninety engine/heat exchanger configuration and cycle combinations were examined These included variations of compressor stage configuration, compressor pressure ratio, turbine design point inlet temperature, heat exchanger effectiveness, and heat-exchanger pressure loss These engine combinations were evaluated and screened on the basis of fuel economy, weight and cost, and several promising configurations were chosen for more detailed analysis The most promising of these was selected for preliminary design The study results indicate that an engine configuration with a cycle pressure ratio of 10 1, a turbine temperature of 2300 F, and a heat exchanger with an effectiveness of 0 70 is most suitable for the 1980 environment However, with fuel costs projected to increase, the analyses indicate that a tubular heat exchanger with an effectiveness approaching 0 80 would be more attractive GRA

N81-21207# Northwestern Univ, Evanston, Ill
BASIC RESEARCH ON CERAMIC MATERIALS FOR ENERGY STORAGE AND CONVERSION SYSTEMS Progress Report, 1 Dec. 1979 - 30 Nov. 1980
D H Whitmore Dec 1980 64 p refs
(Contract DE-AS02-76ER-02564)
(COO-2564-6) Avail. NTIS HC A04/MF A01

Appropriate experimental probes are utilized for measuring the movement of ionic and electronic charge carriers in ceramic materials suitable for solid electrolyte and electrode applications in high performance, secondary battery, and fuel cell systems Special emphasis is placed on developing (1) a better understanding of the effects of structure, impurities, and composition on charge carrier transport mechanisms in such materials, and (2) detailed knowledge of the kinetics and mechanisms in such materials, and (2) detailed knowledge of the kinetics and mechanism of reactions occurring (on a microscopic scale) at the electrode-electrolyte interfaces of energy storage and conversion systems DOE

N81-21298# New Mexico Univ, Albuquerque Coll of Engineering
VARIABLE SPEED CONSTANT FREQUENCY CONSTANT VOLTAGE ALTERNATOR Annual Report
W W Grannemann, C E Yang, and P H Seo Jul 1980 41 p refs
(Contract DE-AC01-79ET-29246)
(DOE/ET-29246-T1, EE-266(80)DOE-808-1) Avail NTIS HC A03/MF A01

A test alternator was operated with digital control of its output frequency for variable shaft speed The machine is a two pole alternator with power removed through slip rings The output frequency of the alternator is controlled by rotating the field by stepping through sixteen coils around the rotor Usually four coils are active at one time The rotating field in the stationary coils of the stator is controlled by microcircuits The control circuits are constructed with available low cost, low power integrated circuits (ICS) The test results from the first test alternator indicate the feasibility of using this type of alternator to convert available wind power directly to usable 60 hertz power DOE

N81-21308# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany) Inst fuer Technische Physik
CONSTRUCTION AND PROPERTIES OF A QUADRUPOLE MASS SPECTROMETER DEVICE, DEVELOPED FOR THE INVESTIGATION OF A THERMIONIC BARIUM-CESIUM-DIODE VAPOR ATMOSPHERE Ph.D. Thesis - Stuttgart Univ.
Dieter Mahr Mar 1979 110 p refs In GERMAN, ENGLISH summary Report will also be announced as translation (ESA-TT-701)
(DFVLR-FB-79-39) Avail NTIS HC A06/MF A01

Construction and operation characteristics of a thermionic converter, incorporating a measurement system which measures diode power output and simultaneously spectrographically analyzes the mixed vapor Ba Cs atmosphere of the thermionic diode are described Results of measurement analysis of current voltage characteristics of the diode and of respective vapor phase, gas composition in the diode quantitatively show the reciprocal action of the vapor components in a mixed vapor system Using this data, the atmospheric composition for optimum performance in terms of power output of the thermionic diode can be calculated Author (ESA)

N81-21533*# Mathtech, Inc, Arlington, Va
STUDY OF FUEL CELL ON-SITE, INTEGRATED ENERGY SYSTEMS IN RESIDENTIAL/COMMERCIAL APPLICATIONS Final Report
R A Wakefield, S Karamchetty, R H Rand, W S Ku, and V Tekumalla Oct 1980 310 p refs
(Contracts DEN3-89, DE-AI03-79ET-11272)
(NASA-CR-165144, DOE/NASA-0089-80/1, E-FC-002) Avail NTIS HC A14/MF A01 CSCL 10A

Three building applications were selected for a detailed study a low rise apartment building, a retail store, and a hospital

Building design data were then specified for each application, based on the design and construction of typical, actual buildings Finally, a computerized building loads analysis program was used to estimate hourly end use load profiles for each building Conventional and fuel cell based energy systems were designed and simulated for each building in each location Based on the results of a computer simulation of each energy system, levelized annual costs and annual energy consumptions were calculated for all systems T M

N81-21536*# Energy Research Corp , Danbury, Conn
TECHNOLOGY DEVELOPMENT FOR PHOSPHORIC ACID FUEL CELL POWERPLANT, PHASE 2 Quarterly Report
Larry Christner Mar 1980 74 p
(Contracts DEN3-67; DE-AL03-79ET-11272)
(NASA-CR-165317; DOE/NASA/0067-79-3, ERC-18, QR-6) Avail. NTIS HC A04/MF A01 CSCL 10A

The technology development for materials, cells, and reformers for on site integrated energy systems is described The carbonization of 25 cu cm, 350 cu cm, and 1200 cu cm cell test hardware was accomplished and the performance of 25 cu cm fuel cells was improved Electrochemical corrosion rates of graphite/phenolic resin composites in phosphoric acid were determined. Three cells (5 in by 15 in stacks) were operated for longer than 7000 hours Specified endurance stacks completed a total of 4000 hours An electrically heated reformer was tested and is to provide hydrogen for 23 cell fuel cell stack R C T

N81-21537*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
THE NASA-LERC WIND TURBINE SOUND PREDICTION CODE
Larry A Viterna 1981 10 p refs Presented at Second DOE/NASA Wind Turbine Dyn Workshop, Cleveland, 24-26 Feb 1981
(Contract DE-AI01-76ET-20366)
(NASA-TM-81737, DOE/NASA/20366-1, E-808) Avail NTIS HC A02/MF A01 CSCL 10B

Development of the wind turbine sound prediction code began as part of an effort understand and reduce the noise generated by Mod-1 Tone sound levels predicted with this code are in good agreement with measured data taken in the vicinity Mod-1 wind turbine (less than 2 rotor diameters) Comparison in the far field indicates that propagation effects due to terrain and atmospheric conditions may amplify the actual sound levels by 6 dB Parametric analysis using the code shows that the predominant contributors to Mod-1 rotor noise are (1) the velocity deficit in the wake of the support tower, (2) the high rotor speed, and (3) off-optimum operation S F

N81-21538*# United Technologies Research Center East Hartford, Conn
APPLICATIONS STUDY OF ADVANCED POWER GENERATION SYSTEMS UTILIZING COAL-DERIVED FUELS. VOLUME 1: EXECUTIVE SUMMARY Final Report
Fred L Robson Mar 1981 21 p
(Contract NAS8-33996)
(NASA-CR-161691, R81-9955343-9-Vol-1) Avail NTIS HC A02/MF A01 CSCL 10B

The technology status of phosphoric acid and molten carbon fuel cells, combined gas and steam turbine cycles, and magnetohydrodynamic energy conversion systems was assessed and the power performance of these systems when operating with medium-Btu fuel gas whether delivered by pipeline to the power plant or in an integrated mode in which the coal gasification process and power system are closely coupled as an overall power plant was evaluated Commercially available combined-cycle gas turbine systems can reach projected required performance levels for advanced systems using currently available technology The phosphoric acid fuel cell appears to be the next most likely candidate for commercialization On pipeline delivery, the systems efficiency ranges from 40 9% for the phosphoric acid fuel cell to 63% for the molten carbonate fuel cell system The efficiencies of the integrated power plants vary from approximately 39-40% for the combined cycle to 46-47% for the molden carbonate fuel cell systems Conventional coal-fired steam stations with flue-gas desulfurization have only 33-35% efficiency A R H

N81-21539*# United Technologies Research Center, East Hartford, Conn
APPLICATIONS STUDY OF ADVANCED POWER GENERATION SYSTEMS UTILIZING COAL-DERIVED FUELS, VOLUME 2 Final Report
Fred L Robson Mar 1981 402 p refs
(Contract NAS8-33996)
(NASA-CR-161692, R81-9955343-9-Vol-2) Avail NTIS HC A16/MF A01 CSCL 10B

Technology readiness and development trends are discussed for three advanced power generation systems combined cycle gas turbine, fuel cells, and magnetohydrodynamics Power plants using these technologies are described and their performance either utilizing a medium-Btu coal derived fuel supplied by pipeline from a large central coal gasification facility or integrated with a gasification facility for supplying medium-Btu fuel gas is assessed A R H

N81-21547*# Energy Research Corp , Danbury, Conn
TECHNOLOGY DEVELOPMENT FOR PHOSPHORIC ACID FUEL CELL POWERPLANT (PHASE 2) Quarterly Report
Larry Christner Dec 1979 52 p refs
(Contracts DEN3-67, DE-AI03-79ET-11272)
(NASA-CR-165316, DOE/NASA/0067-79/2, QR-5) Avail NTIS HC A04/MF A01 CSCL 10A

The status of technology for the manufacturing and testing of 1200 sq cm cell materials, components, and stacks for on-site integrated energy systems is assessed Topics covered include (1) preparation of thin layers of silicon carbide, (2) definition and control schemes for volume changes in phosphoric acid fuel cells, (3) preparation of low resin content graphite phenolic resin composites, (4) chemical corrosion of graphite-phenolic resin composites in hot phosphoric acid, (5) analysis of electrical resistance of composite materials for fuel cells, and (6) fuel cell performance and testing A R H

N81-21548*# Energy Research Corp , Danbury, Conn
TECHNOLOGY DEVELOPMENT FOR PHOSPHORIC ACID FUEL CELL POWERPLANT (PHASE 2) Quarterly Report
Larry Christner Mar 1980 75 p refs
(Contracts DEN3-67, DE-AI03-79ET-11272)
(NASA-CR-165317, DOE/NASA/0067-79/3, QR-6) Avail NTIS HC A04/MF A01 CSCL 10A

Progress is reported in the development of technology for materials, cell components, and reformers for on-site integrated energy systems Carbonization of 25 sq cm, 350 sq cm, and 1200 sq cm cell test hardware was accomplished The performance of 25 sq cm fuel cells was improved by using this material Electrochemical corrosion rates of graphite phenolic resin composites in phosphoric acid were determined Three cell, 5 in by 15 in stacks operated for more than 7,000 hours Specified endurance stacks completed 4,000 hours A electrically heated reformer to provide hydrogen for a 23 cell fuel cell stack was tested A R H

N81-21551# Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)
ENERGY PRODUCTION FROM WASTE HEAT BY MEANS OF ELASTOMERS OR MEMORY METALS
Lars Ljung May 1980 49 p refs In SWEDISH
(STU-79-6394) Avail NTIS HC A03/MF A01

Calculation of the energy of an ideal heat engine for a flow between waste water and cooling water was made Also the Brayton, Carnot and Rankine cycles were computed as well as the processes with nitinol or elastomers as converters It was shown that half the energy can be recovered by a nitinol heat engine which is comparable to or has better efficiency than the Rankine cycle The memory metal makes better use of the temperature difference than the Rankine cycle Elastomers or Gadolinium may be used to utilize energy at low waste heat temperatures DOE

N81-21552# Automation Industries, Inc, Silver Spring, Md Vitro Labs Div
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: MOULDER CORPORATION, WEST GREENWOOD, INDIANA Progress Report, Oct. 1979 - Apr. 1980
C Y Whitehead 1980 74 p refs
(Contract DE-AC01-79CS-30027)
(SOLAR/1001-80/14) Avail NTIS HC A04/MF A01
The performance of a single-family home which has 704 sq ft of air, flat-plate collectors and an 850 cu ft rock bin buried under the house is discussed The system was designed to contribute 84% of the space heating and 100% of the water heating Actual contributions were 17% of the hot water load and 21% of the space heating load Problems with the systems are described DOE

N81-21572# Los Alamos Scientific Lab, N Mex
PROSPECTS OF FUEL CELLS WITH ALKALINE, SOLID-POLYMER, AND SUPERACID ELECTROLYTES AS POWER SOURCES FOR ELECTRIC VEHICLES
S. Srinivasan 1981 38 p refs Presented at the Elec and Hybrid Vehicle Advanced Technol Seminar, Pasadena, Calif, 8-9 Dec 1980 Submitted for publication
(Contract W-7405-eng-36)
(LA-UR-81-293, CONF-801242-1) Avail NTIS HC A03/MF A01
The state of the art and expected progress with fuel cells using alternatives to phosphoric acid as the electrolyte, that is, alkaline, solid polymer, and superacid electrolytes is reviewed. Alkaline fuel cells are appealing because of the good performance at less than 1000 C and potential for finding nonnoble metal catalysts, but are handicapped by the fact that pure hydrogen will have to be stored and used as the fuel The solid polymer electrolyte fuel cell has the best prospect for attaining the highest power densities, which are important from the point of view of reducing cost, weight, and volume of the power plant. However, this type of fuel cell uses an expensive electrolyte membrane and has a difficult water management problem Enthusiasm is growing for the development of fuel cells using organic superacids as the electrolyte The bulk of the studies to date are with aqueous trifluoromethanesulfonic acid Electrode kinetics of the oxygen reduction action are sufficiently enhanced in the superacids as compared with phosphoric acid The noble metal content of the electrodes can be minimized and perhaps eliminated in fuel cells with such electrolytes DOE

N81-21578# Midwest Research Inst, Golden, Colo Solar Energy Research Inst
WIND ENERGY SYSTEMS INFORMATION USER STUDY
W W Belew, B L Wood, T L Marle, and C L Reinhardt Jan 1981 278 p refs
(Contracts DE-AC02-77CH-00178, EG-77-C-01-4042)
(SERI/TR-751-749) Avail NTIS HC A13/MF A01
The results of a series of telephone interviews with potential users of information on wind energy conversion are described. These interviews, part of a larger study covering nine different solar technologies, attempted to identify the type of information each distinctive group of information users needed, and the best way of getting information to that group Groups studied include, wind energy conversion system researchers, wind energy conversion system manufacturer representatives, wind energy conversion system distributors, wind turbine engineers, utility representatives, educators, county agents and extension service agents, and wind turbine owners DOE

N81-21581# Advanced Mechanical Technology, Inc, Newton, Mass
DESIGN AND DEVELOPMENT OF STIRLING ENGINES FOR STATIONARY POWER GENERATION APPLICATIONS IN THE 500 TO 3000 HORSEPOWER RANGE, VOLUME 1
Mark Schuetz, Joseph Gerstmann, Lawrence Hoagland, Walter Syniuta, Rolf Krisher, and Cyril Randall 15 Sep 1980 294 p refs
(Contract DE-AC02-79ET-15207)
(DOE/ET-15207/T2-Vol-1) Avail NTIS HC A13/MF A01
The conceptual design and associated cost estimates of a stationary Stirling engine capable of being fueled by a variety of heat sources are discussed with emphasis on coal firing The development and evaluation of conceptual designs are separated into two broad categories the A designs which represent the present state-of-the-art and which are demonstrable by 1985 with minimum technical risk, and the B designs which involve advanced technology and therefore would require significant research and development prior to demonstration and commercialization, but which may ultimately offer advantages in terms of lower cost, better performance, or higher reliability DOE

N81-21582# Aerojet Energy Conservation Co, Sacramento, Calif
IMPROVED LIQUID/SOLIDS HANDLING MODULE Final Report, 1 Sep. 1979 - 31 Oct. 1980
L K West 1980 65 p refs
(Contract DE-AC03-79ET-27193)
(DOE/ET-27193/T1, FR-2321 01) Avail NTIS HC A04/MF A01
A Mobile Liquid/Solids handling (L/S) unit was constructed that is the active element for a low cost Advanced Primary Geothermal Heat Exchanger (APEX), presently under development The L/S system incorporates two alternating hydrocyclone-accumulator tank combinations and an injection pump Sand particles are injected into the main flow and then separated and recirculated at capture efficiencies of greater than 99% The system was tested at varying flowrates, solids concentrations, and particle sizes to determine an optimum operating point DOE

N81-21592# Rosenblatt (M) and Son, Inc, New York
PRELIMINARY DESIGNS FOR MODULAR OTEC PLATFORMS' STATION-KEEPING SUBSYSTEMS, VOLUME 3 Final Report
29 Feb. 1980 176 p refs
(Contracts DE-AI01-77ET-20396; EG-77-A-29-1078)
(DOE/NOAA/OTEC-30-Vol-3, MRS-Rept-604206) Avail. NTIS HC A09/MF A01
The basic design assumptions, the technical approach followed, and the results of design iterations, reliability and performance analyses are given The summary cost estimates for each of the alternative SKSS concepts considered are given, and a time schedule for the recommended concept is provided The effects of varying some of the important parameters used in SKSS design on the performance and cost of the mooring system are investigated and results presented The tests required and other developmental recommendations in order to verify and confirm the basic design assumptions are discussed DOE

N81-21612# Argonne National Lab, Ill
STARFIRE: A COMMERCIAL TOKAMAK FUSION POWER PLANT STUDY, VOLUME 2
Sep 1980 863 p refs Prepared in cooperation with McDonnell Douglas Astronautics Co, St Louis, General Atomic Co, and Parsons (Ralph M) Co, Los Angeles
(Contract W-31-109-eng-38)
(ANL/FPP-80-1-Vol-2) Avail NTIS HC A99/MF A01
The construction of the plant and the balance of the plant design are discussed Radioactivity, heat transport and energy conversion, tritium systems, cryogenics, and instrumentation and control equipment are also discussed The maintenance and operation of the plant are described T M

N81-21626# Atomic Energy Commission Research Establishment, Riso (Denmark) Engineering Dept
INVESTIGATIONS OF STRUCTURAL DYNAMICS ON THE GEDSER WTG AND ON NEW DANISH WIND TURBINES
P Lundsager and C J Christensen Dec 1978 57 p refs Presented at 1st Meeting of Experts on Struc Dyn/IEA Implementary Agreement for Cooperation in the Develop of Large Scale Wind Energy Conversion Systems, Munich Oct 1978
(RISOE-M-2146, ISBN-87-550-0695-7 ISSN-0418-6435) Avail NTIS HC A04/MF A01
Structural dynamic analyses are reviewed for an existing wind turbine and two prototypes The upwind located rotors

have an inner part with a tubular steel beam and glass reeinforced plastic (GRP) shells and outer part of a spun GRP main spar with GRP shells Results from a conventional beam model are presented Structural and electrical output data from the operating turbine are summarized A comparison of the spectrum of the electrical power output and a power spectrum of the torque in the induction generator shaft is made with a mathematical model of the system Author (ESA)

N81-21629# Texas A&M Univ, College Station Dept of Chemistry
METAL CHELATE CATALYSTS FOR FUEL CELLS Annual Report
Minoru Tsutsui, Ronald Darby, Ralph White, Gilbert Albelo, Paul Deininger, and J Balliew Aug 1980 28 p
(Contract GRI-5014-363-0174)
(PB81-132953, GRI-79/0059) Avail NTIS HC A03/MF A01 CSCL 10B

An aromatic dialdehyde, 9,9-dimethyl-4,5-xanthene-dicaroxaldehyde, suitable for the synthesis of a stacked polymer of meso-tetraphenyl-porphyrin was synthesized in high yield From this, a dimer was formed The cobalt complex of this dimer, along with metal complexes of polymers of phthalocyanine and TAA were tested for catalytic activity for the reduction of oxygen The stacked dimer of TPP and the sheet polymer of TPP exhibited greater catalytic activity as the cobalt complexes than all other compounds tested with the exception of CoTAA GRA

N81-21632# Rensselaer Polytechnic Inst, Troy, N Y Dept of Mechanical Engineering
AERODYNAMIC CHARACTERISTICS OF THE TARP (TOROIDAL ACCELERATOR ROTOR PLATFORM) WIND ENERGY CONVERSION SYSTEM Final Report, 1978 - 1979
Robert E Duffy, Chris Jaran, and Charles Ungermann Feb 1980 72 p refs
(PB81-140675, NYSERDA-80-7) Avail NTIS HC A04/MF A01 CSCL 10A

Augmented wind energy conversion systems (WECS) are designed to increase the ambient wind velocity at the turbine blades The Toroidal Accelerator Rotor Platform (TARP) is an augmenting structure for use with horizontal axis WECS Its shape resembles that of a horizontally oriented wheel rim and is intended to be built into or retrofitted onto structures built for other purposes, which could increase the use of WECS in urban areas Variations of the basic TARP structure, about three feet in diameter, were tested in a wind tunnel to determine the optimum design The model system produced up to 4 5 times the power which the rotor and generator extracted without the TARP GRA

N81-21634# New York Univ, N Y Dept of Applied Science
THE LEBOST WIND TURBINE EXPERIMENTAL PROGRAM Progress Report, Sep. 1978 - May 1980
G Miller, M Hoffert, B Rugg, and D Corren May 1980 55 p refs
(PB81-141467, NYSERDA-80-16) Avail NTIS HC A04/MF A01 CSCL 10A

The Lebost Wind Turbine is unique in two respects it consists of a vertical axis turbine which is encased in a perforated hemispherical shroud which acts to focus or concentrate ambient wind energy onto the turbine blades, and the turbine's shaft is directly coupled to a water twister/heat brake assembly which heats water via direct mechanical agitation, in other words, the turbine can be used to heat water without electrical interface Results of an experimental field test/evaluation of a 20 foot diameter lebost turbine are reported GRA

N81-21635# Aeronautical Research Inst of Sweden, Stockholm
THE VELOCITY INDUCED BY THE WAKE OF A WIND TURBINE IN A SHEAR LAYER, INCLUDING GROUND EFFECT
Bo C A Johansson Jun 1980 43 p
(PB81-142184, FFA-133) Avail NTIS HC A03/MF A01 CSCL 10A

A theory is developed for the calculation of the velocity field induced by the wake of a horizontal axis wind turbine in a wind shear layer and in the vicinity of a plane ground surface, when the force distribution of the turbine is known The turbine is approximated by a disk area of continuous distributions of thrust and force parallel to the disk plane Its wake is represented by a semi-infinite cylinder of distributed vorticity A numerical example is calculated The theory is based upon assumptions strictly valid only for small perturbations of the undisturbed flow However, the results may have a wider range of applicability GRA

N81-21916# Ohio State Univ, Columbus
PRELIMINARY DESIGN PROCEDURE FOR HIGH POWER DENSITY MHD GENERATORS Final Report, Jun. - Aug. 1978
Pau-Chang Lu Wright-Patterson AFB, Ohio AFWAL Dec 1980 37 p refs Sponsored by AF
(AD-A096144, AFWAL-TR-80-2077) Avail NTIS HC A03/MF A01 CSCL 10/2

The steps to be taken in the preliminary design of a high power density, segmented Faraday or diagonal, open-cycle MHD generator are formalized The recommended design procedure starts with the optimum choice of the combustion chamber pressure The optimization is based on a semi-empirical expression of the effective power density, developed by Smith and Nichols As a result of this optimization, a rough estimate of the realizable power density is made, which yields the order of magnitude of the transverse dimension keeping the length-to-diameter ratio around 10 for the desired power output It is then recommended that the area variation and length be calculated on the basis of an isothermal core flow This preliminary shape of the duct will serve as the base on which alterations can be made by a computer to accommodate wall effects in detailed design stage that will follow the preliminary consideration An alternate route for the preliminary design is provided by using scaling laws Starting with a well-designed generator which is demonstrably high in power density, dynamically similar units can be produced using these laws The laws are developed following the modern procedure of ordering Numerical examples are provided to illustrate the procedure GRA

N81-21919# McElroy (Ralph) Co, Austin, Tex
MAX PLANCK INSTITUTE FOR PLASMA PHYSICS
Brigitte Rothlein and Uwe Schumacher Aug 1980 114 p
Transl into ENGLISH of "Max-Planck-Gesellschaft zur Foerderund der Wissenschaften Berichte und Mitteilungen" Max Planck Inst for Plasma Physics, West Germany, 1977 Prepared for LASL
(Contract W-7405-eng-36)
(LA-tr-80-25) Avail NTIS HC A06/MF A01

Some insight is provided on the various problems that are encountered on the road towards development of a fusion reactor Several important experimental systems are described as well as solutions to the difficult physical and technical problems RCT

N81-21920# Gilbert/Commonwealth, Reading, Pa
OXYGEN-ENRICHED AIR PRODUCTION FOR MHD POWER PLANTS
May 1980 46 p refs
(Contracts DE-AC01-77ET-11058, ET-78-C-01-2683)
(DOE/ET-11058/T4) Avail NTIS HC A03/MF A01

An analysis of several of the cryogenic air separation process cycle variations and compression schemes designed to minimize net system power requirements for supplying pressurized, oxygen-enriched air to the combustor of a 2000 MWt (coal input) baseload MHD power plant is presented DOE

06

ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION

Includes transport of fuels by pipelines, tubes, etc., microwave power transmission, and superconducting power transmission

A81-21295 **Excitation of a superconducting strip resonator by a system of point Josephson contacts.** S. I. Zub (Akademiia Nauk Ukrainskoi SSR, Fiziko-Tekhnicheskii Institut Nizkikh Temperatur, Kharkov, Ukrainian SSR) *(Zhurnal Tekhnicheskoi Fiziki,* vol. 50, Apr 1980, p 854-857.) *Soviet Physics - Technical Physics,* vol. 25, Apr 1980, p 512-514. Translation.

The amplitudes of oscillations generated by a system of spot contacts in a strip resonator, the shape of the current-voltage curve, and the emitted power are studied as a function of the resonator and contact system parameters. It is shown that the effective excitation of a superconducting strip resonator by a system of Josephson point contacts is possible within a range of well defined relations between the parameters of the resonator and the contact system. The conditions for optimum excitation are formulated V L

A81-24831 * **SPS design with solid-state transmitter.** M. Ettenberg (RCA David Sarnoff Research Center, Princeton, N.J.). *Space Solar Power Review,* vol 1, no. 4, 1980, p 345-349. Contract No NAS9-15755

The replacement of the klystrons in the microwave transmitter in the SPS leads to major redesign considerations Several curves are presented which show the interrelations of the major design features, the power level and the transmitting and receiving dimensions. (Author)

A81-24832 **Workshop on the microwave power transmission system for the solar power satellite - Review panel report.** J. W Freeman and W. L Wilson (Rice University, Houston, Tex.). *Space Solar Power Review,* vol. 1, no. 4, 1980, p. 361-371.

A81-25011 **An assessment of the use of chemical reaction systems for thermal energy transport.** H T Chen, J. C Hsu, W. R. Mounce (Gilbert Associates, Inc, Reading, Pa), and F D Nankani (Ecolaire, Inc., Malvern, Pa.). In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 2. Washington, D C, Hemisphere Publishing Corp., 1981, p. 553-565. Research sponsored by the Electric Power Research Institute and U.S Department of Energy

A means of transporting thermal energy by employing waste heat to drive a reversible reaction in the endothermic direction is described Most promising among the chemical combinations available for this effect is the Benzene/Cyclohexane system, whose reaction products would be transported via pipeline to another location where the reversible reaction would be conducted to release the exothermic heat of reaction for its intended application. These reaction products are then returned to the heat source by means of another pipeline, thereby completing the cycle. Details on the conceptual design are presented together with life cycle cost analysis and possible market potential O.C

A81-30109 # **Energy transport system optimization for distributed networks of solar collectors** J S. Barnhart (Battelle Pacific Northwest Laboratories, Richland, Wash) *American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, Houston, Tex, Jan 18-22, 1981, Paper 81-SOL-1* 8 p 10 refs Members, $2.00, nonmembers, $4.00 Research supported by the U.S. Department of Energy

A computer program, ETRANS, was developed for optimizing the piping network associated with distributed networks of solar collectors ETRANS employs frequently cited field layouts for dish and trough collectors Using discrete piping component sizes, ETRANS determines realistic estimates of operating expenses and capital item costs This paper describes the field layouts employed, the system performance calculations, and the costing methodology Also included are results of preliminary simulations of dish and trough collector fields over a range of sizes and operating parameters (Author)

N81-16533*# National Aeronautics and Space Administration Lyndon B Johnson Space Center, Houston, Tex
SOLAR POWER SATELLITE MICROWAVE TRANSMISSION AND RECEPTION
R H Dietz Dec 1980 271 p refs Workshop held in Houston, Tex, 15-18 Jan 1980
(NASA-CP-2141, S-503) Avail NTIS HC A16/MF A01 CSCL 10A

Numerous analytical and experimental investigations related to SPS microwave power transmission and reception are reported Aspects discussed include system performance, phase control, power amplifiers, radiating elements, rectenna, solid state configurations, and planned program activities

N81-16535*# Boeing Aerospace Co, Seattle, Wash
SOLAR POWER SATELLITE MICROWAVE POWER TRANSMISSION SYSTEM DESCRIPTION EXECUTIVE SUMMARY
Gordon R Woodcock *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 18-27
Avail NTIS HC A16/MF A01 CSCL 10A

The history of the concept of microwave power beaming to Earth is reviewed with emphasis on transmission frequency selection. Constraints on the system power level results from (1) required rejection of waste heat resulting from inefficiencies in the cover conversion of dc electric power to microwave power, (2) the rf power intensity in the ionosphere, and (3) the effect of sidelobe level on aperture illumination factors Transmitter arrangement, the power distribution system, attitude control, subarrays, waveguides, and alignment are discussed A R H

N81-16536*# Raytheon Co, Lexington, Mass
INITIAL MPTS STUDY RESULTS: DESIGN CONSIDERATIONS AND ISSUES
Owen E Maynard *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 28-32
Avail NTIS HC A16/MF A01 CSCL 10A

One of the key issues identified during investigations of microwave power transmission systems from 1965 to 1976 was the need to assure that the billions of diodes on ground-based rectennas are sufficiently reliable to support long life times of approximately 30 years Major systems studies conducted focused on waveguides, radio frequency interference and biological considerations, the relationship between performance, weight, and cost, risk assessment, crossed field directional amplifier noise, a 48 kW klystron, effects of the environment on propagation and phase control, rectenna technology, a rationale for the ground power density region, alternate technologies for orbital assembly, ionospheric effects and phase control, and reception conversion (rf to dc collector/converter) A R H

N81-16537*# Boeing Aerospace Co, Seattle, Wash
SPS LARGE ARRAY SIMULATION
S Rathjen, B R Sperber, and E J Nalos *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 33-42

Avail NTIS HC A16/MF A01 CSCL 10A

Three types of computer simulations were developed to study the SPS microwave power transmission system (MPTS) The radially symmetric array simulation is low cost and is utilized to investigate general overall characteristics of the spacetenna at the array level only 'Tiltmain', a subarray level simulation program, is used to study the effects of system errors which modify the

far-field pattern The most recently designed program, 'Modmain,' takes the detail of simulation down to the RF module level and so to date is the closest numerical model of the reference design
A R H

N81-16543*# Lockheed Engineering and Management Services Co., Inc., Houston, Tex
DESIGN AND BREADBOARD EVALUATION OF THE SPS REFERENCE PHASE CONTROL SYSTEM CONCEPT
P M Hopkins and V R Rao *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 119-128 refs

(Contract NAS9-15800)
Avail NTIS HC A16/MF A01 CSCL 10A

The total breadboard system includes one pilot transmitter, one pilot receiver, nine phase distribution units, and two power transponders With this complement of equipment, segments of a typical phase distribution system can be assembled to facilitate the evaluation of significant system parameters The achievable accuracy of a large phase distribution system, the sensitivity of the system to parameter variations, and the limitations of commercially available components in such applications were determined
T M

N81-16544*# LinCom Corp., Los Angeles, Calif
COHERENT MULTIPLE TONE TECHNIQUE FOR GROUND BASED SPS CONTROL
C M Chie *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1981 p 129-138 refs
(Contract NAS9-15782)
Avail NTIS HC A16/MF A01

The control system achieves beam forming by adjusting the phases of the individual transmitters onboard the solar power satellite To specify the correct amount of adjustments, the phases of the power beams from each individual transmitter arriving at the rectenna center are measured, the appropriate corrections determined, and then relayed to the satellite The functional operation of the ground based phase control concept is summarized The key issues examined were measurement waveform design and selection, phase measurement pilot reference design and selection, uplink phase corrections command link format and design, and system synchronization techniques
T M

N81-16545*# Novar Electronics Corp., Barberton, Ohio
AN INTERFEROMETER-BASED PHASE CONTROL SYSTEM
James H Ott and James S Rice *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1981 p 139-140 refs

Avail NTIS HC A16/MF A01 CSCL 10A

A system for focusing and pointing the SPS power beam is discussed The system is ground based and closed loop One receiving antenna is required on earth A conventional uplinked data channel transmits an 8-bit phase error correction back to the SPS for sequential calibration of each power module Beam pointing resolution is better than 140 meters at the rectenna
T.M

N81-16546*# Novar Electronics Corp., Barberton, Ohio.
A SONIC SATELLITE POWER SYSTEM MICROWAVE POWER TRANSMISSION SIMULATION
James H Ott and James S Rice *In* NASA Johnson Space Center Solar Power Microwave Transmission and Reception Dec 1981 p 141-143 ref

Avail NTIS HC A16/MF A01 CSCL 10A

A simulator is described which generates and transmits a beam of audible sound energy mathematically similar to the SPS power beam The simulator provides a laboratory means for analysis of ground based closed loop SPS phase control and of ionospheric effects on the SPS microwave power beam
Author

N81-16547*# Boeing Aerospace Co., Seattle, Wash
SPS PHASE CONTROL STUDIES
W W Lund, B R Sperber, and G R Woodcock *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 144-153

Avail NTIS HC A16/MF A01 CSCL 10A

To properly point and form the satellite microwave power beam, the outputs of the power amplifiers in the transmitting array must be phased in a specific and coherent fashion A retrodirective CW phase conjugating system using a spread spectrum uplink signal and a reference phase signal that is distributed via fiber optics, was selected as the control system for SPS The design details are presented and applications of the system are discussed
T M

N81-16548*# Boeing Aerospace Co., Seattle, Wash
SPS FIBER OPTIC LINK ASSESSMENT
T O Lindsay and E J Nalos *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1981 p 154-158

Avail NTIS HC A16/MF A01 CSCL 10A

Fiber optic technology was tentatively selected in the SPS baseline design to transmit a stable phase reference throughout microwave array Over a hundred thousand microwave modules are electronically steered by the phase reference signal to form the power beam at the ground receiving station The initially selected IF distribution frequency of the phase reference signal was at 980 MHz or a submultiple of it Fiber optics offers some significant advantages in view of the SPS application Optical transmission is highly immune to EMI/RFI, which is expected to be severe when considering the low distribution power In addition, there are savings in both mass, physical size, and potentially in cost
T M

N81-16549*# Rockwell International Corp., Pittsburgh, Pa
IONOSPHERIC EFFECTS IN ACTIVE RETRODIRECTIVE ARRAY AND MITIGATING SYSTEM DESIGN
A K Nandi and C Y Tomita *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 159-168 refs

Avail. NTIS HC A16/MF A01 CSCL 10A

The operation of an active retrodirective array (ARA) in an ionospheric environment (that is either stationary or slowly-varying) was examined The restrictions imposed on the pilot signal structure as a result of such operation were analyzed A 3 tone pilot beam system was defined which first estimates the total electron content along paths of interest and then utilizes this information to aid the phase conjugator so that correct beam pointing can be achieved
T M

N81-16550*# Boeing Aerospace Co., Seattle, Wash
HIGH EFFICIENCY SPS KLYSTRON DESIGN
E. J Nalos *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 175-184
Avail NTIS HC A16/MF A01

The most likely compact configuration to realize both high efficiency and high gain (approx 40 dB) is a 5-6 cavity design focused by an electromagnet The basic klystron efficiency cannot be expected to exceed 70-75% without collector depression It was estimated that the net benefit of a 5 stage collector over a 2 stage collector is between 1 5 and 3 5 kW per tube. A modulating anode is incorporated in the design to enable rapid shutoff of the beam current in case the r f drive should be removed
T M

N81-16551*# Varian Associates, Palo Alto, Calif
HIGH EFFICIENCY KLYSTRON FOR THE SPS APPLICATION
A D LaRue *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 185-205 refs
Avail NTIS HC A16/MF A01 CSCL 10A

The enhancement of klystron efficiency through the use of collector depression, that is by recovering energy from the spent electron beam after microwave amplification, was investigated Design considerations included noise, harmonics, cooling, and service life The mod anode, to be employed for beam control, and the depressed collector, used in spent electron beam energy recovery, are described T M

N81-16552*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
ANALYTICAL INVESTIGATION OF EFFICIENCY AND PERFORMANCE LIMITS IN KLYSTRON AMPLIFIERS USING MULTIDIMENSIONAL COMPUTER PROGRAMS; MULTI-STAGE DEPRESSED COLLECTORS; AND THERMIONIC CATHODE LIFE STUDIES
H G Kosmahl *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 206-213 refs
Avail NTIS HC A16/MF A01 CSCL 10A
An extensive parametric investigation was performed of the extraction of energy in output gaps of klystron amplifiers, using 3-D computer programs Due to complexity of the program which used a hydrodynamic, axially and radially deformable disk ring model and the resulting long computing time, the investigation was limited to the output gap, by far the most important and difficult part of the klystron interaction Results show that, for a confined flow focused beam throughout the penultimate cavity, radial velocities remain very small and the beam is highly laminar It was, therefore, concluded that possible errors resulting from treating only the output cavity in 3-D would remain small T M

N81-16553*# Raytheon Co, Lexington, Mass
THE ADAPTING OF THE CROSSED-FIELD DIRECTIONAL AMPLIFIER TO THE REQUIREMENTS OF THE SPS Progress Report
William C Brown *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 214-222 refs

Avail NTIS HC A16/MF A01 CSCL 10A
Progress was reviewed with special emphasis upon recent developments in controlling the phase and amplitude of the microwave power output, and a perceived architecture for its placement in the subarray Development in the critical pivotal areas of noise, potential cathode life, and efficiency are reported T M

N81-16554*# Boeing Aerospace Co, Seattle, Wash
REFERENCE SYSTEM DESCRIPTION
C D Lunden, W W Lund, and E J Nalos *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 227-234

Avail NTIS HC A16/MF A01 CSCL 10A
Several candidate antenna configurations are evaluated in terms of weight, efficiency, and structural rigidity Particular emphasis is given to the waveguide slot array and its application to solar power satellites SPS The electronic aspects of an SPS specific waveguide slot array are defined R C T

N81-16562*# Jet Propulsion Lab, California Inst of Tech, Pasadena Telecommunications Science and Engineering Div
RECTENNA ARRAY MEASUREMENT RESULTS
Richard M Dickinson *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 307-318 refs

Avail NTIS HC A16/MF A01 CSCL 10A
The measured performance characteristics of a rectenna array are reviewed and compared to the performance of a single element It is shown that the performance may be extrapolated from the individual element to that of the collection of elements Techniques for current and voltage combining are demonstrated The array performance as a function of various operating parameters is characterized and techniques for overvoltage protection and automatic fault clearing in the array are demonstrated A method for detecting failed elements also exists Instrumentation for deriving performance effectiveness is described Measured harmonic radiation patterns and fundamental frequency scattered patterns for a low level illumination rectenna array are presented M G

N81-16563*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
MICROWAVE POWER TRANSMISSION SYSTEM WORKSHOP, SESSION ON SOLID STATE
Woolsey Finnell *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 323-327
Avail NTIS HC A16/MF A01 CSCL 10A
The development of solid state technology for solar power satellite systems is briefly addressed The economic advantages of solid state based systems are listed along with some conclusions and issues regarding specific design concepts M G

N81-16564*# Boeing Aerospace Co, Seattle, Wash
MODIFIED REFERENCE SPS WITH SOLID STATE TRANSMITTING ANTENNA
G R Woodcock and B R Sperber *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 328-337

Avail NTIS HC A16/MF A01 CSCL 10A
The development of solid state microwave power amplifiers for a solar power satellite transmitting antenna is discussed State-of-the-art power-added efficiency, gain, and single device power of various microwave solid state devices are compared The GaAs field effect transistors and the Si-bipolar transistors appear potentially feasible for solar power satellite use The integration of solid state devices into antenna array elements is examined and issues concerning antenna integration and consequent satellite configurations are examined M G

N81-16565*# Boeing Aerospace Co, Seattle, Wash
SPS SOLID STATE ANTENNA POWER COMBINER
G W Fitzsimmons *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 338-347
Avail NTIS HC A16/MF A01 CSCL 10A
A concept for a solar power satellite antenna power combiner which utilizes solid state dc-rf converters is described To avoid the power combining losses associated with circuit hybrids it is proposed that the power from multiple solid state amplifiers be combined by direct coupling of each amplifier's output to the radiating antenna structure The selected power-combining antenna consists of a printed (metalized) microstrip circuit on a ceramic type dielectric substrate which is backed by a shallow lightweight aluminum cavity which sums the power of four microwave sources The antenna behaves like two one-half wavelength slot-line antennas coupled together via their common cavity structure A significant feature of the antenna configuration selected is that the radiated energy is summed to yield a single radiated output phase which represents the average insertion phase of the four power amplifiers This energy may be sampled and, by comparison with the input signal, one can phase error correct to maintain the insertion phase of all solid state power combining modules at exactly the same value This insures that the insertion phase of each SPS power combining antenna module is identical An experiment verification program is described M G

N81-16566*# Rockwell International Corp, Pittsburgh, Pa
SOLID STATE SYSTEMS CONCEPTS
J K Schroeder *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 348-357
Avail NTIS HC A16/MF A01 CSCL 10A
Two prototype solid state phased array systems concepts for potential use in the Solar Power Satellite are described, the end-mounted and the sandwich systems In both concepts, the beam is centered on the rectenna by means of phase conjugation

of a pilot signal emanating from the ground In the end-mounted system 36-watt amplifiers are mounted on the ground-plane, whereas in the sandwich the amplifiers are elevated to the dipoles, and their waste heat is dissipated by beryllium oxide discs The feed lines are underneath the ground-plane, and a coaxial transmission line is carried all the way to the amplifier input Also discussed is solid state amplifier development. M G

N81-16567*# RCA Corp, Princeton, N J
SOLID STATE DEVICE TECHNOLOGY FOR SOLAR POWER SATELLITE
David G Weir *In* NASA Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 358-366
Avail· NTIS HC A16/MF A01 CSCL 10A

The feasibility of using solid state elements in the solar power satellite transmitter system is addressed Recommendations are given concerning device types, the antenna modules, and the overall antenna system. The development of a solid state amplifier based on GaAs field effect transistor devices is also described M.G

N81-16568*# Raytheon Co, Waltham, Mass Equipment Div.
SOLID STATE SANDWICH CONCEPT: DESIGNS, CONSIDERATIONS AND ISSUES Progress Report
Owen E Maynard *In* NASA. Johnson Space Center Solar Power Satellite Microwave Transmission and Reception Dec 1980 p 367-372
Avail NTIS HC A16/MF A01 CSCL 10A

Progress in analysis and design of solid state approaches to the solar power satellite microwave power transmission system is reviewed with special emphasis on the Sandwich concept and the issues of maintenance of low junction temperatures for amplifiers to assure acceptable lifetime Ten specific issues or considerations are discussed and their resolution or status is presented Author

N81-16584*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
DEVELOPMENT AND TESTING OF HEAT TRANSPORT FLUIDS FOR USE IN ACTIVE SOLAR HEATING AND COOLING SYSTEMS Final Report
John C Parker Jan 1981 43 p Sponsored in cooperation with DOE Prepared in part by Houston Chemical Corp, Corpus Christi, Tex
(Contract NAS8-32255)
(NASA-TM-82395) Avail NTIS HC A03/MF A01 CSCL 10B

Work on heat transport fluids for use with active solar heating and cooling systems is described Program objectives and how they were accomplished including problems encountered during testing are discussed S F

N81-17288# McMullen (John J) Associates, Inc, New York, N Y
NATIONAL PETROLEUM RESERVE - ALASKA: MARINE TRANSPORTATION SYSTEM ANALYSIS Final Report
M D MacPherson Oct 1980 486 p refs
(Contract DO-A01-78-00-3082; MA Proj 2791-4072)
(PB81-105041, Rept-2791/4072-F, MA-RD-940-81013) Avail NTIS HC A21/MF A01 CSCL 21D

The analysis provides the transportation cost for icebreaking and ice strengthened surface tankers and LNG carriers over a range of ship sizes and propulsion power levels and for submarine tankers for each of a number of routes from four loading ports in the Arctic to discharge ports on the East and Gulf Coasts of the United States. The report includes discussions of the technical factors related to Arctic ship construction and operation, ice technology, and the environmental and institutional factors which must be included in an evaluation of an Arctic marine transportation system. GRA

N81-17289# McMullen (John J.) Associates, Inc., New York, N.Y.
NATIONAL PETROLEUM RESERVE - ALASKA: MARINE TRANSPORTATION SYSTEM ANALYSIS. EXECUTIVE SUMMARY
M. D. Macpherson Oct. 1980 25 p
(Contract DO-A01-78-00-3082; MA Proj. 2791-4072)
(PB81-105033; MA-RD-940-81012) Avail. NTIS HC A02/MF A01 CSCL 21D

The analysis provides the transportation costs for icebreaking and ice-strengthened surface tankers and LNG carriers over a range of ship sizes and propulsion power levels and for submarine tankers for each of a number of routes from four loading ports in the Arctic to discharge ports on the East and Gulf Coasts of the United States The technical factors related to Arctic ship construction and operation, ice technology, and the environmental and institutional factors which must be included in an evaluation of an Arctic marine transportation system are discussed. GRA

N81-17290# Katzen (Raphael) Associates, Cincinnati, Ohio
FARM AND COOPERATIVE ALCOHOL PLANT STUDY: TECHNICAL AND ECONOMIC ASSESSMENT AS A COMMERCIAL VENTURE
Oct 1980 241 p
(Contract NAFC-T-16076549)
(PB81-112641, NAFC-80-08) Avail NTIS HC A11/MF A01 CSCL 21D

The production of motor fuel grade (MFG) ethanol in small plants was evaluated. Several parameters were explored as follows. six agricultural locations, three plant sizes of 90,000, 300,000, and 900,000 gallons per year, five feedstocks, ethanol proof levels of 190 and 199; and by-product distillers grains either as whole stillage or prepared by various degrees of drying. Plants were assumed to operate only 6000 hours per year (sugar beets only 3600 hours) because of limitations of time (or beet feedstock) Locally, available boiler fuels were chosen Simplified processing was identified so as to be realistically within the time and experience available to a farmer operator. GRA

N81-18962# California Univ, Livermore Lawrence Livermore Lab
INDUCTIVE ENERGY TRANSFER IN TRANSPORTATION
Carl E Walter and John D Salisbury 8 Nov 1980 31 p refs Presented at the 4th UMTA R and D Conf., Norfolk, Va, 21 Nov 1980
(Contract W-7405-eng-48)
(UCRL-85141, CONF-801162-1) Avail. NTIS HC A03/MF A01

The use of inductive energy transfer system in transportation systems is reviewed An inductive energy transfer system has an energy source consisting of insulated electrical conductors placed beneath the surface of a roadway, aligned with the direction of travel and fed a relatively high alternating current A vehicle, e g, car, bus, or rail car, is equipped with a coil suitably wrapped around magnetic material and suspended beneath the vehicle a short distance from the road surface The ac in the energy source produces an alternating magnetic field which couples inductively with the power pickup coil under the vehicle and results in vehicle propulsion Investigations of this energy source for transportation in the US have considered the effect of its use on petroleum fuel consumption, system design and operation factors, adaptability to city and highway transportation, vehicle performance, and assessment of the application of this system to automobiles carrying auxiliary battery power equipment These studies are briefly described DOE

N81-19459*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
ADVANCED CONTINUOUSLY VARIABLE TRANSMISSIONS FOR ELECTRIC AND HYBRID VEHICLES
Stuart H Loewenthal 1980 29 p refs Presented at Electric and Hybrid Vehicle Advanced Vehicle Seminar, Pasadena, Calif, 8-9 Dec 1980
(Contract DE-AI01-77CS-51044)
(NASA-TM-81718, DOE/NASA/51044-17 E-752) Avail NTIS HC A03/MF A01 CSCL 13F

A brief survey of past and present continuously variable transmissions (CVT) which are potentially suitable for application

with electric and hybrid vehicles is presented Discussion of general transmission requirements and benefits attainable with a CVT for electric vehicle use is given The arrangement and function of several specific CVT concepts are cited along with their current development status Lastly, the results of preliminary design studies conducted under a NASA contract for DOE on four CVT concepts for use in advanced electric vehicles are reviewed
Author

N81-19602# Rice Univ, Houston, Tex
SATELLITE POWER SYSTEM (SPS). RECTENNA SITING: AVAILABILITY AND DISTRIBUTION OF NOMINALLY ELIGIBLE SITES
Nov 1980 283 p refs
(Contract DE-AC01-79ER-10041)
(DOE/ER-10041/T10) Avail NTIS HC A13/MF A01

Siting of 60 ground receiving stations (rectennas) for the SPS may pose a problem due to the large area per rectenna (15,000 hectares, 38,000 acres) and numerous siting constraints This study analyzes areas potentially eligible for rectenna sites by mapping, at a national scale, those conditions which would preclude rectenna construction. These exclusion variables which reflect restricted lands, topography, safety, national policy and electromagnetic (microwave) effects, were computer encoded and tabulated Subsequent analysis of the nine electric power planning regions that make up the contiguous states indicate an apparently adequate number of nominally eligible sites in all regions in comparison to projected electrical generation
DOE

N81-20328*# Novar Electronics Corp, Barberton, Ohio
A THEORETICAL STUDY OF MICROWAVE BEAM ABSORPTION BY A RECTENNA Final Report
James H. Ott, James S Rice, and Donald C Thorn 14 Jan 1981 133 p refs
(Contract NAS9-16055)
(NASA-CR-160921) Avail. NTIS HC A07/MF A01 CSCL 20N

The theoretical operational parameters for the workable satellite power system were examined The system requirements for efficient transmission and reception of an environmentally benign microwave beam were determined

N81-20329*# Novar Electronics Corp, Barberton, Ohio
A THEORETICAL STUDY OF MICROWAVE BEAM ABSORPTION BY A RECTENNA, INTRODUCTION
In its A Theoret Study of Microwave Beam Absorption by a Rectenna 14 Jan 1981 p 1-36 refs

Avail NTIS HC A07/MF A01 CSCL 20N

The conditions required for a large rectenna array (i e, reference design) to absorb nearly 100% of transmitted energy were studied Desigh parameters including element spacing, and the manner in which these affect scatter were formulated Amplitutes and directions of scatter and development of strategies for mitigation were also investigated The effects on rectenna behavior of external factors such as weather and aircraft overflights were determined
R C T

N81-20335*# Novar Electronics Corp, Barberton, Ohio
TROPOSPHERIC/IONOSPHERIC TRANSMISSION TESTS
In its A Theoret Study of Microwave Beam Absorption by a Rectenna 14 Jan 1981 p 111-118

Avail NTIS HC A07/MF A01 CSCL 20N

Four tests are described which are designed to evaluate the magnitude, type, and frequency of occurence of amplitude and phase variations in the solar power satellite power (SPS) beam as seen by the rectenna Particular attention is given to the degree of deviation in the propagation observed under two conditions unique to the SPS monochromaticity, and smallness of the effective aperture of individual rectenna element dipoles
R C.T

N81-20495*# Jet Propulsion Lab, California Inst of Tech, Pasadena
CRITICAL PARAMETERS FOR COARSE COAL UNDERGROUND SLURRY HAULAGE SYSTEMS
David P Maynard 15 Feb 1981 53 p refs
(Contracts NAS7-100, DE-AI01-76ET-12548)
(NASA-CR-164075, JPL-Pub-81-11, DOE/ET-12548/4) Avail NTIS HC A04/MF A01 CSCL 08I

Factors are identified which must be considered in meeting the requirements of a transportation system for conveying, in a pipeline, the coal mined by a continuous mining machine to a storage location neat the mine entrance or to a coal preparation plant located near the surface For successful operation, the slurry haulage the system should be designed to operated in the turbulent flow regime at a flow rate at least 30% greater than the deposition velocity (slurry flow rate at which the solid particles tend to settle in the pipe) The capacity of the haulage system should be compatible with the projected coal output Partical size, solid concentration, density, and viscosity of the suspension are if importance as well as the selection of the pumps, pipes, and valves The parameters with the greatest effect on system performance ar flow velocity, pressure coal particle size, and solids concentration
A R H

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07
ENERGY STORAGE

Includes flywheels heat storage, underground air storage, compressed air, storage batteries, and electric hybrid vehicles

A81-19897 # **Efficiency of energy storage in photochemical electron transfer reactions (Effektivnost' zapasaniia energii v foto-khimicheskikh reaktsiiakh perenosa elektrona).** V E Korobov and A. K. Chibisov (Akademiia Nauk SSSR, Institut Geokhimii i Analiticheskoi Khimii, Moscow, USSR). *Akademiia Nauk SSSR, Doklady,* vol 255, no 3, 1980, p 634-637 6 refs In Russian.

The present work analyzes the efficiency of energy storage in the products (states) of photochemical reactions involving electron transfers Attention is given to a reversible photochemical reaction where electron transfer occurs between an excited donor and an acceptor in a liquid (polar) solution Optimal conditions for energy storage are derived for potential use in solar energy conversion and storage applications T.M.

A81-20491 **Use of the ATOP system in the control of an off-peak storage device.** C B Winn and K Robinson (Colorado State University, Fort Collins, Colo). In Conference on Decision and Control, and Symposium on Adaptive Processes, 18th, Fort Lauderdale, Fla., December 12-14, 1979, Proceedings Volume 2 Piscataway, N.J , Institute of Electrical and Electronics Engineers, Inc , 1979, p 911-916 7 refs Contract No. EG-77-S-02-4519.

An off-peak heat storage device has been installed in Colorado State University Solar House I The device may be charged with heat during the off-peak hours (10 pm to 6 am) and the heat may then be utilized as required in order to satisfy the building heating requirements that are not satisfied by the solar system. A methodology for determining the amount of heat required to be stored and for determining an optimal charging sequence is presented in this paper Quantitative results obtained during the past heating season (1978-79) are also presented (Author)

A81-21114 # **Enhanced heat conduction in phase-change thermal energy storage devices** R H Henze (Spectron Development Laboratories, Inc, Costa Mesa, Calif) and J A C Humphrey (California, University, Berkeley, Calif) *American Society of Mechanical Engineers, Winter Annual Meeting, Chicago, Ill , Nov 16-21, 1980, Paper 80-WA/HT-45* 12 p 25 refs Members, $2 00, nonmembers, $4 00 Research supported by the University of California

Phase-change energy storage devices have an inherent disadvantage due to the insulating properties of the phase-change materials (PCMs) used Such systems are difficult to analyze theoretically due to the nonlinearities of the moving liquid-solid interface and the presence of natural convection as shown by several recent numerical and experimental investigations Previous work has been unsuccessful in predicting the performance of phase-change devices in the presence of fins and natural convection. This study presents a simplified numerical model based on a quasi-linear, transient, thin fin equation, which predicts the fraction of melted PCM, and the shape of the liquid-solid interface as a function of time with sufficient accuracy for engineering purposes Experimental results are compared in dimensionless form with model predictions, and show fairly good agreement To achieve high heat transfer rates with a fixed amount of PCM and metal fin material, the model indicates that melting the PCM in a pure conduction mode with closely spaced thin fins is preferable to melting PCM with thicker fins spaced further apart, even in the presence of natural convection (Author)

A81-21391 **Thermal energy storage and regeneration.** F W Schmidt (Pennsylvania State University, University Park, Pa) and A. J. Willmott (York, University, Heslington, England). Washington, D C , Hemisphere Publishing Corp , 1981 368 p 132 refs $35 50

The book examines the heat storage medium as a solid through whose channels or pores passes the heat-transporting fluid, usually a gas The 'single blow problem' where the gas passes through heat-storing packing in one direction is analyzed, followed by consideration of thermal regenerators, heat storage exchangers, and packed beds Finally, correlations are made between the estimates of the heat transfer coefficients and the pressure drop in storage units Topics covered include finite conductivity models, parallel-flow regenerators, counterflow regenerators, and heat storage design optimization A T

A81-21740 **Prediction model for fatigue crack growth in windmill structures** R W Finger (Boeing Engineering Co , Seattle, Wash) In Effect of load spectrum variables on fatigue crack initiation and propagation, Proceedings of the Symposium, San Francisco, Calif., May 21, 1979 Philadelphia, Pa , American Society for Testing and Materials, 1980, p 185-199, Discussion, p 199-204. 7 refs

A spectrum load test program was conducted with uniaxially loaded surface flaw specimens to produce data on the effects of differences in load spectra on crack growth behavior to provide the 30-yr life for the Boeing Mod II windmill Four load spectra were tested applicable to Grade A ASTM steels used in parent and weld metal stress relieved structures The stress relieved components require an analysis of tensile loads only, since the negative minimum stress/maximum stress (R) ratios were considered the same as the R ratios of zero A T

A81-23439 **An evaluation of superconducting magnetic energy storage** B M Winer and J Nicol (Arthur D Little, Inc , Cambridge, Mass) *(Applied Superconductivity Conference, Santa Fe, N Mex., Sept 29-Oct 2, 1980.) IEEE Transactions on Magnetics,* vol MAG-17, Jan 1981, p. 336-339 5 refs U.S Department of Energy Contract No. 31-109-38-4914

A Superconducting Magnetic Energy Storage (SMES) system will accept and regenerate ac electrical energy very efficiently It can therefore compete economically with alternative advanced storage technologies if (1) the unit's cost and efficiency are within the presently expected ranges, and (2) the unit is sized so as to perform the same task as the alternatives and no more Present conceptual SMES designs are unlikely to meet the electric utilities' needs for reliability, maintainability and system protection, and the environmental impact of the magnetic field may be large Consequently, the uncertainties associated with the costs of an acceptable SMES system are large. Their reduction should be the principal goal of future component and system research (Author)

A81-23440 **Superconductive energy storage for diurnal use by electric utilities.** R. W Boom (Wisconsin, University, Madison, Wis) *(Applied Superconductivity Conference, Santa Fe, N Mex , Sept. 29-Oct 2, 1980.) IEEE Transactions on Magnetics,* vol. MAG-17, Jan 1981, p 340-343 9 refs Research supported by the Wisconsin Electric Utility Research Foundation, Contract No DE-AC02-76ET-26602

A summary report of a five-year study of superconductive energy storage for electric utility systems is presented Conceptual designs over that period have all been for one layer solenoids of aluminum-NbTi composite conductors cooled to 1 8 K in superfluid helium The solenoids are mounted underground in bedrock in one or more tunnels. The two preferred designs in 1980 are a 15 tunnel solenoid arranged in a circular pattern and a large radius single tunnel solenoid The electrical energy storage efficiency in all cases is 95 to 96%. (Author)

A81-23450 **Design of the BPA superconducting 30 MJ energy storage coil.** E Hoffmann, J. Alcorn, W. Chen, Y -H Hsu, J Purcell (General Atomic Co , San Diego, Calif), and R. Schermer (General Atomic Co , San Diego, Calif , California, University, Los Alamos, N Mex) *(Applied Superconductivity Conference, Santa Fe,* N Mex, Sept 29-Oct 2, 1980) *IEEE Transactions on Magnetics*, vol MAG-17, Jan 1981, p 521-524 DOE Order 4-X9-6722H-1

The design of a superconducting magnetic energy storage coil is presented. The purpose of this coil is to stabilize low frequency power oscillations in long high voltage ac power lines The practical application for this specific coil will be the installation in the Pacific intertie between Washington State and Los Angeles, California. The guiding principles of the design are performance, fabrication economy and reliability (Author)

A81-24995 **Physical and chemical processes for latent heat storage at low temperatures** F Reiter (Commission of the European Communities, Joint Research Centre, Ispra, Italy) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 1 Washington, D C., Hemisphere Publishing Corp, 1981, p 341-365 17 refs

A81-24996 **PCM thermal energy storage in cylindrical containers of various configurations** A S Mujumdar, F A Ashraf, A S Menon, and M E Weber (McGill University, Sainte-Anne de Bellevue, Quebec, Canada) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 1 Washington, D C, Hemisphere Publishing Corp, 1981, p 367-382 12 refs

Experimental measurements are reported for the time variation of surface-averaged rate of heat storage during melting in single, thin-walled cylindrical containers of copper filled with a commercially available paraffin wax For the wax used the enthalpy-temperature curve was obtained using a differential scanning calorimeter according to the ASTM method Three lengths and three equivalent diameters of plain circular, plain square and internally partitioned cylinders were studied for their heat storage characteristics The heat transfer measurements revealed the importance of natural convection during melting The effects of cylinder geometry and temperature of the external fluid on instantaneous and integral heat storage rate were examined experimentally (Author)

A81-24997 **A cycle life tester for the long-term stability of phase change materials for thermal energy storage.** A Grandbois, J Sangster, and J R Paris (Ecole Polytechnique, Montreal, Canada) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 1 Washington, D C, Hemisphere Publishing Corp, 1981, p 383-388 15 refs

Testing of the long-term stability of large quantities of a phase-change material, intended for low potential thermal storage of solar energy, was conducted on an accelerated freeze-thaw cycle apparatus with microcomputer monitoring Such testing is considered essential for the selection of optimal substances among a wide variety of candidates O C

A81-25002 **High temperature storage for a wind energy system** R Ramshaw and D Bowman (Waterloo, University, Waterloo, Ontario, Canada) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 1 Washington, D C, Hemisphere Publishing Corp, 1981, p 453-458

A81-25003 **Assessment of high-head turbomachinery for underground pumped hydroelectric storage plants** S W Tam, A A Frigo, and C A Blomquist (Argonne National Laboratory, Argonne, Ill) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 1 Washington, D C, Hemisphere Publishing Corp, 1981, p 459-474 9 refs Research supported by the U S Department of Energy

Underground pumped hydroelectric storage (UPHS) plants equipped with advanced reversible pump turbines for operating heads from 500 to 1500 m are discussed in terms of cost efficiency It is found that the use of advanced machinery shifts the minimum UPHS plant cost to the head range 1200-1500 m. The interactive effects of pump-turbine efficiencies and charge/discharge ratios are examined It is shown that under certain conditions, a pump-turbine option with a higher charge-discharge ratio at the expense of somewhat lower operating efficiency may be desirable V.L

A81-25019 **Ammoniated salt heat pump.** W R Haas, F J Jaeger, and T J Giordano (Martin Marietta Aerospace, Denver, Colo) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 2 Washington, D C, Hemisphere Publishing Corp., 1981, p 651-663

A thermochemical heat pump/energy storage system using liquid ammoniate salts is described The system, which can be used for space heating or cooling, provides energy storage for both functions The bulk of the energy is stored as chemical energy and thus can be stored indefinitely The system is well suited to use with a solar energy source or industrial waste heat Several liquid ammoniates are identified and the critical properties of three of the most promising are presented Results of small scale (5000 Btu) system tests are discussed and a design concept for a prototype system is given This system represents a significant improvement over the system using solid ammoniates investigated previously because of the increase in heat transfer rates (5 to 60 Btu/hr sq ft F) and the resulting reduction in heat exchanger size As a result the concept shows promise of being cost competitive with conventional systems (Author)

A81-25035 **A 'two-tank' seasonal storage concept for solar space heating of buildings** B K Cha, D W Connor, and R O Mueller (Argonne National Laboratory, Argonne, Ill) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10 13, 1979 Volume 2 Washington, D C, Hemisphere Publishing Corp, 1981, p 851-863 7 refs. Research supported by the U S Department of Energy

This paper presents an analysis of a novel 'two-tank' water storage system, consisting of a large primary water tank for seasonal storage of solar energy plus a much smaller secondary water tank for storage of solar energy collected during the heating season The system offers the advantages of high collection efficiency during the early stages of the heating season, a period when the temperature of the primary tank is generally high By preferentially drawing energy from the small secondary tank to meet load, its temperature can be kept well below that of the larger primary tank, thereby providing a lower-temperature source for collector inlet fluid The resulting improvement in annual system efficiency through the addition of a small secondary tank is found to be substantial - for the site considered in the paper (Madison, Wisconsin), the relative percentage gain in annual performance is in the range of 10 to 20% A simple computer model permits accurate hour-by-hour transient simulation of thermal performance over a yearly cycle The paper presents results of detailed simulations of collectors and storage sizing and design trade-offs for solar energy systems supplying 90% to 100% of annual heating load requirements (Author)

A81-25322 **Plastic-bonded electrodes for nickel-cadmium accumulators. V - Influence of the current collector and mechanical compression on the current carrying capability of the nickel oxide electrode** V Koudelka, J Malik (Prazska Akumulatorka, Mlada Boleslav, Czechoslovakia), J Mrha, I Krejci (Ceskoslovenska Akademie Ved, Ustav Fyzikalni Chemie a Elektrochemie, Prague, Czechoslovakia), and M Spinka (Vysoke Uceni Technicke, Brno, Czechoslovakia) *Journal of Power Sources*, vol 6, Apr 1981, p 161-169 11 refs

A81-25323 **Testing the mechanical characteristics of sintered nickel battery plaque and their relationship to nickel electrode performance.** D H Fritts (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) *Journal of Power Sources*, vol. 6, Apr 1981, p 171-184 8 refs USAF-supported research

The performance of nickel battery electrodes was investigated in respect of sintered nickel plaque mechanical characteristics It was found that plaque fatigue, sensitivity, and hardness directly affect nickel electrode performance In addition, wide variations in these parameters was found in various manufactured plaques It is concluded that quality control procedures should include testing for fatigue and hardness Recommended procedures for performing these tests are presented (Author)

A81-25565 **Electrochemical power sources· Primary and secondary batteries** Edited by M Barak Stevenage, Herts, England, Peter Peregrinus, Ltd (IEE Energy Series 1), 1980 512 p $53

The development of voltaic cells is reviewed, and the basic thermodynamic and kinetic principles underlying the conversion of chemical to electrical energy are outlined The most popular types of primary batteries for civilian use are discussed including the neutral air-depolarized, Leclanche, and alkaline manganese batteries as well as the mercury/zinc and silver/zinc button cell assemblies The two basic groups of rechargeable storage batteries are described, and cells operating at ambient temperatures with an inorganic electrolyte are surveyed Molten salt electrolytes and solid ion-permeable diaphragms in high-temperature cells are also considered L S

A81-25566 **Alkaline storage batteries.** U Falk (NIFE Jungner AB, Oskarshamn, Sweden) In Electrochemical power sources Primary and secondary batteries Stevenage, Herts, England, Peter Peregrinus, Ltd, 1980, p 325-402 74 refs

Alkaline storage batteries are characterized in terms of their reaction mechanisms, manufacturing processes, performance characteristics, and applications The batteries discussed include the nickel/cadmium pocket type cell, the nickel cadmium sintered plate cell, the nickel/iron battery, the silver/zinc and silver/cadmium assemblies, and the nickel/zinc battery The basic technical data for the alkaline systems are provided along with 1978 estimates of worldwide battery production L S

A81-25567 **High temperature batteries** J L Sudworth In Electrochemical power sources Primary and secondary batteries Stevenage, Herts, England, Peter Peregrinus, Ltd, 1980, p 403-463 91 refs

Molten salt electrolyte cells with lithium as the negative electrode and solid electrolyte cells with sodium as the negative electrode are described with attention to cell design and performance The thermal management of the cells is reviewed, and a comparison of the battery systems is provided Emphasis is given to the discussion of the lithium-aluminum/iron sulfide cell and the sodium/sulfur cell with beta alumina electrolyte L S

A81-25568 **Room temperature cells with solid electrolytes.** T Dickinson (Newcastle-upon-Tyne, University, Newcastle-upon-Tyne, England) In Electrochemical power sources Primary and secondary batteries Stevenage, Herts, England, Peter Peregrinus, Ltd, 1980, p 464-481 46 refs

Solid-state room-temperature primary cell systems with cationic conductor electrolytes are reviewed Silver ion, copper ion, proton, sodium ion, fluoride ion, and lithium ion conductor cell systems are discussed with attention to the electrolytes and power sources The advantages of solid-state systems include durability, the ability to operate over wide temperature ranges, ease of miniaturization, and long shelf and operating lives. L S

A81-25603 **Flat-plate tubular TP lead-acid traction battery for electric vehicles.** P Ruetschi (Leclanché, S A, Yverdon, Switzerland) In Progress in batteries and solar cells Volume 3 Cleveland, Ohio, JEC Press, Inc, 1980, p 187-189

A81-25604 **An automobile manufacturer and his electric vehicle** M Sugitani (Daihatsu Motor Co, Ltd, Ikeda, Osaka, Japan) In Progress in batteries and solar cells Volume 3 Cleveland, Ohio, JEC Press, Inc, 1980, p 206-208

A new engine-electric hybrid system is reviewed In the system, the revolutions and torque of the drive train are picked up as electrical signals, and are compared with the electrical signals from the accelerator pedal The computer then calculates the most suitable driving conditions and gives operational commands to the engine and/or the electrical motors The output power from the engine and/or electrical motors is converted to an electrical signal, and returns to the computer as a feedback signal for correcting operational commands L S

A81-25605 **GE's electric powered automobile** R H Guess (General Electric Co, Schenectady, N Y) In Progress in batteries and solar cells Volume 3 Cleveland, Ohio, JEC Press, Inc, 1980, p 210-212

The Centennial Electric all-electric subcompact vehicle is described A series dc motor, front mounted in the vehicle, drives the front wheels using a fixed-ratio transmission Speed is controlled up to 3000 rpm at 30 miles per hour by a thyristor controller which adjusts the voltage applied to the armature of the motor and limits battery current to 360 amperes Higher speed up to 60 miles per hour is obtained by connecting a resistor in parallel with the field for field weakening The estimated life-cycle cost of the vehicle for its projected 10 year life is less than 18 cents per mile in 1979 dollars, L S

A81-25606 **Recent developments in secondary batteries for use in electric vehicles** B W Burrows (Gould Laboratories, Rolling Meadows, Ill) In Progress in batteries and solar cells Volume 3 Cleveland, Ohio, JEC Press, Inc, 1980, p 220-222

The status of the Department of Energy's electric vehicle battery program is reviewed The near-term, ambient temperature batteries discussed include the lead-acid, nickel-zinc, and nickel-iron batteries The advanced batteries such as the lithium-metal sulfide and sodium-sulfur batteries are seen as longer-term, potentially low-cost alternatives that will have substantially higher performance than the near-term batteries The performance goals of the battery program to be achieved by 1985 are listed L S

A81-25607 **Zinc-bromine batteries for energy storage** J E Oxley (Gould Laboratories, Rolling Meadows, Ill) In Progress in batteries and solar cells Volume 3 Cleveland, Ohio, JEC Press, Inc, 1980, p 223-226

The development of the zinc-bromine battery system for energy storage in utility load-leveling and solar energy applications is examined. The electrode reactions and the problem of self-discharge in the zinc-bromine system are reviewed The advantages of employing a flowing electrolyte system with external storage of the bulk of the reactants are noted, and the main components of the Gould zinc-bromine battery are schematized The major efforts in the Gould program to date have been devoted to the development of a basic understanding of the cell electrochemistry, the selection and characterization of cost-effective materials of construction, and engineering scale-up L S

A81-26012 **Gas turbine combustor liner durability - The hot streak problem.** G J Sturgess (United Technologies Corp, Pratt and Whitney Aircraft Group, East Hartford, Conn) In Gas turbine combustor design problems Washington, D C, Hemisphere Publishing Corp, 1980, p 133-148, Discussion, p 148-150 11 refs

Predictions of gas turbine combustor liner temperatures minimize durability difficulties and provide hot-section life evaluations to determine maintenance costs The combustor liner is cooled by interior injection equipment whose design requires the knowledge of film effectiveness and wall temperature boundary conditions Practical combustor test results do not agree with the predictions because of the inadequate modeling of flow processes in the combustor, three-dimensional modeling of flows will be needed to solve the hot-streak problem A T

A81-25613 Low cost fabrication methods for LiAl/iron sulfide cells with molten salt electrolyte W Borger, D Kunze, and H S Panesar (Varta Batterie AG, Kelkheim, West Germany). In Progress in batteries and solar cells Volume 3
Cleveland, Ohio, JEC Press, Inc, 1980, p 251-253 5 refs Bundesministerium fur Forschung und Technologie Contract No ET-4155-A, Commission of the European Communities Grant No 244-77-EED

Fabrication procedures for LiAl/FeS cells with molten salt electrolyte are discussed with a view toward developing manufacturing methods which do not require high purity inert gas atmospheres Charged negative electrodes are produced from lithium foil protected by aluminum foil and porous aluminum sheets by pressing a sandwich-layered structure of these materials under normal atmospheric conditions These electrodes were used in engineering scale cells (100 Ah) together with positive electrodes prepared from FeS and KCl The fabrication of the electrodes and cell assembly were performed at 298 K and 40% relative humidity A comparison of the cell built by the above procedure with one of the same type manufactured under pure argon shows that fabrication in air does not affect cell performance L S

A81-25614 Energy analysis of high temperature batteries. M Matsunaga (Kyushu Institute of Technology, Kita-Kyushu, Japan), Y Ito, and S Yoshizawa (Kyoto University, Kyoto, Japan). In Progress in batteries and solar cells Volume 3
Cleveland, Ohio, JEC Press, Inc, 1980, p 254-259. 12 refs

An analysis of the energy balance in high temperature batteries for energy storage is presented in terms of the supply and demand curves of electrical power Two self-heating systems and a heat reservoir which utilizes the heat of fusion are discussed The self-heating systems are subject to the limitations of charge and discharge current densities, and excessive temperature variations A constant temperature operation with a heat reservoir is found to be preferable with respect to temperature control and energy efficiency L S

A81-25615 A preliminary investigation of an Al/FeS2 secondary cell. N Koura, T Inoue, and S Takahashi (Tokyo Science University, Noda, Chiba, Japan) In Progress in batteries and solar cells Volume 3. Cleveland, Ohio, JEC Press, Inc, 1980, p 260-262 7 refs

An investigation is presented of an advanced secondary candidate Al/FeS2 cell for load leveling and electric vehicle applications The cell is operated in a molten salt (AlCl3-NaCl system) electrolyte, or an AlCl3-organic solvent electrolyte Coulombic efficiencies were nearly 100%, and the discharge curve showed two plateaus, one at 0 9 V, and one at 0 6 V The low operating temperature of the cell lessens material corrosion problems, and cell materials are inexpensive A schematic diagram of the experimental cell and discharge curves at various temperatures are provided L S

A81-25616 Sealed nickel-cadmium batteries for memory backup H Hashimoto and K Nakatani (Sanyo Electric Co, Ltd, Sumoto, Hyogo, Japan) In Progress in batteries and solar cells Volume 3 Cleveland, Ohio, JEC Press, Inc, 1980, p 263-265

The development of a specialized Cadnica battery that is float-charged when power is being supplied, and powers a memory circuit the moment power fails in order to protect data is reported The battery is designed with low recharge and discharge power and outlasts conventional batteries The design eliminates liquid leakage, so that the battery may be directly mounted on a printed circuit board Self-discharge is less than with other batteries, so that it may preserve computer memory circuits for a considerable time O C

A81-25618 A new airborne nickel cadmium battery concept R Bonnaterre and E Leocard (Societe des Accumulateurs Fixes et de Traction, Romainville, Seine-Saint-Denis, France) In Progress in batteries and solar cells Volume 3
Cleveland, Ohio, JEC Press, Inc, 1980, p 270-273 Research supported by the Direction Technique des Constructions Aeronautiques and Ministry of Defence of England

A new battery design with increased power-to-weight and energy-to-weight ratios as a result of improvements in the volumetric efficiency of its elements is disclosed Research work culminating in the design, encompassed electrode thickness and separation optimization, ionic permeability for hydroxide ions through a separator and impermeability to oxygen transfer between electrodes, better mechanical and thermal behavior of the separator material, and extended electrolyte volume to reduce the frequency of maintenance operations Such batteries supply a number of aircraft on-board devices that are indispensable to the aircraft in case of main generator failure O C

A81-25837 Mathematical modeling of the lithium-aluminum, iron sulfide battery I - Galvanostatic discharge behavior. II - The influence of relaxation time on the charging characteristics. R Pollard and J Newman (California, University, Berkeley, Calif) *Electrochemical Society, Journal*, vol 128, Mar 1981, p 491-507 52 refs Contract No W-7405-eng-48

A mathematical model of the LiAl/LiCl, KCl/FeS high temperature battery is presented The model considers a whole prismatic cell which consists of negative electrode, separator, electrolyte reservoir, and positive electrode Physical phenomena described are ohmic potential drop and diffusion potential in the electrolyte, changes in porosity and electrolyte composition due to electrochemical reactions, local reaction rates, and diffusion, convection and migration of electrolyte In addition, the analysis includes finite matrix conductivities, variable physical properties and the possibility of specific simultaneous reactions in the positive electrode The theoretical results show many of the trends in behavior observed experimentally D K

A81-26858 Energy transfer in a system of superconductive magnets. M Masuda, T Shintomi, and K Asaji (National Laboratory for High Energy Physics, Ibaraki, Japan) In Advances in cryogenic engineering Volume 25 - Proceedings of the Cryogenic Engineering Conference, Madison, Wis, August 21-24, 1979
New York, Plenum Press, 1980, p 61-68

The paper describes a technique useful for superconductive energy storage, namely energy transfer between two superconducting coils, one of which is the storage coil and the other the accelerator magnet or the poloidal coil in a tokamak An experiment involving two coils each storing 100 kJ has shown that not only is it possible to transfer pulsed energy from one coil to the other but also to allow a surge of energy to flow back and forth between the two superconducting coils It is shown that the decay of the total energy in the system is caused by the losses of the thyristor, lead wires, and the commutation capacitors, except for the protection resistor loss P T H

A81-26861 Shape optimization study for a three-tunnel superconductive energy storage magnet M N El-Derini (Petroleum and Minerals University, Dhahran, Saudi Arabia) and R W Boom (Wisconsin, University, Madison, Wis) In Advances in cryogenic engineering Volume 25 - Proceedings of the Cryogenic Engineering Conference, Madison, Wis, August 21-24, 1979
New York, Plenum Press, 1980, p 114-119 Research supported by the U S Department of Energy, Wisconsin Electric Utilities Foundation, and NSF

A broad study for a three tunnel solenoid has been performed to determine the best shape of a segmented solenoid which minimizes the axial forces and shear stresses It is shown that the constant-field C-shaped magnet is a good solution for the shear stress and axial force problems In addition, the constant-field C has the advantages of the constant-field solenoid, i e, it utilizes the superconductor more effectively and does not have the end-field problem Another important advantage is that tunnel excavation is relatively simpler P T H

A81-27232 **System design, test results, and economic analysis of a flywheel energy storage and conversion system for photovoltaic applications.** A R Millner (MIT, Lexington, Mass) and T Dinwoodie (MIT, Cambridge, Mass) In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p 1018-1024 Research sponsored by the U S Department of Energy

MIT Lincoln Laboratory is developing a flywheel interface and storage system for use with photovoltaic power sources Test data on the performance of components built to investigate the feasibility of such a system, and the results of economic studies of the system showing user-worth analysis and manufacturing-cost estimates, are presented The system has magnetic bearings, a maximum-power-point tracker, dc input, and cycloconverter output from an ironless-armature motor-generator (Author)

A81-27233 **Energy storage in grid-connected applications.** G J Jones (Sandia Laboratories, Albuquerque, N Mex). In Photovoltaic Specialists Conference, 14th, San Diego, Calif , January 7-10, 1980, Conference Record New York, Institute of Electrical and Electronics Engineers, Inc , 1980, p 1025-1028 6 refs Research supported by the U S Department of Energy.

While energy storage is usually an option when designing any photovoltaic system, in grid-connected applications the decision for or against on-site storage is based on operational considerations If the photovoltaic system has the option of returning energy to the utility grid for credit, then the question of storage is determined by the capital cost of storage and its efficiency versus the 'cost' of sellback in terms of lost energy The present paper analyzes this situation, as well as time-of-day pricing, in detail to determine the allowable lifecycle cost of storage in each of the possible operating modes (Author)

A81-29257 **Storage of cold water in aquifers** R R Davison, W B Harris, and D L Reddell (Texas A & M University, College Station, Tex) *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif, Nov 25-29, 1979) AIChE Symposium Series,* vol 76, no. 198, 1980, p 34-40 7 refs Research supported by the Texas A & M University and U S Department of Energy

A81-29260 **Heat exchanger for in-ground heat storage.** O J Svec and J H L Palmer (National Research Council, Ottawa, Canada) *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif, Nov 25-29, 1979) AIChE Symposium Series,* vol 76, no 198, 1980, p 56-61 9 refs

A81-29266 **Electrical energy storage via high efficiency-cost effective hydrogen/halogen regenerative fuel cell systems.** J F McElroy and G G Patwa (General Electric Co , Wilmington, Mass) *(American Institute of Chemical Engineers, Annual Meeting, 72nd, San Francisco, Calif, Nov 25-29, 1979) AIChE Symposium Series,* vol 76, no 198, 1980, p 123-128 6 refs

Preliminary design concepts are considered in which a solid polymer electrolyte electrochemical cell will operate as (1) a halogen acid electrolyzer during the charging mode, to generate hydrogen and the (either Cl_2 or Br_2) halogen, and (2) as a hydrogen/halogen fuel cell during discharge Electric-to-electric conversion efficiencies of 85% are possible for such cycles, whose hydrogen may be stored in a metal hydride bed while the halogen is kept in tanks in liquid form It is concluded in view of the $41/kW-hr capital cost projections of an economic analysis for near-term components technology, and safety and reliability analyses, that the hydrogen/bromine cycle has great potential in load-leveling applications O C

A81-30158 # **Complex computation of flywheel power systems for flight vehicles (Kompleksnyi raschet makhovichnykh energosistem letatel'nykh apparatov)** N F Sviridenko *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no 47, 1980, p 37-41 5 refs. In Russian

A theoretical analysis is presented of the operation of a power system consisting of a flywheel, and a stable-frequency current generator of stepless transmission design A complex computation method is developed for the determination of the load and kinematic characteristics of the stepless transmission, and the moment of inertia of the flywheel, the method ascertains whether the system meets energy consumption requirements P.T H

N81-16523# Texas A&M Univ , College Station
HEAT TRANSPORT IN GROUNDWATER SYSTEMS. VOLUME 2: LABORATORY MODEL Progress Report, 1 Jul. 1976 - 31 Dec. 1978
David Bryan Reed and Donald L Reddell Aug 1980 168 p refs 2 Vol
(Contracts DI-14-34-0001-7091, DI-14-34-0001-7092, DI-14-34-0001-8046)
(PB81-104135, TR-104-Vol-2; W80-06700-Vol-2, OWRT-A-039-TEX(2)-Vol-2) Avail NTIS HC A08/MF A01 CSCL 08H

A laboratory model tank (1 8288 m deep, 0 2 radian sector, with 7 01 m in the radial direction) was constructed to simulate injection of hot water (heated from solar collectors) into a confined aquifer Temperature and pressure were taken to monitor the hot water front as it moved through the model Temperatures were measured at 6 different radial distances from the well and 7 vertical heights above the bottom of the flow layer Four runs were made with water supplied to the tank at constant temperature and flow rate, one in which no heat transfer occurred and hydraulic conductivity was measured, three in which heat transfer was monitored For the latter runs, hydraulic conductivity increased as aquifer temperature increased Injection rates were only indirectly related to thermal efficiency GRA

N81-16591# Argonne National Lab , Ill Advanced Battery Projects Dept
LITHIUM/IRON SULFIDE BATTERIES FOR ELECTRIC-VEHICLE PROPULSION AND OTHER APPLICATIONS Progress Report, Oct. 1979 - Mar. 1980
D L Barney, R K Steunenberg, A A Chilenskas, E C Gay, J E Battles, W E Miller, D R Vissers, and H Shimotake Aug 1980 105 p refs
(ANL-80-49) Avail NTIS HC A06/MF A01

Research and development activities on lithium/iron sulfide batteries are described Although the major emphasis is currently on batteries for electric vehicle propulsion, stationary energy storage applications are also under investigation The individual battery cells, which operate at 400-500 C, are of a vertically oriented, prismatic design with two or more positive electrodes of FeS or FeS_2, facing negative electrodes of lithium aluminum or lithium silicon alloy, and molten LiCl-KCl electrolyte Effects of design modifications on cell performance and post test examinations of cells are included Efforts to develop high reliability cells having boron nitride felt separators are described S F

N81-16599# Battelle Pacific Northwest Labs , Richland, Wash
LABORATORY STUDIES OF HARD ROCK FOR CAES
Arlo F Fossum Oct 1980 7 p
(Contract DE-AC06-76RL-01830)
(PNL-SA-8971) Avail NTIS HC A02/MF A01

The properties of hard rock specimens, from formations suitable for compressed air energy storage (CAES) that are subject to the conditions envisioned for a CAES cavern, were investigated by means of laboratory testing. It was concluded that although the compressive and tensile strengths are adversely influenced by a CAES cavern environment, the reduced failure strength of hard rocks is sufficiently high to indicate that a CAES plant could be operated satisfactorily L F M

N81-16600# Battelle Pacific Northwest Labs, Richland, Wash
COMPRESSED AIR ENERGY STORAGE TECHNOLOGY PROGRAM OVERVIEW
W V Loscutoff and L D Kannberg Oct 1980 6 p refs
(Contract DE-AC06-76RL-01830)
(PNL-SA-8988) Avail NTIS HC A02/MF A01

Studies were conducted to develop stability criteria for long-term operation of large underground reservoirs used for compressed air storage and to develop new concepts that will require little or no petroleum fuels for operation Major accomplishments during FY-80 are presented, and future activities required to meet objectives are identified L F M

N81-17590# Little (Arthur D), Inc, Cambridge, Mass
CAPITAL COST ESTIMATES OF SELECTED ADVANCED THERMAL ENERGY STORAGE TECHNOLOGIES Final Report
W Thompson Lawrence Jun 1980 284 p
(Contract W-31-109-eng-38)
(ANL/SPG-11) Avail NTIS HC A13/MF A01

A method for evaluating the first cost of diverse advanced thermal energy storage (TES) concepts on a common basis is presented For a total sample of at least 20 baseline and advanced TES technologies, the methodology developed was to be applied in the calculation of actual cost and performance measures Work on the development of TES focused on 5 types of applications areas electric power generation, with solar input in which TES is used to store energy for use during cloudy periods or at night, conventional fuel fired electric power generation, in which TES is used to improve load factors, cyclic losses, in which TES is used to reduce losses that occur when devices start and stop, batch losses, in which TES is used to recover waste heat, and source/sink mismatch, in which TES is used to increase the efficiency of processes that are dependent upon ambient temperatures DOE

N81-17591# Acres American, Inc, Columbia, Md
ADIABATIC COMPRESSED AIR ENERGY STORAGE IN HARD ROCK
C L Driggs Oct 1980 29 p refs Presented at the DOE Thermal-Mech Energy Storage Ann Contractors Rev Meeting Prepared for Pacific Northwest Lab, Richland, Wash
(Contract DE-AC06-76RL-01830)
(PNL-SA-9010) Avail NTIS HC A03/MF A01

Findings are discussed of a conceptual design study performed which examined pure adiabatic CAES cycles operating in the temperature range of 700 to 900 F The project involved an investigation of the technical and economic feasibility of using commercially available technology to construct a plant DOE

N81-17602# Battelle Pacific Northwest Labs., Richland, Wash
SEASONAL THERMAL ENERGY STORAGE PROGRAM
James E Minor 1980 46 p refs
(Contract DE-AC06-76RL-01830)
(PNL-SA-9030) Avail: NTIS HC A03/MF A01

Seasonal thermal energy storage technology is described Demonstration programs involving aquifers, environmental effects studies, legal aspects, economics, numerical simulation, and field testing are discussed DOE

N81-17607# Brown, Boveri und Cie, A G, Heidelberg (West Germany). Zentrales Forschungslabor
DEVELOPMENT OF SODIUM/SULFUR BATTERIES Final Report
Roland Bauer, Wilfried Fischer, Wilhelm Haar, Bernd Hartmann, Herbert Kleinschmager, Henner Meinhold, and Gert Weddigen Bonn Bundesministerium fuer Forschung und Technologie Dec 1980 125 p refs In GERMAN, ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-79-60, ISSN-0340-7608) Avail NTIS HC A06/MF A01, Fachinformationszentrum, Karlsruhe, West Germany DM 26,05

The principle of an Na/S storage battery was defined, problems were identified and solved, and a 10 kW hr experimental battery was built and successfully tested In particular the beta-alumina solid electrolyte was optimized with respect to electrical conductivity and lifetime Furthermore, the sulfur electrode with respect to sulfur utilization and the cathode current collector case with respect to corrosion resistance were also optimized. Cells used in the experimental battery (60 to 90 W hr/kg depending on charge/discharge time) were cycled up to 350 times Capacity declines 3 to 30% during this time, the rate being dependent on casing material The results obtained with single cells Extrapolation of the experimental results permits the conclusion that the properties necessary for application can be achieved The energy density of cells optimized with respect to weight is shown to be 165 W hr/kg. However, problems in achieving higher energy density, longer lifetime, and better thermal insulation still exist Author (ESA)

N81-17618# Swedish Council for Building Research, Stockholm
THERMOCHEMICAL ENERGY STORAGE: PROCEEDINGS FROM THE INTERNATIONAL SEMINAR ON THERMOCHEMICAL ENERGY STORAGE
Gunnar Wettermark 1980 420 p refs Seminar held at Stockholm, 7-9 Jan 1980 Sponsored in part by Swedish National Board for Technical Development, Swedish National Board for Energy Source Development and Royal Swedish Academy of Engineering Sciences
(PB81-114324, ISBN-91-540-3301-2, IVA-MEDDELANDE-229) Avail NTIS HC A18/MF A01 CSCL 10C

Energy storage problems are explored Tomorrow's energy sources will provide a continuous flow of energy Matching supply and demand will necessitate a wide range of storage capabilities For storing heat thermochemical and economic solutions may take advantage of the various options inherent in this kind of storage, namely heat pumping, transport of heat and direct conversion to other desired forms of energy such as electricity and mechanical work There is a need to regularly summarize the knowledge and research in the field of thermochemical energy storage in different parts of the world GRA

N81-17961# Army Mobility Equipment Research and Development Command, Fort Belvoir, Va
VERIFICATION TEST OF JET INDUSTRIES ELECTRA-VAN 1000P
Edward J Dowgiallo, Jr, Ivan R Snellings, and William H Blake Oct 1980 32 p
(Contract EC-77-A-31-1042)
(AD-A093738, MERADCOM-2311) Avail NTIS HC A03/MF A01 CSCL 13/6

The Electra-Van 1000P is a Chrysler Corp pickup truck which has been converted to an electric vehicle It was tested as part of a Department of Energy demonstration program The Electra-Van 1000P performance test results are presented. The 1000P is powered by 24 6 volt lead acid batteries through an SCR Controller to a 37-hp electric motor It has a manual 4 speed transmission and front disc and rear drum brakes It does not have regenerative braking GRA

N81-17963# California Univ, Livermore Lawrence Livermore Lab
EVALUATION OF A HYBRID FLYWHEEL/BATTERY PROPULSION SYSTEM FOR ELECTRIC VEHICLES
E P Cornell, F G Turnbull, and T M Barlow 16 Oct 1980 9 p refs Prepared in cooperation with G E Co, Schenectady, N Y
(Contract W-7405-eng-48)
(UCRL-15259) Avail NTIS HC A02/MF A01

The system consists of a steel flywheel coupled to a high-speed inductor motor/alternator fed by a load-commutated inverter/rectifier which does not utilize a shaft position sensor for inverter control Computer control is used to provide component as well as overall system control and data acquisition This flywheel energy storage system was laboratory tested over the SAE J227a Schedules D, C, and B driving cycles, using a laboratory simulation of an electric vehicle drive Results show that maximum benefit occurs on the Schedule D cycle for which the overall system was optimized From these tests, recommendations for additional improvements to this propulsion system are presented DOE

N81-18485 Purdue Univ, Lafayette, Ind
MATHEMATICAL PROGRAMMING APPLIED TO POWER SYSTEMS EXPANSION PLANNING WITH PUMPED STORAGE Ph.D. Thesis
Enayat Ibrahim Hafez 1980 165 p
Avail: Univ Microfilms Order No 8102661

Power systems expansion planning problem may be decomposed into three separate sub problems, generation, transmission, and distribution planning Essentially it is the capability expansion problem versus dispatching problem The sub problem of generation expansion planning (capacity expansion planning) that can use pumped hydroelectric storage is discussed The sub problem of capacity expansion planning can be completely solved without considering the transmission and distribution sub problems A multipurpose hydrostorage (conventional and pumped hydroplants) was considered which is to meet the needs of irrigation, flood control, and recreation A linear programming (LP) formulation was developed for power systems expansion planning which incorporates the pumped hydro along with the conventional power plants (hydro, nuclear, thermal, etc) The pumped hydro will be expected to meet peak demands The size of the LP model is reduced using the Z substitute method which results in a reduction of computational time Dissert Abstr

N81-18486 Alabama Univ, University
HIGH TEMPERATURE THERMAL ENERGY STORAGE IN AQUIFERS WITH A SOLAR POWER PLANT APPLICATION Ph.D. Thesis
Jasem Mohammad Al-Ansari 1980 205 p
Avail Univ Microfilms Order No 8100557

In this system, energy injection and withdrawal are accomplished by reversing flow through a system of wells connecting the aquifer to the surface Each well contains a submerged pumping system and controls Two computer programs have been developed for the proposed system The first program computes the location of a fluid particle as it moves between the injection well and the withdrawal well for a given period of time The second program computes the rate of heat transfer within the storage system during injection and withdrawal periods The thermal energy storage system is analyzed in conjunction with a solar power plant system The storage system provides energy during nighttime bad weather, and winter low insolation periods The power plant system consists of a Rankine steam cycle, a two dimensional concentrating solar collector system, and the aquifer thermal energy storage system The per kilowatt solar plant capital cost is approximately $10,000/kW The storage system is only $40/kW of 0 4 percent of capital cost Dissert Abstr

N81-18509# Mississippi State Univ, Mississippi State Dept of Mechanical Engineering
DEVELOPMENT OF A SYSTEM FOR OFF-PEAK ELECTRICAL ENERGY USE BY AIR CONDITIONERS AND HEAT PUMPS
Lynn D Russell May 1980 61 p refs
(TVA-EDT-122, MSSU-EIRS-MS-80-1) Avail NTIS HC A04/MF A01

Investigation and evaluation of several alternatives for load management for the TVA system are described Specific data for the TVA system load characteristics were studied to determine the typical peak and off peak periods for the system The alternative systems investigated for load management included gaseous energy storage, phase change materials energy storage, zeolite energy storage, variable speed controllers for compressors, and weather sensitive controllers After investigating these alternatives, system design criteria were established, then, the gaseous and PCM energy storage systems were analyzed The system design criteria include economic assessment of all alternatives Handbook data were developed for economic assessment A liquid/PCM energy storage system was judged feasible DOE

N81-18531# Sargent and Lundy, Engineers, Chicago, Ill
COMPRESSED AIR ENERGY STORAGE: PRELIMINARY DESIGN AND SITE DEVELOPMENT PROGRAM IN AN AQUIFER, TASK 2. VOLUME 2: CHARACTERIZE AND EXPLORE POTENTIAL SITES AND PREPARE RESEARCH AND DEVELOPMENT PLAN
Dec 1980 431 p refs Sponsored in part by Electric Power Research Inst
(Contracts DE-AC02-78ET-29232, ET-78-C-01-2159)
(DOE/ET-29232/T1-Vol-2) Avail NTIS HC A19/MF A01

The characteristics of sites in Indiana and Illinois which are being investigated as potential sites for compressed air energy storage power plants are documented These characteristics include geological considerations, economic factors, and environmental considerations Extensive data are presented for 14 specific sites and a relative rating on the desirability of each site is derived DOE

N81-19575# Naval Research Lab, Washington, D C
PULSED HIGH VOLTAGE AND HIGH CURRENT OUTPUTS FROM HOMOPOLAR ENERGY STORAGE SYSTEM Interim Report
R D Ford, D Jenkins, W H Lupton, and I M Vitkovitsky 4 Feb 1981 16 p refs
(RR0110941)
(AD-A094910, NRL-MR-4433) Avail NTIS HC A02/MF A01 CSCL 10/2

Large energy storage capability of inertial inductive systems provides an attractive option for satisfying the pulse power requirements associated with such applications as plasma confinement and heating, electromagnetic projectile acceleration and with production of intense radiation These applications require high rate of energy delivery to the load at specific current and voltage levels In conjunction with self-excited homopolar generator current source, an opening technology has been developed to provide up to 1 MJ output pulses, alternately, at hundreds of kilovolts or at megampere levels The overall system efficiency, which depends sensitively on the load requirements, was measured over a range from 10% to more than 90% for different pulser load circuit arrangements GRA

N81-19580# Air Force Inst of Tech, Wright-Patterson AFB, Ohio School of Engineering
COMPUTER SIMULATION OF SOLAR AIR HEATING SYSTEMS USING ROCK BED THERMAL STORAGE UNITS M.S. Thesis
Daniel Bartholomew Fant Dec 1980 144 p refs
(AD-A094771, AFIT/GAE/AA/80D-4) Avail NTIS HC A07/MF A01 CSCL 09/2

This thesis is concerned with the analysis and design of solar air heating systems utilizing rock beds as thermal storage units A computer simulation model capable of estimating the response of both the solar collector and the rock bed is described Differential equations describing the rock bed were approximated in a finite-difference form and solved numerically on a digital computer The temperature of both the solid (rock) and the fluid (air) is determined as a function of time and distance along the bed The simulation required both charging and discharging of the rock bed for time-varying inlet fluid temperatures The numerical method used to solve the rock bed equations proved to be stable and convergent and showed satisfactory agreement in comparison to an analytical solution for constant-inlet air temperature A cost analysis was also incorporated within this program, by varying the collector area one could determine the optimum collector size for maximum savings Pressure drop relationships for flat-plate collectors, duct work and packed beds were used to determine operating costs The particular air system tested proved to be cost effective when compared with natural gas fuel costs for an economic term of 20 years GRA

N81-19586# Public Service Co of Indiana, Plainfield
COMPRESSED AIR ENERGY STORAGE: PRELIMINARY DESIGN AND SITE DEVELOPMENT PROGRAM IN AN

AQUIFER. TASK 1: ESTABLISH FACILITY DESIGN CRITERIA AND UTILITY BENEFITS
Oct 1980 390 p Sponsored in part by EPRI
(Contracts DE-AC02-78ET-29232, ET-76-C-01-2159)
(DOE/ET-29232/T2) Avail NTIS HC A17/MF A01

Compressed air energy storage (CAES) stores mechanical energy in the form of compressed air during off-peak hours, using power supplied by a large, high efficiency baseload power plant At times of high electrical demand, the compressed air is drawn from storage and is heated in a combustor by the burning of fuel oil, after which the air is expanded in a turbine Essentially all of the turbine output can be applied to the generation of electricity, unlike a conventional gas turbine which expends approximately two-thirds of the turbine shaft power in driving the air compressor The separation of the compression and generation modes in the system results in increased net generation and greater premium fuel economy Work performed in establishing facility design criteria for a CAES system with aquifer storage includes determination of initial design bases, preliminary analysis of the CAES system, development of data for site-specific analysis of the CAES system, detailed analysis of the CAES system for three selected heat cycles, CAES power plant design, and an economic analysis of CAES DOE

N81-19606# California Univ, Berkeley Lawrence Berkeley Lab Earth Sciences Div
AQUIFER THERMAL ENERGY STORAGE: A SURVEY
Chin Fu Tsang, Deborah Hopkins, and Goeran Hellstroem Jan 1980 49 p refs
(Contract W-7405-eng-48)
(LBL-10441) Avail NTIS HC A03/MF A01

The technical, economic, and environmental aspects of aquifers storage were investigated The state of the art of various projects associated with aquifer storage technology were surveyed with emphasis on three broad categories field experiments, feasibility studies, and theoretical and modeling studies R C T

N81-19633# Rocketdyne, Canoga Park, Calif
THERMAL STABILITY TESTS OF HEAT TRANSFER FLUIDS FOR TRANSFER AND STORAGE OF THERMAL ENERGY
G R Schneider Dec 1980 142 p refs Prepared in cooperation with McDonnell Douglas Astronautics Corp, Huntington Beach, Calif
(Contracts E4-76-C-03-1108, DE-AC03-76ET-20417)
(DOE/ET-20417/4, MDC-G9331) Avail NTIS HC A07/MF A01

Laboratory tests were conducted to evaluate the high temperature (288 to 343 C) thermal stability, material compatibility, and surface fouling of selected commercial heat transfer fluids for a sensible heat thermal energy storage system to be used with a solar thermal electrical power generation plant The tests provided information on the rate of fluid replenishment required, the change of viscosity, the composition of lost products, and the rate of fouling of heat transfer surfaces as a function of temperature and time Determinations were made of the effect of the presence of materials likely to be used in the energy storage subsystem on these properties DOE

N81-19643# Swedish Council for Building Research, Stockholm
CONTINUOUS HEAT SOURCE MODEL FOR GROUND HEAT STORAGE
Johan Claesson and Mats Johansson 1980 32 p refs
(PB81-122889, ISBN-91-540-3323-3, D34-1980) Avail NTIS HC A03/MF A01 CSCL 13B

The ground volume is penetrated by a duct system for injection and extraction of heat The heat transfer properties between the ground and such a system is here characterized by a heat transfer length The heat exchange between the soil and the ducts is represented by a heat source/sink distribution in the storage region GRA

N81-19644# Swedish Council for Building Research, Stockholm
SWEDISH ENERGY STORAGE PROJECTS 1979: RESEARCH-DEVELOPMENT-FULL-SCALE EXPERIMENTS SUPPORTED BY GOVERNMENTAL ORGANIZATIONS
Stellan Atterkvist 1980 144 p refs
(PB81-122947, ISBN-91-540-3257-1, D19-1980) Avail NTIS HC A07/MF A01 CSCL 10C

The material contains 94 projects Projects included general studies and comparisons of storage methods, sensible storage in water, sensible storage in ground and rock, sensible storage in parts of building structures, latent storage, thermochemical storage, batteries, storage of hydrogen GRA

N81-19969# Air Force Academy, Colo Dept of Physics
THE USAF ACADEMY FLYWHEEL-ELECTRIC CAR Final Technical Report, 31 May 1979 - 31 Dec. 1980
Robert G Schwein, Jr Dec 1980 36 p
(AF Proj 2303)
(AD-A095130, FJSRL-TR-80-0025, FTR-2) Avail NTIS HC A03/MF A01 CSCL 13/6

This is the second and final report on the USAF Academy Flywheel-Electric Car The car is an operational test vehicle, not a prototype for a commercial car It weights 3100 pounds, carries 4 passengers, and cruises at 40 miles per hour for about 100 miles before recharging Technical details are presented that will provide guidance to the reader who wishes to construct a similar vehicle GRA

N81-19970# Air Force Inst of Tech, Wright-Patterson AFB, Ohio School of Engineering
ELECTRIC VEHICLE SIMULATION FOR DESIGN OPTIMIZATION M.S. Thesis
Kenneth A Stafford Dec 1980 118 p refs
(AD-A094734, AFIT/GAE/AA/80D-19) Avail NTIS HC A06/MF A01 CSCL 13/6

Currently available electric passenger vehicles have revealed a lack of design sophistication that has highlighted the need for an accurate method of forecasting performance An electric vehicle computer simulation program was developed to satisfy that need The approach was to establish a very comprehensive and flexible vehicle model and simulate its operation on a realsitc driving cycle The driving cycle selected was the Federal Urban Driving Sequence A thorough vehicle model was established that incorporates aerodynamic drag, rolling resistance, both rotational and translational inertial effects, and component by component dynamic power train efficiencies Battery discharge performance is tracked by a fractional-utilization algorithm with corrections for short-term discharge effects The simulation compares required power obtained from the driving cycle speed schedule and vehicle model characteristics with the available power at the motor for each time increment of the driving cycle to compute battery fraction used and deviation from the speed schedule when available power is insufficient These results of the simulation can be used to evaluate an existing vehicle's performance, or, if desired, to develop vehicle parameters to obtain a specified performance level GRA

N81-20561# Department of Energy, Washington, D C
THE 1980 FLYWHEEL TECHNOLOGY SYMPOSIUM
1980 470 p refs Symp held at Scottsdale, Ariz, Oct 1980 Sponsored in part by ASME
(Contract W-7405-eng-48)
(CONF-801022) Avail NTIS HC A20/MF A01

Forty-eight papers were presented at the meeting and are included in the proceedings A separate abstract was prepared for each of 45 papers Three papers were previously processed for EDB DOE

N81-20575# United Technologies Corp, South Windsor, Conn Power Systems Div
EVALUATION OF BATTERY CONVERTERS BASED ON 4.8-MW FUEL CELL DEMONSTRATOR INVERTER Final Report
Oct 1980 184 p refs
(Contract DE-AC01-76ET-26961)
(DOE/RA-26961/01) Avail NTIS HC A09/MF A01

The use of existing self-commutated converter technology with modification for use in battery energy storage systems was evaluated The program consists of three parts evaluation of the cost and performance of a self-commutated converter modified to maintain production commonality between battery and fuel cell power conditioners, demonstration of the principal characteristics required for the battery application in MW-scale hardware, and investigation of the technical requirements of operation isolated from the utility system A power-conditioning system consisting of a self-commutated converter augmented with a phase-controlled rectifier was selected and a preliminary design, prepared A principal factor in this selection was production commonality with the fuel cell inverter system Additional types of augmentation, and the use of a self-commutated converter system without augmentation, were also considered A survey of advanced battery manufacturers was used to establish the dc interface characteristics DOE

N81-20591# Gould, Inc, Rolling Meadows, Ill
DEVELOPMENT OF ZINC-BROMINE BATTERIES FOR UTILITY ENERGY STORAGE Annual Report, 1 Sep. 1978 - 31 Aug. 1979
Ronald A Putt, Alan J Attia, Po-Yen Lu, and James H Heyland May 1980 161 p refs Sponsored in part by Electric Power Research Inst
(Contracts DE-AC02-78ET-29345, EW-78-C-02-4984, EPRI Proj RP635-2)
(DOE/ET-29345/21, AR-1) Avail NTIS HC A08/MF A01
Development work on the Zn/Br battery is reported A major improvement was the use of a bipolar cell design, this design is superior with respect to cost, performance, and simplicity A cost and design study for an 80 kWh module resulted in a cost estimate of $54/kWh(1979$) for purchased materials and components, on the basis of 2500 MWh of annual production A cell submodule (nominal 2 kWh) of full sized electrodes (1 sq ft) accured over 200 continuous cycles in a hands off, automatic routine with efficiencies in the range of 53 to 56 percent Initial testing of a full sized 8 kWh submodule demonstrated energy efficiencies of 65 to 67 percent DOE

N81-21359# Alabama Univ, Huntsville Kenneth F Johnson Environmental and Energy Center
CHANGE-OF-PACE ELECTRIC AUTOMOBILE USER DEMONSTRATION (COMCAR 2) Final Report
K E Johnson Nov 1980 75 p
(Contract EC-77-X-01-3559)
(DOE/TIC-11373) Avail NTIS HC A04/MF A01
A present technology electric car was tested under conditions which were as close as possible to real life conditions as opposed to the laboratory conditions encountered on the dynamometer or the test track The test program was conducted over several months, so that the data would realistically reflect the performance characteristics of the car under urban driving conditions In addition to demonstrating the change of pace, the ComCar 2 project was expected to make contributions toward product improvement Engineering evaluations of car components were performed in close cooperation with the manufacturer, in an effort to help solve several technical problems which were encountered Information was obtained and is presented on vehicle performance, operating costs, drivers' responses to electric vehicles, and the support structures need to operate and maintain electric vehicles DOE

N81-21495*# Electrochem Industries, Inc, Clarence, N Y
PERFORMANCE AND SAFETY CHARACTERISTICS OF Li/BCX AND Li/CSC SYSTEMS
Robert M Murphy *In* NASA Goddard Space Flight Center The 1980 Goddard Space Flight Center Battery Workshop Mar 1981 p 23-30
Avail NTIS HC A19/MF A01 CSCL 10C
The performance and safety characteristics of the lithium BMX and lithium CSC battery system are discussed A comparison is made between the two systems with respect to open circuit voltage, energy density, and operating temperature R C T

N81-21505*# Hughes Aircraft Co, Los Angeles, Calif
HIGH ENERGY DENSITY BATTERIES FOR SATELLITE APPLICATIONS
Lynn Marcoux and R Marsh (Air Force Aero Propulsion Lab, Wright-Patterson AFB, Ohio) *In* NASA Goddard Space Flight Center The 1980 Goddard Space Flight Center Battery Workshop Mar 1981 p 143-154
12-44)
Avail NTIS HC A19/MF A01 CSCL 10C
The performance requirements of high-energy batteries for terrestrial applications were examined to establish whether or not these systems showed any promise in aerospace applications The technology assessment is reported and consists of a battery technology evaluation, preliminary engineering studies, and system selection Major candidate systems are compared and a program schedule is provided T M

N81-21509*# MPD Technology Corp, Wyckoff, N J
THE CMG NICKEL ELECTRODE
Robert A DePaul and Ian Gutridge *In* NASA Goddard Space Flight Center The 1980 Goddard Space Flight Center Battery Workshop Mar 1981 p 183-195
Avail NTIS HC A19/MF A01 CSCL 10C
The development and design of the Controlled Microgeometry electrode are described Advantages of the electrode over others in existance include a higher number of ampere hours per kilogram and the ability to make them over a wide range of thicknesses The parameters that control the performance of the electrode can be individually controlled over a wide range Therefore, the electrode may be designed to give the optimum performance for a given duty cycle T M

N81-21510*# Naval Surface Weapons Center, White Oak, Md
LIGHTWEIGHT COMPOSITE CADMIUM ELECTRODES
R A Sutula and W Ferrando *In* NASA Goddard Space Flight Center The 1980 Goddard Space Flight Center Battery Workshop Mar 1981 p 197-205
Avail NTIS HC A19/MF A01 CSCL 10C
The design and fabrication of the electrodes are discussed The electrode efficiency of different impregnations of plaques is reported The chemical impregnation for commercial use has the lowest efficiency, and for aerospace application it has higher efficiency The electrochemically impregnated electrode is the most efficient T M

N81-21512*# Hughes Research Labs, Malibu, Calif
PBI TREATED POLYPROPYLENE BATTERY SEPARATOR
Scott A Veryzwyvelt *In* NASA Goddard Space Flight Center The 1980 Goddard Space Flight Center Battery Workshop Mar 1981 p 217-223
Avail NTIS HC A19/MF A01 CSCL 10C
A generalized procedure for fabricating the separator is described Some of the desired properties considered in fabricating the separator material for nickel-cadmium cells were good mechanical strength, good chemical stability, good wettability to the electrolyte, high electrolyte retention, and gas passage T M

N81-21526*# RCA Labs., Princeton, N J
RCA SATCOM IN-ORBIT EXPERIENCE
David Stewart *In* NASA. Goddard Space Flight Center The 1980 Goddard Space Flight Center Battery Workshop Mar 1981 p 379-384
Avail: NTIS HC A19/MF A01 CSCL 10C
The F1 and F2 spacecraft battery systems are described Battery reconditioning and discharge are discussed and graphically illustrated Current sharing as a measure of battery performance is also plotted E.D K

N81-21586# EIC, Inc, Newton, Mass
LOW TEMPERATURE ALKALI METAL-SULFUR BATTERIES Final Report, 1 Dec. 1974 - 30 Nov. 1978
S B Brummer, R D Rauh, K M Abraham, F W Dampier, V Subrahmanyam, G F Pearson, J K Surprenant, and J M Buzby Mar 1980 128 p refs
(Contracts DE-AC02-76ET-25003, EY-76-C-02-2520)
(COO-2520-7) Avail NTIS HC A07/MF A01
Work on the development of rechargeable, ambient-temperature Li sulfur and Li metal sulfide batteries is reported The Li-S system has the cathode material dissolved in the electrolyte, as Li_2S_n Tetrahydrofuran, 1M $LiAsF_6$, is one

of the more attractive electrolytes discovered for this cell, since it can dissolve up to approx 10M S as Li2Sn Despite the oxidative nature of the electrolyte, Li is stable in it and can be electrodeposited from it on battery charge DOE

N81-21587# General Electric Co, Santa Barbara, Calif Center for Advanced Studies

GUIDELINES FOR CONCEPTUAL DESIGN AND EVALUATION OF AQUIFER THERMAL ENERGY STORAGE

C F Meyer and W Hauz Columbus, Ohio Battelle Memorial Inst Oct 1980 249 p refs

(Contract DE-AC06-76RL-01830)

(PNL-3581) Avail NTIS HC A11/MF A01

Guidelines are presented for use as a tool by those considering application of aquifer thermal energy storage (ATES) technology The guidelines assist utilities, municipalities, industries, and other entities in the conceptual design and evaluation of systems employing ATES The potential benefits of ATES are described, an overview is presented of the technology and its applications, and rules of thumb are provided for quickly judging whether a proposed project has sufficient promise to warrant detailed conceptual design and evaluation The characteristics of sources and end uses of heat and chill which are seasonally mismatched and may benefit from ATES are discussed Storage and transport subsystems and their expected performance and cost are described A methodology is presented for conceptual design of an ATES system and evaluation of its technical and economic feasibility in terms of energy conservation, cost savings, fuel substitution, improved dependability of supply, and abatement of pollution DOE

08
GENERAL

A81-21701 Summer Computer Simulation Conference, Toronto, Canada, July 16-18, 1979, Proceedings. Conference sponsored by AGU, AIAA, AMS, BMES, IMACS, IEEE, ISA, SCS, and S H A R E Montvale, N J, AFIPS Press, 1980 997 p $30

Topics discussed include simulation methodology, hybrid systems, simulation credibility and validation, system engineering, and simulation for training Particular attention is given to simulation in the chemical sciences, the physical sciences, the environmental sciences, biomedical systems, the managerial and social sciences, and energy B J

A81-21730 *Effect of load spectrum variables on fatigue crack initiation and propagation*, Proceedings of the Symposium, San Francisco, Calif., May 21, 1979. Symposium sponsored by the American Society for Testing and Materials Edited by D. F Bryan (Boeing Wichita Co, Wichita, Kan) and J M Potter (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). Philadelphia, Pa, American Society for Testing and Materials (ASTM Special Technical Publication, No 714), 1980 244 p $27

The symposium focused on load spectra of engineering structures, gas turbines, windmill structures, analytical and experimental fatigue and fracture data, the effects of spectrum editing, time dependent changes in material characteristics, compression loads, and gust alleviation Topics include 7XXX Al alloy fatigue crack growth resistance under constant amplitude and spectrum loading, crack retardation resulting from the load sequencing characteristic of military gas turbine operation, and the effects of fighter attack spectrum on crack growth A T

A81-22208 Winter Simulation Conference, San Diego, Calif, December 3-5, 1979, Proceedings. Volumes 1 & 2. Conference sponsored by ACM, AIIE, IEEE, NBS, ORSA, SCS, and TIMS. Edited by H J Highland (New York, State University, Farmingdale, N Y), M. G Spiegel (Federal Computer Performance Evaluation and Simulation Center, Washington, D C), and R Shannon (Alabama, University, Huntsville, Ala) New York, Institute of Electrical and Electronics Engineers, Inc, 1979 Vol 1, 350 p, vol 2, 341 p Price of two volumes, $40 50

Consideration is given to such topics as experimental design in computer simulation, computer-aided digital autopilot design and analysis, simulation of passive solar systems, simulation of an advanced inertial stabilization concept, and simulation in project management. Factor screening methods in computer simulation experiments, a simulation model for network routing, and simulation of merge junctions in a dynamically entrained automated guideway transit system are also examined B.J

A81-22757 * # Space construction technology needs. L M. Jenkins (NASA, Johnson Space Center, Program Development Office, Houston, Tex) *American Institute of Aeronautics and Astronautics, Conference on Large Space Platforms Toward Permanent Manned Occupancy of Space, 2nd, San Diego, Calif., Feb 2-4, 1981, Paper 81-0442* 5 p 9 refs

Space construction systems made feasible by an operational Space Shuttle are discussed with a view toward assembly, installation and construction support equipment. The level of construction capability will be reflected in the number of launches to accomplish a certain mission, either in terms of the mission time line or on the density of packaging in the Orbiter payload bay. It is noted that the development of construction support equipment in zero-gravity simulations should be the most productive initial activity Crew EVAs, as well as the beam builder, cherrypicker and power distribution buses are covered in detail L S

A81-22877 Systems engineering - Fundamental limits and future prospects. A P Sage (Virginia, University, Charlottesville, Va) *IEEE, Proceedings*, vol 69, Feb 1981, p. 158-166 8 refs

Presently perceived fundamental limits in systems engineering are described along with contemporary and projected future efforts to reach, circumvent, or ameliorate the effects of these limits To present an overall view of the many frontiers being explored and extended in the realm of systems, man and cybernetics, a set of twenty-five objectives for systems engineering in the 1980's is first described. This is followed by a summary description of systems engineering The paper continues with a discussion of limits associated with modeling, human and behavioral factors, and utility and value measurement It concludes with examples of how these limits affect the design of planning and decision support systems, and energy policy analysis using technology forecasting and assessment (Author)

A81-23496 The absorption process for heating, cooling and energy storage - An historical survey. H Bjurstrom and W Raldow (Kungl Tekniska Hogskolan, Stockholm, Sweden) *International Journal of Energy Research*, vol 5, Jan -Mar. 1981, p 43-59 132 refs Research supported by the Styrelsen for Teknisk Utveckling

A historical overview of the absorption process is given and a wide range of applications, from household refrigerators and air conditioners to topping processes in power plants, are surveyed in historical perspective. The production of mechanical energy and open systems are also included The current development of the absorption process is sketched out and special attention is given to the aspects of thermal energy storage D K

A81-25004 Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979 Volume 2 - Solar Energy 2. Conference supported by the International Association for Hydrogen Energy, IAEA, ISES, Florida International University, and University of Miami Edited by T. N Veziroglu (Miami, University, Coral Gables, Fla) Washington, D.C, Hemisphere Publishing Corp., 1981 529 p Price of nine volumes, $595

The conference focused on heat transfer and energy transport, water heating, heat pumps, heating and cooling, and various applications of alternative energy sources Papers are presented on the numerical resolution of the heat transfer equations in a latent heat solar energy storage system, the series solar heat pumps and energy conservation, solar air conditioning with solid absorbents and earth cooling, and the use of solar energy in multi-storied buildings V.L

A81-25040 Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 3 - Solar energy 3. Conference supported by the International Association for Hydrogen Energy, IAEA, ISES, Florida International University, and Univeristy of Miami Edited by T N Veziroglu (Miami, University, Coral Gables, Fla) Washington, D C, Hemisphere Publishing Corp, 1981 507 p Price of nine volumes, $595

The book examines the topics of distillation, thermal power, direct electrical conversion, and solar energy economics and planning. Several papers are presented on the subjects of thin film photovoltaic solar energy conversion, the solar thermionic power plant, the construction cost of thermal storage for solar systems, and the thermodynamic method for the quantitative treatment of conduction electrons L S

A81-25048 Combined solar and fossil fuel systems for electric power generation. K W. Li (North Dakota State University, Fargo, N Dak) and J. Cashman (Charles T. Main, Inc, Boston, Mass.). In Alternative energy sources II, Proceedings of the Second

Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 3 Washington, D.C., Hemisphere Publishing Corp, 1981, p 1123-1130

The paper is intended to present a parametric study for the combined solar and fossil fuel system for electric power generation. The combined system is so designed that the solar energy will be utilized to a maximum extent at the time when the solar energy is available The balance of energy requirement is met by burning fossil fuels such as coal, oil and natural gas. The basic system arrangement is the partial heating of feedwater by solar energy The study includes an identification of major parameters affecting the solar energy utilization as a supplementary fuel for electric power generation In addition a break-even cost analysis is made. (Author)

A81-25065 **Alternative energy sources II; Proceedings of the Second Miami International Conference, Miami Beach, Fla., December 10-13, 1979. Volume 4 - Indirect solar energy.** Conference supported by the International Association for Hydrogen Energy, IAEA, ISES, Florida International University, and University of Miami Edited by T. N. Veziroglu (Miami University, Coral Gables, Fla.) Washington, D C., Hemisphere Publishing Corp., 1981. 425 p. Price of nine volumes, $595.

This volume gives consideration to the topics of wood energy, wind turbines and siting, wind power generation, wave and current energy, tide energy and ocean thermal energy. Particular attention is given to the performance analysis of vertical axis wind turbines, estimating wind potential for small scale energy generation, and the effects of wind integration with conventional electrical generating systems The development of tidal power in Korea, the design of the OTEC Seacoast Test Facility at Keahole Point, Hawaii, and wind energy utilization possibilities in Turkey are reviewed. L.S.

A81-25165 **Energy accounting for solar and alternative energy sources.** W D Devine, Jr (Oak Ridge Associated Universities, Inc, Oak Ridge, Tenn) In Alternative energy sources II, Proceedings of the Second Miami International Conference, Miami Beach, Fla, December 10-13, 1979 Volume 9 Washington, D.C, Hemisphere Publishing Corp, 1981, p 3815-3844. 14 refs.

Shortcomings in energy data collection, display and accounting practices are of minor consequence in an economy of today in which most end use services are provided via fossil fuels and electricity However, the emergence of a variety of alternative technologies that might be used to provide these services suggests that present accounting practices be reexamined and a more appropriate system devised. The paper proposes an energy accounting framework based upon the actual services provided to end users An energy service is a measure of the service actually provided to ultimate consumers by their own use of energy, quantified, for example, using units of work or of heat at various temperatures Fifteen categories of energy service are described and some of their characteristics are identified. The proposed energy accounting framework consists of two matrices - an energy service matrix and an energy carrier matrix The energy service matrix displays quantities of energy carriers used to provide energy services The energy carrier matrix displays quantities of energy carriers used to produce and distribute energy carriers to ultimate consumers (Author)

A81-25601 **Progress in batteries and solar cells. Volume 3.** Edited by A Kozawa, K V Kordesch (Graz, Technische Universitat, Graz, Austria), E Voss (Varta Batterie AG, Kelkheim, West Germany), H Ogawa (Matsushita Electric Industrial Co, Ltd, Osaka, Japan), H Ikeda (Sanyo Electric Co, Ltd., Kobe, Japan), J P. Gabano (Société des Accumulateurs Fixes et de Traction, Romainville, Seine-Saint-Denis, France), H M Joseph (Union Carbide Corp., Battery Products Div, New York, N Y), K Fueki (Tokyo, University, Tokyo, Japan), Y Uetani (Hitachi Maxell Co, Osaka, Japan), and T Shirogami (Toshiba Corp, Toshiba Research and Development Center, Kawasaki, Japan) Cleveland, Ohio, JEC Press, Inc, 1980 356 p $48

A technology yearbook is presented summarizing the progress made in battery, solar cell, and energy-related research Raw materials, components, manufacturing processes, and machinery are reviewed. Research papers and patents are included along with reports on new devices and equipment While the emphasis is on the translation of Japanese, German and French information into English, major developments in the U S and U S S R are also covered L.S

A81-25610 **Major electrochemical developments related to the energy problem.** E. Yeager (Case Western Reserve University, Cleveland, Ohio) In Progress in batteries and solar cells Volume 3. Cleveland, Ohio, JEC Press, Inc, 1980, p 242-244.

The ways in which electrochemistry can help to lessen dependence upon and make more effective use of hydrocarbon fuels are surveyed. Primary and storage battery systems for electrochemically powered vehicles are examined Hydrogen-air fuel cells offer promise for vehicle propulsion if a reasonable means of storing H2 can be developed, perhaps in the form of a metal hydride Electric utility applications discussed include battery systems for peak shaving and load leveling, H2 phosphoric acid on-site fuel cells, and the combination of coal gasification and fuel cells in a large (over 500 MW) central electronic power station Systems for the photoelectrochemical generation of electricity are also reviewed L S

A81-26476 **Behaviour of high temperature alloys in aggressive environments; Proceedings of the Petten International Conference, Petten, Netherlands, October 15-18, 1979** Conference sponsored by Bond voor Materialenkennis, CEC, Metals Society, et al Edited by I Kirman (Inco Europe, Ltd, London, England), J B Marriott, M Merz (Commission of the European Communities, Joint Research Centre, Petten, Netherlands), P R Sahm (Aachen, Technische Hochschule, Aachen, West Germany), and D P Whittle (California, University, Berkeley, Calif) London, Metals Society, 1980 1088 p In English and French $35

Studies presented in this volume deal with the mechanical properties and corrosive behavior of metal alloys in aggressive high temperature environments Emphasis is placed on iron, nickel, and cobalt base alloys used, or potentially of use, in high-temperature industrial applications, including petrochemical and coal gasification processes, nuclear process heat, and high-temperature power plants. V L.

A81-27301 **Wind engineering, Proceedings of the Fifth International Conference, Colorado State University, Fort Collins, Colo., July 8-14, 1979 Volumes 1 & 2** Conference sponsored by NSF, Exxon Research and Engineering Co, U S Nuclear Regulatory Commission, et al Edited by J E Cermak (Colorado State University, Fort Collins, Colo) Oxford, Pergamon Press, Ltd, 1980 Vol 1, 673 p, vol 2, 803 p Price of two volumes, $200

The conference focused on social and economic impact of wind storms, wind characteristics, local wind environments, wind loading, dynamic responses of tall buildings and towers, physical and mathematical modeling, and wind engineering applications Papers included an assessment of potential cyclone damage to dwellings in Australia, vertical coherence in the atmospheric boundary layer, wind induced heat loss from buildings, wind loads on building frames, and vortex shedding from circular cylinders in turbulent flow. Also, topics analyzed involved drifting snow similitude-drift deposit rate correlation, wind tunnel investigation of the dispersion of chemical vapors emitted from marine chemical carriers, and aerodynamics of heliostats for solar power plant applications A T

A81-29251 **Fundamentals and applications of solar energy, Proceedings of the Seventy-Second Annual Meeting, San Francisco, Calif., November 25-29, 1979.** Meeting sponsored by the American Institute of Chemical Engineers Edited by I H Farag (New Hampshire, University, Durham, N H) and S S Melsheimer

(Clemson University, Clemson, S C) *AIChE Symposium Series*, vol 76, no 198, 1980 177 p

Topics discussed include the design and analysis of parabolic, concentrating solar collectors, thermal energy storage in underground and phase change material systems, and the design and operational characteristics of solar heating systems Also considered are concentrating collector, cooling and energy storage devices for photovoltaic systems, and the derivation of fuels from biomass sources O C

A81-29688 **The boundless dimension - Space flight Volume 1 - Prospects and problems (Die grenzenlose Dimension - Raumfahrt. Volume 1 - Chancen und Probleme).** H O Ruppe (Munchen, Technische Universitat, Munich, West Germany) Dusseldorf, Econ Verlag GmbH, 1980 736 p In German $19 50

A review of the history and the state of the art of space flight is given The first section examines the early history of space flight up to 1979 which was made possible by scientific developments in physics, communications technology, thermodynamics, space mechanics and many other disciplines Projected developments of the next 20 years are covered in the second section, especially the NASA Space Shuttle, Skylab, and advances in payload and propulsion systems. The third section presents speculative trends in propulsion and space travel advances for the next century Proposed propulsion systems based on nuclear energy and other power mechanisms are discussed along with prospects for energy production in space, such as energy satellites The problems and prospects of space settlement and interstellar flight are also detailed The fourth section examines the costs of space flight and makes a plea for the long-term benefits to be had from a generous investment, not only in military terms but in terms of research in astronomy and in terms of economic benefits from satellite mapping of resources and land use D K

N81-16773# National Technical Information Service, Springfield, Va
A DIRECTORY OF COMPUTER SOFTWARE APPLICATIONS: ENERGY Progress Report, Feb. 1977 - Apr. 1980
Apr 1980 305 p
(PB80-105497, NTIS/SA-80/01) Avail NTIS HC $30 00/MF $30 00 CSCL 09B

Computer programs and/or documentation developed for a variety of applications to the field of energy are cited The computer software includes applications to solar, geothermal and nuclear energy, petroleum and natural resources, batteries, electrohydrodynamics and magnetohydrodynamic generators, and hydroelectric power production Examples of software use include simulation and modeling, calculations of future energy requirements, calculatons of conservations measures and computations of economic considerations of energy systems GRA

N81-17968*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
THE MARSHALL CENTER: ITS PLACE IN NASA
[1981] 31 p refs
(NASA-TM-82254) Avail. NTIS HC A03/MF A01 CSCL 05A

The organizational structure and facilities available at the Marshall Space Flight Center are described and the role of the Center in NASA program management is demonstrated in a review of the Center's past history and current development projects Particular attention is given to space shuttle and the space transportation system, the preparation of experiments and management of Spacelab missions, and the development of the space telescope Energy related activities discussed include the automatic guidance and control of the longwall shearing machine for coal extraction, systems for the solar heating and cooling of buildings, and the design of the solar power satellite Products developed by Center personnel highlighted include the power factor controller to reduce electrical consumption by motors and the image enhancement process being used to restore early historical photographs A free flying solar power source to increase mission duration of the orbiter and its payloads, techniques for the orbital assembly of large space structures, facilities for materials processing in space, the orbit transfer vehicle, solar electric propulsion systems, and the preparation of science and applications payloads are also described A R H

N81-18940# Strasbourg Univ (France)
GENERAL REFLECTIONS ON THE THEME OF INNOVATIONS
Nicholas Georgescu-Roegen *In* ESA Econ. Effects on Space and Other Adv Technol Sep 1980 p 47-51 refs

Avail NTIS HC A12/MF A01

Technological innovation or 'exosomatic mutation' is analyzed in a historical context The difficulties of recognizing future trends with special reference to the energy crisis are discussed The steam engine rescued man from a crisis similar to the present one The breeder reactor is mentioned as an invention of the same importance Author (ESA)

N81-18955# Commission of the European Communities, Brussels (Belgium) Forecasting and Assessment in Science and Technology
EUROPE IN FACE OF THE FUTURE [L'EUROPE FACE AUX FUTURS]
Michel Godet *In* ESA Econ Effects of Space and Other Adv Technol Sep 1980 p 191-197 refs In FRENCH

Avail NTIS HC A12/MF A01

Trends toward increased productivity and increased energy costs are examined and the social and economic impact on Europe is analyzed Present limitations in forecasting, the price of energy and its relation to new development, unemployment as a consequence of automation, the relative position of developed and underdeveloped countries, and the desirability of social and economic policies are discussed Author (ESA)

N81-19174*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
SPACE PLATFORM REFERENCE MISSION STUDIES OVERVIEW
James K Harrison *In* NASA Langley Research Center Large Space Systems Technol, 1980, Vol 1 Feb 1981 p 129-132

Avail NTIS HC A19/MF A01 CSCL 22B

The design requirements for three major space platform systems are identified The three were the Science and Applications Space Platform (SASP), the Geostationary Platform (GSP), and the Satellite Power System (SPS) Because the SASP and GSP were assumed to require no advanced technology for their development an advanced version of each was selected on which to base the design requirements The SPS represented the opposite development state hence a nearer term test article was selected on which to base the requirements The development period for these missions is estimated M G

N81-19611# Argonne National Lab, Ill Energy and Environmental Systems Div
EMPLOYMENT IMPACTS OF SELECTED SOLAR AND CONVENTIONAL ENERGY SYSTEMS: A FRAMEWORK FOR COMPARISONS AND PRELIMINARY FINDINGS
Kenneth K Smeltzer Jan 1980 37 p refs
(Contract W-31-109-eng-38)
(ANL/EES-TM-116) Avail NTIS HC A02/MF A01

Preliminary comprehensive analyses of quantitative and qualitative employment effects of selected solar and conventional energy systems are presented A framework is proposed for analyzing the direct, indirect, induced, displacement, disposable income, and qualitative employment effects of alternative energy systems The analyses examine current research findings on these effects for a variety of solar and conventional energy sources and compare expected employment impacts In general, solar energy systems have higher direct and indirect employment requirements than do conventional energy systems In addition, employment displaced from conventional sources and employment effects due to changes in consumers' disposable income are highly significant variables in net employment comparisons Analyses of the size and location of projected energy developments suggest that dispersed solar energy systems have a more beneficial impact on host communities than do large conventional facilities, regardless of the relative magnitude of employment per unit of energy output DOE

N81-20004# Technical Research Centre of Finland, Espoo
[APPLIED RESEARCH ACTIVITIES FOR 1979] Annual Report
1980 26 p Original contains color illustrations
Avail: NTIS HC A03/MF A01

Work in building construction, city planning, materials development and processing; energy technology, and information technologies is reviewed Structural stress from ice loads, building design, reactor safety, the use of peat in power plants, and the industrial use of enzymes are mentioned Author (ESA)

N81-21007# National Bureau of Standards, Washington, D C
DIMENSIONS/NBS. VOLUME 64, NO. 8, OCTOBER 1980 Monthly Report, October 1980
Oct. 1980 32 p refs
(PB81-133654, NBS/DIM-64/8) Avail NTIS HC A03/MF A01 CSCL 14B

Short summaries of major technical developments, highlights of work in progress and major speeches and statements by Bureau management are presented as well as a listing of NBS publications Articles in this issue are. A Look at Federal Office Automation, S Radack, Safer Practice Makes Perfect, K Kuo, Electrical Wiring Staying on the Safe Side, G Porter, I-C Test Structures for Random Faults, M Baum, Temperature Reference Materials Available, SRM, Degradation of Solar Absorber Coatings, L. Masters; Test of Radiation Exposure Calculation for Reactor Pressure Vessels, E. McGarry GRA

N81-21580# Department of Energy, Washington, D C Assistant Secretary for Conservation and Solar Energy
ALTERNATE SOURCES OF ENERGY
1980 155 p Presented at the Alternate Sources of Energy Conf, New York, 29 Sep 1980
(CONF-8009109) Avail: NTIS HC A08/MF A01

Eleven papers are included A separate abstract was prepared for each for Energy Research Abstracts (ERA), seven were selected for Energy Abstracts for Policy Analysis DOE

N81-21633# Federal Lab Consortium, Washington, D C
THE ENERGY LINK CATALOG VOLUME 2: ENERGY RESOURCE CATALOG
P Thomas Stiko Feb 1980 136 p Prepared in cooperation with San Diego Science and Technology Action Center, Calif and Naval Weapons Center, China Lake Calif
(Grant NSF ISP-78-22221)
(PB81-140824, NSF/RA-800264, LLL-MISC-138-2) Avail NTIS HC A07/MF A01 CSCL 10A

The Energy Link Project, through the development of a simplified resource/technology locator system, has improved the accessibility and usability of resources from the Federal Laboratory system in the energy field This locator system was designed from the point of view of local government management This orientation allows the user to identify his needs and then retrieve the resources applicable to alternative solutions from the Federal Laboratory system Instructions are provided on how to use the catalog and obtain publications Entries are categorized and include title, abstract, contact, and availability GRA

N81-21645# Argonne National Lab, Ill Materials Science Div
STATE-OF-THE-ART REVIEW OF MATERIALS-RELATED PROBLEMS IN FLUE GAS DESULFURIZATION SYSTEMS
P S Maiya Oct 1980 45 p refs
(Contract W-31-109-eng-38)
(ANL-80-59) Avail: NTIS HC A03/MF A01

The chemical and mechanical environments to which the structural components used in flue gas desulfurization (FGD) are exposed are discussed Information pertinent to various FGD processes currently in use are reviewed with particular emphasis on lime/limestone scrubbing technology, so that the materials problems and processing variables encountered in FGD systems can be better defined and appreciated The report also describes the materials currently used and their performance to date in existing wet scrubbers With more extensive use of coal and flue gas scrubbers by utilities and other segments of private industry, a better understanding of the material failure mechanisms, performance limitations, and potential problem areas is required for the design of more reliable and cost effective FGD systems To meet the above objectives, a materials evaluation program is proposed DOE

N81-21949*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
RESEARCH AND TECHNOLOGY: ANNUAL REPORT Annual Report
1980 62 p
(NASA-TM-82314) Avail NTIS HC A04/MF A01 CSCL 05B

Activity conducted in the following areas is highlighted space sciences, space transportation systems, space and energy technology, and space terrestrial applications A R H

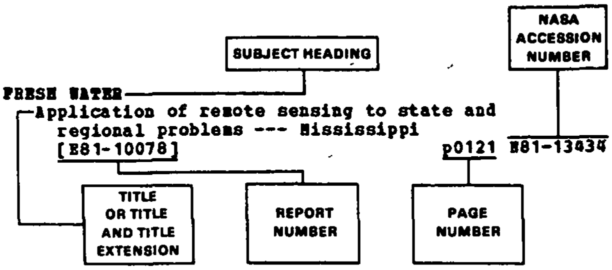
N81-21960# Logistics Management Inst, Washington, D C
DEFENSE ENERGY INFORMATION SYSTEM (DEIS): DEIS-80 SYSTEM DESIGN SPECIFICATION Final Report
Joan Lengel Aug 1980 177 p
(Contract MDA903-77-C-0370)
(AD-A096263, LMI-ML917) Avail NTIS HC A09/MF A01 CSCL 05/1

The Defense Energy Information System (DEIS) is a worldwide, automated, energy management information system It provides data on petroleum products used as mobility fuels by the military departments as well as most energy sources used for utility services at DoD installations DEIS consists of two related information systems DEIS 1 reports the disposition and consumption of petroleum products, notably aviation gasoline, jet fuels, motor gasoline, distillate and residual oils within DoD DEIS II reports the consumption of utility energy, such as electricity, natural gas, purchased steam/hot water, fuel oil and coal It reports the consumption and generation of energy from renewable sources This document presents the System Design Specification for the enhanced DEIS (DEIS 80) As specified, DEIS 80 improves the utility of the existing system by including additional data, supporting management queries of the DEIS 80 data bases on-line, and providing the capability for automated data analysis This system design specification serves as the guide for the computer programming of DEIS 80 It adheres to the requirement for system specification in the 'Automated Data Systems Documentation Standards' GRA

N81-21975# National Oceanic and Atmospheric Administration, Boulder, Colo Environmental Research Labs
SCIENTIFIC AND TECHNICAL PUBLICATIONS OF THE ENVIRONMENTAL RESEARCH LABORATORIES' FISCAL YEAR 1978 Bibliography, 1 Oct. 1977 - 30 Sep. 1978
Jun 1980 48 p
(PB81-141301, NOAA-80110406) Avail NTIS HC A03/MF A01 CSCL 05B

Approximately 675 citations in environmental research are presented Topics covered include investigation of ocean processes and their interactions with the atmosphere, studies of the ocean environment as it is affected by waste disposal and development of energy resources, fundamental studies of the upper atmosphere and space environments, lower atmosphere research on the weather and climates, research on tsunamis, severe local storms, and hurricanes, studies of weather modification, and the environmental effects of global pollution or similar influences on ecology, and development of equipment, instruments, systems, and facilities for these programs Publications from research contracts and work done by cooperating institutes, and international aid programs are included GRA

Typical Subject Index Listing



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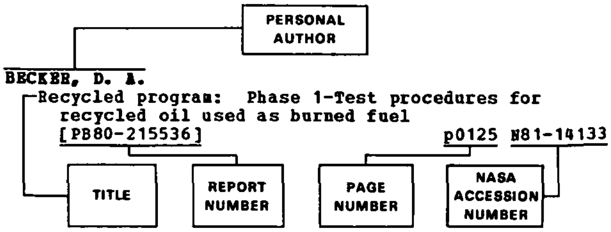
PERSONAL AUTHOR INDEX

Typical Personal Author Index Listing



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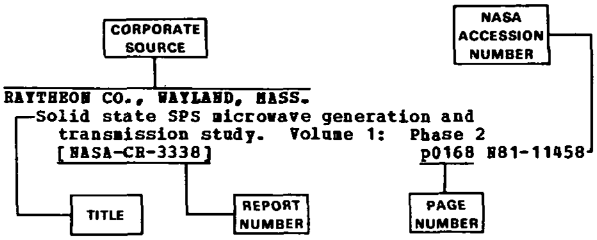

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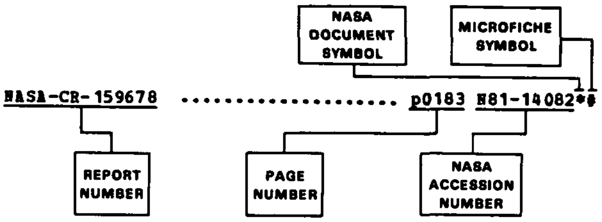

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