NASA SP-7043 (14)

ENERGY

A CONTINUING BIBLIOGRAPHY

WITH INDEXES

JULY 1977

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ACCESSION NUMBER RANGES

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

IAA (A-10000 Series)	A77-19299 – A77-30088
STAR (N-10000 Series)	N77-15974 – N77-22041

Previous publications announced in this series/subject category include:

DOCUMENT	*DATE*	*COVERAGE*
NASA SP-7042	April 1974	January 1968 – December 1973
NASA SP-7043(01)	May 1974	January 1, 1974 – March 31, 1974
NASA SP-7043(02)	November 1974	April 1, 1974 – June 30, 1974
NASA SP-7043(03)	February 1975	July 1, 1974 – September 30, 1974
NASA SP-7043(04)	May 1975	October 1, 1974 – December 31, 1974
NASA SP-7043(05)	August 1975	January 1, 1975 – March 31, 1975
NASA SP-7043(06)	October 1975	April 1, 1975 – June 30, 1975
NASA SP-7043(07)	December 1975	July 1, 1975 – September 30, 1975
NASA SP-7043(08)	February 1976	October 1, 1975 – December 31, 1975
NASA SP-7043(09)	April 1976	January 1, 1976 – March 31, 1976
NASA SP-7043(10)	July 1976	April 1, 1976 – June 30, 1976
NASA SP-7043(11)	October 1976	July 1, 1976 – September 30, 1976
NASA SP-7043(12)	January 1977	October 1, 1976 – December 31, 1976
NASA SP-7043(13)	April 1977	January 1, 1977 – March 31, 1977

This bibliography was prepared by the NASA Scientific and Technical Information Facility operated for the National Aeronautics and Space Administration by Informatics Information Systems Company.

NASA SP-7043 (14)

ENERGY

A Continuing Bibliography

With Indexes

Issue 14

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, 1977 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

Scientific and Technical Information Office JULY 1977
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington, D.C.

This Supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161, at the price code E05 ($9.00 domestic; $18.00 foreign).

INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(14)) lists 1000 reports, journal articles, and other documents announced between April 1, 1977 and June 30, 1977 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 listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. 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. The indexes are of the cumulating type throughout the year, with the fourth quarterly publication containing abstracts for the fourth quarter and index references for the four quarterly publications.

AVAILABILITY OF CITED PUBLICATIONS

IAA ENTRIES (A77-10000 Series)

All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies are available at $5.00 per document up to a maximum of 20 pages. The charge for each additional page is 25 cents. Microfiche[1] are available at the rate of $1.50 per microfiche for documents identified by the # symbol following the accession number. A number of publications, because of their special characteristics, are available only for reference in the AIAA Technical Information Service Library. Minimum airmail postage to foreign countries is $1.00. Please refer to the accession number, e.g., (A77-10121), when requesting publications.

STAR ENTRIES (N77-10000 Series)

One or more sources from which a document announced in *STAR* is available to the public is ordinarily given on the last line of the citation. The most commonly indicated sources and their acronyms or abbreviations are listed below. If the publication is available from a source other than those listed, the publisher and his address will be displayed on the availability line or in combination with the corporate source line.

Avail: NTIS. Sold by the National Technical Information Service. Prices for hard copy (HC) and microfiche (MF) are indicated by a price code followed by the letters HC or MF in the *STAR* citation. Price codes are given in the tables on page vii of the current issue of *STAR*.

Microfiche[1] is available regardless of age for those accessions followed by a # symbol.

Initially distributed microfiche under the NTIS SRIM (Selected Research in Microfiche) is available at greatly reduced unit prices. For this service and for information concerning subscription to NASA printed reports, consult the NTIS Subscription Unit.

NOTE ON ORDERING DOCUMENTS: When ordering NASA publications (those followed by the * symbol), use the N accession number. NASA patent applications (only the specifications are offered) should be ordered by the US-Patent-Appl-SN number. Non-NASA publications (no asterisk) should be ordered by the AD, PB, or other *report* number shown on the last line of the citation, not by the N accession number. It is also advisable to cite the title and other bibliographic identification.

Avail: SOD (or GPO). Sold by the Superintendent of Documents, U.S. Government Printing Office, in hard copy. The current price and order number are given following the availability line. (NTIS will fill microfiche requests, at the standard $3.00 price, for those documents identified by a # symbol.)

Avail: NASA Public Document Rooms. Documents so indicated may be examined at or purchased from the National Aeronautics and Space Administration, Public Documents Room (Room 126), 600 Independence Ave., S.W., Washington, D.C. 20546, or public document rooms located at each of the NASA research centers, the NASA Space Technology Laboratories, and the NASA Pasadena Office at the Jet Propulsion Laboratory.

(1) A microfiche is a transparent sheet of film, 105 by 148 mm in size, containing as many as 60 to 98 pages of information reduced to micro images (not to exceed 26:1 reduction).

Avail: ERDA Depository Libraries. Organizations in U.S. cities and abroad that maintain collections of Energy Research and Development Administration reports, usually in microfiche form, are listed in *Nuclear Science Abstracts*. Services available from the ERDA and its depositories are described in a booklet, *Science Information Available from the Energy Research and Development Administration* (TID-4550), which may be obtained without charge from the ERDA Technical Information Center.

Avail: Univ. Microfilms. Documents so indicated are dissertations selected from *Dissertation Abstracts* and are sold by University Microfilms as xerographic copy (HC) and microfilm. All requests should cite the author and the Order Number as they appear in the citation.

Avail: USGS. Originals of many reports from the U.S. Geological Survey, which may contain color illustrations, or otherwise may not have the quality of illustrations preserved in the microfiche or facsimile reproduction, may be examined by the public at the libraries of the USGS field offices whose addresses are listed in this introduction. The libraries may be queried concerning the availability of specific documents and the possible utilization of local copying services, such as color reproduction.

Avail: HMSO. Publications of Her Majesty's Stationery Office are sold in the U.S. by Pendragon House, Inc. (PHI), Redwood City, California. The U.S. price (including a service and mailing charge) is given, or a conversion table may be obtained from PHI.

Avail: BLL (formerly NLL): British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England. Photocopies available from this organization at the price shown. (If none is given, inquiry should be addressed to the BLL.)

Avail: ZLDI. Sold by the Zentralstelle für Luftfahrtdokumentation und -Information, Munich, Federal Republic of Germany, at the price shown in deutschmarks (DM).

Avail: Issuing Activity, or Corporate Author, or no indication of availability. Inquiries as to the availability of these documents should be addressed to the organization shown in the citation as the corporate author of the document.

Avail: U.S. Patent Office. Sold by Commissioner of Patents, U.S. Patent Office, at the standard price of 50 cents each, postage free.

Other availabilities: If the publication is available from a source other than the above, the publisher and his address will be displayed entirely on the availability line or in combination with the corporate author line.

GENERAL AVAILABILITY

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.

SUBSCRIPTION AVAILABILITY

This publication is available on subscription from the National Technical Information Service (NTIS). The annual subscription rate for the quarterly supplements is $30.00 domestic; $60.00 foreign. All questions relating to the subscriptions should be referred to NTIS, Attn: Subscriptions, 5285 Port Royal Road, Springfield Virginia 22161.

ADDRESSES OF ORGANIZATIONS

American Institute of Aeronautics
and Astronautics
Technical Information Service
750 Third Ave.
New York, N.Y. 10017

British Library Lending Division,
Boston Spa, Wetherby, Yorkshire,
England

Commissioner of Patents
U.S. Patent Office
Washington, D.C. 20231

Energy Research and Development
Administration
Technical Information Center
P.O. Box 62
Oak Ridge, Tennessee 37830

ESA-Space Documentation Service
ESRIN
Via Galileo Galilei
00044 Frascati (Rome) Italy

Her Majesty's Stationery Office
P.O. Box 569, S.E. 1
London, England

NASA Scientific and Technical Information
Facility
P.O. Box 8757
B. W. I. Airport, Maryland 21240

National Aeronautics and Space
Administration
Scientific and Technical Information
Office (KSI)
Washington, D.C. 20546

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Pendragon House, Inc.
899 Broadway Avenue
Redwood City, California 94063

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

University Microfilms
A Xerox Company
300 North Zeeb Road
Ann Arbor, Michigan 48106

University Microfilms, Ltd.
Tylers Green
London, England

U.S. Geological Survey
1033 General Services Administration
Building
Washington, D.C. 20242

U.S. Geological Survey
601 E. Cedar Avenue
Flagstaff, Arizona 86002

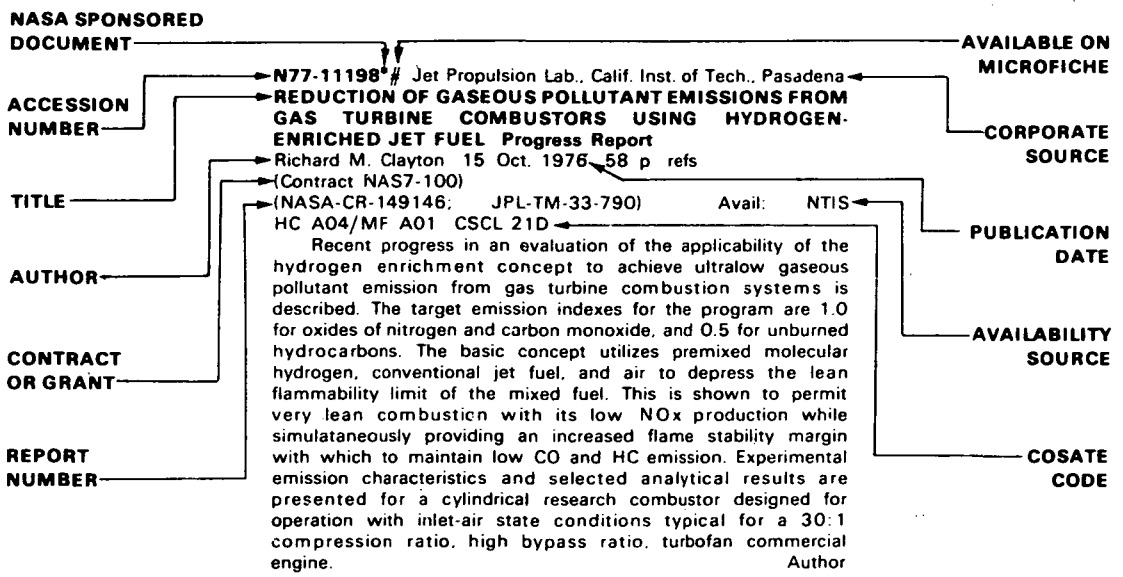
U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94025

U.S. Geological Survey
Bldg. 25, Denver Federal Center
Denver, Colorado 80225

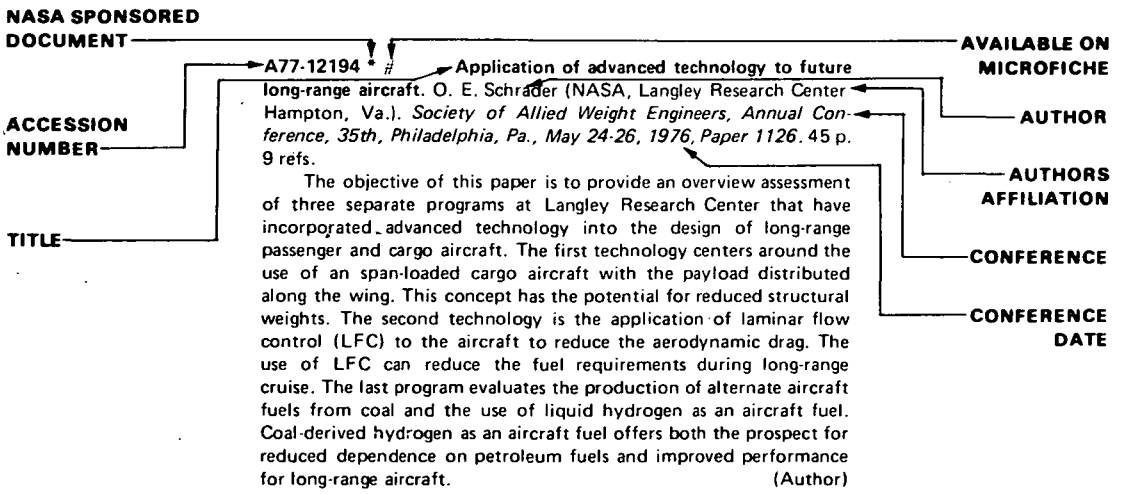
Zentralstelle für Luftfahrtdoku-
mentation und -Information
8 München 86
Postfach 880
Federal Republic of Germany

TABLE OF CONTENTS

TYPICAL CITATION AND ABSTRACT FROM *STAR*



TYPICAL CITATION AND ABSTRACT FROM *IAA*



A Listing of Energy Bibliographies Contained In This Publication:

ENERGY

A Continuing Bibliography (Issue 14)

JULY 1977

IAA ENTRIES

A77-19635 **Ceramic thin film CdTe solar cell.** N. Nakayama, H. Matsumoto, K. Yamaguchi, S. Ikegami, and Y. Hioki (Matsushita Electric Industrial Co., Ltd., Wireless Research Laboratory, Osaka, Japan). *Japanese Journal of Applied Physics*, vol. 15, Nov. 1976, p. 2281, 2282. Research supported by the Agency of Industrial Science and Technology.

An experimental investigation was performed on a ceramic thin film CdTe solar cell fabricated by the screen printing method. The film has a resistivity of about 0.2 ohm-cm and a film thickness of about 20 microns. The volt-ampere characteristics of the cell were observed under 1.0 solar constant illumination level, with the conversion efficiency of the cell evaluated as 8.1%. The spectral response of the short-circuit current, normalized to constant incident energy, is presented. For easy analysis of microstructure at the junction level, a specimen having a thick Cu2Te layer was prepared. An X-ray microanalyzer was then used to observe the distribution curves of the elements (Cu, Cd) and the electron voltaic effect on the cross section near the junction. B.J.

A77-19706 **Liquid flow pattern in extraction of geothermal energy.** G. N. Kononenko, M. B. Sidorovskaia, and A. S. Tsyrul'nikov (Akademiia Nauk Ukrainskoi SSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR). *Fluid Mechanics - Soviet Research*, vol. 5, Jan.-Feb. 1976, p. 34-40. Translation.

Various aspects of coolant flow in underground thermal circulation systems with a three-dimensional filtration zone are examined. Graphs of the effect of various factors on pressure loss in this circulation system are presented. (Author)

A77-19833 # **Slag interaction phenomena on MHD generator electrodes.** D. B. Stickler and R. DeSaro (Avco Everett Research Laboratory, Inc., Everett, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif., Jan. 24-26, 1977, Paper 77-109.* 13 p. 20 refs. Research supported by the Electric Power Research Institute.

Coal slag layer development and equilibration in an open cycle MHD generator has been investigated. The purpose is to define requirements imposed on flow system and electrode design by generator operation on potassium seeded plasma produced by direct coal combustion. Experiments at 0.7 Kgm/sec flow have been conducted using clean fuel with oxygen enriched air, with coal ash fed to simulate coal combustor mineral carryover. Results indicate that a stable, flowing slag layer can be developed, that it is self renewing via deposition from the gas and shear flow, and that it is compatible with base load generator operation. Constraints on combustor slag carryover quantity and composition, system flow field, and electrode design are described. (Author)

A77-19848 # **Potential aerodynamic analysis of horizontal-axis windmills.** E. O. Suciu, R. D. Preuss, and L. Morino (Boston University, Boston, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif., Jan. 24-26, 1977, Paper 77-132.* 11 p. 16 refs. NSF Grant No. AER-75-00548; Contract No. E(49-18)-2415.

The problem of a horizontal-axis windmill in steady, incompressible, potential flow is considered. The problem is formulated in a frame of reference rigidly connected with the rotor. Two different integral equations are presented. The finite-thickness integral equation relates the values of the potential on the surface of the windmill to the values of the normal derivative, which are known from the boundary conditions. The wake is treated as a doublet layer of prescribed helicoidal geometry. In order to solve the integral equation, the windmill surface is divided into small quadrilateral surface elements. The values of the potential and its normal derivative within each element are assumed to be constant and equal to the values at the centroid of the e ement. This yields a set of linear algebraic equations in the unknown values of the potential. The zero-thickness integral equation and the corresponding numerical formulation are obtained as the limit of the finite-thickness one. Numerical results are presented. (Author)

A77-19886 # **Annular-flow solar heater collector tubes.** A. J. Saber (Concordia University, Montreal, Canada). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif., Jan. 24-26, 1977, Paper 77-190.* 7 p. 7 refs.

An electrical analogy model shows that the heat transfer to solar heater collector tubes is improved when flow is restricted using a central core. The prediction is substantiated by experiments on such annular-flow devices. Tests on a 1.6 cm O.D. by 76 cm long cylindrical copper collector tube with a 0.1 cm wall, using water, reveal a 50% improvement over the unrestricted case at 1.5 g/sec flow when a 0.6 cm diameter brass core lies along the centerline. However, for other flow rates from 0.2 to 4.0 g/sec improvement diminishes. The results are explained on the basis of decreased boundary layers in the annular flow tube for the same mass flow as the unrestricted case. Non-solar applications to boiler, radiator and heater design are suggested. (Author)

A77-19887 * # **Effects of one-sided heat input and removal on axially grooved heat pipe performance.** Y. Kamotani (NASA, Goddard Space Flight Center, Greenbelt, Md.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif., Jan. 24-26, 1977, Paper 77-191.* 8 p. 6 refs.

The performance of an axially grooved heat pipe with one-sided heat input and removal was investigated analytically. Under zero-g condition the maximum heat transport of the pipe may decrease as much as 30% depending on the liquid slug behavior in the condenser section. In one-g environment the performance depends mainly on the fluid charge. The maximum heat transport, if over-charged, is almost equal to the value for uniform heating and cooling due to puddling effect. However, for some heater-cooler combinations the temperature drop across the heat pipe becomes very large. Computed results for tilted heat pipes compare favorably with available experimental data. (Author)

A77-19918 **Lasers and controlled thermonuclear fusion. I (Le laser et la fusion thermonucléaire contrôlée. I).** J.-L. Bobin (Commissariat à l'Energie Atomique, Centre d'Etudes de Limeil,

Villeneuve-Saint-Georges, Val-de-Marne, France): *L'Onde Electrique,* vol. 56, June-July 1976, p. 319-324. In French.

A tentative assessment is begun of empirical progress and theoretical advances in approaching thermonuclear fusion conditions via implosion of pellets or shells by a focused laser beam. Self-sustained explosive thermonuclear reactions, required energy densities, and isentropic compression conditions are reviewed. The behavior of solid pellets and hollow shells under concentrated laser bombardment is compared. Density, temperature, and pressure variations in the interaction of a laser beam and a solid surface, and ablation, absorption, or conduction, are studied. Typical low efficiencies of laser implosion processes to date are indicated. R.D.V.

A77-20004 # **Problems of transportation power plants (Problemy transportnoi energetiki).** D. P. Velikanov. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport,* Nov.-Dec. 1976, p. 135-145. 8 refs. In Russian.

A survey is presented of power plants and consumption of energy resources in transportation in the USSR. Comparative data are presented on energy consumption by various types of vehicles and conveyances (including: railways, automotive, maritime, waterways, pipeline, municipal electrically powered transportation, and aircraft). Types of fuel (gasoline, diesel oil, fuel-oil, electric power, natural gas, and coal) and transport parameters (vehicular speed, average fuel burning rate, passenger capacity, net mass, and kg fuel per seat-km) are given in tabular form, and new forms of transportation (VTOL, STOL, ACV, foilborne rivercraft, vehicles powered by gas turbine plants, and trains moving on air cushions) are included in the survey. Some estimates are offered for experimental vehicles powered by electric batteries, fuel cells, or experimental engines. R.D.V.

A77-20042 # **Wind power (Vindkraft).** Lyngby, Akademiet for the tekniske Videnskaber, 1975. 20 p. 7 refs. Translation.

The present report contains the findings of a Committee set up to study the conditions for wind energy utilization in Denmark, mainly on the basis of wind climate recordings at 31 domestic meteorological survey stations. The major conclusions are that economically efficient wind power plants can be built at spots characterized by high average wind speeds, such as the Faroe Islands. This, however, must be preceded by extensive research and development work with respect to wind-power plant equipment and design. V.P.

A77-20074 # **Coal gasification and its relation to tested power plants (A szenelgazositas es vizsgalt eromuvi kapcsolatai).** B. Gergely (Budapesti Muszaki Egyetem, Budapest, Hungary). *Energia es Atomtechnika,* vol. 29, Nov. 1976, p. 481-487. In Hungarian.

Coal gasification (CG) processes, both autothermic and with nuclear power backup, are described, with flowsheets, along with dual-power plants based on combined gas and steam use, and combined nuclear and CG plants. Gasification of coal with the aid of heat from high-temperature reactors (HTR) is given close attention, along with the transportation of gas from combined HTR-CG plants to distant users, as part of a regional energy utilities system. Flowsheets using lignite or bituminous coals, with slag, methane, coke, tar, CO2, H2S product streams, are presented. The outlook for profitable combined HTR-CG plants under present Hungarian conditions is examined, along with gas-heating and water-heating applications, with cautious optimism. R.D.V.

A77-20102 # **Principles of atomic central heating (Printsipy atomnoi teplofikatsii).** L. A. Melent'ev (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *Teploenergetika,* Nov. 1976, p. 6-9. In Russian.

The economic and engineering aspects of the utilization of nuclear reactor fuel are studied. It is shown that optimal utilization of such fuel in the heat and energy balance of the USSR is possible only if it finds widespread use both for power and heat supply. Some aspects of the selection and production of turbines for central-heating atomic power plants, including selection of the optimal heating coefficient and steam and hot-water parameters, are examined. V.P.

A77-20105 # **Some results of an investigation with the U-25 experimental-industrial facility, aimed at raising its parameters to the design level (Nekotorye itogi issledovanii na opytno-promyshlennoi ustanovke U-25 po dovodke ee do proektnykh parametrov).** V. A. Kirillin and A. E. Sheindlin. *Teploenergetika,* Dec. 1976, p. 2-7. 9 refs. In Russian.

The work described was performed over a period of several years to improve the parameters of the U-25 energy converter employing a 25-MW MHD-generator. The major topics discussed include refinement of the hardware, the technological processes, and the operation of thermally stressed combustion chambers and of mixing systems for ionizing additions. Attention is given to studies of MHD-channel operation and to problems involved in the conversion of direct to alternating current. V.P.

A77-20107 # **Measurement of the excess oxidant ratio in the combustion products of an MHD-generator (Ob izmerenii koeffitsienta izbytka okislitelia v produktakh sgoraniia MGD generatora).** M. S. Pinkhasik, V. D. Mironov, I. A. Zakharko, and A. I. Plavinskii (IVTAN; Vsesoiuznyi Teplofizicheskii Institut, USSR). *Teploenergetika,* Dec. 1976, p. 10-14. 6 refs. In Russian.

The determination of the excess oxidant ratio is of importance for the optimization of the operation of an MHD-generator and its combustion chamber (plasma generator). In the present paper, it is shown experimentally that an electrochemical gas analyzer can be use successfully to measure excess oxidant ratios smaller than unity. An expression is derived which relates the emf of an electrochemical gas analyzer to the excess oxidant ratio (smaller than unity) in the case of a 40% oxygen enrichment of the oxidant and the presence of ionizing additions. V.P.

A77-20109 # **Heat tests with a GT-35 gas turbine as an element of steam-gas facility with a high-pressure steam generator (Teplovye ispytaniia gazoturbinnoi ustanovki GT-35 v sostave PGU s vysokonapornym parogeneratorom).** G. G. Ol'khovskii, L. B. Povolotskii, M. P. Kaplan, A. O. Bumarskov, A. I. Belov, L. I. Chernomordik, and P. I. Korzh (Khar'kovskii Turbogeneratornyi Zavod, Kharkov, Ukrainian SSR; Vsesoiuznyi Teplofizicheskii Institut, USSR). *Teploenergetika,* Dec. 1976, p. 51-55. In Russian.

The gas turbine of the PGU-200 power plant can be drived either by combustion or with steam generated in a boiler. The tests described in the present paper were carried out at loads of up to 35 MW. At maximal loads, the rate of airflow through the compressor was between 220 and 240 kg/sec; the pressure behind the compressor was 0.67 to 0.72 MPa, and the mean temperature in front of the turbine was 700 to 735 C. These parameters satisfy the required operating conditions of the high-pressure boiler and the installation itself. The indices of the major turbine elements were compatible with the design values: a compressor efficiency of 86 to 87%; a turbine efficiency of 87 to 88%; and a throughput of 1.00 to 1.01. Recalculated to autonomous operation and standard external conditions, the turbine power was 30.5 to 31.5 MW and the efficiency was 23.3 to 23.7%. V.P.

A77-20381 **Flue gas desulfurization experience.** M. Esche (Saarberg-Hölter Umwelttechnik GmbH, West Germany) and W. Meyer (Saarbergwerke AG, West Germany). *Power Engineering,* vol. 81, Jan. 1977, p. 56-59.

On-stream experience with a Saarberg-Hölter flue gas desulfurization (FGD) process applied at a power station in SW Germany is described. The FGD wet scrubbing process works on line, using special additives, requiring about 0.95% of the power of the 150 MW coal-fired power plant. The flowchart of the process is displayed, and process steps (scrubbers, washing, rotational partial separator, chemical treatment, processing of SO2 absorption) are described. The FGD facility has been on stream for 11,000 h, with 90% availability during the first year. The recovered gypsum product is used in wallboard fabrication. R.D.V.

A77-20388 **Demand electric rates - A new problem and challenge for solar heating.** G. Mills (CMK Industries, Englewood, Colo.). *ASHRAE Journal,* vol. 19, Jan. 1977, p. 42-44.

With the increasing number of solar heating installations, public utilities are beginning to realize the possible effects that these installations may have on their operations. As a result they are beginning to change their rate structures to protect themselves and their customers from these effects. For example, the Public Service Company of Colorado has received permission to charge all new residential customers who use electricity as their primary source of heat or as their primary backup source on what is called a demand/energy rate. This demand/energy rate structure bases the charge for electrical service on the total KWh used, plus the kW load determined by the 15-minute period in which the maximum use was recorded during the monthly billing period. Ways to overcome the problems facing solar heating system designers implicit in this new rate structure are suggested. B.J.

A77-20390 ***The energy crisis today - A perspective.*** W. S. Smith (American Road Builder's Association, Washington, D.C.; South Carolina Safety Council, S.C.). *Traffic Quarterly,* vol. 31, Jan. 1977, p. 5-19. 21 refs.

What is known about energy and its present crisis is reviewed. The nature of energy supply and demand is discussed and a number of solutions to the energy shortage: short-range, medium-range, and long-range are examined. Some interesting medium-range solutions are substitutes for petroleum, solar energy, wind energy, geothermal energy, and nuclear (fission and fusion) power. Some environmental problems are discussed along with the role of energy in transportation. B.J.

A77-20391 **Commuter van programs - An assessment.** G. K. Miller and M. A. Green (Urban Institute, Washington, D.C.). *Traffic Quarterly,* vol. 31, Jan. 1977, p. 33-57. 21 refs. Research supported by the Urban Mass Transportation Administration.

Commuter van service is defined as a prearranged ride-sharing form in which vans are used for regular tripmaking between home and workplace, with a distinction made between vanpooling where the driver does not receive a fee and a subscription service where the driver receives compensation and the passengers pay in advance. Attention is given to existing commuter van operations, organized chiefly by private companies (a table is presented). The benefits of such a service are discussed including cost savings, energy savings, and reduction of the number of cars at the work site. Desirable service characteristics are discussed along with legal issues (public regulation, liability and insurance, and competition with conventional transit). B.J.

A77-20392 **Applications of new systems to urban transportation.** R. C. Rand and W. Avery (John Hopkins University, Baltimore, Md.). *Traffic Quarterly,* vol. 31, Jan. 1977, p. 97-117. 11 refs.

Systems are investigated that might provide service capable of attracting travelers away from automobiles at today's prices. Such systems would have the following characteristics: (1) area-wide coverage making trip possible from any part of the urban area to any other part, (2) access to within one-fourth mile from all points within the area covered, and (3) trip times (door to door) including walking and waiting, comparable to prevailing automobile trip times. The analysis is conducted using Baltimore in 1962 (traffic patterns are similar to those of the present) as the transportation data base. The candidate systems are (1) Group Rapid-Transit Systems consisting of medium-sized vehicles carrying 25-30 people, (2) Personal Rapid Transit Systems consisting of small single-party vehicles and offering demand-actuated station-to-station service on dedicated guideways, (3) Moving Way Systems which include cable-drawn vehicles as well as moving walkways, and (4) ski-lift systems. A cost analysis of these systems is presented. B.J.

A77-20397 **Equations for cold production of an absorption refrigerating solar unit (Uravneniia dlia kholodoproizvoditel'nosti absorbtsionnoi kholodil'noi solnechnoi ustanovki /AKhSU/).** A. Kakabaev, N. Orazmukhamedov, and A. Khandurdyev (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). *Akademiia Nauk Turkmenskoi SSR, Izvestiia, Seriia Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk,* no. 5, 1976, p. 60-65. In Russian.

Equations are derived for the cold productivity of a solar refrigerating unit which operates on the principle of regeneration of weak aqueous solutions of salts (LiCl and LiBr) on a solar-irradiated open surface. The equations describe the relation of the cold productivity of the unit as a whole to the productivities of the heat transfer surfaces of different components, taking account of heat and mass transfer coefficients, and consumption of cooled water. To simplify the analysis, it is assumed that there are no heat or cold losses in separate components of the unit except from the regenerator surface, and that water vapor pressure in the absorber and evaporator is equal. B.J.

A77-20521 **Demonstration of pyrolysis and materials recovery in San Diego, California.** Y. M. Garbe (U.S. Environmental Protection Agency, Resource Recovery Div., San Diego, Calif.). *Waste Age,* vol. 7, Dec. 1976, p. 82-85.

Process equipment, flowchart, product streams, and waste recovery system of a facility for pyrolysis of solid wastes and recovery of trash glass and aluminum are discussed, along with tests and evaluation of system performance. The plant converts the organic fraction of municipal solid waste into a storable pyrolytic 'oil' resembling No. 6 oil (low sulfur, high viscosity, fluidity increasing with temperature). The pyrolytic reactor, froth flotation cells for glass recovery, an eddy current separation step using linear induction motors for separation of aluminum, and some additional processing and storage techniques (storage of shredded solid waste, doffing roll bins for storing and metering shredded material, zig zag air classifier, trommel preseparation of glass and Al-rich fractions) are described. R.D.V.

A77-20685 * **Electric load management and energy conservation.** N. A. Kheir (Alabama, University, Huntsville, Ala.). In: Annual Southeastern Symposium on System Theory, 8th, Knoxville, Tenn., Apr. 26, 27, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 108-115. 26 refs. Grant No. NGT-01-003-044.

Electric load management and energy conservation relate heavily to the major problems facing power industry at present. The three basic modes of energy conservation are identified as demand reduction, increased efficiency and substitution for scarce fuels. Direct and indirect load management objectives are to reduce peak loads and have future growth in electricity requirements in such a manner to cause more of it to fall off the system's peak. In this paper, an overview of proposed and implemented load management options is presented. Research opportunities exist for the evaluation of socio-economic impacts of energy conservation and load management schemes specially on the electric power industry itself. (Author)

A77-20686 **Regression study of solar radiation and electrical energy consumption.** J. S. Tiller (Georgia Institute of Technology, Atlanta, Ga.). In: Annual Southeastern Symposium on System Theory, 8th, Knoxville, Tenn., Apr. 26, 27, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 116-121. NSF-Grant No. SIA-74-20662.

To test the reliability of a solar energy system in delivering a specific load of electric power, correlation and regression analyses were performed concerning solar insolation and electrical consumption for a site in Florida and another in Georgia, based on available solar data on horizontal radiation levels. The objective was to determine whether electrical demand increases when solar radiation is intense. The regression analysis showed that for both sites, solar insolation and electricity are positively correlated. The correlation, however, is not high enough to negate very low levels of radiation during periods of high demand. Potential benefits of solar energy storage are discussed. Actual operating systems, situated at an angle, would recive more intense radiation, especially in winter. S.D.

A77-20699 **Amtrak's newest turboliners.** *Gas Turbine International,* vol. 17, Nov.-Dec. 1976, p. 10-14.

The design of the gas turbine engine (GTE) propelled Rohr Turboliner passenger trains being tested on NY State Amtrak is outlined, with attention given to the GTE proper, ratings, and truck suspension. The 125 mph design speed is not currently attained because of track conditions; GTE output is rated 1140 hp, and speed is 5700 rpm maximum. The train is capable of operating on or off the third rail (on via a separate motor), requires no turnaround at the end of the route, and features variable (quick-change) seating density. The advanced dual suspension system of the trucks, effectively isolating the car bodies and passengers from track irregularities, and with controls for high speed-curve handling (aided by low train C. of G.), is described. R.D.V.

A77-20706 # **Electron beam research at Sandia Laboratories, USA.** G. Yonas (Sandia Laboratories, Albuquerque, N. Mex.). In: Experimental aspects of laser and electron-beam produced thermonuclear plasmas; Proceedings of the Meeting, Trieste, Italy, August 25-29, 1975. Vienna, International Atomic Energy Agency, 1976, p. 43-47.

Investigations are conducted concerning the feasibility of using intense electron beams to achieve inertial confinement fusion. The program includes the development of electron accelerators of increasingly higher power. Major technical questions currently under study are related to the delivery of intense beams to targets of a few mm diameter, problems concerning an efficient energy absorption, the symmetry of ablation, and the stability of spherically imploding shells. The outline of a theoretical program is discussed, taking into account aspects of diode physics, the characteristics of fluid models, hydrodynamic code modeling of target response, and target design questions. A description of an experimental program involving the use of three types of electron accelerators is also provided. G.R.

A77-20717 # **Air transport propulsion for the 1980's.** J. W. Witherspoon (United Technologies Corp., Commercial Engineering Dept., East Hartford, Conn.). In: Air transportation for the 1980's. College Park, Md., University of Maryland, 1976, p. 153-225.

It is maintained that the days are past when technology alone determines the success or failure of a new aircraft engine, and that in order to market a new engine, one must prove that the combined aircraft-engine system will provide an attractive return on investment to the airlines, and that it will be environmentally acceptable in terms of noise and emissions. Attention is given to propulsion technology that will be important in the 1980s, including the JT8D refan engine, the JT10D engine, and the reduction of fuel consumption through component development. Also considered are the energy shortage and future engine cycles, and the development of SST engines. B.J.

A77-20725 **Deashing of coal liquefaction products via partial deasphalting. I - Hydrogen-donor extraction effluents. II - Hydrogenation and hydroextraction effluents.** E. Gorin, C. J. Kulik, and H. E. Lebowitz (Conoco Coal Development Co., Library, Pa.). *(American Chemical Society, National Meeting, 169th, Philadelphia, Pa., Apr. 6-11, 1975.) I & EC - Industrial and Engineering Chemistry, Process Design and Development,* vol. 16, Jan. 1977, p. 95-107. 18 refs.

The first part of the work describes the de-ashing of extraction effluents produced by hydrogen-donor extraction of bituminous and subbituminous coals by batch and continuous gravity settling with and without the use of de-asphalting solvents to accelerate the settling process. The second part presents data on the extension of the same de-ashing technique to coal liquefaction products produced by direct hydrogenation of Illinois No. 6 bituminous coal. The de-ashing experiments were carried out both with products produced by liquid-phase hydrogenation in the presence of an ebullated bed of hydrofining type catalyst (H-Coal Process) and with products produced by hydroextraction without added catalyst. In contrast to the donor extraction case, the addition of a de-asphalting solvent is required in both the H-Coal and hydroextraction cases to obtain an acceptable rate of de-ashing. The use of coal-derived saturated distillates as precipitants is presently under investigation. S.D.

A77-20742 # **On the solar energy problem (K probleme solnechnoi energetiki).** I. I. Sobel'man (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR). *Uspekhi Fizicheskikh Nauk,* vol. 120, Sept. 1976, p. 85-96. 20 refs. In Russian.

Economically competitive conversion of the energy of solar radiation into heat and electricity is reviewed. Attention is centered on solar heating to fairly high temperatures (in the neighborhood of 500 C) and on the use of modern heat power machinery and turbines to convert solar heat to electric power. The need for fairly simple solar radiation concentrators, selective collectors, and selective coatings is emphasized, and the spectral properties of gaseous selective collectors (IBr in particular) are discussed. The feasibility of large-scale solar-powered electric power generating stations is contemplated, and attention is given to costs of solar-derived electric power. R.D.V.

A77-20749 # **An automatic solar disk tracking system for incident energy measurements (Un sistema automatico di puntamento del disco solare per misure di energia incidente).** G. Bolle, P. Marietti (Roma, Università; CNR, Gruppo Nazionale Struttura della Materia, Rome, Italy), and G. Ciccarella (L'Aquila, Università, L'Aquila, Italy). *Alta Frequenza,* vol. 45, Nov. 1976, p. 715-723. 6 refs. In Italian.

An automatic solar disk tracking system, its performance, efficiency, limitations, and structure, are described. Clear-day insolation data for systems directly converting solar energy to heat, ways of separating the energy due to direct or diffuse incident radiation on the capture surface, and mechanical and electrical components of the tracking system are discussed. The stability of the control system is characterized by absence of limit cycles. The tracking system is adaptable to solar heat systems employing concentrators or flat-plate collectors, features simple design and low cost, can be oriented in any position, and offers precision tracking to within one degree. R.D.V.

A77-20951 # **The helium turbine - A power station of the future (Die Heliumturbine - Ein Kraftwerk der Zukunft).** K. Bammert (Hannover, Technische Universität, Hanover, West Germany). *Hannover, Technische Universität, Zeitschrift,* vol. 3, no. 2, 1976, p. 20-31. 5 refs. In German.

Current nuclear power stations have a relatively low operational temperature. A significant improvement in operational efficiency can be obtained by employing high temperature reactors (HTR). The HTR use helium as cooling medium. In a two-circle system, the heat from the HTR carried by the helium is used as energy source for the operation of steam turbines. In a one-circle system, the helium itself is employed as the operational medium for gas turbines. The turbines in both cases are coupled to generators. Details of system design are discussed, taking into account operational aspects, the utilization of waste heat, the control of the helium turbine system, the design of helium turbomachines, the design of high-power helium turbines, nuclear power stations with helium turbines according to conventional and to integrated design concepts, a power station with helium turbine using fossil fuels, and approaches for waste heat disposal. A brief description is also given of solar-energy power stations with helium turbines. G.R.

A77-20999 **Energy balance for anaerobic digestion.** S. I. Ojalvo and J. D. Keenan (Pennsylvania, University, Philadelphia, Pa.). *Journal of Environmental Systems,* vol. 6, no. 3, 1976-1977, p. 183-198. 16 refs.

A model is developed which describes the energy balance of an anaerobic digestion system for energy recovery from organic wastes. The model is used to evaluate the energy efficiency of the process which consists of pre-treatment including primary shredding, magnetic separation, trommel screening, secondary shredding and air classification of the organic fraction; anaerobic digestion yielding methane fuel gas; gas scrubbing for removal of carbon dioxide and hydrogen sulfide; and dewatering of the waste solids. The results

indicate that energy efficiencies for the entire process, excluding transportation of input and output materials, of 48 to 65 per cent are possible; and, 20 to 30 per cent are achievable with present technology. The system is relatively insensitive to front-end and back-end power requirements and to the energy needed for digester operation and maintenance. The most significant factor influencing energy conversion efficiency is the rate and degree of completion of the digestion process. (Author)

A77-21018 **Composition and size distribution of in-stack particulate material at a coal-fired power plant.** E. S. Gladney (California, University, Los Alamos, N. Mex.), J. A. Small, G. E. Gordon, and W. H. Zoller (Maryland, University, College Park, Md.). *Atmospheric Environment,* vol. 10, no. 12, 1976, p. 1071-1077. 33 refs. ERDA-supported research; NSF Grant No. GI-36338X.

A77-21025 **Response of a partially illuminated solar cell.** B. M. Seth (Delhi, University, Delhi, India) and S. R. Dhariwal (Government College, Ajmer, India). *International Journal of Electronics,* vol. 42, Jan. 1977, p. 41-48. 8 refs. Research supported by the University of Delhi.

Collection efficiency of a solar cell partially illuminated by light is calculated by considering two-dimensional diffusion. The effect of surface recombination at the edges is considered as a perturbation. It is found that the collection efficiency of a cell can be improved by concentrating light at its center. (Author)

A77-21154 **A microwave energy converter with a reversing magnetic field.** V. A. Bardenkov, V. A. Vanke, I. S. Gorshkov, and V. M. Lopukhin. *(Radiotekhnika i Elektronika,* vol. 21, Apr. 1976, p. 821-828.) *Radio Engineering and Electronic Physics,* vol. 21, Apr. 1976, p. 107-113. 18 refs. Translation.

The microwave energy converter described in this paper operates in the following way: the microwave signal enters a Cuccia resonator with a transverse magnetic field and imparts additional kinetic energy to the electron flux in the form of azimuthal rotation of the beam about the axis of the system. A reversible magnetic field changes its sign, thus converting the energy of beam rotation into additional longitudinal energy equal (at 100% conversion efficiency) to the energy of the microwave signal. A numerical analysis is performed on the conversion of the rotational energy of the beam to longitudinal energy and it is shown that the efficiency of this conversion can exceed 90% if the length of the reversible magnetic field region is equal to or greater than the cyclotron wavelength. B.J.

A77-21214 **Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, University of Pennsylvania, Philadelphia, Pa., May 24-26, 1976.** Symposium sponsored by the University of Pennsylvania. Edited by B. Zauderer. Philadelphia, Pa., GE Space Sciences Laboratory, 1976. 415 p. $20.

Electrode and wall phenomena are considered, taking into account a joint test of a U.S. electrode system in the USSR U-02 MHD facility, a U.S. electrode wall for testing in the USSR U-02 MHD facility, recent MHD generator studies at an American company, slag-refractory behavior under hot wall generator conditions, axial field limitations in MHD generators, and an investigation of physical processes in the near-electrode region of MHD generators. Other subjects discussed are related to electrode materials and slag properties, MHD systems, combustion gas generators, liquid metal MHD generators, inert gas MHD generators, and auxiliary components. G.R.

A77-21215 # **Joint test of an U.S. electrode system in the U.S.S.R. U-02 facility.** W. D. Jackson (ERDA, Washington, D.C.), S. J. Schneider (National Bureau of Standards, Washington, D.C.), W. E. Young (Westinghouse Research Laboratories, Pittsburgh, Pa.), A. E. Sheindlin, G. P. Telegin, and D. K. Burenkov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. (A77-21214 08-75) Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. I.1.1-I.1.12.

A description is presented of a test which has been conducted in September 1975 as part of the U.S.-USSR cooperative program on MHD. The test involved an experiment with a section of an MHD generator which consisted of U.S. designed anode and cathode modules and USSR-supplied insulating walls. The test had the objective to evaluate the behavior and performance of the electrode system and to establish the characteristics of the various materials of constructions during long-term operation under real MHD conditions. G.R.

A77-21222 # **In-channel observations on coal slag.** J. K. Koester, M. E. Rodgers, and R. H. Eustis (Stanford University, Stanford, Calif.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. I.6.1-I.6.10. 8 refs. Research supported by the Electric Power Research Institute.

Experiments on slag depositions and on electric current transport through slag layers under MHD generator duct conditions are described. The fluid mechanics of slag layers were studied using a synthetic ash, a Pittsburgh coal, and a Montana coal. Slag layer development, deposition onto various surfaces, and transverse ripple behavior were observed. The slag layer composition and microstructure were investigated. The slag layer response to applied electric fields was measured with voltage probes and cinephotography. Diffuse and arc modes of slag current transport were observed. Results for a smooth surface, diffuse discharge slag layer model are presented. The regime for the diffuse mode was very sensitive to the electrode surface temperature. A correlation is suggested for defining the diffuse mode stability boundary. (Author)

A77-21223 # **Replenishment processes and flow train interaction.** D. B. Stickler and R. DeSaro (Avco Everett Research Laboratory, Inc., Everett, Mass.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. I.7.1-I.7.10. 9 refs. Research supported by the Electric Power Research Institute.

Measurements have been conducted of slag layer development and properties in subsonic and in supersonic flows. Test conditions were designed to simulate baseload generator conditions. Local calorimetry methods were employed and still photography was used. Optical bolometers, scanning over the wall, were also utilized. The experimental observations are discussed, taking into account flow field and transport results. Attention is given to aspects of slag layer growth modeling and to questions related to current transport and reentrainment boundaries. G.R.

A77-21224 # **Slag layers in direct coal-fired MHD power generation.** L. W. Crawford, J. B. Dicks, M. S. Beaton, J. Whiteford, and J. W. Muehlhauser (Tennessee, University, Tullahoma, Tenn.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. I.8.1-I.8.6. Contract No. E(49-18)-1760.

Aspects of coal slag layers formed in the MHD generator of the MHD power generation system at The University of Tennessee Space Institute are described. Scanning electron micrographs show features and energy dispersive X-ray spectra of the slag layers show elemental composition (qualitative) and distribution in the layers. Sulfur is in higher concentration near the cold surface for the cathode than near the hot surface, while the reverse occurs for silicon and aluminum. For the anode, the sulfur is in lower concentration near the cold surface than near the hot surface. Potassium occurs through the layers. Electrode metal (copper, nickel from Inconel) occurs near the cold surface in higher concentrations than background. For copper the higher concentration remains at the cold surface, apparently indicating a chemical reaction during layer buildup. Isolated areas of nickel have been identified all the way to the plasma surface of the slag layer for an anode sample. (Author)

A77-21227 # **Test results on the spinel electrode module in laboratory and simulated MHD environment.** R. L. Pober, J. Nash-Webber, M. Yoshimura, and H. K. Bowen (MIT, Cambridge, Mass.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. II.3.1-II.3.4. 9 refs. ERDA-supported research.

A description is given of the design and the operational characteristics of a small-scale MHD simulation facility which was constructed for the evaluation of materials and electrode assemblies in a realistic environment. The facility can also be used for the study of slag-layer fluid mechanics and for instrumentation development work. Recent results considered are related to the testing of iron-base spinel and other electrode assemblies in clean and slagging environments. Attention is given to physical property data concerning electrode and insulator, aspects of electrode module fabrication, and simulation experiments. G.R.

A77-21228 # **Crystallization and vaporization studies on synthetic coal slag compositions.** L. P. Cook, E. R. Plante, T. Negas, R. S. Roth, and C. D. Olson (National Bureau of Standards, Washington, D.C.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. II.4.1-II.4.6. 18 refs. ERDA-sponsored research.

Important problem areas concerning the development of open cycle, coal fired MHD electric power generation are related to the interaction of seed, as K2O, with slag. Chemical variation in coal slag is considered and the characteristics of the MHD environment are discussed. Quench experiments on K2O-CaO-Al2O3-SiO2 are reported. The experiments were conducted in sealed platinum capsules at temperatures in the range from 1300 to 1400 C. Attention is also given to vaporization measurements which were carried out to determine the activity of K2O in the liquid slag solution. G.R.

A77-21229 # **Thermionic emission characteristics of seeded coal slags.** C. K. Petersen and R. W. Ure, Jr. (Utah, University, Salt Lake City, Utah). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. II.5.1-II.5.4. NSF-supported research.

A seeded coal-slag atmosphere simulation system has been built to examine the electron emission characteristics of various coal slags over a wide range of temperatures and seed-to-slag ratios. At relatively low current densities, the emission goes into an arcing mode. In the temperature range 1350 C to 1700 C, the maximum current density for normal emission was approximately an order of magnitude less than the 1 A/sq cm suggested for MHD electrode operation. The maximum current density for normal emission was found to be independent of the seed fraction in the gas. If the maximum current for normal emission is taken as the thermionic limited current, the Richardson-Dushman equation can be used to fit the data. For the five slags investigated, work functions from 1.45 to 2.36 eV with Richardson constants of 0.000144 to 0.067 A/sq cm were calculated. (Author)

A77-21230 # **Utilization of Western coal for MHD energy conversion.** P. D. Bergman and D. Bienstock (ERDA, Pittsburgh Energy Research Center, Pittsburgh, Pa.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. III.1.1-III.1.19. 51 refs.

The problems associated with fueling future MHD power plants on Montana subbituminous coal are evaluated. Economic sulfur removal, relative to conventional coal-fired power plants will be a preeminent positive feature of MHD electricity production with low-rank western coals. Moisture removal must unquestionably be instituted in order to render these low-calorific fuels suitable for MHD energy conversion. Even though thermal drying installations predominate in this country, steam drying is recommended as a form of drying, which may be particularly compatible with MHD power generation. Steam drying is about 3/8 as energy intensive as thermal drying, produces a superior product, and could be readily operated on waste steam available from the MHD topping cycle. Appreciable improvement in system efficiency derives from integrating steam drying into the MHD power cycle. Various areas of critical concern in handling and processing low-rank solid fuels such as ease of pulverization, coal transportation, slacking and weathering, slagging characteristics, fire and explosion hazards, freezing of coal, and reabsorption of moisture are also discussed. (Author)

A77-21231 # **Influence of coal type and drying upon MHD power plants and components.** N. J. Patel, W. A. Updike, C.-L. Lu, and J. C. Cutting (STD Research Corp., Arcadia, Calif.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. (A77-21214 08-75) Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. III.2.1-III.2.6. 10 refs. Contract No. E(49-18)-2001.

The use of MHD topped steam plants will make a more efficient utilization of coal possible. Such plants offer a 30% decrease in fuel consumed per kilowatt-hour over conventional coal fired electric power generating stations. To obtain this improvement, the characteristics of the type of coal to be used at individual power stations must be taken into account. Western coals with a high percentage of moisture must be dried. A description is given of a parametric study concerning the effects produced in the case of a use of four representative coals. Attention is given to anthracite, bituminous coal from Illinois, subbituminous coal from Montana, and lignite from North Dakota. G.R.

A77-21232 # **Development of a baseline reference design for an open cycle MHD power plant for commercial service.** W. D. Jackson, R. V. Shanklin, III (ERDA, Washington, D.C.), R. L. Lawit, R. A. Stoudt, M. G. Klett (Gilbert Associates, Inc., Reading, Pa.), S. T. Demetriades, J. C. Cutting, C. D. Maxwell, and R. F. Schnörr (STD Research Corp., Arcadia, Calif.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. III.3.1-III.3.9. 5 refs. Contracts No. E(49-18)-2001; No. E(49-18)-2228.

A detailed reference design for a coal-fired open cycle MHD/steam binary cycle power-plant is being developed under sponsorship of the United States Energy Research and Development Administration. The design effort is to be carried beyond the conceptual and preliminary stages so that hardware procurement specification actually could be written. This paper describes the conceptual basis for the design, the envelope of economic and engineering constraints within which plant optimization has been carried out, and selected critical design problems. It is shown that for certain coals, fuel preprocessing promises significant benefits. The impact of coal drying and its influence on bottoming plant design is examined in detail. Also discussed are plant startup, availability, NOx control problems, and the approach to instrumentation and control to be used. (Author)

A77-21233 # **The technology base for large MHD superconducting magnets.** D. B. Montgomery and J. C. E. Williams (MIT, Cambridge, Mass.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. III.9.1-III.9.7. 16 refs. ERDA-supported research.

Experience over the last decade with large superconducting magnets and MHD magnets in particular is examined to determine what further development is necessary to allow construction a decade hence of base-load scale MHD magnets. Preliminary concepts for large MHD magnets are discussed to identify specific priority areas for development. A program for development is presented in terms of (1) Reference Design; (2) Supportive Research; (3) Analytical Tools; (4) Large Winding Technology; (5) Staged construction of magnets utilizing large magnet concepts. (Author)

A77-21237 # **Progress on the Mark VI long-duration MHD generator.** S. Petty, A. Solbes, G. Enos, and A. Dunton (Avco Everett Research Laboratory, Inc., Everett, Mass.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. IV.5.1-IV.5.10. ERDA-supported research.

Progress achieved over the past year on the Mark VI generator experiment is reported. The paper focuses on the Mark VI-C channel. To date, 150 power hours have been accumulated on this channel. Of these, 98 power hours were during a continuous test of 103 hours. 20,500 kWh were generated during the test. A description is given the channel and its operating gas-dynamic and electrical characteristics. The development of voltage and current non-uniformities and local methods of loading and control are discussed in detail. Two long-duration tests are described and observations made during post run inspections are reported. (Author)

A77-21238 # **Experimental investigation on a direct coal-fired MHD generator.** Y. C. L. Wu, J. B. Dicks, J. W. Muehlhauser, M. H. Scott, G. Kroeger, and T. My (Tennessee, University, Tullahoma, Tenn.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. IV.6.1-IV.6.7. 5 refs. Contract No. E(49-18)-1760.

This paper describes a number of experiments of the UTSI direct coal-fired 60 deg diagonal conducting wall (DCW) generator. Results presented include a study of the behavior of individual electrodes, the effect of cermet coating on the electrode, the overall performance of the generator when operating in the multiple load mode and a current distribution study. The aim of these experiments is to gain further understanding of the direct coal-fired DCW generators so that improved performance can be made. (Author)

A77-21248 # **Effects of devolatilization kinetics and ash behavior on coal fired MHD combustor design.** H. Kobayashi (MIT, Cambridge, Mass.), A. Padia (MIT, Cambridge, Mass.; Halcon International, Inc., New York, N.Y.), and J. Chomiak. In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. VII.1.1-VII.1.7. 13 refs. Contract No. E(49-18)-2215.

A systematic study is conducted of the physical and chemical behavior of mineral matter during the rapid combustion of pulverized coal particles. The behavior of coal at high temperatures under rapid heating conditions is investigated and questions are considered concerning the behavior of the mineral matter in coal under the extreme conditions of temperature and turbulence encountered in MHD combustors. G.R.

A77-21249 # **Applications of the rapid devolatilization of coal in MHD power cycles.** R. E. Gannon, S. K. Ubhayakar, C. W. vonRosenberg, Jr., D. B. Stickler, and F. A. Hals (Avco Everett Research Laboratory, Inc., Everett, Mass.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. VII.2.1-VII.2.7. 5 refs. Research supported by the U.S. Department of the Interior, Electric Power Research Institute, Baltimore Gas and Electric Co., Boston Edison Co., Consolidated Edison Company of New York, NEGEA Service Corp., New England Power Co., Northeast Utilities Service Co., Avco Corp., and ERDA.

An analytical model and a computer program were developed for the description of the process involved in the rapid devolatilization of coal. The theoretical results produced by the computer program were found to be in good agreement with experimental data. The theoretical relation between volatile yield and particle size was confirmed for the finer coal sizes but higher yields than predicted were obtained for the coarse fraction. G.R.

A77-21250 # **Recent experimental studies of the interaction of potassium seed with coal slag in a direct-coal fired MHD generator.** K. E. Tempelmeyer, E. Hamlett, L. Becker, and J. Martin (Tennessee, University, Tullahoma, Tenn.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. VII.3.1-VII.3.6. Contract No. E(49-18)-1760.

The separation and efficient recovery of the seed material from the ash constitutes one of the key technical problems in the development of direct coal-fired MHD power generators in which all or a large portion of the ash passes through the generator. A description is given of data which have been obtained in an experimental investigation of the interaction of potassium seed with coal slag, taking into account results obtained in a scanning electron microscope analysis. G.R.

A77-21251 # **Kinetics of regeneration of spent seed from MHD power generation systems.** J. I. Joubert, P. F. Mossbauer, T. C. Ruppel, and D. Bienstock (ERDA, Pittsburgh Energy Research Center, Pittsburgh, Pa.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. VII.4.1-VII.4.9. 11 refs.

The chemical kinetics involved in regenerating spent potassium seed produced under MHD conditions was investigated. The solid material studied was extracted from a spent seed/fly ash mixture generated in high-temperature seeded coal combustion tests. The extract was approximately 90% potassium sulfate by weight. A two-step regeneration scheme was considered. The first step consisted of reduction of potassium sulfate to potassium sulfide with hydrogen or carbon monoxide. The second step involved conversion of potassium sulfide to potassium carbonate with steam/carbon dioxide mixtures, thereby liberating sulfur as hydrogen sulfide. Both hydrogen and carbon monoxide are effective reducing agents in the temperature range 700-800 C. The fly ash extract could be reduced completely with either gas. The desulfurization of reduced extract with steam and carbon dioxide was studied at temperatures ranging from 300 to 800 C. Optimum conditions were found to occur at 500 C, using a 50% CO2 - 50% H2O mixture. Overall sulfur removal of up to 97% could be achieved. (Author)

A77-21252 # **Voltage consolidation and control circuits for multiple-electrode MHD generators.** R. J. Rosa (Montana State University, Bozeman, Mont.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. VII.5.1-VII.5.4. Research supported by the Electric Power Research Institute, Baltimore Gas and Electric Co., Boston Edison Co., Consolidated Edison Company of New York, NEGEA Service Corp., New England Power Co., Northeast Utilities Service Co., Avco Corp., and ERDA.

A method is described for allowing more than one electrode pair of a segmented Faraday or diagonal MHD generator to be coupled to a single inverter. The method basically employs feedback of A. C. power to drive rectifier circuits which 'boost' the D. C. output of one or more electrodes up to a common voltage level. Several circuit variations are described for doing this. These circuits also provide using pure nitrogen and mixtures of nitrogen and carbon dioxide at flow conditions appropriate to an open cycle disk. To date, an effective Hall parameter of 4.5 has been achieved; peak output power has been about 2.3 MW corresponding to 5.5% enthalpy extraction. (Author)

A77-21253 # **Curve of current delivered from MHD generator to a conventional power grid by inverter system.** E. Mitkowski, A. Kordus, J. Stiller, and A. Grzybowski (Poznan, Politechnika, Poznan, Poland). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. VII.6.1-VII.6.6.

This paper reports principles of theoretical analysis of current deformations appearing in a three-phase bridge inverter operating with an MHD generator. For verification of obtained theoretical

results, experimental investigations for inverter systems were carried out. Experimental investigations allowed the definition of harmonics in a current delivered to a power grid in an MHD generator. (Author)

A77-21254 # **Progress on the testing of refractories for directly-fired MHD air heater service.** J. E. Fenstermacher, Jr., D. G. DeCoursin, and R. R. Smyth (Fluidyne Engineering Corp., Minneapolis, Minn.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. VIII.1.1-VIII.1.10. 9 refs. Contract No. E(49-18)-1537.

This paper reports initial experimental work carried out with regard to refractory corrosion and flow-passage plugging in simulated directly-fired MHD air-heater environments. Commercially available ceramic materials were tested at 2800 F by exposure to a seed/slag-laden gas stream with potassium sulfate serving as the seed and fly ash from a low-sulfur coal as the slag. The results indicate that the following materials exhibit sufficient corrosion resistance to justify further tests: magnesia-chromite, magnesia-spinel, magnesia, and mullite. Tests of a small heater under cycling conditions with commercial magnesia-chromite and magnesia-spinel as cored-brick bed materials show that only a small amount of seed and slag accumulated in bed holes and that no accumulation occurred when the minimum temperature of the bed bottom was above 2000 F. It is noted that some accumulation did occur when the bed bottom was cycled between 1400 and 1700 F, but the seed/slag layer was removed during subsequent operation at 2800 F. F.G.M.
DATA SUMMARY: Chemical compositions and material properties given for 24 refractories classified as alumina, alumina-chromia, alumina-mullite, alumina-zirconia-silica, chromite, forsterite, magnesia, magnesia-chromite, magnesia-spinel, mullite, silicon carbide, and zirconia; variables are fly-ash composition, ceramic chemical composition, apparent porosity, bulk density, modulus of rupture, slag viscosity, temperature; one figure and three tables include numeric data.

A77-21257 # **Joint US-USSR experimental studies of the dependence of plasma electrical conductivity on plasma temperature performed in the Avco Mark VI MHD facility.** I. A. Vasilieva, G. P. Maluzhonok, A. P. Nefedov, L. P. Poberezhskii, E. M. Shelkov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR), W. Smith, S. Petty (Avco Everett Research Laboratory, Inc., Everett, Mass.), and W. D. Jackson (ERDA, Washington, D.C.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. IX.1.1-IX.1.8. Contract No. E(49-18)-1789.

In the joint USA-USSR diagnostic experiment at the Mark VI MHD installation located at the Avco Everett Research Laboratory (AERL), the electrical conductivity of plasma of combustion products of heavy oil (CH2) in oxygen-enriched air was measured as a function of temperature. Potash (K2CO3) was used as an ionizing seed which was fed into the combustion chamber either as a water solution or in a powdery state. The seed concentration varied in a range of 0.1-2.6%, the plasma temperature was changed from 2250 to 3000 deg K. The temperatures and the plasma conductivity were measured in a single cross-section plane in a special measuring unit sized 75 x 160 sq mm which was mounted behind the combustion chamber. (Author)

A77-21261 # **Consideration of three-dimensional effects in MHD power generators.** C. D. Maxwell, E. D. Doss, B. P. Curry (STD Research Corp., Arcadia, Calif.), and D. A. Oliver. In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976.
Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. IX.6.1-IX.6.10. 25 refs. Contract No. E(49-18)-2001.

Two approaches are proposed to the problem of modeling three-dimensional effects in the periodic region of rectangular MHD channels. In one approach, calculation of the coupled fluid and electrical equations is carried out on planes normal to the mean flow direction (y-z planes). The effects of typical secondary flows on the distribution of currents and fields in an MHD generator are taken into consideration. A solution to a pressure equation is obtained in which the effects of the two-dimensional distribution of current and secondary-flow components in the plane normal to the flow are taken into account. In the other approach, the performance of rectangular MHD channels with insulating side walls is analyzed by allowing the two-dimensional solution of the flow between the two electrode walls (in the x-y plane) to interact with the two-dimensional solution of the gasdynamic flow over the side walls (in the x-z plane). V.P.

A77-21266 # **All-round technical and economic investigations of open-cycle industrial MHD generator channels and superconducting magnet systems.** L. S. Popyrin and N. N. Pshenichnov (Akademiia Nauk SSSR, Sibirskii Energeticheskii Institut, Irkutsk, USSR). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. LP.2.1-LP.2.5. 6 refs.

Some systematic problems and results of industrial MHD generator (MHDG) investigations are considered with the help of MHD power plant (MHDPP) mathematical model (MM). The model describes in detail both 'high temperature part' (HTP - combustion chamber, nozzle, MHDG, superconducting magnet system (SCMS), invertor, diffuser, oxygen preheater, compressor, and oxygen plant) and 'low potential part' (LPP - steam generator, steam turbine, etc.). (Author)

A77-21267 * # **System studies of coal fired-closed cycle MHD for central station power plants.** B. Zauderer (GE Space Sciences Laboratory, Philadelphia, Pa.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. III.5.1-III.5.15. 20 refs. ERDA-NSF-supported research; Contract No. NAS3-19406.

This paper presents a discussion of the closed cycle MHD results obtained in a recent study of various advanced energy conversion (ECAS) power systems. The study was part of the first phase of this ECAS study. Since this was the first opportunity to evaluate the coal fired closed cycle MHD system, a number of iterations were required to partially optimize the system. The present paper deals with the latter part of the study in which the direct coal fired, MHD topping-steam bottoming cycle was established as the current choice for central station power generation. The emphasis of the paper is on the background assumptions and the conclusions that can be drawn from the closed cycle MHD analysis. The author concludes that closed cycle MHD has efficiencies comparable to that of open cycle MHD and that both systems are considerably more efficient than the other system studies in Phase 1 of the GE ECAS. Its cost will possibly be slightly higher than that of the open cycle MHD system. Also, with reasonable fuel escalation assumptions, both systems can produce lower cost electricity than conventional steam power plants. Suggestions for further work in closed cycle MHD components and systems is made. (Author)

A77-21268 # **ECAS MHD system studies.** D. Q. Hoover, T. E. Lippert, T. C. Tsu, and W. E. Young (Westinghouse Research Laboratories, Pittsburgh, Pa.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976. Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. III.6.1-III.6.3.

Under the Energy Conversion Alternatives Study (ECAS), performed for the NASA Lewis Research Center, the National Science Foundation, the Energy Research and Development Administration and the Office of Management and Budget, Westinghouse considered three basic MHD systems: open cycle, closed cycle nonequilibrium and liquid metal. The object of the study was to develop a data base to facilitate decision making in the areas of energy research and technology and to provide an estimate of the

development and operating costs and the probability of success of each concept resulting in a commercially viable power plant. (Author)

A77-21269 # **Liquid-metal MHD coupled to coal-fired fluidized-bed combustors.** A. R. *Brunsvold and* E. S. *Pierson* (Argonne National Laboratory, Argonne, Ill.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Fifteenth Symposium, Philadelphia, Pa., May 24-26, 1976.
Philadelphia, Pa., GE Space Sciences Laboratory, 1976, p. III.8.1-III.8.8. 7 refs.

A continuing study of the two-phase liquid-metal MHD (LMMHD) concept coupled to a coal-fired fluidized-bed combustor was prompted by the results and conclusions of the Energy Conversion Alternatives Study, Phase I. In this paper the LMMHD concept is briefly described, and the results obtained to date both in the ECAS and the ANL follow-up studies are summarized. Emphasis is placed on the more-recent results not included in the ECAS Phase I study; they are presented and discussed in detail. Based on these latest findings the economics of LMMHD systems are reconsidered. (Author)

A77-21270 **Problems of analysis of the power characteristic of a high capacity magnetohydrodynamic power station.** G. B. Levental, S. A. Pashkov, and E. V. Shishkov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teploenergetika,* vol. 22, Nov. 1975, p. 5-8.) *Thermal Engineering,* vol. 22, Nov. 1976, p. 4-7. 7 refs. Translation.

The generalized power characteristic of a flexible generating unit of an MHD power station reveals the internal interaction of its elements (assemblies) at different values of electric load. The use of this kind of power characteristic makes it possible in designing to ensure optimal correspondence of parameters and particular power characteristics of elements to the required thermal efficiency of the whole generating unit in variable modes of its operation. The paper presents equations for the power characteristics. B.J.

A77-21281 **Solar energy and electric utilities - Should they be interfaced.** J. G. Asbury *and* R. O. *Mueller* (Argonne National Laboratory, Argonne, Ill.). *Science,* vol. 195, Feb. 4, 1977, p. 445-450. 13 refs. ERDA-supported research.

An investigation is conducted concerning the economics of solar energy systems which interface with conventional electric utility supply networks. It is found that solar collection systems generally will be economical only if they can deliver solar energy at a cost lower than the variable (fuel) cost component of off-peak electricity. It is concluded that solar energy systems and conventional electric utility systems represent a poor technological match. Attention is given to solar/electric-resistance heating, solar energy/heat pump systems, and aspects of solar electric power generation. G.R.

A77-21310 **The quality category in solar engineering.** R. A. Zakhidov, P. A. Panov, and V. N. Sokolov (Akademiia Nauk Uzbekskoi SSR, Tsentral'noe Proektnoe Konstruktorsko-Tekhnologicheskoe Biuro Nauchnogo Priborostroeniia, Uzbek SSR). *(Geliotekhnika,* vol. 12, no. 3, 1976, p. 3-11.) *Applied Solar Energy,* vol. 12, no. 3, 1976, p. 1-7. 20 refs. Translation.

The seven fundamental principles of quality evaluation (qualimetrics) are presented and applied to solar devices. An algorithm is presented for the complex evaluation of quality, and tables are presented consisting of the functional and economic quality properties of a solar concentrator. B.J.

A77-21311 **Investigation of p-Al/x/Ga/1-x/As-n-GaAs heterojunction cells by means of optical measurements and photoluminescence spectra.** T. M. Golovner, M. B. Kagan, T. L. Liubashevskaia, T. A. Nuller, and M. N. Kholeva (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). *(Geliotekhnika,* vol. 12, no. 3, 1976, p. 12-17.) *Applied Solar Energy,* vol. 12, no. 3, 1976, p. 8-12. 16 refs. Translation.

Analysis of photoluminescence spectra has shown that the growth of p-Al(x)Ga(1-x)As-n-GaAs heterojunction solar cells leads to heteroformation of dopants in the course of liquid phase epitaxy. For realization of maximum photocurrents, the epitaxial growth regime is so chosen that the depth of the p-n junction does not exceed 0.5 microns for an impurity concentration of 5 x 10 to the -17th to 5 x 10 to the -18th/cu cm. It has been experimentally shown that, for an aluminum content of 0.6-0.7 mole fractions in the solid-solution films and a final film thickness of about 5 microns, the most efficient cells with an area of 1-2 sq cm have a series resistance not exceeding 5 ohms. B.J.

A77-21312 **Effect of solar-radiation density and angular size of radiation source on efficiency of solar power plants.** E. A. Krasina, O. A. Nevezhin, and I. M. Rubanovich (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). *(Geliotekhnika,* vol. 12, no. 3, 1976, p. 18-24.) *Applied Solar Energy,* vol. 12, no. 3, 1976, p. 13-17. 7 refs. Translation.

The example of a solar thermoemission power plant is used for the analysis of certain features of solar-power-plant operating regimes for various radiation densities and angular sizes of the radiation source. The calculations are performed both on the assumption of exact pointing of the collector optical axis at the radiation source and with allowance for error. Results are reported for plant-efficiency optimization calculations, together with data on the permissible error angles of the solar tracking system. (Author)

A77-21313 **Investigation of composite radiant-energy concentrators with conical radiation sources.** L. Ia. Paderin. *(Geliotekhnika,* vol. 12, no. 3, 1976, p. 25-34.) *Applied Solar Energy,* vol. 12, no. 3, 1976, p. 18-24. 5 refs. Translation.

The paper presents a theoretical investigation of a radiant-energy concentrator composed of a set of conical rings generated on the basis of surfaces having different eccentricities. The system under consideration includes a radiation source and a mirror surface reflecting the radiant fluxes arriving from the source. In calculating the radiative heat transfer, the mirror reflecting surface is considered as an emitting surface. The study is relevant to the development of solar concentrators. B.J.

A77-21314 **Tower-type solar energy plant - Configuration and energy efficiency of concentrator.** D. I. Tepliakov and R. R. Aparisi (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *(Geliotekhnika,* vol. 12, no. 3, 1976, p. 35-48.) *Applied Solar Energy,* vol. 12, no. 3, 1976, p. 25-34. 11 refs. Translation.

Three configurations of tower-type solar power plants with stationary reflectors are considered from the standpoint of mirror-surface utilization and stability of diurnal, seasonal and annual energy output. The configurations considered are: (1) a flat solar plant with a circular reflector field, (2) a flat plant with a square collector field, the tower shifted to the north, and (3) a mountain plant with the field of reflectors located on the slopes. A method of isocoses is proposed whereby the lines of the constant cosine of the angle of incidence of the rays on the mirror surface of a reflector can be used to evaluate the energy efficiency of mirror-surface utilization. B.J.

A77-21316 **Conversion of solar energy by photosynthetic production of molecular hydrogen.** I. V. Berezin and S. D. Varfolomeev (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). *(Geliotekhnika,* vol. 12, no. 3, 1976, p. 60-73.) *Applied Solar Energy,* vol. 12, no. 3, 1976, p. 45-54. 25 refs. Translation.

Molecular mechanisms of photosynthesis (including decomposition of water and electron transport under the action of light) are capable of providing conditions necessary for the production of hydrogen. Attention is given to solar-energy conversion efficiency in the photosynthetic production of hydrogen. Also considered are technical requirements for the development of systems for the biophotolysis of water, thermodynamic requirements for exogenous electron acceptors of the electron transport chain, the catalysis of molecular hydrogen formation, and the reliability of water biophotolysis systems. B.J.

A77-21360 **Air Force applications of lightweight superconducting machinery.** C. E. Oberly (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *(Applied Superconductivity Conference, 7th, Stanford University, Stanford, Calif., Aug. 17-20, 1976.) IEEE Transactions on Magnetics,* vol. MAG-13, Jan. 1977, p. 260-268. 68 refs.

Following the successful application of stability theories, programs in the areas of superconducting alternators, MHD generator coils and inductive energy storage coils have been productive. The universal Air Force requirement for lightweight machinery eliminates cryostatic stability from consideration for lightweight designs of superconducting coils. Maximum overall current density is necessary. Serious transient field losses are induced by armature currents in synchronous alternators, conductive gas currents in MHD generators and discharge currents in energy storage coils. Shock and vibration structural support of the superconductor to prevent motion induced quenches remains a challenge to the machine designer. Exotic superalloy or advanced composite structures are required to achieve high stiffness and lightweight. Development of flexible multifilament Nb3Sn is underway to create thermal margin for superconducting machinery. The problems of achieving ultralightweight performance are reviewed with special emphasis on the interrelated problems of potting, structural support and cooling at high current density in an environment of transient magnetic field. Second generation machinery development programs are beginning. With acceptance of superconducting systems and attendant cryogenic support problems, wider application of superconducting machinery may result. (Author)

A77-21361 **Superconducting machinery for Naval ship propulsion.** H. O. Stevens, M. J. Superczynski, T. J. Doyle, J. H. Harrison, and H. Messinger (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Annapolis, Md.). *(Applied Superconductivity Conference, 7th, Stanford University, Stanford, Calif., Aug. 17-20, 1976.) IEEE Transactions on Magnetics,* vol. MAG-13, Jan. 1977, p. 269-274. 14 refs.

The Navy is developing the technology base for superconducting electric propulsion machinery systems for ship drives in the range of 40,000 to 75,000 hp per shaft. Full scale system development is aimed at the 1980-85 period. Current progress includes design, construction and tests of laboratory superconductive machinery in the 400 to 1000 hp range, preliminary design of 40,000 hp systems and ongoing construction of 3000 hp feasibility models of full scale systems. The objectives, scope, technical content and current progress of this program are presented. Brief technical discussion of the areas of machine design, liquid metal current collectors, superconducting magnet-dewar construction, and helium refrigeration development is included. (Author)

A77-21376 **Superconducting induction coil for a doublet Tokamak experimental fusion power reactor.** W. Y. Chen, W. Toffolo, and J. R. Purcell (General Atomic Co., San Diego, Calif.). *(Applied Superconductivity Conference, 7th, Stanford University, Stanford, Calif., Aug. 17-20, 1976.) IEEE Transactions on Magnetics,* vol. MAG-13, Jan. 1977, p. 624-627. Research supported by the Electric Power Research Institute.

A superconducting induction coil system was designed for a noncircular Tokamak experimental fusion power reactor based on the Doublet concept. This coil system is used for inducing and sustaining the plasma current during the thermonuclear burn. The coil must be cycled in about 2 seconds; thus, it is important to design it for low ac loss during pulsing operation. A braided superconducting cable capable of carrying 450 kA at a central field of 5.65 Tesla was chosen as the conductor. The coil system consists of a central solenoid and 12 outer coils, with a total of 157 series connected turns. The central solenoid has a single layer winding of 134 turns on a fiberglass epoxy spool. The outer coils are located so that the error field generated at the plasma location is limited to a few gauss. The winding is reinforced by prestressed stainless steel bands on the outer surface, so that there is no relative motion between the cable and the coil spool or insulation during pulsing. (Author)

A77-21379 **Superconducting magnets for an MHD test facility and base load power plant.** Z. J. J. Stekly, R. J. Thome, and W. F. B. Punchard (Magnetic Corporation of America, Waltham, Mass.). *(Applied Superconductivity Conference, 7th, Stanford University, Stanford, Calif., Aug. 17-20, 1976.) IEEE Transactions on Magnetics,* vol. MAG-13, Jan. 1977, p. 636-639. Contract No. E(49-18)-2217.

The development MHD power generation in the U.S. may involve the construction of an Engineering Test Facility (ETF) as a step toward a base-load or full-scale power plant. This paper describes the superconducting-magnet requirements for the ETF and base-load plants and gives the results to date in a program involving production of magnet reference designs for the two systems. Each magnet produces a tapered field profile with a maximum of 6.0 T on axis. Overall electrical and mechanical characteristics for the design points are given. Some of the areas which present unique design and construction problems for magnets of the appropriate size are discussed. (Author)

A77-21383 **High speed superconducting generator.** R. D. Blaugher, J. H. Parker, Jr. (Westinghouse Research Laboratories, Pittsburgh, Pa.), and J. L. McCabria (Westinghouse Electric Corp., Aerospace Electrical Div., Lima, Ohio). *(Applied Superconductivity Conference, 7th, Stanford University, Stanford, Calif., Aug. 17-20, 1976.) IEEE Transactions on Magnetics,* vol. MAG-13, Jan. 1977, p. 755-758. 8 refs. Contract No. F33615-71-C-1591.

A technology development program is discussed which is directed toward the design, construction, and test of a 12,000-rpm ac generator with a design capability of 10 MVA utilizing a superconducting field winding. The first phase of this program demonstrated that a four-pole superconducting rotor could be spun at 12,000 rpm with the field excited to the design current level. This program is currently in its second phase with the construction of a complete generator. The design of the second-phase rotor is generally based on the information obtained from the phase-one effort and involves design changes in the superconducting coils, insulation system, helium flow scheme, and mechanical approach. This paper reviews the generator design, with special emphasis on the cryogenic and mechanical features. Design changes relative to the phase-one rotor are discussed, followed by a review of the test objectives. Certain features of future machine designs and requirements are also discussed. (Author)

A77-21384 **Thermal performance of the rotor of the MIT-EPRI 3 MVA superconducting alternator.** A. Bejan and P. Thullen (California, University, Los Alamos, N. Mex.). *(Applied Superconductivity Conference, 7th, Stanford University, Stanford, Calif., Aug. 17-20, 1976.) IEEE Transactions on Magnetics,* vol. MAG-13, Jan. 1977, p. 763-766. 12 refs. Research supported by the Electric Power Research Institute.

The MIT-EPRI 3 MVA superconducting alternator has undergone a number of successful electrical and mechanical tests. During these tests a great deal of information on the thermal performance of the rotor has been collected. This information has not been presented in the literature or discussed generally. Thermal performance data of interest to generator designers such as: helium flow circuit behavior and conceptual design, electrical lead performance following reconstruction and shield thermal performance is discussed. (Author)

A77-21386 **Superconducting a.c. generators - Progress on the design of a 1300 MW, 3000 rev/min generator.** A. D. Appleton, J. S. H. Ross, J. Bumby, and A. J. Mitcham (International Research and Development Co., Ltd., Newcastle-upon-Tyne, England). *(Applied Superconductivity Conference, 7th, Stanford University, Stanford, Calif., Aug. 17-20, 1976.) IEEE Transactions on Magnetics,* vol. MAG-13, Jan. 1977, p. 770, 771. 7 refs.

A77-21391 **Ultra high-current superconducting cables for a 2.2-tesla, 300-kilojoule energy storage magnet.** G. A. Miranda (California, University, Los Alamos, N. Mex.), R. Rhodenizer, P.

Rackov (Intermagnetics General Corp., Guilderland, N.Y.), W. F. B. Punchard, and T. A. de Winter (Magnetic Corporation of America, Waltham, Mass.). *(Applied Superconductivity Conference, 7th, Stanford University, Stanford, Calif., Aug. 17-20, 1976.) IEEE Transactions on Magnetics*, vol. MAG-13, Jan. 1977, p. 844-847. ERDA-sponsored research.

A77-21400 Wind energy for human needs. M. F. Merriam (California, University, Berkeley, Calif.). *Technology Review*, vol. 79, Jan. 1977, p. 28-39. 8 refs.

Following a description of ancient windmills, the paper presents an economic and technological outlook into wind energy extraction possibilities. The difficulties in the utilization of the wind energy, like the low air density and the impossibility of effective channelization of the air stream, are pointed out and the physics and technology of wind machines are discussed together with the theory, which shows that the windpower is proportional to the cube of the velocity of the wind. The possibility of supporting the windmills in the air stream is proposed and the widely used vertical-axis windmills are described together with the large wind generators for electric power including the Smith-Putnam wind turbine with a two-blade propeller driving a 1,250 kw synchronous generator, and 175 ft. diameter. The urgent needs for power windmills, and a systematic search for good sites where the windmills will be cost-effective, are stressed. The possibility of obtaining 300-350 million megawatt-hours per year, from well-engineered wind generators, is predicted. A.Y.

A77-21544 Entropy production, efficiency, and economy in the case of the thermochemical production of synthetic fuels - The sulfuric acid-hybrid process for thermochemical water decomposition (Entropie-Produktion, Wirkungsgrad und Wirtschaftlichkeit der thermochemischen Erzeugung synthetischer Brennstoffe - Der Schwefelsäure-Hybrid-Prozess zur thermochemischen Wasserspaltung). K. F. Knoche (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany) and J. E. Funk (Kentucky, University, Lexington, Ky.). *Brennstoff-Wärme-Kraft*, vol. 29, Jan. 1977, p. 23-27. In German.

A77-21545 Wide-range control of a thermal interconnection network (Weitbereichsregelung eines Wärmeverbundnetzes). A. H. Glattfelder and L. Gross (Eidgenössische Technische Hochschule, Zurich, Switzerland). *Brennstoff-Wärme-Kraft*, vol. 29, Jan. 1977, p. 27-33. In German.

The urban refuse incineration plant of Zurich in Switzerland was connected with an existing long-distance heat supply network by means of a steam-carrying pipeline. This procedure made it possible to reduce by one half the fuel oil consumption for the heating power station connected with the network. The environmental air pollution effects produced by the heating power station were, therefore, correspondingly reduced. There were, however, a number of operational difficulties. A description is given of approaches which made it possible to overcome these difficulties with the aid of appropriate control measures. G.R.

A77-21546 Thermal convection of water in a porous medium - Effects of temperature- and pressure-dependent thermodynamic and transport properties. J. M. Straus (Aerospace Corp., Space Sciences Laboratory, Los Angeles, Calif.) and G. Schubert (Aerospace Corp., Space Sciences Laboratory; California, University, Los Angeles, Calif.). *Journal of Geophysical Research*, vol. 82, Jan. 10, 1977, p. 325-333. 20 refs. Research supported by the Aerospace Corp.

The investigation concerns the conditions for the onset of thermal convection and the character of that convection in a water-saturated porous layer with a large temperature difference and pressure difference across the thickness. Calculations of the critical Rayleigh number were performed with full account taken of the variable viscosity and thermodynamic and transport properties of water and of non-Boussinesq effects, and the results are compared to those of calculations where the water was treated as a Boussinesq fluid with constant properties. The consequence of allowing for variable water properties is that the layer becomes much less stable to convection, the critical Rayleigh number being reduced by as much as a factor of 31 for thick layers. The major effects are due to the temperature dependences of the thermal expansivity and viscosity. P.T.H.

A77-21617 Batch autoclave studies of catalytic hydrodesulfurization of coal. Y. K. Yen, D. E. Furlani, and S. W. Weller (New York, State University, Buffalo, N.Y.). *I & EC - Industrial and Engineering Chemistry, Product Research and Development*, vol. 15, Mar. 1976, p. 24-28. 26 refs. Research supported by the Corning Glass Works.

The liquefaction and hydrodesulfurization of a high sulfur Kentucky coal has been studied in batch autoclave experiments, with tetralin or methylnaphthalene as solvents, and several Co-Mo-Al2O3 catalysts. In tetralin, an excellent hydrogen-donor solvent, gas phase hydrogen and catalyst are still important in determining both the conversion of asphaltene to oil and the extent of desulfurization. Superimposed on other effects, the disproportionation of tetralin to naphthalene and decalin has been discovered to occur to approximately equilibrium at 455 C, even in nitrogen and with no catalyst. Two commercial catalysts and two catalysts made from controlled-pore size aluminas have been studied in coal hydrodesulfurization with methylnaphthalene as solvent, at a 1% catalyst level. Appreciable differences were observed in product distribution. The most favorable results were obtained with large pore diameter (220 A) catalyst, even though this had the lowest total surface area. (Author)

A77-21623 Upgrading coal liquids to gas turbine fuels. I - Analytical characterization of coal liquids. R. B. Callen, J. G. Bendoraitis, C. A. Simpson, and S. E. Voltz (Mobil Research and Development Corp., Paulsboro, N.J.). *I & EC - Industrial and Engineering Chemistry, Product Research and Development*, vol. 15, Dec. 1976, p. 222-233. 19 refs. Research supported by the Electric Power Research Institute and Mobil Research and Development Corp.

The physical properties and chemical compositions of three coal liquids (SRC, H-Coal, and Synthoil) were determined. Coal liquids contain less hydrogen (6-8 wt % vs. about 11 wt %) than petroleum fuels or residua, whereas their concentrations of nitrogen and oxygen are considerably higher. The aromaticities of coal liquids are much greater (60-75 vs. 20-35 atom % aromatic carbon) than petroleum residua; they also have very high concentrations of asphaltenes. The detailed molecular compositions were analyzed by gradient elution chromatography. Improvement in certain physical and chemical properties will be required to upgrade coal liquids for use as gas turbine fuels. (Author)

A77-21673 Alcohol - A Brazilian answer to the energy crisis. A. L. Hammond. *Science*, vol. 195, Feb. 11, 1977, p. 564-566.

The Brazilian plan of replacing oil with ethyl alcohol is outlined as a possible answer to the energy crisis, and the agricultural and economic difficulties involved are discussed. Experiments show that a properly designed alcohol engine can operate at a 43% higher compression ratio than a gasoline engine, and produce 18% more power per liter. Large-scale production of alcohol from manioc, which is already a major crop in Brazil, by a particular enzymatic method is proposed due to the limited nature of the sugar cane (the current source of alcohol) production. It is estimated that in the early 1980's 1-2 million hectares of manioc will be required to produce 4 billion liters of alcohol which will substitute 20% of gasoline consumption. The importance of the existing cheap labor to meet this demand is stressed. This plan is predicted to lower the pollution by up to 50%, create up to 1 million new jobs, stimulate the capital goods industries by adding a major new internal market and build a national self-confidence by being the pioneer. A.Y.

A77-21698 * # Simulation of fluidized bed combustors. I - Combustion efficiency and temperature profile. M. Horio and C. Y. Wen (West Virginia University, Morgantown, W. Va.). *American*

Institute of Chemical Engineers, Annual Meeting, 69th, Chicago, Ill., Nov. 28-Dec. 2, 1976, Paper. 58 p. 30 refs. Contract No. NAS3-19725.

A chemical engineering analysis is made of fluidized-bed combustor (FBC) performance, with FBC models developed to aid estimation of combustion efficiency and axial temperature profiles. The FBC is intended for combustion of pulverized coal and a pressurized FBC version is intended for firing gas turbines by burning coal. Transport phenomena are analyzed at length: circulation, mixing models, drifting, bubble wake lift, heat transfer, division of the FB reactor into idealized mixing cells. Some disadvantages of a coal FBC are pointed out: erosion of immersed heat-transfer tubing, complex feed systems, carryover of unburned coal particles, high particulate emission in off-streams. The low-temperature bed (800-950 C) contains limestone, and flue-gas-entrained SO2 and NOx can be kept within acceptable limits. R.D.V.

A77-21700 **Solar photothermal power generation.** A. B. Meinel and M. P. Meinel (Arizona, University, Tucson, Ariz.). *Environmental Conservation*, vol. 3, Spring 1976, p. 15-21. 10 refs.

Viable biological and technological solar-energy options of power generation for the future are discussed from the standpoint that transitions which cause the least change in the way people live and think are the ones which have the best chance of success. Conversion of solar energy to electrical power is outlined in terms of photovoltaic and photothermal conversion. Solar thermal conversion is examined relative to solar saline ponds, nonconcentrating collectors, and concentrating collectors. The success or failure of solar energy to become a new and major ingredient in the world's energy picture will depend largely on the cost-effective solution of problems in the applied fields of materials science and engineering. S.D.

A77-21701 # **Research on battery-operated electric road vehicles (K issledovaniiu elektrooborudovaniia elektropodvizhnykh ustanovok, pitaiushchikhsia ot akkumuliatornoi batarei).** V. S. Varpetian (Erevanskii Politekhnicheskii Institut, Yerevan, Armenian SSR). *Akademiia Nauk Armianskoi SSR, Izvestiia, Seriia Tekhnicheskikh Nauk*, vol. 29, no. 2, 1976, p. 43-50. In Russian.

A mathematical analysis of battery-operated electric vehicles is presented. Attention is focused on assessing the influence of the battery on the mechanical and dynamical characteristics of dc electric motors with series and parallel excitation, as well as on evaluating the influence of the excitation mode and speed control system on the performance of the battery. The superiority of series excitation over parallel excitation with respect to vehicle performance is demonstrated. It is also shown that pulsed control of the electric motor, as compared to potentiometric control, provides a more effective use of the battery and decreases the cost of recharging. A.Y.

A77-21737 # Review on the IAEA workshop on large fusion Tokamak projects. E. I. Kuznetsov and V. S. Strelkov (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). In: European Conference on Controlled Fusion and Plasma Physics, 7th, Lausanne, Switzerland, September 1-5, 1975, Proceedings. Volume 2. (A77-21726 08-75) Lausanne, Ecole Polytechnique Fédérale de Lausanne, 1976, p. 119-126.

The main objective of the international workshop held in Dubna, USSR, July 4-11, 1975 sponsored by the International Atomic Energy Agency was to consider four large Tokamak devices, namely: JET, TFTR (TCT), DFTR (T-20), and JT-60. Brief descriptions are given of the design, operating conditions, and plasma and device parameters. B.J.

A77-21744 # Overview of energy research and development administration inertial confinement fusion program. G. W. Kuswa (ERDA, Washington, D.C.). In: European Conference on Controlled Fusion and Plasma Physics, 7th, Lausanne, Switzerland, September 1-5, 1975, Proceedings. Volume 2. Lausanne, Ecole Polytechnique Fédérale de Lausanne, 1976, p. 186-195. 10 refs.

The principal aspects of the U.S. inertial fusion program are discussed. The aim of the program is to develop methods for driving symmetrically a spherical shell (pellet) of material toward its center, thereby compresing, heating, and containing the fusile material within the shell to yield more energy than was expended. One of the means investigated is to apply a laser pulse to the surface of a sphere in as uniform manner as possible and at as short a wavelength as practical. The lasers being studied and developed for this type of experiment are discussed. Another approach is to use powerful electron beams to deposit their energy in the outer regions of targets to be imploded. It is attractive owing to the high efficiency of beam devices. Other promising approaches studied are based on using ion pulses to implode pellets. V.P.

A77-21745 # **Hydrodynamics and compression of a laser irradiated target.** J. L. Bobin and J. M. Reisse (Centre d'Essais des Landes, Villeneuve-St-Georges, Val-de-Marne, France). In: European Conference on Controlled Fusion and Plasma Physics, 7th, Lausanne, Switzerland, September 1-5, 1975, Proceedings. Volume 2. Lausanne, Ecole Polytechnique Fédérale de Lausanne, 1976, p. 196-210. 12 refs.

In order to meet fusion energy balance requirements, when the principle of pellet compression by a high-power laser is used to achieve a thermonuclear burn, the target should be compressed isentropically. In the present paper, the efficiency of the process is analyzed, using a Lagrangian formulation to study the dynamics of the process. It is shown how, starting from analytical theories, similarity laws can be derived and can be used effectively in the planning of experiments with lasers of limited energy, using targets that are initially in the solid state. V.P.

A77-21751 * **Solar power from satellites.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *Physics Today*, vol. 30, Feb. 1977, p. 30-32, 34, 36-38. 15 refs. NASA-supported research.

Microwave beaming of satellite-collected solar energy to earth for conversion to useful industrial power is evaluated for feasibility, with attention given to system efficiencies and costs, ecological impact, hardware to be employed, available options for energy conversion and transmission, and orbiting and assembly. Advantages of such a power generation and conversion system are listed, plausible techniques for conversion of solar energy (thermionic, thermal electric, photovoltaic) and transmission to earth (lasers, arrays of mirrors, microwave beams) are compared. Structural fatigue likely to result from brief daily eclipses, 55% system efficiency at the present state of the art, present projections of system costs, and projected economic implications of the technology are assessed. Two-stage orbiting and assembly plans are described. R.D.V.

A77-21757 # **Space power systems - What environmental impact.** B. K. Ching (Aerospace Corp., El Segundo, Calif.). *Astronautics and Aeronautics*, vol. 15, Feb. 1977, p. 60-65. 10 refs.

Preliminary studies have indicated that space power systems are viable concepts that could become both economically and technologically feasible by the end of the present century. The impact of space power systems on the earth's atmospheric environment from ground level to the ionosphere is discussed. Microwave beam and vehicle exhaust are shown to affect the ionosphere and upper atmosphere. Ways in which booster exhaust products may influence the stratosphere and ionosphere are examined. Although effluents are released over a wide range of altitudes, the stratosphere causes greatest concern because it provides the protective layer of ozone that shields the earth's surface from harmful solar ultraviolet radiation. Research objectives of satellite power system concepts related to microwave beam propagation and transportation-system pollutants are identified. S.D.

A77-21761 **Is commercial coal conversion practical.** *Energy*, vol. 2, Winter 1976, p. 16-19.

Controversies and development problems confronting production, use, acceptance, and marketing of synthetic natural gas (SNG) under present and likely U.S. and world conditions are surveyed.

Uncertain price and market pictures, costs and prices of liquefied natural gas (LNG), possible inflationary effects and political decisions, present development programs and SNG facilities investments are discussed. Plans for liquefaction and gasification, ERDA-funded coal conversion projects, and arguments raised against SNG programs are outlined. Coal reserves and water availability in the western U.S. important for SNG development are discussed. R.D.V.

A77-21762 Worldwide energy development - Delayed opportunities. C. W. Hull and C. W. Snyder (Bechtel Financing Services, Inc., San Francisco, Calif.). *Energy,* vol. 2, Winter 1976, p. 20-24. 22 refs.

Worldwide energy reserves and development of energy facilities are surveyed with a breakdown of five major geographical/economic regions: (1) Middle East and North Africa; (2) Sub-Saharan Africa; (3) Europe; (4) Far East, Australasia (including Indonesia, Japan); (5) Latin America; (6) United States; (7) non-capitalist countries (USSR, China). Effects of the overall energy crunch and petroleum shortfalls on industrially developed countries and on less-developed or underdeveloped countries are assessed. Factors contributing to steep rises in investment costs are outlined, banking and financing practices, obstacles to existing development plans, and foreseeable energy policies in some areas are given attention. R.D.V.

A77-21776 International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports (Colloque International sur l'Electricité Solaire, Toulouse, France, March 1-5, 1976, Communications). Conference sponsored by the Centre National d'Etudes Spatiales and Centre National de la Recherche Scientifique. Toulouse, Centre National d'Etudes Spatiales, 1976. 1050 p. In French and English.

The papers collected here report on recent developments in the technology, components, design, and analysis of the major types of engineering system currently under development for converting solar energy into electric energy. These main technologies are photovoltaic conversion, photoelectrochemical conversion, and thermodynamic conversion. Some of the topics covered include silicon solar cell development, cellular antiloss structures, simulation of solar collector performance, theoretical analysis of the CdS-Cu2S solar cell, fabrication of CdS solar cells, the selectivity-concentration compromise in collecting solar energy, optimization of photogalvanic cells, design and analysis of heterojunction solar cells, problems of thermal storage, turbines for thermodynamic solar power plants, thermal energy of the sea, and a modular fixed-mirror Brayton cycle solar power system.

P.T.H.

A77-21777 Computational program for accurate predetermination of irradiance and illuminance in connection with solar energy utilization (Programme de calcul pour la prédétermination précise des éclairements énergétiques et lumineux en relation avec l'utilisation de l'énergie solaire). R. Dogniaux (Institut Royal Météorologique de Belgique, Brussels, Belgium). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 9-18. In French.

The paper gives mathematical expressions for calculating solar irradiance and illuminance in terms of direct, diffuse, global, and reflected components for clear sky and overcast sky. The formulas can be implemented on computer. The following parameters are taken into consideration: latitude, date, time, degree of atmospheric turbidity, and orientation and inclination of the receiving surface.

P.T.H.

A77-21778 The economic collection and efficient utilization of solar energy. L. L. Vant-Hull (Houston, University, Houston, Tex.). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports.
Toulouse, Centre National d'Etudes Spatiales, 1976, p. 19-26.

Several techniques for loss suppression, flux concentration, energy concentration and for energy storage in solar devices are described and analyzed briefly. Various approaches to the collection of solar energy are then categorized according to the extent to which they depend upon these techniques. Fundamental limitations on the various techniques and considerations are discussed and recommendations made for future work. Based on this analysis, selection of the central receiver or solar tower approach for development in the United States is justified, and the schedule for construction of a pilot plant and a commercial demonstration plant is presented. Finally, we present a summary of U.S. Government expenditures for research and development of solar energy. (Author)

A77-21779 Thermodynamic constraints, effective temperatures and solar cells. P. T. Landsberg and J. R. Mallinson (Southampton, University, Southampton, England). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 27-42. 16 refs.

Two general steady state efficiencies of a system are obtained, one of which yields the Carnot efficiency as a special case, and a 'radiation in-radiation out' efficiency which is always less than the Carnot efficiency. Using typical realistic incident radiation spectra, effective solar temperatures and effective earth temperatures can be associated with each of them, both being wavelength-dependent. This leads to theoretical, but unrealistically high, Carnot and radiation in-radiation out efficiencies for each spectrum. By means of a two-level model these efficiencies can be reduced, and more detailed solar cell models can reduce them still further. (Author)

A77-21780 French developments in silicon photovoltaic cells (Les développements français des photopiles au silicium). H. Durand (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 43-56. 12 refs. In French.

The state of the art of solar cells is reviewed, economic goals for the next ten years of solar panel production are examined, and the French program for development of silicon photovoltaic cells is outlined. A brief analysis of the present cost of producing silicon cells is given. Brief mention is made of current French involvement in raw material production, single crystal technology, heterostructures and Schottky diodes, silicon thin films, assembly and reliability, and concentration. P.T.H.

A77-21781 Recent progress in low cost CdS-Cu2S solar cells. J. F. Jordan (D. H. Baldwin Co., Cincinnati, Ohio). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 57-80. 5 refs.

The chemical spray process, based on the well-known float glass process for the manufacture of glass, for producing CdS-Cu2S solar cells is outlined and its costs are examined. Estimates of cell cost, solid state power handling, site construction, land, and maintenance are given for the current attainable efficiency of 5.85 per cent and the projected 10 per cent efficiency. The electrical characteristics of current devices are given, and the means by which a projected 10 per cent efficiency will be obtained are indicated. P.T.H.

A77-21782 The current status of the U.S. Photovoltaic Conversion Program. L. M. Magid (ERDA, Div. of Solar Energy, Washington, D.C.). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports.
Toulouse, Centre National d'Etudes Spatiales, 1976, p. 81-94.

The objectives of the U.S. Photovoltaic Conversion Program are enunciated, and the structure of the program is described. Some of the objectives are: to conduct research, development and demonstrations to establish a factor of forty reduction in solar array prices to $500 peak kWe by 1986; conduct a focused R & D effort on new materials and devices to show the feasibility of a reduction in solar array prices of 100 or greater by 1986 and to establish the viability of this advanced technology by the year 2000; develop concentration systems to demonstrate early low-cost electrical and thermal power generation systems. P.T.H.

A77-21783 **Thermodynamic conversion systems as applied to solar energy (Systèmes de conversion thermodynamique appliqués à l'énergie solaire).** J. Martinet and J. L. Peube (Poitiers, Université, Poitiers, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 105-112. In French.

The paper attempts to give a general overall view of the problems involved in developing a thermodynamic solar power system. The general structure of such a system is described without details. Attention is given to the degree of solar concentration possible through different optical systems; the solar furnace and the associated problem of reducing radiative, conductive, and convective losses; storage techniques; the choice of thermodynamic cycle as it depends on temperature of the thermal engine; the cold source; and the choice of turbine or piston engine for final conversion. P.T.H.

A77-21784 **Silicon solar cell development.** M. Wolf (Pennsylvania, University, Philadelphia, Pa.). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 113-140. 18 refs.

The paper takes a look at some of the main fronts on which effort in silicon solar cell development is being focused. These are the improvement of collection efficiency and of the current-voltage characteristic; increasing the production rate of solar arrays; and the search for large-scale low-cost production methods. At present there is a problem with the low open circuit voltage attainable on silicon solar cells, and some of the possible causes under investigation are indicated. Several approaches to obtaining low cost silicon of adequate purity are outlined. Estimates of the required capital for plant and equipment to provide for given planned production rates are made. P.T.H.

A77-21785 **Assessment of high-efficiency solar cells performance.** J. C. Larue and K. Bogus (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 141-159. 6 refs.

This paper presents the results of a comparative performance evaluation of 12 different types of silicon solar cells. The samples were submitted to electron and photon irradiation, humidity, thermal cycling and boiling water tests. Performance evaluation before and after tests included the measurement of I/V characteristics at 25 C, determination of temperature coefficients from 10 to 75 C and spectral response measurements. Computation of the cell performance under various illumination conditions indicated that cells made from low ohmic base material or cells with a back surface field will have the highest output in terrestrial applications. However, for space applications, cells made from higher resistivity silicon have a better end-of-life performance. (Author)

A77-21786 **High-efficiency thin silicon solar cells (Cellules solaires minces au silicium à haut rendement).** J. Michel, E. Fabre, and M. Mautref (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. (A77-21776 08-44) Toulouse, Centre National d'Etudes Spatiales, 1976, p. 161-168. In French.

Computer analysis of 'black' silicon solar cells with a n(plus)/p/p(plus) structure have been made. Detailed results are shown as a function of doping level, minority carrier diffusion length in bulk material and cell thickness. Experimental results show that good conversion efficiencies can be achieved with thin cells (100 microns) without any antireflective coating. (Author)

A77-21789 **A novel cover slide for solar cells.** A. Meulenberg, Jr. (Communications Satellite Corp., Clarksburg, Md.). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 199-208. 5 refs. Research sponsored by the Communications Satellite Corp.

The paper describes a new cover slide for solar cells which, having a sawtooth surface of periodicity equal to that of the solar cell grids, refracts the incident light so that it is all directed onto the semiconductor surface between the grids. This makes it possible to recover about half the incident light which is obstructed by conventional grid patterns. The sawtooth pattern also ensures that reflected light interacts with the cover slide surface a second time, so that nearly all light otherwise reflected from the cover slide surface is regained. P.T.H.

A77-21790 **Antiloss cell structures - Coupling with a selective surface (Structures cellulaires anti-pertes - Association avec une surface sélective).** P. Gallet, A. Ropke, F. Papini, and R. Pasquetti (Aix-Marseille I, Université, Marseille, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 211-218. 5 refs. In French.

Some theoretical considerations regarding the desirable properties of collector surfaces for direct conversion of solar energy into thermal energy are discussed. Selective surfaces were fabricated consisting of a metal support reflecting infrared rays, on which are deposited two thin films. The first layer of PbS absorbs below a certain wavelength cutoff and is transparent above it, while the upper layer of ZnS is likewise transparent above the cutoff frequency. Antiradiation properties of antiloss cells placed over such a selective surface were calculated. P.T.H.

A77-21791 **Antiloss cellular structures - The effect of the material cutoff wavelength (Structures cellulaires anti-pertes - Influence de la longueur d'onde de coupure du matériau).** P. Gallet and A. Ropke (Aix-Marseille I, Université, Marseille, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 219-222. In French.

At fairly low temperatures, the range of transmitted wavelengths and the range of radiated wavelengths from the base of cellular antiloss structures are disjoint, and the exact position of the material cutoff wavelength is not essential. However, as temperature increases the two ranges overlap, and the effect of the cutoff wavelength on the heat balance of the device becomes important. Calculations are performed showing how the radiative loss factor depends on temperature of the base. P.T.H.

A77-21792 **A solar collector of glass.** A. Keller (Universidad Técnica, Valparaiso, Chile). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 223-227.

The paper describes a thermal solar collector consisting of a glass cylinder in which a glass absorbing body is placed, consisting of a U-shaped tube flattened everywhere between two plates except at the ends where the fluid to be heated enters and leaves. Thermal radiation losses are reduced by covering the absorbing body with thin copper foil with a selective surface. Losses by thermal conduction are reduced by filling the glass cylinder with a gas of low thermal conductivity at about 0.03 torr (producing a vacuum would be too expensive for mass-produced collectors). For a collector of 45-mm inner diameter and an absorbing body 36 mm in width, at an average temperature of 90 C of the absorbing body and at standard solar irradiance, the heat collection efficiency is about 0.68, the overall efficiency being much less. Production costs are estimated at $0.56 per collector. P.T.H.

A77-21793 **A geometrical spectral selective window.** J. H. A. van Wakeren and J. Verhoeven (Stichting voor Fundamenteel Onderzoek der Materie, Instituut voor Atoom- en Molecuulphysica, Amsterdam, Netherlands). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p.

229-233. 7 refs. Research supported by the Nederlandse Organisatie voor Zuiver-Wetenschappelijk Onderzoek and EURATOM.

A spectral selective window, with large transmission for solar radiation and high reflection for thermal infrared, based on a geometrical metal structure is proposed. The structure consists of a metal foil with as many holes in it as possible. Each hole has a diameter of 1 micron; a hole of this size in metal acts as a waveguide for sunlight. A blackbody placed behind this waveguide structure is heated by solar radiation. The radiation loss of the blackbody is suppressed because the surface with its small holes acts as a mirror for the thermal infrared radiation. When aluminum foil is used as material for this spectral selective window, a transmittance over emittance ratio greater than 10 and a maximum working temperature of 800 K are possible. (Author)

A77-21794 Testing of collectors on the solar simulator - Fitting to the theoretical model and extrapolation (Expérimentation de capteurs au simulateur solaire - Recalage au modèle théorique et extrapolation). R. Ployart, B. Devin, and J. Colomes (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 235-249. In French.

A method is described for complete testing of a flat plate solar collector, including fitting of test data to theoretical curves and extrapolation of test data. Global parameters of the collector and its environment are defined, permitting comparison among various collectors. These parameters also allow the prediction of performance of a collector in an extrapolated environment by means of manual calculations and use of tables. P.T.H.

A77-21795 Effect of the geometric arrangement of a collector array on technico-economic performance of a fixed-power utilization system (Influence de la disposition géométrique d'un réseau de capteurs sur les performances technico-économiques d'un système d'utilisation à puissance fixe). B. Devin, R. Ployart, and J. Colomes (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 251-263. In French.

The potential performance of arrays of dihedral solar collectors was calculated in order to determine the possibility of increasing the daily operating time of solar thermodynamic systems without storage. A substantial reduction in output cost is possible by moving to a dihedral structure, for which the optimal operating time is extended from 4 to 6.5 hours per day. The net balance of the modification, whereby the added cost for extra surface area of the dihedral arrangement partially negates the savings due to increased operating time, depends on a single characteristic cost parameter for the system elements. P.T.H.

A77-21796 Evaluation of CdS photovoltaic cells in the framework of the development of solar electric power plants (Evaluation de la filière CdS en vue du devéloppement de centrales électriques solaires). W. Palz (Centre National d'Etudes Spatiales, Paris, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 265-272. In French.

A cost analysis is performed on a conventional electric power plant and followed by a cost analysis of a solar photovoltaic power plant. In addition, an analysis of the state of the art of CdS solar cell technology leads to the conclusion that the development of solar power plants is a feasible objective for the latitudes of Europe. B.J.

A77-21797 Theoretical prospects of the CdS-Cu2S solar cell. A. Rothwarf (Delaware, University, Newark, Del.). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 273-284. 24 refs. NSF Grant No. 03478.

The theory of the operation of thin film CdS-Cu2S solar cells is examined. The important role of interface states in determining the properties of the cells is demonstrated. The effects of crystallite size are included. Ways of increasing the efficiency of the cells are indicated. (Author)

A77-21798 Technology of large area Cu/x/S-CdS solar cells. H.-W. Schock, G. Bilger, G. H. Hewig, F. Pfisterer, and W. H. Bloss (Stuttgart, Universität, Stuttgart, West Germany). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 285-291. 10 refs. Bundesministerium für Forschung und Technologie Grant No. ET-45.

Thin-film Cu(x)S-CdS solar cells can be fabricated by various technological processes. The paper describes a fabrication process in which CdS is evaporated from a graphite source and baffling is achieved by means of a quartz frit with a 100-micron porosity. After vacuum deposition, the CdS layers are etched in a dilute HCl solution to improve surface properties and to enhance the absorption coefficient of the final cell. Ordinary glass can be used as substrate material. The front contact consists of a gold-plated copper grid whose structure is printed on a copper foil by silk screening technique. Two types of cells are fabricated: small cells with an area of 4 sq cm to perform parametric studies, and large cells with an area of 40 sq cm. Characteristics data and material costs are presented. S.D.

A77-21801 Photovoltaic properties of thin-film Cu2S-CdS heterojunctions (Propriétés photovoltaiques des hétérojonctions Cu2S-CdS en couches minces). J. Bernard and T. Amand (ONERA, Centre d'Etudes et de Recherches de Toulouse, Toulouse, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 309-315. In French.

Reliability tests were carried out with thin-film CdS polycrystalline photovoltaic cells. In particular, it was found that open-circuit cells subjected to long-term illumination experienced considerable degradation. The tests described in the present paper, were aimed at determining the causes of this degradation phenomenon by using the photocapacitance method to study the modifications of the heterojunction interface as a function of time. A persistent increase in capacitance up to 40 per cent in complete darkness was found to subsist after illumination of the junction by a light source with an energy corresponding to the CdS gap at 104 K. This was accompanied by an increase up to 60 per cent in photocurrent as a function of the wavelength and a decrease in threshold voltage of the Cu2S-CdS diode. V.P.

A77-21803 Investigation on the crystalline structure of Cu/x/S-CdS solar cells. M. K. Mukherjee, F. Pfisterer, G. H. Hewig, and H.-W. Schock (Stuttgart, Universität, Stuttgart, West Germany). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 325-331. 11 refs. Research sponsored by the Bundesministerium für Forschung und Technologie and Alexander von Humboldt Foundation.

Cu(x)S-CdS solar cells were bevelled at an angle of 40 deg and suitably etched to expose grains of CdS, cracks, and the junction region. Using a SEM, the average CdS grain size and the average distance between cracks occurring on the surface of the cells, fabricated with a CuCl dipping solution of pH = 4, were determined to be about 0.5 micron and about 2 microns respectively. The experiments also indicate that the thickness of the Cu(x)S layer perpendicular to the surface is strongly nonuniform due to reactions in grain boundaries. It could be shown that conclusions about the CdS grain size can not be made from observations of the surface roughness of the as-grown CdS layer. Some of the observations were confirmed by cathodoluminescence studies carried out with an electron scanning system developed at the institute. Considering these results some comments can be made concerning the real crystalline structure of the cells, the shape of the p-n junction, the

optimum CdS grain size, and the optimum Cu(x)S layer thickness for high efficiency cells. (Author)

A77-21805 Optimal parameters for solar cell films. A. Myszkowski (ONERA, Département d'Etudes et de Recherches en Technologie Spatiale, Toulouse, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 341-353.

The paper analyzes the efficiency of direct-gap semiconductor films in solar cells composed of two regions (n-type and p-type) connected by a junction. The discussion is limited to the efficiency of one region only, regardless of the properties of the second region and of the junction. It is assumed that the region is a homogeneous semiconductor thin film. Particular attention is directed to a discussion of the optimal conditions for the solar collection process. Calculations are presented for an n-type material, but they are valid for a p-type material as well. Major conclusions are that (1) a very thin semiconductor film that is a few times thicker than the light absorption length can give a good collection efficiency; (2) the surface recombination velocity should be less than D/d, where D is the diffusion constant for minority carriers and d is the film thickness; and (3) the concentration of the deep recombination centers should not exceed D divided by the product of C and d squared, where C is the recombination probability for minority carriers. S.D.

A77-21808 Focusing collectors of solar radiation (Capteurs à concentration du rayonnement solaire). J. Desautel, G. Peri, and B. Imbert (Aix-Marseille I, Université, Marseille, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 397-411. In French.

In an analysis of the conversion efficiency of a focusing solar collector, an equation describing the operation of the collector has been derived. The equation takes account of energy balance at the absorbing surface with consideration of radiative, conductive and convective heat transfer. The behavior of different types of collector is studied with a compromise established between radiation concentration at the focus of the absorber and the selectivity of the absorber. The effects of geometry on concentration are computed for a number of different collectors including parabolic, cylindro-parabolic, conical, and spherical. B.J.

A77-21809 The ONERSOL collector and its performance (Le capteur ONERSOL et ses performances). A. Moumouni and A. Wright (Office de l'Energie Solaire, Niamey, Niger). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 413-428. In French.

The plane solar collectors described in the present paper are sufficiently efficient to serve at moderate temperatures (between 100 and 130 C) as a heat source for a vapor-driven solar motor. An array of eight collectors of this type, coupled to a mirror shaped as a parabolic cylinder is shown to be capable of imparting a heat flux on the order of 340 kcal/sq m-hr to a circulating fluid at temperatures in the neighborhood of 170 C. V.P.

A77-21810 Tradeoff between selectivity and concentration in the collection of solar energy (Le compromis 'sélectivité/concentration' dans la captation de l'énergie solaire). G. Peri, F. Papini, and R. Pasquetti (Aix-Marseille I, Université, Marseille, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 429-434. In French.

The paper deals with three of the principal parameters that are important in designing solar collector and conversion systems. The parameters are the working fluid temperature, incident radiation (or the radiation concentration factor), and selectivity of the absorbing surface. Since the usable energy should be maximal, the three parameters are not independent. In particular, for a given operating temperature, it is possible to determine the threshold values of the parameters that are characteristic of the selectivity of the absorbing surface as a function of the concentration factor, i.e., the values above which no significant increase in energy can be obtained. In the present paper, the radiation balance of the absorbing surface is established in a manner involving the three parameters under consideration. The results are then used to demonstrate the possible tradeoffs between selectivity and concentration. V.P.

A77-21811 Study of a heliostat system for a solar thermal converter with an energy of 10 MW (Etude d'un système d'orienteurs pour une centrale thermique solaire d'une puissance de 10 MWe). J. Grassin, Mr. Thouvenin, Mr. Verot (Saint-Gobain Techniques Nouvelles, Courbevoie, Hauts-de-Seine, France), and Mr. Rocher (Saint-Gobain Industries, Neuilly-sur-Seine, Hauts-de-Seine, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 435-444. In French. Research supported by the Centre National de la Recherche Scientifique.

The experimental program described was initiated to study such intrinsic properties of commercial glasses as absorption, smoothness, energy distribution, etc., and to solve theoretical and experimental problems involved in the production and guidance of heliostats made of plane glass mirrors. It is shown that for a given receiver, accumulation of energy can be substantially increased by using slightly focusing heliostats made of focusing (commercial-glass) mirrors of constant thickness. A method of calculating the mirror profiles and their tolerances is proposed. V.P.

A77-21812 Description of a new photoelectrochemical generator (Déscription d'un nouveau générateur photoélectrochimique). P. Clechet, J. R. Martin (Lyon, Ecole Centrale, Ecully, Rhône, France), F. Juillet (CNRS, Lyons, France), and R. Olier. In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 445-451. 12 refs. In French.

The authors describe a photoelectrochemical generator of an original conception. It converts the light into electrical energy by means of the photoelectrochemical properties of some semiconductor oxides which are able to oxidize water, at a potential lower than its thermodynamic standard potential, when irradiated by electromagnetic waves of energy higher than their band gap. This generator is original in the fact that the photon into electron conversion does not involve the consumption of chemical species. This peculiarity presents two advantages: the cell which, on the other hand, has no separation between anodic and cathodic partitions, can be tight, and theoretically, the cell can work undefined in an autonomous manner. (Author)

A77-21813 Hydrogen production by photoelectrochemistry in visible light (Production d'hydrogène par photoélectrochimie en lumière visible). G. Lepoutre and M. De Backer (Lille, Facultés Catholiques, Lille, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 453-458. 8 refs. In French.

A photoelectrochemical cell is described which uses four visible photons per molecule of water photolysed. The photochemical reactions occur in liquid phase, with soluble photosensitive dyes. The reactants are regenerated by spontaneous dark reactions which make use of the excess energy stocked during the first step. Inert electrodes (photopotentials) and a selective membrane are used for the regeneration. The operation of this cell is compared to those of photosynthesis, of photogalvanic cells, and of cells with photosensitive electrodes. Problems concerning this cell are stated and analyzed. Preliminary results are given. The dyes which are used are sulfonated phtalocyanines. According to their nature, their relative concentration, their environment, they yield oxidation or reduction photopotentials which may be greater than 0.5 Volts. This is more than sufficient for the spontaneous regeneration of the reactants without any other input of energy. (Author)

A77-21814 **Method of investigation, experimental results, and optimization criteria for photoelectrochemical converters (Méthode d'étude, resultats expérimentaux et criteres d'optimalisation des piles photogalvaniques).** L. Aiache, J. P. David, G. Mathian, and A. Martin (Aix-Marseille III, Université, Aix-en-Provence, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 459-467. 11 refs. In French.

Process analysis techniques are applied to the study of photoelectrochemical converters of two types. One type of converter employs a photosensitive nonself-oscillating redox mixture; the other type employs a photosensitive self-oscillating redox mixture. It is shown how the experimental data can be used to identify the converter kinetics. The data illustrate the importance of the alternating illumination mode that manifests itself as a conversion mode in which the role of polarizations is diminished. V.P.

A77-21815 **Efficiency of photovoltaic cells employing Schottky diodes (Rendement de photopiles à diodes de Schottky).** D. Esteve, J. C. Suau (CNRS, Laboratoire d'Automatique et d'Analyse des Systèmes, Toulouse, France), J. Bernard, and M. Riboulet (ONERA, Centre d'Etudes et de Recherches de Toulouse, Toulouse, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports.
Toulouse, Centre National d'Etudes Spatiales, 1976, p. 469-479. 7 refs. In French.

Numerical simulation is used to compare the respective efficiency of p-n junctions and Schottky diodes for use in photovoltaic cells. Particular attention is given to the capability of MIS structures in which a thin insulating layer is inserted between the metallic contact and the semiconductor. The theoretical analysis, which accounts for the effect of this thin insulating film, is based on the tunneling currents for the two types of carriers at the interface. S.D.

A77-21817 **Heterostructures for silicon solar cells (Hétérostructures pour cellules solaires au silicium).** E. Fabre (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France) and R. Tijburg (Natuurkundig Laboratorium, Eindhoven, Netherlands). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 493-498. 7 refs. In French.

Major advantages of the In2O3(n plus)/Si(p) heterojunction are that the same layer provides the three functions of antireflective layer, transparent electrode, and collection barrier; that there is no 'dead' layer in the vicinity of the surface as it may be the case with the diffusion-type; and that deposition of layer is achieved at low temperature. The paper discusses the characteristics of In2O3(n plus)/Si(p) heterojunction cells in which the oxide layer is deposited by reactive evaporation of indium and tin in an oxygen atmosphere, with thickness being adjusted between a few hundred angstroms and one micron. Preliminary results have demonstrated the suitability of this heterojunction to the development of solar cells. S.D.

A77-21818 **Improvement of the efficiency of M-S solar cells by interfacial modifications (Amélioration du rendement de cellules solaires M-S par modifications interfaciales).** J. A. Roger, P. Eisenberg, J. Pivot, C. H. S. Dupuy (Lyon, Université, Villeurbanne, Rhône, France), G. Vendura, and S. J. Fonash (Pennsylvania State University, University Park, Pa.). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 499-505. 14 refs. In French.

A method for improving the conversion efficiency of M-S (metal-semiconductor) Schottky-barrier solar cells is described which consists of the introduction of a very thin interfacial layer and by the formation of surface states at the insulator-semiconductor interface. An examination of the volt-ampere characteristics of both M-S and M-I-S cells shows that the introduction of a very thin interfacial oxide films leads to a considerable improvement in efficiency. B.J.

A77-21819 **Improving MIS silicon solar cells by HF-treatment of the insulating oxide layer.** A. H. M. Kipperman and R. J. C. van Zolingen (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports.
Toulouse, Centre National d'Etudes Spatiales, 1976, p. 507-512. 6 refs.

Refering to the desired properties of the oxide layer in MIS structures, a convenient low-temperature HF-treatment is presented for MIS silicon solar cells. With this treatment large area cells can be made showing a good homogeneity. This type of processing seems very applicable to polycrystalline silicon. (Author)

A77-21820 **Open-circuit voltage of silicon solar cells (Tension en circuit ouvert des cellules solaires au silicium).** J. P. Ponpon and P. Siffert (CNRS, Centre de Recherches Nucléaires de Strasbourg, Strasbourg, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 513-522. 11 refs. In French.

The increase of the open circuit voltage of Schottky silicon solar cells can be obtained by three different ways: a proper choice of the metal (MS structure), the use of MIS structure with an interfacial implanted layer and the use of a MOS structure. These structures have been studied and the main results will be presented, especially, the dependence of the open circuit voltage upon the barrier height at the contact. Special attention has been devoted to the study of gold-oxide-n type silicon diodes. Depending upon the properties of the oxide interfacial layer the open circuit voltage has been increased up to 550 mV, that is an improvement of about 70 percent. (Author)

A77-21821 **Calculation of the efficiency of a heterojunction solar cell.** A. De Vos and H. Pauwels (Fonds National de la Recherche Scientifique; Gent, Rijksuniversiteit, Ghent, Belgium). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 523-534.

The efficiency is calculated of a heterojunction solar cell with ideal diode characteristic and ideal absorption characteristics. It is calculated as a function of the two semiconductor bandgaps Eg1 and Eg2. It is proved that a possible benefit of using a heterojunction, is less severe conditions for the semiconductor parameters. It is also shown that a heterojunction solar cell exhibits a better current efficiency than a homojunction cell, if the cell is illuminated from the appropriate side. (Author)

A76-21823 # **An alternative definition of material properties.** A. J. Medland (Hatfield Polytechnic, Hatfield, England). *Strain*, vol. 12, Jan. 1976, p. 14-19. 11 refs.

The elements of two well established approaches to the definition of material properties are examined, one of which is based on the theory of elasticity and the other on the strength of materials. The alternative approach discussed is based on the phenomenon of wave motions in solids, arising from dynamic loading. For a structure under impact, the most important property of the material is the speed with which it can radiate a strain disturbance throughout the structure. This redistribution occurs in the form of a series of waves which move at constant speeds and depend directly upon the material constants. Some aspects of measuring short-duration low-amplitude pulses are examined, along with the details of the required instrumentation. The advantages of the approach are that the properties can be determined from nondestructive tests, that the measurements can be made with the same strain gauges that are used in subsequent tests, and that the process can be readily automated. V.P.

A77-21824 **Interaction between the solar mirror field and the thermodynamic system of a turning solar power plant (Interaction entre le champ d'héliostats et le système thermodynamique d'une centrale solaire à tour).** B. Dessus, C. Mersier, F. Pharabod (Electricité de France, Direction des Etudes et

Recherches, Chatou, Yvelines, France), and J. L. Abatut (CNRS, Laboratoire d'Automatique et d'Analyse des Systèmes, Toulouse, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 559-586. In French.

The geometrical concept of a mirror field, the individual size of each mirror, and the size of the receiver are the primary elements of an optimal choice of the thermodynamic conversion system. In this study, keeping as a criterium the optimal thermooptical ratio, the influence of the maximal energy density at the receiver focus as well as the average energy concentration ratio is analyzed. Nature of heat transfer fluids, temperature of cycle, and thermic exchange system are discussed. Some total ratios are given as examples. (Author)

A77-21825 ***Use of solar water-heating installations in the* combined cycle of a thermal electric power plant (L'emploi des chauffe-eau solaires dans un cycle combiné d'une station thermique électrique).** I. Aladiev, B. Garf, V. Kozlov, and Iu. N. Malevskii (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 587-594. 8 refs. In French.

The paper examines a solar installation for the regenerative heating of water to be used in the thermodynamic cycle of a thermal electric power plant. An energy-production cost analysis is presented and attention is given to the type of turbine, the amount of supplementary power produced, and the area of the solar installation. B.J.

A77-21826 Problems relating to heat storage (Problèmes liés au stockage thermique). C. Etievant, Mr. Allard, Mr. Bonnin, Mr. Pharabod (Electricité de France, Clamart, Hauts-de-Seine, France), J. L. Peube, and Mr. Vialaron. In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 595-612. In French.

Different types of solar-heat storage at a solar thermal power plant are discussed including short-term (1-2 h) storage associated with cloud variations, daylong (15-24 h) storage for averaging output power, storage for providing peak-hour power, and seasonal storage. An economic analysis is carried out with emphasis on the effect of storage costs on the costs of electric power produced. Criteria for the choice of heat-storage materials are discussed and a number of specific materials are examined including NaCl, NaCl/CaCl2, NaOH, HITEC, and LiH. B.J.

A77-21827 Utilization of solar radiation in large solar power plants with hydraulic storage (L'utilisation de la radiation solaire dans les grandes centrales énergetiques solaires avec accumulation hydraulique). R. R. Aparisi and D. I. Tepliakov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 613-634. 5 refs. In French.

The paper discusses a solar power plant with pump storage of solar energy effected diurnally, seasonally, and annually. The operation of the pump-storage system is studied as a function of the regime of incidence of solar radiation. The efficiency of the system is analyzed for three cases of storage (diurnal, seasonal, and annual) and such quantities as diurnal, nocturnal, and monthly energy outputs are presented. Attention is given to problems of safety and minimization of solar-energy costs. B.J.

A77-21828 Turbines and turbogenerators for solar power plants with thermodynamic cycles (Turbines et turbogénérateurs pour centrales solaires à cycles thermodynamiques). M. P. Pocard (Société Rateau, La Courneuve, Seine-Saint-Denis, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 635-638. In French.

A turbogenerator covering the power range 20-200 kW has been developed for thermodynamic-cycle solar power plants which use small temperature variations. A prototype generator has been developed with an output power of 30 kW and is being used in Mexico in association with a flat-collector installation for the pumping of water. The generator in question is Rankine-cycle; the working fluid is Freon, with a discharge rate of 2.66 kg/s, which expands into an open-type centripetal turbine. B.J.

A77-21829 The thermodynamic cycle of the ONERSOL engine (Le cycle thermodynamique du moteur ONERSOL). A. Moumouni and A. Wright (Office de l'Energie Solaire, Niamey, Niger). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 639-644. In French.

ONERSOL (Office de l'Energie Solaire) is developing a freon-vapor piston engine with a Rankine cycle that utilizes an external heat source consisting of a combination of flat solar collectors and a cylindrical-parabolical solar concentrator. For a collector surface of 24 sq m, the engine is predicted to have a power of about 2 kW. B.J.

A77-21830 Thermal optimization of steam generating systems for tower type solar steam power plants - Tasks and methods. D. I. Tepliakov and R. R. Aparisi (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 645-669. 8 refs.

Technical and economical optimization is an important feature of analytical and experimental studies of various versions of high-power solar tower systems. To obtain reliable data, optimization must be applied to all stages of design. In the present paper, methods that should be helpful in evaluating solar system designs are discussed. V.P.

A77-21831 The solar tower as a source of thermal electric energy. L. L. Vant-Hull (Houston, University, Houston, Tex.). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 671-680. 8 refs.

The paper describes the basic features and cost effectiveness of a large-scale solar tower capable of producing 10 to 1000 MW of thermal energy at a single elevated central receiver that employs an array of thousands of large mass-produced identical heliostats. In the tower concept, the dishes are replaced by essentially flat reflectors of the same size, which are substantially easier to fabricate with flat float process glass than are the rather deep parabolic dishes. The system has been scaled to utilize heliostats of the size most economical to mass produce and install while still maintaining the efficiency of 500 C steam temperature. Diurnal variation of the collected energy for each month of the year for a certain site is presented. Also discussed are the basic thermocycle of the power-plant and future developments. S.D.

A77-21832 A study on solar tower power system. K. Fukuda, H. Higuchi, K. Yanagi, and A. Yoshihara (Mitsubishi Heavy Industries, Ltd., Hiroshima, Japan). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 681-695.

The paper deals with research and development work on solar tower power systems within the program of the Sunshine Project initiated in 1974. Particular attention is given to a 10 kW thermal test apparatus for solar energy collectors. Tests carried out with this apparatus are described. The results showed a solar to thermal energy conversion efficiency of approximately 50% at an absorber surface temperature of 220 C, with about 6 kW of solar energy collected by the mirrors. The specifications of a planned 50 kW solar tower test apparatus are presented, along with the results of a study of the technical feasibility of a 1 MW electric pilot plant with the following specifications: a field area of 117 by 117 m; a tower height of 58.5 m; and about 800 mirrors, measuring 3.84 by 3.84 m each. V.P.

A77-21833 **Thermal energy of oceans (Energie thermique des mers).** P. Vitureau. In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 697-718. 16 refs. In French.

The paper reviews different aspects of the conversion of solar energy to electrical energy by utilization of ocean temperature gradients. The technological parameters of this type of conversion scheme are discussed including effective cycle, turbine and generator efficiency, thermic power, and heat transfer coefficients of the exchangers. The implantation of an ocean thermal power plant is considered along with the nature of the thermodynamic cycle (open and closed) employed. Design parameters and problems of cost are examined. B.J.

A77-21835 **100 kilowatt-hours per day with RTC silicon solar cells (100 kilowatt-heures par jour avec les cellules solaires au silicium R.T.C.).** B. Dalibot (La Radiotechnique Compelec, Paris, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 739-745. In French.

Recent research and development at La Radiotechnique Compelec (RTC) in the field of silicon solar cells is reviewed. Attention is focused on the development of a common language for expressing solar-cell output power, and to the operation of solar cells, studying reliability, service life, and output power as a function of illumination. Non-space applications of solar cells are considered including for rural hydraulics and irrigation. Costs are analyzed with regard to thermodynamic and photovoltaic infrastructures. B.J.

A77-21836 **Status report on the German experimental study for terrestrial solar electric generators.** H.-W. Schuemann and R. Buhs (Telefunken AG, Wedel, West Germany). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 747-754.

A77-21837 **Performance rating of photovoltaic solar generators for terrestrial applications.** F. C. Treble (Royal Aircraft Establishment, Space Dept., Farnborough, Hants., England). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 755-764.

Procedures and equipment for measuring the terrestrial performance of photovoltaic solar generators in natural and simulated sunlight are reviewed and the problems of minimizing errors and discrepancies discussed. Recommendations are made for an international code of practice, stipulating the use of standard solar cells calibrated by a recognized agency for monitoring the intensity of illumination during performance tests and relating it to 'standard sunlight' at 100 mW per sq cm. The recommendations cover the selection and calibration of standard cells, performance test procedures, solar simulators, temperature control and instrumentation. (Author)

A77-21838 * **Photovoltaic test and demonstration project.** A. F. Forestieri, H. W. Brandhorst, Jr., and J. N. Deyo (NASA, Lewis Research Center, Cleveland, Ohio). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 765-769.

The considered project consists of three subprojects related to applications, device performance and diagnostics, and endurance testing. The objectives of the applications subproject include the determination of the operating characteristics for a variety of photovoltaic conversion systems. A system test facility is being constructed in this connection and a prototype residence experiment is to be conducted. Market demand for solar cells is to be stimulated by demonstrating suitability of solar cells for specific near-term applications. Activities conducted in connection with device performance studies and diagnostics are also discussed along with developments in the area of endurance testing. G.R.

A77-21839 **A power plant of the Aerosolec type (La station d'énergie type 'Aérosolec').** R. Colin (CNET, Issy-les-Moulineaux, Hauts-de-Seine, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 775-781. In French.

The Aerosolec electric power plant has been developed to supply isolated telecommunication centers. Power is generated by wind and/or sun. The plant comprises a solar generator, an aerogenerator, a storage battery and chemical dry batteries, both generators being in parallel and sharing in producing power depending upon wind and sun conditions prevailing on the site. The storage battery caters for the storage, regularity and continuity of power supply. The dry batteries are used as ultimate standby, warranting permanent supply even in case of outage of the other sources. Power ratings anticipated today range from 100 to 400 watts for continued round the clock service. With lacking wind and/or sun, independent operation for a fortnight is foreseen on storage batteries and dry batteries. (Author)

A77-21840 **Preliminary work on photovoltaic solar electric generator for rural electrification at Universiti Sains Malaysia.** D. Chuah, S. K. Tan, C. Singh, R. Ratnalingam, and C. K. Koh (University of Science, Penang, Federation of Malaysia). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 783-803. 5 refs.

A feasibility study is being carried out to determine the application of a low power output photovoltaic solar electric generator to light an individual home in the rural area. In particular, a 25 watt 24 volt silicon solar electric generator is currently under test to determine its performance under local atmospheric conditions. The various characteristics of the generator and the sunshine hours are being recorded simultaneously. From these data the requirements including cost would be extrapolated for a 125 watt 24 volt generator. (Author)

A77-21841 **Effect of components on converters (Influence des composants sur les convertisseurs).** J. M. Peter (Thomson-CSF, Département Orientation Application, Aix-en-Provence, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 805-820. In French.

The paper reviews some of the basic performance characteristics of the available types of transistors and thyristors that will be used in the conversion units which convert the variable voltage in the solar cell array to the fixed-voltage of the utilization grid in a solar power plant. At present, the maximum voltage controllable by a thyristor is about 100 times greater than that controllable by a transistor. The transistor will require larger dimensions than a thyristor for an equal power yield at high voltage. The transistor has several advantages over the thyristor when it comes to switching; it switches without an auxiliary circuit, and the switching frequency can be much higher with lower switching losses. P.T.H.

A77-21842 **10 MW solar thermal electric power plant design for solar day operation.** A. F. Romero (Universidad Nacional Autónoma de México, Mexico City, Mexico). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 821-830. 6 refs.

A complete design is presented to supply power to the city of Hermosillo, Sonora in the northwest part of Mexico. Even though the design covers only solar day operation (eight to twelve hours daily), its main objective is to increase fossil fuel savings. Further improvements can be made to include night and day operation, provided that a good design on energy storage is made. However, continuous operation is disregarded in this paper, due to the extremely high increase in initial investment. An analysis of available solar insolation data for the zone is included and also some experimental measurements, as well as some other geophysical

characteristics, which led to the decision of selecting an open Brayton cycle (gas turbine), using air as the working fluid. (Author)

A77-21844 Development of a 10 kWe solar thermal power station. H. Hopmann, K. Berndorfer, and P. Vinz (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 839-850.

Small solar power plants with thermal and electrical power storage systems are a viable solution for well-insolated developing countries - such as Egypt and India - situated within the tropical zone. The design concept of a 10-kWe solar thermal power plant employing two separate closed thermal cycles is discussed, with special emphasis on the working fluid in the Rankine cycle. The hazard-free low-pressure refrigerant R114 (C2Cl2F4) is chosen as the working medium, since it has a high thermal stability and is completely nonpoisonous, noninflammable and virtually neutral. Major components of a prototype plant with a flat-plate collector array and a screw expansion prime mover are described. S.D.

A77-21845 Optimization of the sizing of a solar power plant in order to obtain a minimal kWh cost (Optimisation du dimensionnement d'une centrale solaire, pour l'obtention d'un prix de kWh minimal). J.-L. Boy-Marcotte and A. Potiron (Société Bertin et Cie., Plaisir, Yvelines, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 851-865. In French.

The sizing of a solar thermoelectric powerplant was achieved by modeling the basic elements of the system: collector, piping, eventual storage, turbogenerator. Reasonable and consistent options have been made prior to modeling the plant, the hot temperature was varied from 200 to 300 C. The digital code developed for this study made it possible to determine the size of the basic elements that lead to the minimum cost of the kWh for a given cost per area of collector. (Author)

A77-21846 A modular fixed-mirror Brayton-cycle solar power system. A. B. Meinel, D. B. McKenney (Helio Associates, Inc., Tucson, Ariz.), and M. P. Meinel (Arizona, University, Tucson, Ariz.). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 867-876. Research supported by the Electrical Power Research Institute and Helio Associates.

A quasi-hemispherical fixed mirror provides a distributed focus of the sun within the bowl. A cylindrical absorber tracks the diurnal motion of the sun, heating compressed air which then expands in the turbine stage of a Brayton cycle engine which is attached to the moving absorber structure. The fixed mirror and moving structure are below the land surface providing excellent protection of the system from storm damage. Elimination of water for cooling makes this modular system well adapted for desert areas. (Author)

A77-21847 Potentialities of electric energy production by means of thermoelectric generators. R. Kh. Baranova, G. A. Gukhman, I. I. Kokhova, and Iu. N. Malevskii (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 877-885. 9 refs.

The paper presents results of a study of solar thermoelectric power generation. A number of thermoelectric materials were examined including Bi2Te3, Sb2Te3, Bi2Se3 as well as solid solutions based on these materials. The design and operational characteristics of panel-type and modular solar thermoelectric generators are considered. B.J.

A77-21848 Thermoelectric conversion of solar energy by means of refractory B14Si compounds (Conversion thermoélectrique de l'énergie solaire au moyen de composés réfractaires B14Si). B. Pistoulet, J. L. Robert, J. M. Dusseau, J. M. Darolles (Montpellier II, Université, Montpellier, France), B. Armas, and C. Combescure (CNRS, Laboratoire des Ultraréfractaires, Font Romeu, Pyrénées-Orientales, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 887-892. 6 refs. In French.

We show that high efficiency thermoelectric conversion can be obtained when using refractory compounds showing hopping conduction, low thermal conductivity, and high thermoelectric power. These conditions are met in B14Si; crystalline films of this compound are deposited by pyrolysis of a mixture of B Br3 and Si Br4 under reduced pressure. The thermoelectric figure of merit is given at 1700 C and 1250 C. The total conversion efficiency would exceed 20 per cent; this is particularly interesting for solar energy conversion. (Author)

A77-21849 Photovoltaic conversion of solar energy using optical concentration systems. K. Krebs (EURATOM and Comitato Nazionale per l'Energia Nucleare, Centro Comune di Ricerche, Ispra, Italy). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 893-923. 43 refs.

The solar cell should be able to convert incident radiation of increased energy into electricity both efficiently and economically. The cost-effectiveness of photovoltaic converter/concentrator devices is discussed. Conditions to make the concentration approach a viable solution are identified. Implementation of the concentration concept shifts the emphasis from developing low-cost cells to the problem of finding the most economical optical concentrator. Properties of some typical quasi-stationary linear systems - such as the V-trough, the parabolic trough, and the linear Fresnel lens types - are outlined. S.D.

A77-21850 Experiences with a 400 watt solar cell array in the Netherlands in the period December 1974-December 1975. F. Schurink and M. C. M. Van Hasselt (KEMA, Arnhem, Netherlands). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 925-939.

In 1974 an array of silicon photovoltaic cells, with a total peak power of 400 watt, was installed at the KEMA in Arnhem, (The Netherlands). An electric system is designed to collect data from solar cells put into practice in The Netherlands. The cells are combined in groups of 24 volts. The system in which these cells supply the electricity consists mainly of a motor and a resistor, while lead-acid batteries serve as storage. Various cells are compared, especially with regard to their radiation intensity and temperature dependence. (Author)

A77-21851 High-voltage photoelectric converters operating at high intensities of solar flux (Transformateurs photo-électrique a haute tension, fonctionnant à flux solaire de haute intensité). V. Baum, B. Bazarov, and V. Terekhin (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 941-946. In French.

The following type of solar photoelectric system is studied: (1) high-voltage photoelectric cells, (2) a system of solar collectors, and (3) a device for turning the collectors after the sun. Results are presented of an investigation of the cooling of the photocells (illuminated with the aid of parabolic collectors) by different refrigerant liquids (distilled water, sulfuric ether, and Freon). B.J.

A77-21852 Manufacture of plastic foam concentrators and their characteristics (Production de concentrateurs en mousse plastique et leur caractéristiques). B. Bazarov and V. Baum (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 957-960. In French.

The fabrication of plastic foam (rigid polyurethane) solar energy concentrators is described and discussed. The advantages of polyurethane foam in this application, pulverization techniques, physico-mechanical properties of the material, and optical properties of the product are outlined. Data are provided on some characteristics of representative samples: apparent bulk density, compressive strength, bending strength, linear shrinkage and moisture absorption over a 24-h period, softening point, and thermal conductivity. R.D.V.

A77-21853 Miniature applications for photovoltaic generators (Applications miniatures des générateurs photovoltaiques). M. Juillerat (ESOTRON S.A., La Chaux-de-Fonds, Switzerland). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 961-964. In French.

The use of photovoltaic microgenerators in transistor radios, tracking emitters, and wrist watches is described. These applications are viewed as a spin-off of space research, and more specifically as a spin-off from fabrication of standard solar cells since failed cells can be used in these applications. Reliability in unattended operation, utilization of solar energy for recharging, and impact resistance are discussed. The contribution of integrated microelectronics to these applications is noted. R.D.V.

A77-21854 The use of solar cells as energy supply for a pumping system (Alimentation par photopiles d'un système de pompage). J. A. Roger, D. Campana, A. Castiel (Lyon I, Université, Lyons, France), P. Lavit, and C. Lepert (Etablissements Pompes Guinard, Courbevoie, Hauts-de-Seine, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 975-984. In French.

Photovoltaic converters are used as an energy supply to pump water by means of an electrical motor and a centrifugal pump. These elements are connected directly to the solar cells pannels since the system described here is to be used in isolated areas and must be as simple as possible. The prototype is going to be set up in Corsica and seasonal water needs are given in the case of a typical farm of this country. Comparatively a statistical treatment of the meteorological data gives the mean solar energy that one can expect on the solar cells for a given tilt of the pannels. The interdependence between the motor-pump group and the solar cells is studied by means of a graphical method and the way to optimize the system is discussed. (Author)

A77-21855 Some applications of photovoltaic solar energy (Quelques applications de l'énergie solaire photovoltaique). J. C. Le Gall (Centre National d'Etudes Spatiales, Toulouse, France). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 985-991. In French.

Some specific applications of solar cells are considered: electrical power supplies for a transatlantic sailing vessel; photocell-powered refrigerator for a remote installation; independent power supplies for a long-life unattended radio relay station. The four-mast sailboat envisaged is to be powered by solar cell panels, wind motors, and direct wind on sail. Power would be needed for: lighting, automatic pilot, closed-circuit TV to monitor sail angles of attack, satellite navigation system, and radio equipment, plus conventional gear. State-of-the-art equipment needed to store acquired solar energy is discussed. R.D.V.

A77-21857 Does solar energy demand more land surface, and more materials or energy investment than nuclear energy or fossil fuels - A preliminary study. C. D. Ouwens (Utrecht, Rijksuniversiteit, Utrecht, Netherlands). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 1000-1015. 41 refs.

The purpose of this article is to compare a number of electricity producing systems as far as their need of land surface, energy investment, use of materials, and manpower for maintenance are concerned. It is shown that the land area necessary for the production of electricity from solar energy is of the same order of magnitude as that needed for the production from coal or uranium. This order of magnitude relation is also true for the materials used for the construction of a electricity generating system as well as for the ratio of the total energy needed for the construction of a system and its energy deliverance. Furthermore it is stated that the future favors solar energy. No ultimate restrictions with respect to the considered quantities are expected if solar energy is widely used. (Author)

A77-21858 Effect of the characteristics of electrical supply networks on the design of solar power plants (Influence des caractéristiques des réseaux électriques sur la conception des centrales solaires). J. Fournier and J. L. Meylan (Battelle, Centre de Recherche de Genève, Geneva, Switzerland). In: International Conference on Solar Electricity, Toulouse, France, March 1-5, 1976, Reports. Toulouse, Centre National d'Etudes Spatiales, 1976, p. 1017-1029. 9 refs. In French.

The characteristics of electricity supply systems are described briefly. Two cases are treated, i.e., strongly interconnected systems typical of industrialized countries, and systems representative of developing countries. A comparison is made between the fluctuations of solar radiation and those of electricity demand. The parameters which are important for the system reliability are reviewed, and their influence on the technical solutions is analyzed. (Author)

A77-21936 Optimum wind-energy conversion systems. U. Hütter (Stuttgart, Universität; INGEST, Stuttgart, West Germany). In: Annual review of fluid mechanics. Volume 9.
Palo Alto, Calif., Annual Reviews, Inc., 1977, p. 399-419. 42 refs.

Windmill developments leading finally to the Dutch windmills with four-blade rotors are briefly considered and the characteristics of wind-energy converters are evaluated. It is found that up to specific speeds where other limitations turn out to be essential, rotors with higher optimum rated speeds are doubtless by far the best solution. Attention is given to limitations for specific speed, rotor characteristics at stall state, the rotor's disk-velocity coefficient, vortex-state problems, the near-critical operating rotor, refinements and simplifications, and optimum rated power. G.R.

A77-22022 100 MW large industrial gas turbine (Une grande turbine à gaz industrielle de 100 MW). J. Hubert (Société Générale de Constructions Electriques et Mécaniques Alsthom-Atlantique, Paris, France). *Entropie,* vol. 12, no. 71, 1976, p. 17-25. In French.

Subsystems, applications, testing, and functions of a large single-shaft gas turbine, model 9000, are described. Expanded applications for the turbine in the present economic setting are outlined: peak load service, emergency backup for power systems, simultaneous generation of electric power and heat, sea water desalination, residential heating, as power source in tandem with a waste-heat boiler. The basic design of the turbine and compressor is outlined, along with information on ancillary systems (electronic controls, hydraulic pumps, shaft rotators). The design of the turbine and associated systems is compact, no cooling water is needed, the noise level is moderate, and the plant produces no smoke or fumes. R.D.V.

A77-22023 Combined gas/steam cycle power and heat generating plants (Les centrales de production d'énergie et de chaleur à cycle combiné gaz/vapeur). M. Widmer (Compagnie Electro-Mécanique, Paris, France). *Entropie,* vol. 12, no. 71, 1976, p. 26-35. In French.

Power plants employing open-cycle gas turbines and combined gas/steam cycle gas turbines (CG/SCGT) and their applications are described. The discussion on applications of CG/SC in power generation covers: combined plant with turbine and waste-heat boiler (WHB), cycles with large or small excess air flow, afterburning upstream of WHB, superheated steam plants, and peaking turbine service. Examples of CG/SCGT for heat generation of water heating

in industrial or municipal utility service are discussed: CG/SCGT with WHB, dual-purpose electric power generation and water desalination plants, and use of backpressure turbines. Higher performances, with higher admission temperatures and higher exhaust temperatures, are envisaged, and CG/SCGT plants are viewed as competitive with large-scale steam plants. R.D.V.

A77-22024 **Small gas turbines and the Total Energy concept (Les petites turbines à gaz et l'Energie Totale).** A. Chiquet (Kongsberg France, Division Turbines à Gaz, Versailles, Yvelines, France). *Entropie*, vol. 12, no. 71, 1976, p. 50-57. In French.

The suitability of liquid-fuel or gas-fuel small gas turbines (SGT) to a Total Energy installation is examined. The ability of SGT to function burning natural gas or a variety of fuels, with far less pollution exhaust than a reciprocating internal-combustion engine, is noted. Fuel savings with SGT systems (ratings 0.5 to 10 MW), efficiencies, the smaller number of auxiliaries needed, flexibility and multipurpose functioning, ruggedness, installation costs and foundations required, and overall design and performance of SGT systems are outlined, with comparisons with Diesel engines and gasoline engines in comparable environments. Utilization of heat energy in the exhaust gas stream is described. R.D.V.

A76-22025 # **The role of the NAE 5-foot x 5-foot wind tunnel in the development of modern airfoil sections.** L. H. Ohman (National Aeronautical Establishment, High Speed Aerodynamics Laboratory, Ottawa, Canada). *Canada, National Research Council, Division of Mechanical Engineering and National Aeronautical Establishment, Quarterly Bulletin*, no. 3, 1975, p. 1-39. 33 refs.

The NAE transonic wind tunnel for airfoil testing has a high pressure shell structure and fairly large air storage (1430 cu m). A two-dimensional test insert (15-in. x 60-in.), designed in modules to be assembled in the transonic test section, is described. Test results are presented for various airfoils, including classical, supercritical, and jet augmented airfoils. Reynolds number effects on mechanical high lift systems were also studied. A schematic diagram of the high Reynolds number two-dimensional insert is presented, and graphs with airfoil test results are included. B.J.

A77-22038 **Theory of metal-insulator-semiconductor solar cells.** J. Shewchun, R. Singh, and M. A. Green (McMaster University, Hamilton, Ontario, Canada). *Journal of Applied Physics*, vol. 48, Feb. 1977, p. 765-770. 31 refs. Research supported by the National Research Council of Canada and NSF.

Recent reports indicate that the introduction of an interfacial oxide layer in a Schottky barrier can greatly increase the photovoltaic conversion efficiency of such devices. An explanation for the operation of such solar cells is proposed, based on the concept that they are minority-carrier nonequilibrium MIS tunnel diodes. Calculations of efficiency as a function of insulator thickness, substrate carrier concentration, surfaces states, and oxide charge are presented. These indicate that a maximum theoretical efficiency of 21% is possible under AM2 illumination for high substrate doping and low interface defect density. (Author)

A77-22079 **Analysis of silicon solar cells with stripe geometry junctions.** C. Hu and J. Edelberg (MIT, Cambridge, Mass.). *Solid-State Electronics*, vol. 20, Feb. 1977, p. 119-123. 8 refs.

Silicon solar cells with stripe geometry are analyzed. The base region collection efficiency is found to be insensitive to the transmissivity of the electrode and/or the diffused layer but quite sensitive to the width and separation of the stripe junctions. The additional losses of carriers are mainly due to the increased bulk recombination rather than the surface recombination. In one case analyzed, the collection efficiency decreases by 22% when the junctions are separated by about one sixth of the diffusion length with the surface recombination velocity at 300 cm/sec. Possible uses of the stripe-junction design in p-n junction cells and Schottky barrier cells are re-examined in the light of the new calculation and found to be less attractive than previously suggested. (Author)

A77-22081 **High efficiency n-CdS/p-InP solar cells prepared by the close-spaced technique.** A. Yoshikawa and Y. Sakai (Tokyo Institute of Technology, Tokyo, Japan). *Solid-State Electronics*, vol. 20, Feb. 1977, p. 133-137. 20 refs.

Heterojunction solar cells have been made by epitaxial growth of CdS on p-type InP using the close-spaced technique. Good rectification and photovoltaic properties have been observed in the cells grown on the (110) face of InP. The characteristics of the most efficient cell are open-circuit V = 807 mV, the fill factor = 0.74 and the power conversion efficiency = 14.4% under the solar input of 77 mW per sq cm. The photovoltaic properties of the cells obtained in this experiment are better than those reported elsewhere, and this is attributed to the superiority of the growth system to those of others in points that the junction is formed at relatively high temperature in a short time. (Author)

A77-22120 # **The technical concept of the IL-62M. II - Fuel system (Die technische Konzeption der IL-62M. II - Brennstoffanlage).** A. Leshchinev, D. Borisov, and A. Sidorov. *(Grazhdanskaia Aviatsiia,* 1976, p. 22, 23.) *Technisch-ökonomische Information der zivilen Luftfahrt*, no. 5, 1976, p. 290-293. In German. (Translation).

The IL-62M aircraft has a greater payload and a longer range than the IL-62. The increase in range was obtained with the aid of a number of technical improvements related to the aerodynamic characteristics of the aircraft and the installation of engines with a smaller fuel consumption. An additional fuel tank with a capacity of 5,000 liters was also provided. The design of the fuel system of the IL-62 is described together with the operational principles. Attention is also given to a device for determining the fuel reserve of the aircraft by means of a capacitance method. G.R.

A77-22121 # **The propulsion system of the aircraft Z-37. I (Die Antriebsanlage des Flugzeugs Z-37. I).** E. Schesky (Dresden, Hochschule für Verkehrswesen, Dresden, East Germany). *Technisch-ökonomische Information der zivilen Luftfahrt*, no. 5, 1976, p. 297-304. In German.

The propulsion system of the aircraft Z-37 consists of the propeller V 520, the engine M 462-RF, and a number of control and regulation systems. The thrust provided by the propulsion system is determined by a number of parameters, which are affected to a large extent by maintenance factors and the pilot. Objective, design, and principles of operation of the propulsion system are discussed and a description is given of characteristic technical-economical parameter values for a comparison of the considered system with other aircraft propulsion systems. G.R.

A77-22123 # **Principal stages in the development of thermoelectric power in the USSR (Osnovni etapi rozvitku termoelektrichnoi energetiki v SRSR).** A. A. Buriak. *Akademiia Nauk Ukrains'koi RSR, Visnik*, vol. 40, Nov. 1976, p. 25-34. 14 refs. In Ukrainian.

The history of the development of thermoelectric generators (TEG) and direct converters of heat energy to electric power, heat sources used, service lifetime of TEG, energy conversion efficiency, and TEG applications are discussed. Aerospace and submarine applications, using to advantage the reliability and durability of TEG, their long service life and life without recharging or refuelling, and their imperviousness to radiation belts, hard vacuum, weightlessness, solar bursts, micrometeorite impact, are emphasized, along with TEG installation on pipelines, at isolated radio and radio relay installations, beacons, magnetic variation patrol stations, or automatic radiometeorological stations. Solar energy, nuclear reactors, and radioisotopes as heat sources for TEG in such applications are discussed. R.D.V.

A77-22142 **The application of laminated wooden blades to a two-meter Darrieus type vertical axis wind turbine.** B. L. Butler and B. F. Blackwell (Sandia Laboratories, Albuquerque, N. Mex.). *SAMPE Quarterly*, vol. 8, Jan. 1977, p. 1-6. 13 refs. ERDA-supported research.

The paper discusses the fabrication and performance of laminated plywood blades for a two-meter-diameter three-bladed

Darrieus-type vertical-axis wind turbine. Material strengths of unidirectionally laminated Lauan, Monalava, poplar, and maple woods are measured and compared with the predicted tensile strengths in each under runaway conditions with no generator output. The performance of two sets of Lauan blades differing only in airfoil shape is evaluated on the basis of low-speed wind-tunnel tests. The results indicate that wooden blades are practical, feasible, and low in cost for the two-meter turbine configuration, but must be designed to resist resonant undulations by increasing airfoil thickness at the expense of turbine performance. F.G.M.

A77-22143 **Fiber glass super flywheels.** J. A. Rolston (Owens-Corning Fiberglas Technical Center, Granville, Ohio). *SAMPE Quarterly,* vol. 8, Jan. 1977, p. 7-12.

Light weight flywheels of fiber glass reinforced epoxy can store more energy at lower cost than the equivalent weight of alloy steel. In competition with batteries, the composite flywheel stores more energy per pound with an unlimited number of charge/discharge cycles. The operating stresses for flywheels are near the ultimate long term strength of the composite. Several composite flywheel design concepts have been proposed; the principal ones are the 'multi-ring' and the 'brush'. (Author)

A77-22144 **Materials and processing approaches to cost competitive wind turbine rotor blades.** E. A. Rothman and H. E. Deabler (United Technologies Corp., Hamilton Standard Div., Windsor Locks, Conn.). *SAMPE Quarterly,* vol. 8, Jan. 1977, p. 13-21.

A study was made of materials and processes using metallics and composites or combination of both for the fabrication of low cost wind turbine blades. As a result of these studies the filament winding process was selected as offering the potential for low cost fabrication while requiring the minimum compromises in aerodynamic shape, optimum structure, and weight. The process is described which is compatible with existing winding facilities and equipment and which results in near optimum structural fiber orientation. Fiberglass material is used with a resin system appropriate for the process and requiring minimum curing time and equipment. (Author)

A77-22342 # **The principles of system studies in nuclear energy research (Osnovy sistemnykh issledovanii v iadernoi energetike).** N. A. Dollezhal' and L. A. Melent'ev. *Akademiia Nauk SSSR, Vestnik,* no. 11, 1976, p. 51-61. In Russian.

A hierarchy of mathematical models for the optimization of nuclear energy systems (primarily fission with possible application to fusion) is presented in the framework of a heuristic approach. The systems approach employed is threefold involving: (1) long range (25-30 years) strategy for the development of nuclear power systems with primary attention directed to investigation of the dynamics of optimal system structure (i.e., reactor configurations and arrangements), (2) a strategy (10-15 years into the future) of optimization of nuclear power systems with incorporation of nuclear energy into the total energy system of the country, and (3) the development of models on an equal hierarchical plane for the control of power distribution, the optimization of the external fuel cycle, and the optimization of thermal power plants which employ nuclear fuel. B.J.

A77-22350 **Energy storage in the form of latent heat (Energiespeicherung in form von latenter Wärme).** M. Taube and S. Pinto (Eidgenössisches Institut für Reaktorforschung, Würenlingen, Switzerland). *Energie,* vol. 28, Dec. 1976, p. 357, 358. In German.

Production and demand in the case of electrical energy show great fluctuations, particularly between day and night. Various types of energy storage systems have been proposed to deal with this situation. A description is presented of a system in which energy is stored in the form of latent heat. The storage system, which is used in connection with light water reactors, makes use of a tank with a eutectic mixture, a heat exchanger, a turbine cycle, and equipment which provides a connection with the light water reactor. G.R.

A77-22537 **The current state and prospects for development of controlled thermonuclear fusion.** E. P. Velikhov (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR) and E. E. Kintner (ERDA, Div. of Magnetic Fusion Energy, Washington, D.C.). *Atomic Energy Review,* vol. 14, Dec. 1976, p. 719-733.

Optimism is expressed on the prospects for success in practical fusion power by the end of this century. Controlled thermonuclear fusion through inertial confinement, magnetic confinement in Tokamaks, systems using lasers, relativistic electron beams, and magnetic fields are reviewed. Recent achievements in plasma heating and confinement are surveyed. Terawatt-output lasers, superconducting magnets, advanced materials, vacuum pumps, feedback control, and improvements in targets, power sources, and fuelling are considered. Some new experimental devices, laser initiation of microexplosions, magnetic compression of shells, and injection of frozen hydrogen pellets are among the topics mentioned. R.D.V.

A77-22552 # **The minimum combustion gas recirculation ratio for fuel gas conversion in a MHD cycle (Minimalny stopien recyrkulacji spalin do konwersji paliwa gazowego w obiegu magneto-gazo-dynamicznym).** W. Grzeskowiak and W. Pudlik (Gdansk, Politechnika, Gdansk, Poland). *Politechnika Gdanska, Zeszyty Naukowe, Mechanika,* no. 24, (1975) 1976, p. 17-31. 6 refs. In Polish.

The combustion gas recirculation ratio (ratio of quantity of combustion gases admitted to converter to total quantity of combustion gases converted in the combustion chamber) as a function of combustion gas temperature and conversion temperature is minimized for assigned levels of nitrogen content in the combustion gases. Natural gas composition of 95% methane, 4% N2, and 1% CO2 is burned in the arrangement. Oxidizers used, energy input to the arrangement, and the thermal balance of the converter are discussed. The ratios are computed numerically for atmospheric pressure and for conversion of natural gas by combustion gases leaving the MHD generator at high temperatures. R.D.V.

A77-22575 **Armature of the MIT-EPRI superconducting generator.** J. L. Kirtley, Jr. (MIT, Cambridge, Mass.). *(Institute of Electrical and Electronics Engineers, Summer Meeting, Portland, Ore., July 18-23, 1976.) IEEE Transactions on Power Apparatus and Systems,* vol. PAS-96, Jan.-Feb. 1977, p. 88-96. 11 refs. Research sponsored by the Edison Electric Institute and Electric Power Research Institute.

This paper is a description of the armature built as part of the second MIT-EPRI experimental superconducting alternator. This armature has several new features, including an integral, nonmagnetic and nonconducting structure, an open header cooling system using the same fluid as coolant and as electrical insulation, and a limited voltage gradient winding pattern. These features are described, along with the results of measurements of the electrical and thermal properties of the armature. (Author)

A77-22641 **Optical and thermal properties of Compound Parabolic Concentrators.** A. Rabl (Argonne National Laboratory, Argonne, Ill.). *Solar Energy,* vol. 18, no. 6, 1976, p. 497-511. 21 refs. ERDA-supported research.

Compound Parabolic Concentrators (CPC) are relevant for solar energy collection because they achieve the highest possible concentration for any acceptance angle (tracking requirement). The convective and radiative heat transfers through a CPC are calculated, and formulas for evaluating the performance of solar collectors based on the CPC principle are presented. A simple analytic technique for calculating the average number of reflections for radiation passing through a CPC is developed; this is useful for computing optical losses. In most practical applications, a CPC will be truncated because a large portion of the reflector area can be eliminated without seriously reducing the concentration. The effects of this truncation are described explicitly. The paper includes many numerical examples, displayed in tables and graphs, which should be helpful in designing CPC solar collectors. (Author)

A77-22642 **One MW/th/ bench model cavity receiver steam generator.** F. A. Blake, T. R. Tracey (Martin Marietta Aerospace, Denver, Colo.), J. D. Walton, and S. Bomar (Georgia Institute of Technology, Atlanta, Ga.). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 18, no. 6, 1976, p. 513-523. Contract No. E(04-3)-1068.

The steam generator considered is developed as a component for a 100-MW solar-energy conversion power system. The power system includes eight solar collector fields which are located around a central steam-turbine-generation power plant. Conversion of the solar energy into superheated steam is accomplished in a boiler/superheater atop a 400 ft tower. Attention is given to a geometric model of the mirror field, a 1000 kW solar furnace used for large scale central receiver development programs, and the thermal performance of the steam generator cavity. G.R.

A77-22643 **Solar space heating and cooling with Bi-heat source heat pump and hot water supply system.** I. Sakai, M. Takagi (Mitsubishi Heavy Industries, Ltd., Nagoya, Japan), K. Terakawa, and J. Ohue (Sekisui Chemical Co., Ltd., Kyoto, Japan). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 18, no. 6, 1976, p. 525-532.

This paper describes specific heat pump system that can solve the problem of low heating capacity at a low ambient temperature - one of the largest problems in the air-source heat pump system. In order to decrease the collector area required, the heat pump is operated by the air-source during the daytime, but at night or at a very low ambient temperature it can be operated with hot water which has been produced by the collector in the daytime. The effect of the solar energy on the air-source heat pump system has many advantages in the moderate winter climate of Japan. The hot water supply system includes an auxiliary electric heater. The experiment has been carried out with a prefabricated test house, which has been constructed in Nara with double glazed windows and high thermal insulation. The results of this experiment are that solar energy enhances the total electric energy savings, increases the heating capacity at low ambient temperature, and eliminates the need for reverse cycle defrosting operation, etc. (Author)

A77-22644 **Preliminary performance of CSU Solar House I heating and cooling system.** D. S. Ward, T. A. Weiss, and G. O. G. Lof (Colorado State University, Fort Collins, Colo.). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 18, no. 6, 1976, p. 541-548. ERDA-NSF-supported research.

A77-22645 **Four different views of the heliostat flux density integral.** F. W. Lipps (Houston, University, Houston, Tex.). *Solar Energy,* vol. 18, no. 6, 1976, p. 555-560. 7 refs. NSF Grant No. GI-39456; Grant No. EG-76-G-05-5178.

The image due to a single heliostat is represented by its flux density, which can be formulated as an integral over the solid angle of the incoming rays. The initial formulation is transformed into three alternative representations, each having some particular utility. The incoming ray formulation leads to analytic results for flat heliostats with polygonal boundaries. The mirror plane formulation leads to a numerical integration over the mirror plane which can be used to study effects due to distortions of the mirror. The pin-hole view leads to an approximate expression for the flux density integral as a convolution of the image due to a point sun with respect to the brightness distribution of the real sun. This formulation allows us to treat the sun size as though it were a source of guidance errors or alternatively, we can introduce a degraded sun which includes the guidance errors. (Author)

A77-22646 **Operational chemical storage cycles for utilization of solar energy to produce heat or electric power.** H. W. Prengle, Jr. and C.-H. Sun (Houston, University, Houston, Tex.). *Solar Energy,* vol. 18, no. 6, 1976, p. 561-567. 13 refs. Research supported by the University of Houston.

A self-sufficient chemical cycle is required which will take solar energy on an intermittent basis and continuously convert it into heat and/or electric power. This paper presents engineering criteria for selection of suitable chemical reactions, and considers in detail two systems, (1) methanol cycle and (2) ammonium hydrogen sulfate (AHS) cycle. The latter appears very attractive as an operational cycle, has liquid storage on both sides of the cycle, essentially meets all criteria, and has high Delta H (reaction), heat and work efficiencies. Preliminary reactor configurations for the AHS cycle are discussed. (Author)

A77-22647 **A comparison of solar absorption air conditioning systems.** P. J. Wilbur and T. R. Mancini (Colorado State University, Fort Collins, Colo.). *Solar Energy,* vol. 18, no. 6, 1976, p. 569-576. 11 refs. Research supported by the Colorado Energy Research Institute.

A computer simulation of solar powered absorption air conditioning systems is discussed. The results of simulations of various systems composed of conventional flat plate or evacuated tube collectors, wet or dry cooling towers, lithium bromide-water or aqua-ammonia working fluids and hot water, chilled water or refrigerant storage alternatives are obtained over a common operating cycle. Performance of the lithium bromide-water working fluid is shown to be superior to aqua-ammonia. Relative performance gains realized with the evacuated tube collector and relative performance losses associated with the dry cooling tower are presented. Chilled water storage is shown to be advantageous for an evacuated collector, dry cooling tower, lithium bromide-water system. (Author)

A77-22648 **Economic competitiveness of solar energy with conventional fuels and electricity.** M. Saif-Ul-Rehamn (Pakistan Council of Scientific and Industrial Research, Solar Energy Group, Lahore, Pakistan). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 18, no. 6, 1976, p. 577-579. 8 refs.

Mathematical relations are presented for assessing the economic competitiveness of solar energy with other sources of energy. A nomogram for obtaining the required numerical data in studies of the economic feasibility of solar energy projects is also provided. The use of the nomogram is illustrated with the aid of specific examples involving a family size solar water heater and a solar cell panel of 1 kW capacity. G.R.

A77-22649 **Solar energy concentration with liquid lenses.** R. S. Chauhan (Punjab Agricultural University, Ludhiana, India). *Solar Energy,* vol. 18, no. 6, 1976, p. 587-589.

A description is given of an inexpensive method for the production of liquid lenses which can be used to concentrate solar energy radiation in schemes related to the utilization of solar energy. The basic materials required include a transparent liquid, such as water and glycerine, and a clear transparent plastic sheet. The use of acrylic sheet is considered. Liquid is supported or enclosed by curved plastic sheets of suitable forms. Cylindrical liquid lenses are used as stationary concentrators of solar radiation when oriented in an east-west direction. G.R.

A77-22650 # **Simulation of wind turbine generator system power flow dynamics.** D. D. Lingelbach (Oklahoma State University, Stillwater, Okla.). *Kansas State University of Agriculture and Applied Science, Midwest Power Symposium, Kansas State University of Agriculture and Applied Science, Manhattan, Kan., Oct. 6-8, 1976, Paper.* 31 p.

The dynamics of the power flow in a particular wind turbine driving different types of generators is analyzed. The types of generator discussed include the conventional synchronous generator, the induction generator, and the field-modulated generator operating into an electrical system and into an isolated pure resistive load. The discussion is limited to the dynamics of real power (watts), disregarding problems of reactive power flow. To obtain the dynamic response of the system, approximate incremental changes in the wind velocity were simulated manually. It is shown that the field-

modulated generator without feedback supplying a pure resistive load is able to extract more energy than the others for variable wind velocities. Regardless of the type of electrical generator used, a system with velocity type damping losses should operate at a tip speed ratio below that yielding maximum power coefficient in order to maximize the electrical power developed. S.D.

A77-22868 **Applications of cryogenic technology. Volume 8.** Edited by S. H. Booth (Kaiser Engineers Center, Oakland, Calif.) and R. W. Vance. Flushing, N.Y., Scholium International, Inc., 1976. 374 p. $22.50.

Papers are presented on the applications of cryogenic technology of liquefied natural gas (LNG). Attention is given to liquefaction facilities for the Trans-Alaska Gas Project, the liquefaction of natural gas with auto-refrigerated cascade cycle, an LNG containment system for marine transport of LNG, an undersea pipeline for off-shore terminals, LNG safety in United States ports, and the volume of flammable mixture resulting from atmospheric dispersion of a leak or spill. Also considered are world trade in LNG, environmental aspects of LNG terminals, and the operation of LNG carriers from Alaska to Japan. B.J.

A77-22876 # **The design and development of a hybrid-electric urban transit vehicle.** V. P. Roan (Florida, University, Gainesville, Fla.). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 25 p. 13 refs.

Results are presented for an urban transit vehicle program directed to develop a hybrid-electric drive train. Attention is focused on computer simulation in the optimization of the hybrid-electric system. Decision is made to employ a series hybrid-electric drive system because the low-speed torque characteristics of a series-wound electric motor ensures satisfactory performance without recourse to a gearbox. In this hybrid-electric system, a small diesel engine, which drives a three-phase alternator, is used to keep the charge level of the batteries at or above some minimum level. Computer simulation is discussed relative to rolling resistance, aerodynamic drag, drag and rolling resistance model, diesel engine fuel consumption, electric motor efficiency, generator, and lead-acid battery characteristics. Results of computer studies are presented. Passenger comfort and convenience features were given high priority in the study. S.D.

A77-22878 # **Traction batteries for existing and future electric road vehicles.** K. Salamon and G. Krämer (Varta Batterie AG, Kelkheim, West Germany). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 29 p. 27 refs.

The paper discusses the development of traction batteries for electric road vehicles as related to a new lead-acid battery and a new nickel-oxide-iron battery. Both systems are examined in terms of the theoretical energy densities derived from thermodynamic principles. The study determines how far the lead-acid battery system can be improved in terms of a combination of the highest possible energy density with cost-effective production. Improvement measures consist essentially of reducing the proportion of dead weight and reducing the voltage drop in the conducting components. Main emphasis of further work will be on improving the efficiency of electrochemical utilization of the active materials and in reducing the quantity of electrolyte. S.D.

A77-22879 * # **The computer simulation of automobile use patterns for defining battery requirements for electric cars.** H.-J. Schwartz (NASA, Lewis Research Center, Cleveland, Ohio). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 15 p. 10 refs.

The modeling process of a complex system, based on the calculation and optimization of the system parameters, is complicated in that some parameters can be expressed only as probability distributions. In the present paper, a Monte Carlo technique was used to determine the daily range requirements of an electric road vehicle in the United States from probability distributions of trip lengths, frequencies, and average annual mileage data. The analysis shows that a daily range of 82 miles meets to 95% of the car-owner requirements at all times with the exception of long vacation trips. Further, it is shown that the requirement of a daily range of 82 miles can be met by a (intermediate-level) battery technology characterized by an energy density of 30 to 50 Watt-hours per pound. Candidate batteries in this class are nickel-zinc, nickel-iron, and iron-air. These results imply that long-term research goals for battery systems should be focused on lower cost and longer service life, rather than on higher energy densities. V.P.

A77-22881 # **Hybrid propulsion systems for electric road vehicles for short range public passenger transport test and operational experience - Prospects.** P. Strifler (Daimler-Benz AG, Stuttgart, West Germany). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 11 p.

A77-22884 # **User experience with the Enfield car.** N. S. Wrench and D. F. Porter (Electricity Council, London, England). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 12 p.

The paper describes initial experience in the UK with a fleet of 61 Enfield 8000 electric cars in road use since February 1976. The mechanical and electrical performance of vehicle is discussed along with results of crash testing and charger evaluation. Attention is also given to energy consumption, maintenance requirements, the motor, the batteries, and the control system. B.J.

A77-22885 # **A comparison between the primary energy consumption of electric and gasoline powered vehicles.** J. P. Altendorf and A. Kalberlah (Volkswagenwerk AG, Wolfsburg, West Germany). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 21 p. 15 refs.

In the present paper, the energy consumption of electrically powered vehicles is compared to that of combustion engine powered vehicles. The comparison is based on the results of measurements and hypothetical studies carried out by several investigators. If measurements are conducted, it is shown that for electrically powered vehicles, the optimal measurement parameter is the consumption of electric energy for battery charging purposes. For combustion engine powered vehicles, preference should be given to the measurement of fuel consumption. A slightly lower consumption was established for the VW 412 squareback with a payload capacity equal to that of the electric vehicle. The values change insignificantly if the energy consumption of the auxiliary heating system is included. However, if the lower payload capacity of the heavier electric vehicle is taken into consideration by relating the consumption to the payload, the primary energy consumption per ton and kilometer of the conventional vehicle is substantially lower than that of the electric vehicle. V.P.

A77-22886 # **Flywheel-electric hybrid vehicle.** D. Locker and M. L. Miller (Scientific Research Foundation, Jerusalem, Israel). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 32 p. 8 refs.

The flywheel-electric hybrid vehicle described was developed for heavy urban traffic conditions. Incorporation of a flywheel permits delivery of high power to the wheels without high current drains from the battery. The flywheel is used as a power source to provide only the amount of energy required for accelerating the vehicle to its

maximum speed. An efficient reversible infinitely variable transmission has been developed to transmit the flywheel power to the vehicle. The efficiency of the transmission ranges from 86 to 91 percent over a 16 : 1 range and is virtually the same in the drive and regeneration modes. Speed variation with the separately excited shunt-wound motor is accomplished solely by field control. V.P.

A77-22888 # **On-the-road evaluation of the efficiency of propulsion system of city vans.** P. Menga (Ente Nazionale per l'Energia Elettrica, Milan, Italy). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 15 p.

Criteria are given for the application of a method developed to study the behavior of electric propulsion systems and their components under various operating conditions and to determine the overall energy balance of the system under conditions of urban operation. The propulsion system parameters are recorded continuously on analog magnetic tapes. The tapes are then adapted to a digital computer. This yields a detailed picture of the operation of the propulsion system, and makes it possible to analyze a given trip in terms of such parameters as acceleration, braking, and constant speed. Some test results obtained with city vans equipped with regenerative braking systems are examined. V.P.

A77-22889 # **Development cost effective battery electric road vehicles.** M. F. Mangan (Chloride Technical, Ltd., Manchester, England). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 12 p.

The best way of promoting the use of electrically driven vehicles is to design a vehicle that is commercially attractive both to the operator and supplier. Analysis of vehicle requirements and duty cycles indicates that a van with a GVW of 7.7 tons would be the easiest to develop with a potential for market penetration. The operating cost of the vehicle depends heavily on battery cost. Overall system efficiency is of paramount importance. It is seen that the separately excited dc motor has the most suitable characteristics for a high-efficiency town vehicle. An electronic control system and a contactor control system are described. V.P.

A77-22890 # **Basic requirements for the various items of equipment for supplying energy to electrically driven road vehicles from the point of view of the user.** T. Merkle (J. M. Voith GmbH Maschinenfabrik, Heidenheim, West Germany) and E. Zander (Gesellschaft für Elecktrischen Strassenverkehr mbH, Düsseldorf, West Germany). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 28 p.

A77-22891 # **Comparison of an electric versus a gasoline powered utility truck in two years of a service test program.** D. K. Miner (Copper Development Association, Inc., Birmingham, Mich.). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 25 p.

A77-22892 # **Opportunities for battery powered road vehicles.** C. Morris (Chloride Technical, Ltd., Manchester, England). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 7 p.

It is suggested that the electric road vehicle be a sensible compromise between reliability, efficiency, cost effectiveness, and low maintenance need. Costs of running a diesel van and a battery-powered van are compared on the basis of a discounted cash flow principle, with favorable results for the electric vehicle. B.J.

A77-22893 # **Studies of electric vehicle drives, illustrated by the example of an urban estate car.** C. O. Naydowski, D. Pohl, and H. C. Skudelny (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 23 p. 24 refs.

A77-22894 # **The nickel-zinc battery - A viable alternative for vehicle powering.** A. W. Petrocelli and J. H. Kennedy (Yardney Electric Corp., Pawcatuck, Conn.). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 27 p. 14 refs.

The paper reviews the analytical and hardware development work conducted at Yardney on the nickel-zinc battery system for structured on-road transportation. Realization of design targets for a nickel-zinc couple capable of increased energy density for range extension and of elevated power density for improved acceleration and gradeability is discussed. A simplified technical-economic analytical model is described whereby two types of special-purpose vehicles with lead-acid and nickel-zinc batteries are compared. For this purpose, a two-stage computer program operable on a small desk-top computer is designed to determine the resistive (drag) and inertial loads of the vehicle and to compare these in terms of consumed energy to available battery energy. Future potential of the nickel-zinc system and tasks to be accomplished for a late 1970s market introduction are noted. S.D.

A77-22897 # **Performance of an electric van fitted with a hydrodynamic torque converter transmission.** J. T. Griffith (Electricity Council, Research Centre, Chester, England). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 10 p. 5 refs.

A77-22898 # **Development of a high performance and lightweight hybrid flywheel/battery powered electric vehicle drive.** R. H. Guess and E. L. Lustenader (General Electric Co., New York, N.Y.). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 28 p.

Today's electric vehicles are severely limited in multi-stop and go driving range and accelerating capability by the lead acid battery's inability to handle high power peaks while maintaining maximum energy storage capability. The paper describes the development of a small high-speed lightweight self-contained energy-storage unit composed of a flywheel and an ac synchronous motor alternator sealed energy storage package coupled to the battery and the dc drive motor system through a simple rectifier/inverter power circuit. This system stores just enough energy in the rotor of the machine for one start-stop cycle. Provision is made to add a flywheel to store energy for several cycles, or enough energy for climbing or descending long grades. The fields of the two machines will be controlled by a microprocessor to achieve optimum performance and effective energy utilization. (Author)

A77-22900 # **The M.A.N. electrobus experience gained in large-scale tests.** H. Hagen and R. Zelinka (Augsburg-Nürnberg AG, Maschinenfabrik, Munich, West Germany). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 23 p.

The paper reports on the large scale testing of 20 battery-driven electrobuses, half fitted with separately excited motors and half with series-wound motors, with a discussion of experience gained in route operation since the end of 1974. Testing emphasized experience with the vehicle (auxiliary units, regenerative braking and tire life, chassis and construction, and heating), experience with the drive system

(controller and motor), and experience with the battery (cell assembly, battery tray, peripheral equipment, etc.). B.J.

A77-22902 # **Impacts of future use of electric cars in US cities.** W. Hamilton (General Research Corp., Santa Barbara, Calif.) and G. Hagey (ERDA, Washington, D.C.). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 13 p. 5 refs.

Effects of widespread use of subcompact electric cars in US urban transport by the turn of the century are anticipated. Advances in battery technology and design, and availability of recharge power, are viewed as crucial. Effects on urban driving patterns, energy use, petroleum consumption, air pollution, travel costs, and pattern of resources consumption are examined. Future automotive pollution is expected to be reduced below that of stationary combustion plants. Severe demands on resources of Pb, Sb, Ni, Ti are envisaged, even if only 10% of automobiles are electric-powered. Needs for heating and air conditioning in vehicles would run power costs of electric cars up in some geographical areas. Projected demands for electric power are graphed for several urban centers (St. Louis, Phila., Los Angeles), for 1980, 1990, and 2000. R.D.V.

A77-22904 # **Development of electric vehicles at Toyota.** K. Imai (Toyota Motor Co., Ltd., Toyota, Japan). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 17 p.

Successful R&D work is described which was carried out in an effort to convert a conventional Toyota truck into an electric truck with a 500 kg payload, and also to develop an electric passenger car. Various electric drive systems, including dc series-wound motors, and dc separately excited motors with and without gear box were tested. For the truck, separately excited motor without gear box proved superior for urban driving, but involved the penalty of a more complex motor controller. Introduction of regenerative braking extended the driving range by 10 to 25%, while a weight reduction of 18% improved performance by 9%. Using a dc separately excited motor in combination with a three-speed gear box, the passenger car excited the following (completely satisfactory) characteristics: a driving range per charge of 180 km at 40 km/hr, or of 110 km in the stop-and-go cycle; a maximum speed of 95 km/hr; and acceleration times of 2.5 sec, 14.2 sec, and 22.8 sec from 0 to 30 km/hr, 0 to 200 km/hr, and 0 to 400 km/hr, respectively. V.P

A77-22905 # **Sodium/sulphur battery design and development for motive power applications.** I. W. Jones (Chloride Silent Power, Ltd., Runcorn, Ches., England). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 11 p. 13 refs.

This paper describes some recent progress in the design and development of sodium sulphur batteries for motive power applications. The historical development of cell designs over the last 10 years is reviewed, including a discussion of development problems such as the durability of beta-alumina and corrosion of the sulphur electrode current collector. The tubular electrolyte is now widely adopted as the preferred development option. A computer analysis shows that a volumetric energy density of about 200 Wh/litre can be obtained in an optimum design of a battery including thermal insulation. An advanced cell design has been adopted in which sodium is fed into the anodic reaction zone by a capillary wick. This design is well suited to the demands of motive power applications in which the stored energy has to be supplied at about the 2 hr rate. The design also permits the use of large electrolyte tubes, at least 30 mm in diameter and 500 mm in length, and this reduces the battery manufacturing costs. A large number of experimental cells have been tested, and over 85% utilization of the sodium and sulphur active materials has been achieved for repeated cycling of developed electrode constructions. (Author)

A77-22909 # **Near-term advanced electric vehicle batteries.** E. S. Carr, W. C. Harsch, Jr., L. R. Erisman, and D. Judd (Eagle-Picher Industries, Inc., Joplin, Mo.). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 21-Sept. 2, 1976, Paper.* 16 p. 35 refs.

The paper discusses the present state of development and cost effectiveness of three near-term advanced battery systems for the electric vehicle industry: lead-acid, nickel-iron, and nickel-zinc. These represent battery systems that can be ready for electric vehicle application in production quantities in 2.5 to 3 years. Improvement goals for each of these systems in near-term battery development are identified. Development work is needed in low-cost manufacturing methods, optimized lead-acid and nickel-iron energy density, and increased cycle life for lead-acid and nickel-zinc. Results of cost analyses for these three advanced battery systems are summarized in tabular form. It is shown that improvements in energy density and life can provide a basis for expansion of electric vehicle acceptance. S.D.

A77-22910 # **Design and testing of lithium/iron sulfide batteries for electric-vehicle propulsion.** A. A. Chilenskas, G. J. Bernstein, J. E. A. Craae, F. Hornstra, V. M. Kolba, M. A. Slawecki, and R. O. Ivins (Argonne National Laboratory, Argonne, Ill.). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 21 p.

Results are presented for an electric propulsion battery program directed to develop a lithium/iron sulfide battery to power an electric automobile of advanced design for short-distance driving. Particular attention is given to the design concept and specifications of the lithium-aluminum/iron sulfide subcell, battery evaluation and testing, cell charge-equalization system, and battery charging system. Also discussed are the battery test automobile and the design of a 30 kWh electric vehicle battery composed of 160 individual prismatic subcells. Meeting the 1981 cell performance goals will provide the electric vehicle with a performance equivalent to today's gasoline-powered subcompact automobile. S.D.

A77-22911 # **Development of large size nickel-zinc cells for electric vehicles.** A. Clarkey (Energy Research Corp., Danbury, Conn.). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 16 p.

A nickel-zinc battery system for electric vehicle is examined in terms of development of inexpensive nonsintered nickel electrodes, development of long-life zinc electrodes, development of stable separators, electrolyte management, and development of 300 Ahr size cells. The identified failure mechanisms for cells comprise loss of nickel electrode capacity by zinc oxide poisoning and graphite oxidation and loss of capacity by drying out of the zinc electrode. It will be possible to improve the energy density of the cell to about 40Wh/lb by utilizing a monobloc structure and reducing the number of electrodes in the cell stack. Cost projections indicate that the present materials and labor costs make a 50 dollar/kWh battery a distinct possibility. S.D.

A77-22912 # **United States Postal Service Electric Vehicle Program.** D. P. Crane and J. R. Bowman (U.S. Postal Service, Washington, D.C.). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 28 p.

A77-22913 # **The DUO bus, a suburban bus with electric drive, supplied either from overhead wire or from battery.** H. Domann and R. Wirtz (Robert Bosch GmbH, Stuttgart, West Germany). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International*

Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper. 12 p.

A77-22915 # **The lithium-water-air battery for automotive propulsion.** A. D. Galbraith (Lockheed Research Laboratories, Palo Alto, Calif.). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 23 p.

The method described was developed to react lithium directly with water, or other aqueous electrolytes, at room temperature to produce electric energy. The presence of hydroxyl ions at concentrations greater than 1.5 molar allows a protective film to form on the lithium anode which is pseudoinsulating, permitting the counter electrode (cathode) to be pressed against the lithium anode without electrical shorting. This greatly reduces the ohmic losses common to other electrochemical systems. Concentration polarization is reduced by circulation of the electrolyte through the cells, thereby increasing the rate of solution of the reaction products. In the basic embodiment of the cell under consideration, the cathode reaction is the evolution of hydrogen with the generation of OH ions. The theoretical open-circuit cell potential is 2.22 V, with normal cell operating voltage ranging from 1.0 to 1.5 V. V.P.

A77-22917 # **Electric delivery vans above the 45th parallel in North America.** M. C. Attendu, J. H. Beaudet (Hydro-Québec, Montreal, Canada), and L. Masson (Hydro-Québec, Institut de Recherche, Varennes, Canada). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 29 p.

Hydro-Québec, the Canadian electric utility, has tested the feasibility of electric delivery vans under severe winter conditions such as are encountered in Quebec. Two vehicles, slightly different in design and characteristics, but both powered by a series-wound motor controlled by a Silicon Controlled Rectifier System and a series of contractors, were used as test vehicles. Two types of tests were performed: (1) tests in controlled conditions including examination of storage batteries, mechanical design, and the efficiency of the motor and power train systems; and (2) road tests which studied energy consumption, the effect of cooling on the batteries, service and maintenance, and the cost of operation. B.J.

A77-22918 # **Comparison of electric drives for road vehicles.** C. Bader and W. Stephan (Deutsche Automobilgesellschaft mbH, Esslingen, West Germany). *Union Internationale des Producteurs et Distributeurs d'Energie Electrique and Electric Vehicle Council, International Electric Vehicle Symposium, 4th, Düsseldorf, West Germany, Aug. 31-Sept. 2, 1976, Paper.* 21 p.

The dc shunt-wound motor with its speed controlled by field weakening appears to be the best electric motor for road vehicles. An investigation of the limitations imposed on the dc motor by the commutator shows that an increase in both the controllable speed range and the rated output of the motor contribute to increasing the size of the machine. Acceleration characteristics are used to evaluate the various drive units for electric motors, and it is shown that the individual drive systems differ considerably and call for a compromise between the demand for a short acceleration time and low energy consumption. Field tests of vehicles with different drive systems, one with a hydrodynamic torque converter and battery changeover, the other with a manually operated gear change and mechanical clutch, are used to illustrate the design of required control and protection devices. B.J.

A77-22921 **The gas turbine (La turbine à gaz).** P. Chambadal, Paris, Eyrolles, Editeur (Electricité de France, Direction des Etudes et Recherches, Collection, No. 26), 1976. 239 p. 44 refs. In French. S24.10.

The book gives a description, with the aid of fairly simple mathematical expressions, of the general theory of gas turbine installations, that is, without going into metallurgical and mechanical design aspects. Systematic coverage is given for the following aspects of gas turbine operation: the Joule cycle, heat and energy efficiency and balance, cycles with intermediate heat sources, refrigeration of gas during compression, reheating during expansion, cycles with recuperation of heat from exhaust gases, the hexagonal cycle and the Ericsson cycle, similarity parameters and characteristic curves for analysis of turbocompressors, centrifugal and axial compressors, analysis of a turbine stage, fuel types and considerations in the choice of fuel, application of gas turbines for simultaneous production of electric power and heat, and combinations of gas turbines with steam turbines. P.T.H.

A77-22924 **New energy systems - Associated thermodynamic cycles (Nouveaux systèmes énergétiques - Cycles thermodynamiques associés).** Paris, Eyrolles, Editeur (Electricité de France, Direction des Etudes et Recherches, Collection, No. 27), 1976. 445 p. In French. S34.10.

Papers are presented which deal with the analysis of different thermodynamic cycles and their utilization in energy production. The studies examine, among others, the following topics: definition and representation of thermodynamic properties of fluids, binary cycles using ammonia, direct gas cycles for nuclear power plants, cryogenic cycles using incorporated cascades, atmospheric cold sources, thermoelectronic cycles, magnetohydrodynamic generator using a gas emulsion in a liquid metal, thermodynamics of the fuel cell, and the hydrogen cell. P.T.H.

A77-22948 **Reduction of atmospheric pollution due to the automobile and energy savings (Réduction de la pollution atmosphérique due à l'automobile et économie d'énergie).** B. Salé (Institut Français du Pétrole, Rueil-Malmaison, Hauts-de-Seine, France). *Institut Français du Pétrole, Revue,* vol. 31, Nov.-Dec. 1976, p. 1045-1064. 19 refs. In French.

The article examines the compatibility of measures to reduce air pollution due to emissions from gasoline (automotive) engines, and measures to cut down on fuel consumption by automotive engines. Types of anti-pollution measures are examined from the vantage point of cost effectiveness and effects on fuel conservation. Measures to improve engine combustion efficiency, afterburning techniques, reduction of lead content in gasoline, and the intensity with which measures are pursued are reviewed in the same context. Effects of fuel mixture ratio on specific fuel consumption, emission of pollutants, and combustion rate, and possible advantages of pellet-filled catalytic reactors and particulate traps, are assessed. R.D.V.

A77-22977 * **Heterojunctions in photovoltaic devices.** D. L. Feucht (Carnegie-Mellon University, Pittsburgh, Pa.). *(American Vacuum Society, National Vacuum Symposium, 23rd, Chicago, Ill., Sept. 21-24, 1976.) Journal of Vacuum Science and Technology,* vol. 14, Jan.-Feb. 1977, p. 57-64. 35 refs. Army-NASA-supported research.

Heterojunctions have interesting optical properties which make them attractive for solar cells. Several types of heterostructure solar cells have been investigated: heteroface, abrupt heterojunction, and graded-gap heterojunction solar cells. The primary advantage of heterostructure cells is the enhanced short-wavelength response although there is potential for low-cost cells with polycrystalline material. The improvement in solar-cell performance for heterojunctions depends upon the selection of semiconductors with useful energy gaps that are closely matched in lattice-spacing and thermal-expansion coefficients. The importance of the heterojunction interface and its dependence on material properties is discussed. Various fabrication methods are discussed and their application to the different types of heterostructures. Recent performance data for material systems representative of each type of heterostructure cell are discussed and considered in terms of maximum expected performance. (Author)

A77-22978 **Growth and characterization of thin-film compound semiconductor photovoltaic heterojunctions.** L. L. Kazmerski, M. S. Ayyagan, Y. J. Juang (Maine, University, Orono, Me.), F. R. White, and R. P. Patterson. *(American Vacuum Society, National*

Vacuum Symposium, 23rd, Chicago, Ill., Sept. 21-24, 1976.) Journal of Vacuum Science and Technology, vol. 14, Jan.-Feb. 1977, p. 65-68. 21 refs. NSF-supported research.

The fabrication and characteristics of several vacuum-deposited photovoltaic heterojunctions involving ternary compounds (CuInSe2, CuInS2, and CuInTe2) and a binary compound (InP) with CdS are described. The light and dark I-V characteristics, spectral response data, and cell parameters (fill factors, open-circuit voltages, short-circuit currents, efficiencies) are reported for the thin-film solar cells. (Author)

A77-22979 **Tunnel MIS solar cells.** R. Singh and J. Shewchun (McMaster University, Hamilton, Ontario, Canada). *(American Vacuum Society, National Vacuum Symposium, 23rd, Chicago, Ill., Sept. 21-24, 1976.) Journal of Vacuum Science and Technology*, vol. 14, Jan.-Feb. 1977, p. 89-91. 39 refs. Research supported by the National Research Council of Canada and NSF.

An explanation was proposed for the operation of Schottky-barrier solar cells with an interfacial oxide layer based on the concept that they are minority-carrier nonequilibrium MIS tunnel diodes. Such devices represent a potentially low-cost method for fabricating large-scale solar-energy-conversion arrays both with single crystals and polycrystalline film semiconductors. These solar cells are identical to the conventional p-n junction device except for the location of the depletion region. Calculations indicate that one would have to grow defect-free ultra-thin (10-15 A in the case of Al-SiO2-Si structure) interfacial oxide layers to get highest conversion efficiencies from these devices. (Author)

A77-22982 **Particulate nature of solar absorbing films - Gold black.** C. Doland, P. O'Neill, and A. Ignatiev (Houston, University, Houston, Tex.). *(American Vacuum Society, National Vacuum Symposium, 23rd, Chicago, Ill., Sept. 21-24, 1976.) Journal of Vacuum Science and Technology*, vol. 14, Jan.-Feb. 1977, p. 259-262. 6 refs. Research supported by the University of Houston.

The structure and composition of a test solar black, gold black, has been investigated in order to more fully understand the particulate nature of good solar-energy absorbers. Inert-gas-evaporated gold-black films showed significant dependence of film-particle size on inert-gas pressure and of particle-packing fraction on pressure. The distribution of particle sizes in the films has been noted to be log-normal with median particle sizes ranging from 50 to 100 A over the pressure range of 1 to 10 torr (133-1330 Pa). (Author)

A77-23032 **The Los Alamos Scientific Laboratory Dry Hot Rock Geothermal Project /LASL Group Q-22/.** M. C. Smith (California, University, Los Alamos, N. Mex.). *Geothermics*, vol. 4, Mar.-Dec. 1975, p. 27-39.

The paper describes the concept of energy extraction from dry hot rock, consisting in circulating water through two holes drilled to sufficient depths and connected within the rock by a crack produced by hydraulic fracturing. At the surface, a primary heat exchanger would be used to provide low-grade heat for various purposes. Exploration holes have been drilled in the Valles Caldera region of north-central New Mexico, and the paper summarizes the drilling experience, the core studies, hydrological studies, heat-flow studies, and geophysical and seismological studies conducted at the first two exploratory sites. The experience with hydraulic fracturing is discussed in relation to a developed theory of circular crack formation in an elastically homogeneous rock. P.T.H.

A77-23034 **Research and development of geothermal energy production in Hungary.** T. Boldizsar (Nehezipari Muszaki Egyetem, Miskolc, Hungary). *Geothermics*, vol. 4, Mar.-Dec. 1975, p. 44-56. 19 refs.

The paper summarizes vast amounts of data on the heat flow, rock temperatures, and temperature gradients in the Pannonian (Carpathian) basin in Hungary; reviews the main characteristics of the thermal water reservoirs in Devonian, Mesozoic, Miocene, and Pliocene formations; and gives an assessment of the geothermal energy resources of the Hungarian Pannonian basin. The Pannonian basin is a conduction dominated reservoir. At present, only the upper 3 km can be economically utilized for the production of geothermal energy. The total amount of recoverable heat in this reservoir is estimated to be 15 times 10 to the 18th cal. P.T.H.

A77-23035 **Problems related to operating thermal wells subject to scaling in Hungary.** L. Belteky (Research Institute for the Development of Water Resources, Budapest, Hungary). *Geothermics*, vol. 4, Mar.-Dec. 1975, p. 57-65. 8 refs.

The paper examines the scaling characteristics of thermal water wells in Hungary, and describes the various procedures tested and adopted for scaling control and scale removal. The most important technique is the HCl acid treatment method for scale removal. The equipment for this technique is described, and some experience in applying it on a thermal well with a high dissolved solids content and an alkaline-bicarbonate chemical composition with strong tendency to scaling is discussed. P.T.H.

A77-23037 **Flow in geothermal hot water wells.** A. P. Szilas and F. Patsch (Nehezipari Muszaki Egyetem, Miskolc, Hungary). *Geothermics*, vol. 4, Mar.-Dec. 1975, p. 79-88. 13 refs.

One of the basic conditions for planning the production of free flowing and airlifted wells is the ability to model correctly the pressure losses incurred in wells with single- and two-phase flows. Based on theories developed in the petroleum industry, as well as the data obtained in the course of Hungarian air-lift water pump tests, the present paper gives a survey of the laws governing vertical flow in high-yield hot water wells of small gas and air content. An explanation is given for the fundamental disagreement between the relationships used to simulate pressure losses in short and long tubing. Methods for calculating the pressure profiles of wells are included. (Author)

A77-23038 **Interaction of hot water reservoirs and deep wells.** A. P. Szilas (Nehezipari Muszaki Egyetem, Miskolc, Hungary). *Geothermics*, vol. 4, Mar.-Dec. 1975, p. 89-95.

A water reservoir and a deep water well producing from it constitute a hydraulic system connected in series. The prescribed amount of water to be produced most economically may be planned and withdrawn only if the elements of the system and the laws of their interaction are known. In the present paper the laws of interaction are given for production planning in the case of free flowing and airlift water production. Using a numerical example, the author demonstrates how the airlift of a water well producing gas-free water is to be planned with a minimum of specific air consumption. (Author)

A77-23095 # **Status and outlook of controlled nuclear fusion (Stand und Perspektive der kontrollierten Kernfusion).** A. Rutscher (Greifswald, Universität, Greifswald, East Germany). *Energietechnik*, vol. 26, Dec. 1976, p. 531-535. 5 refs. In German.

Plausible techniques for future energy production are outlined and a close look is taken at the thermonuclear fusion picture. The present state of the art in plasma heating and confinement techniques is reviewed. Prospective timetables for achieving milestones in fusion research and technology are considered, along with the advantages and unsolved problems in fusion technology. R.D.V.

A77-23096 # **Path of development and developmental status of the lignite high-temperature coking process in the DDR - An example of effective utilization of lignite as energy vehicle (Entwicklungsweg und -stand der Graunkohlenhochtemperaturverkokung in der DDR - Ein Beispiel zur effektiven Nutzung des Energieträgers Braunkohle).** W. Dubsky (VEB PKM Anlagenbau, Leipzig, East Germany), E. Klose (Freiberg, Bergakademie, Freiberg, East Germany), and B. Knauth (VEB, Gaskombinat Schwarze Pumpe, Stammbetrieb, Hoyerswerda, East Germany). *Energietechnik*, vol. 26, Dec. 1976, p. 536-545. 17 refs. In German.

A quarter century of research and development work on lignite as an energy source is reviewed, with emphasis on the BHT high-temperature lignite coking process developed in the German Democratic Republic (DDR). The development of the Lauchhammer and Schwarze Pumpe coking works is detailed, stages in develop-

ment, equipment diagrams and process flowsheets, and compactification problems are presented. The importance of lignite to the DDR economy - the DDR lignite production is the highest in the world - is highlighted. R.D.V.

A77-23097 # **Mathematical simulation of the fixed-bed pressurized gasification process (Mathematische Modellierung der Festbett-Druckvergasung).** E. Klose and W. Toufar (Freiberg, Bergakademie, Freiberg, East Germany). *Energietechnik,* vol. 26, Dec. 1976, p. 546-555. 11 refs. In German.

Two partial models are developed for simulation processes occurring in fixed-bed gasification under pressure. An algorithm is developed for a model encompassing preheating, drying, and degasification, and an independent model is elaborated for simulation of processes occurring in the reaction zone and ash zone. Heat transfer is identified as the rate-determining step in the first model, and reaction kinetics figure prominently in the gasification reactions. Water content, exit temperature, particulate size, and throughput capacity are varied to find optimum conditions. R.D.V.

A77-23098 # **Hydrocarbon cracking developments in the DDR (Entwicklung bei der Spaltung von Kohlenwasserstoffen in der DDR).** G. Seifert (Gaskombinat Schwarze Pumpe, Hoyerswerda, East Germany), P. Göhler, and M. Schingnitz (Brennstoffinstitut, Freiberg, East Germany). *Energietechnik,* vol. 26, Dec. 1976, p. 555-564. 8 refs. In German.

Some problems and achievements in cracking of hydrocarbons in East Germany (DDR) are reported. Cyclic catalytic cracking of petrochemicals, various hydrocarbons, and natural gas, noncatalytic partial oxidation of hydrocarbons under high pressure, and redox processes involving nickel catalyst are detailed. Mathematical simulation of the cyclic catalytic cracking process is described, conversion of nickel catalyst via spinel formation is discussed, and costs and consumption rate of oxygen as a function of the content of methane residue in cracked gas fractions are studied. (Author)

A77-23099 # **On the production of town gas from off-gases of the chemical processing industry (Zur Erzeugung von Stadtgas aus Chemierestgasen).** J. Wilsdorf, W. Hippke, and A. Reinhardt (VEB, Ingenieurtechnisches Zentralbüro, Böhlen, East Germany). *Energietechnik,* vol. 26, Dec. 1976, p. 564-568. In German.

Preparation of town gas from residual gases of the CPI is characterized, availability of types of CPI offtakes is outlined, and theoretical and technological fundamentals of the production of town gas, various mixed gas compositions, and domestic and imported natural gas are discussed. Mixing diagrams for important combinations of gases are reproduced, and CIP processes yielding useful off-gases are mentioned. Recent development and future potentialities of town gas production from CPI off-gases are dealt with, and the discussion is extended to investment costs and possible cost savings. R.D.V.

A77-23106 **Ignition of a pulsed thermonuclear reaction by high-current ion beams.** B. I. Ivanov, A. A. Kalmykov, and O. A. Lavrent'ev. *(Pis'ma v Zhurnal Tekhnicheskoi Fiziki,* vol. 2, Feb. 12, 1976, p. 129-133.) *Soviet Technical Physics Letters,* vol. 2, Feb. 1976, p. 49, 50. 9 refs. Translation.

The possibility of a controlled fusion reaction using a convergent charge-and-current compensated ion beam to heat a spherical D-T pellet is examined. The main advantages of ion-beam fusion are the possibility of spatial-temporal focusing and inertial plasma confinement. The following are the initial conditions: a target diameter of 1 cm, a limiting temperature of 10 to the 4 eV, and inertial plasma confinement time of 5 nanoseconds, an energy input of 10 to the 8 Joules and a heating time of 5 nanoseconds. Irradiating the pellet with a beam of energy up to 10 MeV, there will occur, in successive stages, gas ionization, electron heating and ion heating. It is speculated that the following parameters are necessary to achieve fusion: an ion-emitter spherical radius of 500 cm, a current density of 30 amps/sq cm (for potassium ions), a pulse duration of 10 to the -7 s, a linear time-dependent growth of voltage from 9 x 10 to the 6 to 1.2 x 10 to the 7 V, and a radial focusing accuracy of 10 to the -3. B.J.

A77-23296 # **Solar energy conversion - Work experience of a team applying methods and techniques of physics research to this sector (La conversione dell'energia solare - Esperienza di lavoro di un gruppo che applica al settore i metodi e le tecniche della ricerca in fisica).** V. Silvestrini (Napoli, Università, Naples, Italy). *International Solar Energy Society,* Sept. 1976, p. 17, 19-37. In Italian.

Attention is centered on applications of solar energy to auxiliary power demands: air conditioning and cooling, space heating, and heating of water for household and industrial use, and agricultural applications. A major role is seen for solar energy in meeting future energy needs; storage of energy is acknowledged as the crucial problem, hydrogen processes show encouraging prospects, and the problem of vast areas needed for energy collection is seen as manageable. Atmospheric effects and the need for a selective radiator surface are considered. Prime applications include: heating and air conditioning of low (one-story) buildings, small and medium refrigerators in some regions, and 'inverse greenhouses' for hot climates. R.D.V.

A77-23297 # **Simulation of the performance of a solar energy plant using uniaxial parabolic collectors, with a one-degree-of-freedom pointing system, at different latitudes (Simulazione delle prestazioni di una centrale solare da collettori parabolici uniassici, dotati di un sistema di orientamento ad 1 grado di libertà, a differenti latitudini).** O. Barra, M. Conti, E. Santamato, R. Scarmozzino, and R. Visentin (Calabria, Università, Cosenza, Italy). *International Solar Energy Society,* Sept. 1976, p. 39, 40-53. In Italian.

Row spacing, row length, number of rows, and heat transfer parameters of an array of linear parabolic collectors aligned N-S or E-W on a horizontal plane are examined for array performance at different latitudes. The study probes into: thermal power output of such a plant working over a one-year period, peak output in summer and winter, diurnal and seasonal variations in insolation at different latitudes, shadow effects of collectors, and heat losses in tubing. Some results are displayed graphically. R.D.V.

A77-23298 # **Design and testing of planar solar collectors (Costruzione e collaudo di collettori solari piani).** C. Bernardini, N. Mandas, P. G. Mura, and G. Tola (Cagliari, Università, Cagliari, Italy). *International Solar Energy Society,* Sept. 1976, p. 55, 57, 59-81. 11 refs. In Italian.

Low-temperature applications of solar energy (water heating, space cooling) are considered promising and dimensions of plate and tube solar collectors are investigated for those applications. Collectors are tested in open circuit to assess the thermodynamic efficiency of a single collector or in closed circuit to test the efficiency of an entire array. Data recorded on an hourly basis and weather/climatic data are examined. The basic design and testing procedures for tube-on-plate collectors are presented, with test results in tabular form. R.D.V.

A77-23299 # **Some preliminary considerations on photovoltaic conversion of solar energy (Considerazioni preliminari sulla conversione fotovoltaica dell'energia solare).** A. Egidi and G. V. Pallottino. *International Solar Energy Society,* Sept. 1976, p. 83, 85, 87-91 (3 ff.). 17 refs. In Italian.

Tentative calculations on the feasibility, cost effectiveness, and overall reliability of solar energy via photovoltaic conversion are carried out. It is estimated that the cost of solar energy conversion will have to be cut by factors of 100 to 200 for it to become competitive with other sources of large-scale power in the foreseeable future. The importance of exploitation of solar energy for Italy, lacking in fossil fuels and hydroelectric development potential, is stressed. Data on ground-level solar energy available at selected sites in Italy are tabulated. Italy's demand on electric power generated by burning fossil fuels would be met by about 500 sq. km of solar cell panels at the present state of the art. R.D.V.

A77-23300 // **Advanced technologies for photovoltaic cell fabrication (Tecnologie avanzate per la fabbricazione di celle fotovoltaiche).** V. Storelli. *International Solar Energy Society,* Sept. 1976, p. 97, 99-106. In Italian.

Several crystal growing techniques of interest for improved fabrication of photovoltaic solar cells are described. Edge-defined film-fed growth, zone melting using electron beams, purification techniques, handling of dislocations and twins, electron-beam induced current techniques, and Czochralski crystal growth are discussed. Quantum yield is plotted as a function of wavelength for some of the techniques, and current/voltage characteristics are displayed for Czochralski and ribbon methods. R.D.V.

A77-23306 Fuel cells - Prospects of their applications for electric utilities. A. Théorêt (Hydro-Quebec Institute of Research, Varennes, Quebec, Canada). *(Engineering Institute of Canada, Annual Congress, 89th, Winnipeg, Canada, Oct. 1, 1975.) Canadian Electrical Engineering Journal,* vol. 1, July 1976, p. 21-26. 11 refs.

Fuel cells developed and tested by the TARGET (Team to advance research for gas energy transformation) consortium of power utilities are described. The design and operation of the 12.5 kW PC-11 hydrocarbon-air fuel cell ('Powercel') is presented in detail, along with a discussion of the testing program. Dispersed power generation in remote areas of Canada and an auxiliary electrical storage system supplementing nuclear or future thermonuclear power systems, in areas where a pumped-storage plant is not feasible, are envisaged for high-output fuel cell plants (40 kW, 75 kW). The immediate objective of the program is to develop a 26 MW fuel cell generator for dispersed power generation. R.D.V.

A77-23307 The energy situation in Canada. D. Cass-Beggs. *Canadian Electrical Engineering Journal,* vol. 1, July 1976, p. 33-38.

The author reviews the current energy scene in Canada and projects this into the next century. Alternative methods of power generation are examined and equated to the increased use of electrical power as a source of energy. This is exemplified by a proposal for the electrification of Canada's railways. A definition of power motive force - the motivation of a society for increased amounts of power - is proposed. (Author)

A77-23308 How six coal gasification processes compare economically. R. Detman (C. F. Braun and Co., Alhambra, Calif.). *Pipeline and Gas Journal,* vol. 204, Feb. 1977, p. 26-29.

A comparative economic analysis is made for six coal gasification processes in pilot plants: HYGAS (Both Steam-Oxygen and Steam-Iron), CO2 Acceptor, BI-GAS, Synthane, and Lurgi. The evaluation is based on commercial concept designs, development of installed costs by factoring equipment costs, estimation of operating and other costs, and computation of gas costs from procedures set forth in the guidelines. The analysis provides indications of the order of magnitude of plant costs, raw material and water requirements, and problem areas that require attention in the process development of commercial plants. In particular, a starting point is formulated for comparative analysis and improvement of each process toward its optimum potential. S.D.

A77-23309 Low-Btu gas from coal has many potential markets. N. Korens (Stanford Research Institute, Menlo Park, Calif.). *Pipeline and Gas Journal,* vol. 204, Feb. 1977, p. 30, 32-34, 36. 9 refs.

The paper shows how low-Btu gas from coal can capture a significant portion of the fuels market in the industrial and the electric power utility sectors of the U.S. national economy. Particular attention is given to a discussion of potential markets, compatibility of the technology for low-Btu gas production with current and future fuel users' installations, interfuel competition, and low-Btu gas economics. The major market potential appears to be in the use of low-Btu gas in small-sized furnaces and steam boilers and in intermediate-load combined-cycle electric power plants with current gas turbine technology. Future gas turbine technology advances may make low-Btu gas competitive for electricity generation even for base load power generation. S.D.

A77-23315 Raw materials for energy generation in Canada. *Resources Policy,* vol. 2, Mar. 1976, p. 25-35.

Canada is known to be one of the few industrialized countries with intrinsic self-sufficiency in energy supply. Domestic energy demand is discussed along with domestic energy sources in terms of present status and future of the industry. The energy minerals discussed include oil, natural gas, coal, and uranium. The outlook for natural gas in Canada appears to be more secure and optimistic than that for oil. The future will find Canada making more domestic use of its abundant coal reserves, although imports are likely to continue at high levels for some time. The projected rate of growth of domestic uranium demand suggests that the known reserves are insufficient to meet Canada's needs beyond the late 1980s. It is concluded that much remains to be done so as to ensure that resources in the ground become usable fuels on the market in a timely and efficient manner. S.D.

A77-23357 Aspects of surface wind behaviour. P. S. Jackson (Ministry of Works and Development, Central Laboratories, Lower Hutt, New Zealand). *Wind Engineering,* vol. 1, no. 1, 1977, p. 1-14. 37 refs.

This paper outlines the current understanding of some of the problems facing the engineer in choosing a design wind speed for a particular site. For the most part the complexity of these problems defies analytic treatment or comprehensive measurements, but there are now sufficient studies of the simpler cases to make this review worthwhile. Most of the relevant material has appeared since 1970. The basic mean wind profile adopted is the log-law, since it can be derived from the equations of motion under ideal (but rather restrictive) conditions. Although these conditions are rarely met in practice, it is shown that the log-law formulation nevertheless describes a very useful reference state of the wind near the ground. The effects of changes in surface roughness and variations in surface slope are derived as perturbations to this ideal state. Two methods of describing extreme wind gusts are also discussed. (Author)

A77-23358 Direct and indirect economics of wind energy systems relative to fuel based systems. B. Sorensen (Copenhagen, University, Copenhagen, Denmark). *(British Hydromechanics Research Association, International Symposium on Wind Energy Systems, Cambridge, England, Sept. 1976.) Wind Engineering,* vol. 1, no. 1, 1977, p. 15-22. 17 refs.

It is shown that the addition of an energy storage system of modest capacity, to a wind energy generator, provides a total wind energy electricity generating system as dependable as current alternative means of producing electricity. It is further shown, based on projections of the mass production costs of wind energy generators and energy storage systems, that such combined systems, as well as fuel saving generators without storage, appear economically competitive to the alternatives, provided the comparison is made over the entire life cycle of the systems. Finally, a number of economically less tangible aspects are touched upon, all of which seem to favor the use of fuel-less energy systems. (Author)

A77-23359 A possible saturation criterion for wind energy extraction. J. W. Railly (Birmingham, University, Birmingham, England). *Wind Engineering,* vol. 1, no. 1, 1977, p. 23-35. 7 refs.

Two hypotheses are advanced for predicting the possible power output from a distribution of wind turbines over a large ground area. When the turbine height is small compared with the height of the planetary boundary layer, the role of shear stress in determining the power level is demonstrated and the modification to the wind structure is predicted. On this basis, realistic values of the ratio of disk area to ground area are calculated. The importance of the stability of the PBL as it affects the power level is demonstrated. (Author)

A77-23360 Large scale Wind Energy Conversion System /WECS/ design and installation as affected by site wind energy characteristics, grouping arrangement and social acceptance. O. Ljungstrom (National Swedish Board for Energy Source Development, Sweden). *(British Hydromechanics Research Association,*

International Symposium on Wind Energy Systems, Cambridge, England, Sept. 1976.) Wind Engineering, vol. 1, no. 1, 1977, p. 36-56. 9 refs.

A77-23361 Balancing power supply from wind energy converting systems. J. P. Molly (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Porz-Wahn, West Germany). *(British Hydromechanics Research Association, International Symposium on Wind Energy Systems, Cambridge, England, Sept. 1976.) Wind Engineering,* vol. 1, no. 1, 1977, p. 57-66. 9 refs.

The random power fluctuation of a wind energy converter can be decreased by the electrical connection of several WECs located at large dispersed sites. It is shown that such a combination reduces the zero output time per year and leads to smaller mean power fluctuations than those of a single WEC with an equivalent storage system. In addition, the way in which mean power fluctuation varies if momentary demand is chosen for reference is investigated. (Author)

A77-23363 # Energy - An emerging role for aerospace. J. S. Foster, Jr. (TRW, Inc., Energy Systems Group, Redondo Beach, Calif.). *Journal of Energy,* vol. 1, Jan.-Feb. 1977, p. 3-8. 8 refs.

An overview is presented of the present and future impact of worldwide energy crisis situations on the U.S. economy, responses of U.S. industry and government to date, and the role open to the aerospace industry in coping with the set of problems. The players in the game are characterized (existing fuel industries, government agencies, universities, the 'public,' the aerospace industry), economic/political/environmental/regulatory disincentives and incentives to production of alternate energy resources (such as oil shale, coal gasification/liquefaction) are identified, and the crisis is assessed as a threat to the 'industrialized world.' R.D.V.

A77-23364 # Improved theory of the silicon p-n junction solar cell. E. S. Rittner (COMSAT Laboratories, Clarksburg, Md.). *Journal of Energy,* vol. 1, Jan.-Feb. 1977, p. 9-17. 34 refs. Research sponsored by the Communications Satellite Corp.

A modification of silicon p-n junction solar cell theory is introduced by incorporating the generation-recombination dark current in the junction, appropriately corrected for the thermal counterpart of the Franz-Keldysh effect, into the theory. The light-generated short-circuit current is found from the known solar spectrum and known band gap, and from estimated losses due to reflection, absorption, obstruction, transmission, and recombination. Empirical current-voltage characteristics of Si solar cells, whether violet, conventional, or nonreflective, are predicted by the improved theory, for space environment conditions. The theory also accounts for the temperature coefficient of the short-circuit current and of the open-circuit voltage, for the power output of the three types of solar cells, and also for the observed decline in power output with increased substrate doping, while predicting maximum efficiency for optimized cell thickness and doping. R.D.V.

A77-23365 # Engineering development status of the Darrieus wind turbine. B. F. Blackwell, W. N. Sullivan, R. C. Reuter, and J. F. Banas (Sandia Laboratories, Albuquerque, N. Mex.). *Journal of Energy,* vol. 1, Jan.-Feb. 1977, p. 50-64. 65 refs. ERDA-supported research.

The aerodynamics, structural stability, and system adaptability of Darrieus wind turbines (DWT) are examined and reviewed. The basic workings, aerodynamic performance, and wind tunnel data on DWT are presented. Structural studies are reviewed, covering blade statics, blade dynamics, blade flutter, the turbine support structure, and materials selection. Functioning of the DWT in a utility power grid is probed, with comparisons of constant-speed and variable-speed wind motor systems, optimization problems for a system incorporating DWT, power conversion, and handling of stalls and time off-line because of inadequate wind. R.D.V.

A77-23373 # Pumped-storage electric power generating plants (Impianti di accumulazione di energia elettrica mediante pompaggio). S. Penati (Ente Nazionale per l'Energia Elettrica, Direzione Centrale delle Costruzioni, Rome, Italy). *L'Energia Elettrica,* vol. 53, Oct. 1976, p. 521-532. In Italian.

Power generation, load coverage, daily/monthly/seasonal load variations, cost effectiveness, installation, spillways, offtakes, and reservoirs are discussed. Several hydroelectric pumped-storage plants on the line or under construction are discussed and data on their offtakes and hydraulic power machinery are presented in tabular form. The performance data on the power stations are extrapolated to a future situation when advanced nuclear reactor plants will take up much of the power generation load. R.D.V.

A77-23380 Can new resources fill the energy gap. K. Owens. *Electric Light and Power,* vol. 54, Oct. 1976, p. 13-15.

Expert opinions concerning the current status of the energy dilemma and also the potential for more energy in the future are reviewed in the present paper. According to these views, suggestions to ignore international sources of energy so the nation can go its independent way by squeezing energy from the tides, milking the sun, spinning with the winds, and trapping steam from the earth are unrealistic concepts for any immediate energy requirements. The existing alternative sources of energy closest to commercialization - tar sands, shale oil, coal gasification, methanol from coal, and coal liquefaction - experience economic, rather than technological, constraints. The investments in plants and technical developments are too high to warrant acceptable returns. In addition the price of these fuels would be equivalent to oil priced in the S24 to S27 range, as compared with its present cost of S11 to S13 per barrel. V.P.

A77-23382 A mathematical model for the digital computation of the hours of sunshine on an inclined plane. E. Coffari (Roma, Università, Rome, Italy). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique,* 1st Quarter, 1976, p. 10-15.

A77-23383 Geometric katoptrics - Applications to solar energy (Catoptrique géométrique - Applications à l'énergie solaire). L. Aiache (Aix-Marseille, Université, Marseille, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique,* 1st Quarter, 1976, p. 16-27. 7 refs. In French.

Katoptric behavior of an isolated mirror (plane or curved) or of an array of mirrors is analyzed and characterized, and terminology is defined. Radiation reflected at a point on a sensor, radiation arriving at one point of a beam reflected by a sensor, and katoptric behavior of a continuous mirror with sun as source of light are analyzed. Several types of katoptric sensors are distinguished, profitable utilizations of such sensors in solar energy practice and some related geometrical optics are discussed. Behavior of a field of reflecting point elements is investigated in the case of a single mirror, turning mirror, and arrays of mirrors. R.D.V.

A77-23385 Periodically adjustable concentrators adapted to solar cell panels. H. Durand, J. Michel, J.-J. Hunzinger, and C. Hily (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique,* 1st Quarter, 1976, p. 39-48.

Specifications of stationary (or periodically adjustable) E-W concentrators for solar cells are drawn. The geometrical gain of simple trapezoidal grooves consisting of two symmetrical mirrors is studied. The astronomical motion of the sun throughout the year is then introduced, and practical yearly average gain is calculated. The influence of an optimized angular tilting position of the concentrator of the practical reflection coefficient, and of the diffused light are examined. A monthly adjustable system gives a yearly gain near to 3 in ideal conditions, of 2.5 with a practical reflection coefficient of 0.9, and of more than 2 with some reasonable amount of diffused light. With current prices of solar panels, such a system brings a saving up to 50 per cent of solar electrical energy cost. (Author)

A77-23386 High-sensitivity detection procedures and devices for angular variations - Application to automatic control of a solar furnace heliostat (Procédé et dispositif de détection de

variations angulaires présentant une grande sensibilité - Application à l'asservissement d'un héliostat de four solaire). R. Delmas (CNRS, Laboratoire des Ultra-Réfractaires, Font Romeu, Pyrénées-Orientales, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique,* 1st Quarter, 1976, p. 50-52. In French.

The design of a precision device intended to transform angular deviations into radiant flux variations is described. The light source is imaged (with reduction in size) onto a screen to form a luminous corona. When the light is made to traverse several lens sectors, several light beams are formed to represent variations in luminous intensity. These variations are picked up by photocells actuating sensitive relays and power relays. The null position corresponds to equal currents in the photocells. Quality control of an actuating motor (to within 1/10 angular minute) can be achieved. R.D.V.

A77-23390 * # **Clean fuels from biomass.** Y.-Y. Hsu (NASA, Lewis Research Center, Cleveland, Ohio). *Energy Quarterly,* vol. 6, Jan. 1, 1976, p. 6-19. 19 refs.

The paper discusses the U.S. resources to provide fuels from agricultural products, the present status of conversion technology of clean fuels from biomass, and a system study directed to determine the energy budget, and environmental and socioeconomic impacts. Conversion processes are discussed relative to pyrolysis and anaerobic fermentation. Pyrolysis breaks the cellulose molecules to smaller molecules under high temperature in the absence of oxygen, wheras anaerobic fermentation is used to convert biomass to methane by means of bacteria. Cost optimization and energy utilization are also discussed. S.D.

A77-23391 * # **The dilemma of future electric power demand.** Y.-C. Wu (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Energy Quarterly,* vol. 6, Apr. 1, 1976, p. 22-29. 6 refs.

Dim prospects are held out for continued exponential growth rates in the generation and use of electric power worldwide and in many local areas, extrapolating from current trends and common projections. While acknowledging the unique advantages of electric power use, the article points out the 30% level of efficiency in conversion of other forms of energy to electrical energy, with huge volumes of wasted energy plus thermal pollution. Even growth at a fixed rate is found problematical, with future needs exhausting water and land resources and fossil fuels in time. Alleviation of the situation by shifting much of the load to still unproven technologies is considered cautiously. R.D.V.

A77-23392 # **Coal - The fossil energy source for the transition period.** Y.-C. Wu. *Energy Quarterly,* vol. 6, July 1, 1976, p. 1-15. 6 refs.

Coal is the one fossil energy source that can play a substantial role as a transitional energy source as one moves from the petroleum and natural gas based economic system to the future economic system based on nondepletable or renewable energy systems. The discussion is centered around classification of coal, problems related to the use of coal, and techniques of coal conversion and associated technologies. The basic chemistry of coal gasification is outlined along with the Lurgi gasification and related synthesis processes and the Garrett flash pyrolysis process. Great efforts are still necessary before commercialization is possible. S.D.

A77-23404 # **Utilization of disposed petroleum products and industrial wastes as fuels (Ob ispol'zovanii v kachestve topliva zabrakovannykh nefteproduktov i otkhodov proizvodstva).** E. D. Baluev (Gor'kovskii Inzhenerno-Stroitel'nyi Institut, Gorki, USSR). *Energetika,* vol. 19, Aug. 1976, p. 133-136. 6 refs. In Russian.

Some recommendations are made concerning the utilization of petroleum residues and similar industrial wastes as boiler fuels. It is shown that addition of such residues to crude oil can lead to a reduction of the required preheating temperature of the fuel and, hence, to substantial heat savings in preheating. V.P.

A77-23406 # **Allocation of standby power units in terms of the output power, in planning the development of power systems (Rezervirovanie energouzlov po generiruiushchei moshchnosti pri proektirovanii razvitiia energosistem).** A. T. Shevchenko and V. A. Venikov (Moskovskii Energeticheskii Institut, Moscow, USSR). *Energetika,* vol. 19, Sept. 1976, p. 13-18. In Russian.

The technical and economic problem of power storage optimization during the construction of standby power networks, which corresponds to the determination of construction costs of the units and the power exchange links between the units, and also the storage cost of the unused power, is examined. Because of the complexity of the computations involved and the uncertainty of the minimizing function, the necessity of normalizing the reliability index is emphasized. During the maintanance of the desired level of reliability and the optimal power distribution between the units, the throughput values become identical in all directions between the parts of the network. A.Y.

A77-23407 # **New requirements for the development and design of thermal power systems (Novye trebovaniia k razrabotke i proektirovaniiu teploenergeticheskikh sistem).** V. F. Stepanchuk (Belorusskii Politekhnicheskii Institut, Minsk, Belorussian SSR) and V. A. Minkov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Belorussian SSR). *Energetika,* vol. 19, Sept. 1976, p. 47-52. 5 refs. In Russian.

New requirements which modern thermal power plants must satisfy are formulated and analyzed. The requirements include drastic reductions in specific energy (fuel and heat) expenditures, and environmental pollution; the adaptability of power systems to the use of fuels of various type and of various quality; and to economical labor under conditions of variable load charts. The cost and the efficiency of power plants is optimized with the help of differential equations. Future trends in the research and development of thermal power plants are indicated. A.Y.

A77-23438 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Semiannual Meeting, Dallas, Tex., February 1-5, 1976, Proceedings. *ASHRAE Transactions,* vol. 82, pt. 1, 1976. 1198 p.

Attention is given to calculations of the energy use of buildings, innovations of the heat pump cycle, rating of refrigerant-to-air heat transfer equipment, and energy conservation through improved fenestration treatment. Solar heating and cooling systems are considered with particular emphasis on the University of Pennsylvania solar heating/cooling program, a computer model for a solar-assisted, closed-loop heat pump system, solar energy retrofit for existing buildings, and a comparison of aqueous ammonia and aqua ammonia cycles for solar-operated absorption water chillers. B.J.

A77-23439 The University of Pennsylvania Solar Heating/Cooling System Program. M. Wolf (Pennsylvania, University, Philadelphia, Pa.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Semiannual Meeting, Dallas, Tex., Feb. 1-5, 1976.) ASHRAE Transactions,* vol. 82, pt. 1, 1976, p. 644-663.

A complete detailed computer model has been constructed for the analysis of a total solar heating/cooling system. The major strength of the model is that it permits analysis of the effects of design variation in the collector in any other subsystem on the performance of the total system, particularly on auxiliary energy saved. This latter quantity determines the economic feasibility of the design variation. The model is applied to a thermal collector performance evaluation, and attention is given to direct heating systems, heating systems using a heat pump, and cooling systems. Results of computer runs are presented with emphasis on the influence of thermal load computations and a comparison of solar assisted heat pump operation with direct heating. B.J.

A77-23441 The ASHRAE monograph on applications of solar energy for heating and cooling buildings. R. C. Jordan and B. Y. H. Liu (Minnesota, University, Minneapolis, Minn.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers,*

Semiannual Meeting, Dallas, Tex., Feb. 1-5, 1976.) ASHRAE Transactions, vol. 82, pt. 1, 1976, p. 808-813. 9 refs.

A review is presented of the historical development of the use of solar energy in general and its use for space heating and cooling in particular. The current status of solar heating and cooling is briefly discussed, followed by a mention of the ASHRAE contribution to solar studies. B.J.

A77-23442 * **Design application using solar energy to control the environment in a major office building.** R. C. Basford (NASA, Langley Research Center, Hampton, Va.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Semiannual Meeting, Dallas, Tex., Feb. 1-5, 1976.) ASHRAE Transactions,* vol. 82, pt. 1, 1976, p. 814-824. 13 refs.

A77-23443 **Solar absorption air-conditioning performance in central Ohio.** S. A. Mumma and C. F. Sepsy (Ohio State University, Columbus, Ohio). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Semiannual Meeting, Dallas, Tex., Feb. 1-5, 1976.) ASHRAE Transactions,* vol. 82, pt. 1, 1976, p. 825-833; Discussion, p. 834. 8 refs.

The paper describes the design and performance of a solar absorption air conditioning system installed at a residential-sized laboratory on the Ohio Exposition Center grounds in Columbus, Ohio. The motivation of the program, developed by Ohio State University and industrially supported, was to identify the technical and economic boundaries applicable to the Ohio and Great Lakes region and to point out the difficulties inherent in the widespread utilization of current absorption cooling technology. Attention is given to collector performance, solar cooling performance with 2000-gallon water storage, and solar cooling performance without storage. B.J.

A77-23444 **Solar energy retrofit for existing buildings.** F. H. Bridgers and R. E. Hopper, Jr. (Bridgers and Paxton Consulting Engineers, Inc., Albuquerque, N. Mex.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Semiannual Meeting, Dallas, Tex., Feb. 1-5, 1976.) ASHRAE Transactions,* vol. 82, pt. 1, 1976, p. 835-847.

The development of a solar heating/cooling retrofit for the U.S. Post Office and Federal Building in Ft. Collins, Colorado is discussed. A summary table is given presenting the results of eight proposed conservation measures for the building and two solar heating and cooling systems, one without any of the energy conservation measures considered and one with full implementation of energy conservation in conjunction with the solar system. For each energy conservation measure and solar system proposed, the estimated initial cost is given along with the annual percentage of energy reduction or increase compared to the existing conventional system and the number of years required to pay back the initial costs. B.J.

A77-23445 **The use of commercially available absorption units on solar-powered cooling systems.** J. M. Porter (Trane Co., La Crosse, Wis.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Semiannual Meeting, Dallas, Tex., Feb. 1-5, 1976.) ASHRAE Transactions,* vol. 82, pt. 1, 1976, p. 943-949.

The paper describes a solar cooling system based on a water cooled aqueous lithium bromide unit. It is shown how the unit capacity and the operating cycle are affected by the overall system operating temperatures. These temperatures establish the following definite cycle operational limits: heat source temperature limit, heat rejection temperature limit, and evaporator temperature limit. An example is considered of a typical full load where the unit operates at its nominal design condition. The system conditions are leaving chilled water temperature of 44 F, cooling tower temperature of 85 F, and an available steam pressure of 12 psig. B.J.

A77-23446 **Relationship between heat source temperature, heat sink temperature and coefficient of performance for solar-powered absorption air conditioners.** E. P. Whitlow (Whirlpool Elisha Gray II Research and Engineering Center, Benton Harbor, Mich.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Semiannual Meeting, Dallas, Tex., Feb. 1-5, 1976.) ASHRAE Transactions,* vol. 82, pt. 1, 1976, p. 950-958.

A77-23447 **Absorption cycles for air-cooled solar air conditioning.** B. A. Phillips (Phillips Engineering Co., St. Joseph, Mich.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Semiannual Meeting, Dallas, Tex., Feb. 1-5, 1976.) ASHRAE Transactions,* vol. 82, pt. 1, 1976, p. 966-974. 6 refs.

A study is presented of solar air conditioning systems based on ammonia-water as the refrigerant-absorbent pair, with particular attention given to the types of absorption cycles which may be suitable. The use of double effect distillation, double evaporation, and heat recuperation for improving cycle efficiency is discussed. Cycles that have been previously used in residential air conditioning systems can achieve coefficients of performance in the 0.55-0.7 range under 95 F rating conditions. Coefficients of performance up to 0.88 are obtainable by applying cycles that have been used primarily in large tonnage industrial equipment. B.J.

A77-23448 **Selecting refrigerant-absorbent fluid systems for solar energy utilization.** R. A. Macriss (Institute of Gas Technology, Chicago, Ill.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Semiannual Meeting, Dallas, Tex., Feb. 1-5, 1976.) ASHRAE Transactions,* vol. 82, pt. 1, 1976, p. 975-988. 13 refs. Research supported by the American Gas Association.

The paper describes the use of new absorption fluid systems compatible with solar-powered cooling requirements. A search and evaluation effort culminated in a number of new fluid combinations for each of the following six refrigerant groups considered: water, ammonia, amines, halogenated hydrocarbons, silanes, and disiloxane. Systems with water as the refrigerant indicated the best performance, with the fluid search in this case emphasizing the need to air-cool. The effort was directed toward either a totally new salt (other than LiBr), or the modification of the LiBr-H2O system by the addition of organic compounds or other salts. B.J.

A77-23457 # **Details of hydrogen-burning thermonuclear reactions.** P. Bouvier and L. Weibel (Genève, Observatoire, Sauverny, Switzerland). *Observatoire de Genève, Publications, Série A,* no. 82, 1976, p. 163-171. 6 refs.

The proton proton (pp) chain is considered in its whole operating temperature range, and expressions are derived for the fractions of the pp I, pp II, and pp III chains as a function of temperature. There is a range of temperatures over which the pp II chain dominates, and energy production is calculated in this range. The CNO tricycle is then considered, which is made up of the basic CN cycle and two additional NO cycles. The temporal behavior of the chemical composition as these cycles approach equilibrium is studied, and it is shown that the presence of the second NO cycle entails a quasi-equilibrium for the CN cycle. P.T.H.

A77-23502 **The national laser-fusion program.** J. D. Hunsuck (ERDA, Washington, D.C.). In: Ultra high power lasers for practicable applications; Proceedings of the Seminar, Reston, Va., March 22, 23, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1976, p. 2-6.

The laser-fusion program of the United States is defined and program milestones (pellet implosion, significant fusion yield, scientific breakeven, net energy gain, operating test system, and demonstration plant) are reviewed. The current state of the technology is examined and attention is given to program strategy and program-budget categories. Electron-beam fusion is touched upon and national capabilities for laser fusion are discussed. B.J.

A77-23503 **Status of large neodymium glass lasers.** J. A. Glaze, W. W. Simmons, and W. F. Hagen (California, University, Livermore, Calif.). In: Ultra high power lasers for practicable applications; Proceedings of the Seminar, Reston, Va., March 22, 23, 1976. Palos Verdes Estates, Calif., Society of

Photo-Optical Instrumentation Engineers, 1976, p. 7-14. 14 refs. Contract No. W-7405-eng-48.

The Nd:glass laser is used extensively for laser fusion and laser plasma interaction studies. After a description of the laser chain of an Nd:glass system, the paper examines two large Nd-glass systems developed at the Lawrence Livermore Laboratory: ARGUS and SHIVA. ARGUS is a two-arm, 3 terrawatt system intended for fusion target irradiation. SHIVA is a 20-arm system operating at 20-30 terrawatts and is intended for the demonstration of significant thermonuclear burn from the isentropic compression of D-T targets. B.J.

A77-23551 **Shale oil, tar sands, and related fuel sources.** Edited by T. F. Yen (Southern California, University, Los Angeles, Calif.). Washington, D. C., American Chemical Society (Advances in Chemistry Series, No. 151), 1976. 191 p. $21.50.

Attention is given to sulfur compounds in oils from the Western Canada Tar Belt, solutions of silica in Green River oil shale, characterization of the Utah Tar Sand bitumen, and the hydrogasification of oil shale. Also considered are the rate of dissolution of carbonate mineral matrix in oil shale by dilute acids, fracturing oil shale with explosives for in situ recovery, feasibility studies of a microbial method for the desulfurization of petroleum, the characterization of synthetic liquid fuels, and direct zinc chloride hydrocracking of sub-bituminous coal and regeneration of spent melt.

Individual items are announced in this issue. B.J.

A77-23552 **Characteristics of synthetic crude from crude shale oil produced by in situ combustion retorting.** R. E. Poulson, C. M. Frost, and H. B. Jensen (ERDA, Laramie Energy Research Center, Laramie, Wyo.). In: Shale oil, tar sands, and related fuel sources. Washington, D.C., American Chemical Society, 1976, p. 1-10. 20 refs.

A synthetic crude prepared by hydrogenating the naphtha, the light oil, and the heavy oil fractions obtained from in situ crude shale oil by distillation and coking of the 850 F + residuum was characterized by examining the fractions. The heavy oil had 935 ppm nitrogen of which 40% was pyridine-type nitrogen, and 60% was pyrrole-type nitrogen. The light oil had 79 ppm nitrogen, all of which was pyridine-type nitrogen. The naphtha had less than 1 ppm nitrogen, which was not characterized. The saturate content of the fractions was - naphtha, 87%; light oil, 77%; and heavy oil, 73%. In addition, the heavy oil contained 6% olefins and 2% polar material. (Author)

A77-23553 **Sulfur compounds in oils from the Western Canada Tar Belt.** D. M. Clugston, A. E. George, D. S. Montgomery, G. T. Smiley, and H. Sawatzky (Fuels Research Centre, Ottawa, Canada). In: Shale oil, tar sands, and related fuel sources. Washington, D.C., American Chemical Society, 1976, p. 11-27. 5 refs.

Sulfur compounds in the gas oil fractions from two bitumens (Athabasca oil sand and Cold Lake deposit), a heavy oil (Lloydminster) from Cretaceous reservoirs along the western Canada sedimentary basin, and a Cretaceous oil from a deep reservoir that may be mature (Medicine River) are investigated. The gas oil distillates were separated to concentrates of different hydrocarbon types on a liquid adsorption chromatographic column. The aromatic hydrocarbon types with their associated sulfur compounds were resolved by gas chromatographic simulated distillation and then by gas solid chromatography. Some sulfur compounds were further characterized by mass spectrometry. The predominant sulfur compounds in these fractions are alkyl-substituted benzo- and dibenzothiophenes with short side chains which have few dominant isomers. (Author)

A77-23554 **Characterization of synthetic liquid fuels.** R. G. Ruberto, D. M. Jewell, R. K. Jensen, and D. C. Cronauer (Gulf Research and Development Co., Pittsburgh, Pa.). In: Shale oil, tar sands, and related fuel sources. Washington, D.C., American Chemical Society, 1976, p. 28-47. 60 refs.

Analytical separation and spectroscopic techniques normally used for petroleum crudes and residues were modified and used to characterize coal liquids, tar sands bitumens, and shale oils. These techniques include solvent extraction, adsorption, ion-exchange, and metal complexing chromatography to provide discrete fractions. The fractions are characterized by various physical and spectroscopic methods such as GLC, MS, NMR, etc. The methods are relatively fast, require only a few grams of sample, provide compound type fractions for detailed characterization, and provide comparative compositional profiles for natural and synthetic fuels. Additional analytical methods are needed in some areas. (Author)

A77-23556 **Hydrogasification of oil shale.** S. A. Weil, H. L. Feldkirchner, and P. B. Tarman (Institute of Gas Technology, Chicago, Ill.). In: Shale oil, tar sands, and related fuel sources. Washington, D.C., American Chemical Society, 1976, p. 55-76. 6 refs. Research sponsored by the American Gas Association.

Colorado oil shale was hydrogasified at temperatures up to 1400 F and pressures up to 500 psia. Both laboratory thermobalance tests and bench-scale moving-bed reactor tests were conducted. The thermobalance tests showed that at elevated hydrogen partial pressures with controlled slow shale heating, over 95% of the shale's organic carbon could be recovered. These results were verified in the bench-scale tests in which countercurrent hydrogen-shale contacting achieved organic carbon recoveries as high as 95%. Mineral carbonate decomposition was suppressed significantly by adding carbon dioxide to the feed gas. (Author)

A77-23557 **Production of synthetic crude from crude shale oil produced by in situ combustion retorting.** C. M. Frost, R. E. Poulson, and H. B. Jensen (ERDA, Laramie Energy Research Center, Laramie, Wyo.). In: Shale oil, tar sands, and related fuel sources. Washington, D.C., American Chemical Society, 1976, p. 77-91. 12 refs. Research supported by the University of Wyoming and ERDA.

Of six modern hydrogenation catalysts tested on a shale oil heavy gas oil, a Ni-Mo-on-alumina catalyst was found superior at 1500 psig and 800 F. This catalyst was used to prepare a premium synthetic crude oil from in situ combustion-produced crude shale oil by hydrogenation of naphtha, light oil, and heavy oil fractions. These fractions were obtained by distillation of the oil, coking the vacuum residuum, and combining like distillate ranges. The synthetic crude contained 250 ppm nitrogen and 5 ppm sulfur. Physical properties were: API gravity, 43.9 degrees; pour point, 32 F; viscosity at 100 F, 32 SUS. The overall yield was 103 vol.%. (Author)

A77-23558 **Solution of silica in Green River oil shale.** W. C. Meyer and T. F. Yen (Southern California, University, Los Angeles, Calif.). In: Shale oil, tar sands, and related fuel sources. Washington, D.C., American Chemical Society, 1976, p. 92-97. Research supported by the American Gas Association; NSF Grants No. GI-35683; No. AER-74-23-797.

Bioleaching of Green River oil shale leaves a silica-enriched residue in which potentially petroliferous organics (primarily kerogen) remained trapped. Organic solvent systems using pyridine, quinoline or water, and potassium hydroxide were examined to ascertain their effectiveness in dissolving silica, thereby liberating trapped organics. Solvent capability of each system was determined as percent weight loss from the initial silica sample. Quinoline plus potassium hydroxide pellets proved most effective, causing approximately 50% weight loss in 5 hr. Saturated aqueous potassium hydroxide yielded a weight loss of approximately 9%. The organic solvents appear to serve as a substrate to allow basic aqueous solution of silica at elevated temperatures. (Author)

A77-23559 **Fracturing oil shale with explosives for in situ recovery.** J. S. Miller and R. T. Johansen (Bartlesville Energy Research Center, Bartlesville, Okla.). In: Shale oil, tar sands, and related fuel sources. Washington, D.C., American Chemical Society, 1976, p. 98-111. 19 refs.

Three different explosive fracturing techniques were developed by the Bureau of Mines for preparing oil shale for in situ recovery near Rock Springs, Wyo. (1) Displacing and detonating nitroglycerin

in natural or hydraulically induced fracture systems; sufficient fragmentation was obtained to sustain an in situ combustion experiment. (2) Displacing and detonating nitroglycerin in induced fractures followed by wellbore shots using pelletized TNT; suitable interwell fragmentation was achieved for in situ recovery experimentation. (3) Detonating wellbore charges using pelletized TNT; suitable interwell fragmentation was not achieved to support an in situ recovery experiment. (Author)

A77-23561 Characterization of a Utah tar sand bitumen. J. W. Bunger (ERDA, Laramie Energy Research Center, Laramie, Wyo.). In: Shale oil, tar sands, and related fuel sources. Washington, D.C., American Chemical Society, 1976, p. 121-136. 22 refs.

A preliminary characterization of a Utah tar sand bitumen has been made using methods developed for high boiling petroleum fractions. The characterization includes information about the major compound types which can be compared with similar data for other tar sand bitumens and, more importantly, can be correlated with data from petroleum samples for which refining characteristics are known. Examination of the P. R. Spring bitumen showed that it differed significantly from representative petroleum residues, principally in its high nonhydrocarbon content. Compositional information is important because of the effects that composition has on the recovery and processing of the bitumen. (Author)

A77-23562 Feasibility studies of a biochemical desulfurization method. A. J. Davis, III and T. F. Yen (Southern California, University, Los Angeles, Calif.). In: Shale oil, tar sands, and related fuel sources. Washington, D.C., American Chemical Society, 1976, p. 137-143. 6 refs. Research supported by the American Chemical Society; NSF Grants No. GI-35683; No. AER-74-23797.

The paper investigates the microbial desulfurization of high-sulfur petroleum. The microorganism Thiobacillus thiooxidans is a possible desulfurizing agent of bound sulfur with an efficiency greater than 20%, oxidizing sulfur to sulfate and producing sulfuric acid as a by-product. A study was conducted on the desulfurization characteristics of T. thiooxidans grown on tertiary butylsulfides for 24 days. Growth of the organism was followed by a decrease in pH and an increase in sulfate production, gravimetrically measured in the barium salt form. B.J.

A77-23647 Fuel cells - A sleeper in the energy race. R. B. Aronson. *Machine Design*, vol. 49, Feb. 24, 1977, p. 20-22, 24.

A 4.8-MW demonstration power plant which is based on the use of fuel cells is to be constructed. The power plant is to be tested for one year by a public utility. It is pointed out that considerable savings in power-generating costs might be obtained by using fuel cells. Significant savings in fuel oil are also possible. Other advantages of fuel cells are related to low pollutant emission levels, the absence of noise, and the lack of cooling-water requirements. Problems in fuel-cell development are related to the conversion of available low-cost fuels into a hydrogen-rich gas which is suitable for fuel cell operation. Fuel cell efficiency, operational life, and aspects of fuel-impurity tolerance depend to a large extent on the electrolyte. Electrolytes considered include phosphoric acid, alkaline electrolytes, molten carbonate electrolytes, and solid oxide. Fuel-cell operational temperatures are in the range from 100 to more than 750 C. G.R.

A77-23651 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Annual Meeting, Seattle, Wash., June 27-July 1, 1976, Proceedings. *ASHRAE Transactions*, vol. 82, pt. 2, 1976. 638 p.

Attention is given to determination of heat transfer coefficients in the dry-out region of a horizontal-tube water-heated evaporator, to a method of estimating solar heating and cooling system performance, and initial test results for a solar-cooled townhouse in a suburb of Washington, D.C. Also considered are the ERDA program for solar heating and cooling, a specially designed solar collector with a Fresnel lens, and an integrated solar-assisted optimized heat pump system. B.J.

A77-23653 Method for estimating solar heating and cooling system performance. D. C. Hittle, G. N. Walton (U.S. Army, Construction Engineering Research Laboratory, Champaign, Ill.), and D. F. Holshouser (Illinois, University, Urbana, Ill.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Annual Meeting, Seattle, Wash., June 27-July 1, 1976.) ASHRAE Transactions,* vol. 82, pt. 2, 1976, p. 56-63; Discussion, p. 64, 65. 6 refs.

A method was devised for estimating the expected performance of a given solar heating and cooling system when applied to typical buildings in various regions of the United States. Computer simulation was employed to perform numerous parametric studies and to provide typical performance curves for several Army buildings. The procedure used was twofold: (1) the utilization of hourly climatological data tapes from the National Climatic Center for making hourly building load estimates, and (2) utilization of the data from the first step for conducting a series of parametric studies using a solar system simulation program. Using this procedure and 200 full-year solar system simulations, the effects of collector area, collector tilt angle, storage tank volume, and heat exchanger effectiveness were examined. B.J.

A77-23654 Why solar energy. A. B. Newton. *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Annual Meeting, Seattle, Wash., June 27-July 1, 1976.) ASHRAE Transactions,* vol. 82, pt. 2, 1976, p. 379-384.

The advantages of solar energy over fossil-fuel and nuclear energy are discussed. Attention is given to energy reserves and the rate of use, and the effects of thermal pollution. The following uses and aspects of solar energy are examined: solar heating of buildings, direct conversion of solar radiation to electricity, windpower utilization, solar cooling of buildings, and solar energy for the rapid controlled growth of algae and other plants. B.J.

A77-23655 Initial test results for a solar-cooled townhouse in the mid-Atlantic region. J. E. Hill, T. E. Richtmyer, and J. P. Jenkins (National Bureau of Standards, Thermal Engineering Section, Washington, D.C.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Annual Meeting, Seattle, Wash., June 27-July 1, 1976.) ASHRAE Transactions,* vol. 82, pt. 2, 1976, p. 389-404. 8 refs. Research supported by the Federal Energy Administration and ERDA.

A townhouse having a floor area of 110 sq m and located in suburban Washington, D.C. was equipped with a solar cooling system and tested during the summer of 1975. The cooling system consisted of 45 sq m of double-glazed flat-plate collector having a nonselective absorber, a lithium bromide absorption air-cooling unit designed for operation using a heated liquid and a 1.9 cu m water storage tank. The system was subjected to extensive testing over a 2-week period. The performance of the system for a typical day was compared with that of an electric vapor-compression cooling system tested in the same house during a previous year. Test results were also compared with computer predictions for this system under the same conditions. B.J.

A77-23656 A progress report on the national program for solar heating and cooling. R. D. Scott (ERDA, Div. of Solar Energy, Washington, D.C.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Annual Meeting, Seattle, Wash., June 27-July 1, 1976.) ASHRAE Transactions,* vol. 82, pt. 2, 1976, p. 405-415. 9 refs.

The solar heating and cooling program is discussed in reference to the primary constraints to which Federal action is considered to be appropriate including building code and regulatory constraints, institutional constraints, technology constraints, and marketability constraints. Program objectives are outlined along with program achievements and demonstration programs which include the Department of Housing and Urban Development Request for Grant

Application and the DOD Residential Demonstration Projects. Attention is also given to commercial buildings demonstration projects, development for demonstration programs, data collection/management/information dissemination, and the standards development program. B.J.

A77-23657 A practical solar concentrator. G. W. Lowery, O. G. Hancock (Florida Solar Energy Center, Cape Canaveral, Fla.), and L. N. Northrup (Northrup, Inc., Nutchins, Tex.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Annual Meeting, Seattle, Wash., June 27-July 1, 1976.) ASHRAE Transactions*, vol. 82, pt. 2, 1976, p. 416-424; Discussion, p. 425. 5 refs.

A new solar collector has been developed that utilizes a specially designed, linear Fresnel lens for concentrating sunlight onto an absorber heat exchanger. As the solar radiation passes through the lens, it is refracted by a computer-designed array of prisms that concentrates the rays onto a copper absorber tube. The concentration ratio is approximately 6:1. This concentrating tracking collector has been performance-tested with instantaneous efficiencies determined for each of two standard absorber coatings and an experimental evacuated-tube absorber. Some applications around the country of this collector are mentioned. B.J.

A77-23658 Operational report on an integrated solar-assisted optimized heat pump system. D. M. Jardine (Kaman Sciences Corp., Colorado Springs, Colo.) and R. F. Kuharich (Colorado Springs, Dept. of Public Utilities, Colorado Springs, Colo.). *(American Society of Heating, Refrigerating and Air-Conditioning Engineers, Annual Meeting, Seattle, Wash., June 27-July 1, 1976.) ASHRAE Transactions*, vol. 82, pt. 2, 1976, p. 426-432.

The solar-assisted heat pump system in question has 72.5 sq m of fluid-heating solar collector with an organic heat transfer fluid as the working fluid. The storage system is 34,091 l capacity uninsulated steel tank buried in a quartz sand envelope. Water is used as the storage medium in the tank and the volume of the water in the tank can be changed for specific research efforts. The system operates in the following modes: direct utilization of stored thermal energy to heat the house and preheat domestic water, air-to-air heat pump for heating the house when storage is depleted, fluid-to-air heat pump operation using a storage system as both a heat source and a heat sink, electric resistance heaters used to add heat to storage during off-peak hours on electric network, and electric resistance heaters in house air stream used to heat house and supplement air-to-air heat pump capacity. B.J.

A77-23717 International cooperation on development of hydrogen technologies. J. Vanderryn (ERDA, Washington, D.C.), F. J. Salzano (Brookhaven National Laboratory, Upton, N.Y.), and M. G. Bowman (California, University, Los Alamos, N. Mex.). *International Journal of Hydrogen Energy*, vol. 1, Jan. 20, 1977, p. 357-363.

The production transmission and utilization of hydrogen has been identified as one of the priority areas for international cooperation under the International Energy Agency. Two coordinating committees and two working panels have been organized to coordinate cooperative activities in the fields of water electrolysis, thermochemical water splitting, the interfacing of nuclear reactors with production processes and the general area of systems studies and assessment of a developing hydrogen technology. Meetings of these groups have been held with participating experts from interested countries. From these developments it is quite clear that the cooperative programs under the IEA will lead to improved R & D programs. One goal of the cooperation is joint participation of the member countries in the large and expensive commercial demonstration of the developing new technology. (Author)

A77-23718 * The thermal efficiency and cost of producing hydrogen and other synthetic aircraft fuels from coal. R. D. Witcofski (NASA, Langley Research Center, Hampton, Va.). *(Energy Research and Development Administration, World Hydrogen Energy Conference, 1st, Miami Beach, Fla., Mar. 1-3, 1976.) International Journal of Hydrogen Energy*, vol. 1, Jan. 20, 1977, p. 365-377. 13 refs.

A comparison is made of the cost and thermal efficiency of producing liquid hydrogen, liquid methane and synthetic aviation kerosene from coal. These results are combined with estimates of the cost and energy losses associated with transporting, storing, and transferring the fuels to aircraft. The results of hydrogen-fueled and kerosene-fueled aircraft performance studies are utilized to compare the economic viability and efficiency of coal resource utilization of synthetic aviation fuels. (Author)

A77-23719 Hydrogen producing cycles using electricity and heat - Hydrogen halide cycles: Electrolysis of HBr. G. H. Schuetz (EURATOM and Comitato Nazionale per l'Energia Nucleare, Centro Comune di Ricerche, Ispra, Italy). *(Energy Research and Development Administration, World Hydrogen Energy Conference, 1st, Miami Beach, Fla., Mar. 1-3, 1976.) International Journal of Hydrogen Energy*, vol. 1, Jan. 20, 1977, p. 379-388.

An alternative to water electrolysis or thermochemical water splitting for hydrogen production could be a process using both electricity and heat. The electrolysis of hydrogen halides may be an important step of such hybrid processes. Some preliminary results obtained by electrolyzing concentrated hydrobromic acid with different electrode materials and at different temperatures are presented. High current densities were obtained at 1 V and less with electrodes of noble metals at low bromine concentrations. (Author)

A77-23720 * Competitively priced hydrogen via high-efficiency nuclear electrolysis. W. J. D. Escher and T. D. Donakowski (Institute of Gas Technology, Chicago, Ill.). *(Energy Research and Development Administration, World Hydrogen Energy Conference, 1st, Miami Beach, Fla., Mar. 1-3, 1976.) International Journal of Hydrogen Energy*, vol. 1, Jan. 20, 1977, p. 389-399. 15 refs. Contract No. NAS8-30757.

A fully dedicated nuclear-electrolytic hydrogen-production facility, based on advanced (1985) technology, has been synthesized and assessed at the conceptual level. The facility integrates an HTGR operating a binary shaftpower-extraction cycle at 980 C top temperature, direct dc electricity generation via acyclic generators, and high-current density high-pressure electrolyzers based on the solid polymer electrolyte approach. All subsystems are close-coupled and optimally interfaced. Pipeline-pressure hydrogen and coproduct oxygen are produced at 6900 kPa. On consistent costing bases, the advanced facility concept was found to provide hydrogen costs that were approximately half those associated with conventional, contemporary-technology nuclear electrolysis. The nuclear heat-to-hydrogen energy conversion efficiency for the advanced system was estimated as 43%, against 25% for the baseline present-day approach. (Author)

A77-23721 Water induction in hydrogen-powered IC engines. R. L. Woolley and D. L. Henriksen (Billings Energy Research Corp., Provo, Utah). *(Energy Research and Development Administration, World Hydrogen Energy Conference, 1st, Miami Beach, Fla., Mar. 1-3, 1976.) International Journal of Hydrogen Energy*, vol. 1, Jan. 20, 1977, p. 401-412. 13 refs.

Addition of water to the hydrogen-air mixture in the intake manifold is an effective means of both suppressing the tendency to backflash and reducing the production of oxides of nitrogen. Tests are run on a Dodge 440 CID V8 engine having a compression ratio of 12:1. Dramatic reduction in oxides of nitrogen is observed as the water flow is increased, yet essentially no change is observed in either power or efficiency. Exhaust temperature, NOx, and equivalence ratio is measured at each exhaust valve. It is found that a large cylinder to cylinder variation in NOx production is caused by slight nonuniformity in mixing of the hydrogen-air streams. It is further shown that NOx production is an exponential function of equivalence ratio, water to hydrogen mass ratio, and engine speed. (Author)

A77-23900 Hybrid propulsion system for motor vehicles with predominantly intermittent mode of operation (Hybridantrieb für Kraftfahrzeuge mit vorwiegend instationärer Betriebsweise). H. J.

Bartsch, J. Helling, and H. Schreck (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *VDI-Z*, vol. 119, no. 3, Feb. 1977, p. 141-146. 11 refs. In German.

In the case of motor vehicles used in city traffic or in other traffic situations involving an intermittent mode of operation, fuel can be saved by making use of an energy storage device. A flywheel system can be employed as such an energy storage device. A theoretical investigation is conducted concerning the operational characteristics of a suitable flywheel system for motor vehicle applications and the energy which can be saved with the aid of such a system. The practical implementation of the considered concepts is discussed and the operational characteristics of vehicles with conventional and with hybrid propulsion systems are compared. G.R.

A77-23901 # **Electrochemical battery trends for aircraft and missile applications.** W. S. Bishop (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-481* 2 p.

New developments which may have a major impact on the use of batteries in aircraft and missile applications are outlined. Aircraft batteries are discussed with special emphasis on rechargeable types and missile batteries are examined with particular stress on the reserve nonrechargeable automatically-activated types. For aircraft batteries, main dc electrical system batteries and special-purpose batteries dedicated to specific systems or pieces of electronic equipment are identified. The nickel-zinc battery is shown to be a compromise between the lead acid, silver-zinc, and nickel-cadmium batteries. The new lithium nonrechargeable battery introduces the idea of throw-away batteries for dedicated avionics-type standby batteries. Current battery developments for missile applications are also discussed. New advances in thermal battery are pointed out. S.D.

A77-23902 # **Space battery technology for the 1980s.** R. L. Kerr and D. F. Pickett (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-482.* 9 p. 42 refs.

In this paper trends in spacecraft battery development are analyzed and expectations for batteries through the 1980s are given. It is expected that nickel-cadmium batteries will continue as the major power storage unit aboard spacecraft until the mid 1980s. The nickel-hydrogen battery is expected to demonstrate its spacecraft worthiness in early 1977. In the early 1980s it should begin to replace the nickel-cadmium batteries. A silver-hydrogen space battery will be developed soon which has some advantages over both nickel-cadmium and nickel-hydrogen. It will be used in cases where higher energy density at the expense of cycle life is justified. Improvements in light weight hardware and plate fabrication processes for nickel-cadmium and nickel-hydrogen batteries is expected to enhance their specific energy. The new plates should also improve their performance and make the nickel-hydrogen system a more viable low earth orbit battery. In cases where power levels exceed 25 kilowatts the lithium-molten salt or high temperature solid electrolyte batteries will probably come into use. (Author)

A77-23903 # **Lithium-aluminum/metal sulfide batteries.** R. K. Steunenberg (Argonne National Laboratory, Argonne, Ill.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-483.* 11 p. 37 refs. ERDA-sponsored research.

Rechargeable lithium-aluminum/metal sulfide batteries are being developed for electric vehicle propulsion and for stationary energy storage applications such as load leveling in electric utility systems. Although these two applications have different requirements, batteries of this type show promise of meeting the performance, lifetime and cost goals for both. Cells are being produced and tested both in-house, and by industrial subcontractors. Conceptual battery designs have been developed and two- and three-cell batteries have been operated successfully. Although the development work has been aimed primarily at these two large-scale applications, batteries of this type may find near-term use in more specialized applications that require high specific energy and power, but where the cost restrictions are less stringent. (Author)

A77-23904 # **Hardened solar photovoltaics.** W. P. Rahilly, J. W. Geis, and L. D. Massie (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-484.* 5 p. 15 refs.

This paper reviews hardening of space photovoltaic power systems in terms of survivability to natural and artificial environments. The specific environments considered are the normal electron and proton fluxes (including proton flares) comprising the Van Allen belt; the X-ray, neutron and electromagnetic pulse environments attendant with nuclear weapon detonation and the various laser environments presently achievable. The effects of these environments are discussed relative to solar cell design, solar cell/substrate design and overall power system design. A discussion is presented concerning presently available techniques to significantly reduce the effects of particulate radiation on solar cell performance. Also discussed are approaches to alleviate vulnerability of solar cells/arrays to high temperature cycles. Projections for solar cell technology are presented along with expected cost and performance information. (Author)

A77-23905 # **Advanced silicon solar cell production technology.** J. A. Scott-Monck (Spectrolab, Inc., Sylmar, Calif.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-485.* 8 p. 16 refs.

Recent technical advancements in improving silicon solar cell electrical performance such as shallow junctions, back surface fields and selective etching, coupled with more sophisticated cell designs such as wraparound contact configurations have acted as a driving force for improved silicon solar cell production technology. Production equipment has been upgraded in such critical areas as contact metallization and antireflection coating. New processes and changes in materials have been developed in order to mass produce cells with AMO efficiencies that are twenty to thirty percent higher than cells manufactured three years ago. (Author)

A77-23906 # **Advanced vertical-junction silicon solar cells.** J. Lindmayer and C. Wrigley (Solarex Corp., Rockville, Md.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-486.* 4 p. 5 refs. Contract No. F33615-76-C-2058.

Technological advances in developing a vertical-junction structure for silicon solar cells of high efficiency and radiation resistance are discussed. A new approach based on growth enhancements is described. In this approach, the silicon slices are first subjected to a phosphorus diffusion around 850 C, which forms a phosphosilicate glass of about 800 A thickness. Sequential exposure of these slices to steam produces the required oxide thickness rapidly and with little difficulty. This glass is then used as the silicon etching mask for the vertical-junction structure fabrication. Oxide removal in hydrofluoric acid and a slight silicon etch to remove the diffused phosphorus layer on the wall tops prepares the structure for solar cell fabrication. The performance of a 2 by 2 cm vertical-junction silicon cell processed by this technique has exceeded 13% under AMO illumination with superior radiation resistance. S.D.

A77-23907 # **Gallium arsenide concentrator system.** R. S. Miller and J. S. Harris (Rockwell International Corp., Space Div., Downey, Calif.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-487.* 7 p. 5 refs.

The development of a modular gallium aluminum arsenide (GaAlAs) solar-cell 500-sun concentrator system for satellite applications is presented. This study includes analytical trades, configuration evaluation, design, fabrication, and test of an 8-watt brassboard concentrator module. A significant effort was dedicated to developing a compatible gallium aluminum arsenide solar cell utilizing a liquid-phase epitaxial (LPE) growth process. Sample

GaAlAs solar cells were flown on a rocket flight to obtain a calibrated standard cell, and additional cells were exposed to radiation environments to determine degradation rates. The modular concentrator has been designed to nest into an array, utilizing maximum projected solar energy and capable of delivering from 250 to 100,000 watts. The optical train consists of a two-mirror system with augmenting light cone to provide an acceptance angle of two degrees. A heat-pipe-augmented hexagonal radiator was used to cool the solar cell. The projected power output of a flight type assembly is greater than 60 W/kg and less than $115/watt using a gallium arsenide cell cost of $20/sq cm. (Author)

A77-23908 # **Advanced low-mass solar array technology.** R. V. Elms, Jr. (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-488.* 18 p.

This paper summarizes present low-mass solar array system technology and discusses expected future technology advances. Space habitats and early space power experiments will continue to employ self-deploying array systems that are launched as separate units or on spacecraft. Array area requirements greater than 4650 sq m will utilize a large planar space structure that is first assembled in orbit. Packages of solar array electrical modules are built, ground tested, and delivered to the orbiting substrate structure. There the array modules are spread over the structure and attached to it. The development of the space structures for supporting large solar arrays will include the application of composites of graphite and fiberglass normally with epoxy resins. Polyimide resins will be used for composite structure applications at temperatures above 93 C as in some areas of sun concentration solar array designs and for near sun spacecraft missions. (Author)

A77-23916 # **The selenide isotope generators.** T. E. Hammel and W. E. Osmeyer (Teledyne Energy Systems, Timonium, Md.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-498.* 7 p. ERDA Contract No. EX-76-C-16-3077.

A description is presented of the configuration and performance characteristics expected of selenide isotope generators over a period of about eight years. Flight system studies related to the development of a radioisotope thermoelectric generator for space applications are discussed, taking into account the ground rules for investigations concerning the design of a suitable radioisotope fueled electrical generator which would yield a specific power of 3 watts per pound, or greater, and be competitive in cost to solar cell space power. G.R.

A77-23918 * # **Thermionic energy conversion technology - Present and future.** K. Shimada (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and J. F. Morris (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-500.* 8 p. 13 refs. Contract No. NAS7-100.

Aerospace and terrestrial applications of thermionic direct energy conversion and advances in direct energy conversion (DEC) technology are surveyed. Electrode materials, the cesium plasma drop (the difference between the barrier index and the collector work function), DEC voltage/current characteristics, conversion efficiency, and operating temperatures are discussed. Attention is centered on nuclear reactor system thermionic DEC devices, for in-core or out-of-core operation. Thermionic fuel elements, the radiation shield, power conditions, and a waste heat rejection system are considered among the thermionic DEC system components. Terrestrial applications include topping power systems in fossil fuel and solar power generation. R.D.V.

A77-23922 * # **Status of the NASA Space Power Program.** J. P. Mullin and L. Holcomb (NASA, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-505.* 8 p. 36 refs.

The NASA Space Power Research and Technology Program has the objective to provide the technological basis for satisfying the nation's future needs regarding electrical power in space. The development of power sources of low mass and increased environmental resistance is considered. Attention is given to advances in the area of photovoltaic energy conversion, improved Ni-Cd battery components, a nickel-hydrogen battery, remotely activated silver-zinc and lithium-water batteries, the technology of an advanced water electrolysis/regenerative fuel cell system, aspects of thermal-to-electric conversion, environmental interactions, multi-kW low cost systems, and high-performance systems. G.R.

A77-23923 # **Advanced photovoltaic power systems.** P. Goldsmith and G. M. Reppucci (TRW Defense and Space Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-506.* 6 p. 14 refs.

The state-of-the-art of synchronous orbit photovoltaic power systems is characterized including performance of solar arrays, batteries and power control components. Advanced developments in each of these areas are reviewed and projections are made for performance improvements in the 1980-1985 time period. It is estimated that overall photovoltaic power system specific weight could decrease from a present value of 126 kg/kW to approximately 43 kg/kW in 1985. These performance predictions are compared to projections of nuclear system performance over the same period. The analysis indicates that advanced photovoltaic power systems will exhibit specific weights which are lower than isotope and reactor nuclear systems at all power levels up to approximately 25 kW. At higher power levels, higher energy density batteries would be required to compete with the projected performance of advanced nuclear systems. (Author)

A77-23926 # **A rationale for large space-based solar power systems.** J. Grey (American Institute of Aeronautics and Astronautics, Inc., New York, N.Y.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-510.* 9 p. 39 refs.

The current status of the various system approaches to space-based solar power is briefly examined, taking into account active photovoltaic conversion, solar-thermal conversion, and passive reflectors to serve as orbital relays for ground-generated power. Arguments for and against the space-based powerplant concept are considered. A space-based powerplant can be used for base-load applications because insolation in geosynchronous orbit is available over 99% of the time. A description of innovative transportation concepts is also provided. An important problem concerning the utilization of space-based powerplants is related to the cost of establishing whether or not they are truly practical. G.R.

A77-23927 * # **Photovoltaic, gravitationally-stabilized solid-state, satellite solar power station /GSS4PS/.** L. J. Cantafio, V. A. Chobotov, and M. G. Wolfe (Aerospace Corp., El Segundo, Calif.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-511.* 16 p. 32 refs. Contract No. NAS8-31842.

The salient feature of a gravitationally-stabilized satellite solar power system (SSPS) for a photovoltaic system is that the large solar array is separated into smaller segments or subunits, joined together in a linear array oriented along the local vertical. Applicability of gravitational stabilization to the design of photovoltaic SSPS is demonstrated. Both actively controlled systems using multiple solar panels oriented to the sun and passively controlled systems requiring no sun orientation are considered and determined to be feasible. Expressions for gravity-gradient induced tension and restoring torques about the local vertical are assessed. Particular attention is directed to the applicability of solid-state approaches to the design of SSPS. It is shown that an all solid-state SSPS utilizing the LITOMIC (light-to-microwave conversion) concept is feasible but that a hybrid system employing a combination of both solid-state and cryogenic

cooled low-voltage techniques to the design of the power management and distribution subsystem may also provide a solution. S.D.

A77-23931 # **An engine designer's view for advanced secondary power systems.** L. D. Emerson (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-517.* 7 p.

The problems faced by a designer in configuring an engine with accommodation for power extraction are illustrated by reviewing studies of modern aerodynamic control concepts intended to enhance maneuverability, particularly of military aircraft. These concepts include jet flaps, vectored thrust, blown flaps, pivoted wings, and aircraft configured for maneuver load control, direct lift control, and side force control. The constraints placed by engine design on secondary power systems that rely on the engine as the primary power source are examined. The need for a team approach to obtain more accurate definitions of new system configurations is indicated. V.P.

A77-23932 # **A solar power system with gallium arsenide solar cells.** J. F. Madewell and A. A. Nussberger (Rockwell International Corp., Space Div., Seal Beach, Calif.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-519.* 9 p. 9 refs.

It is pointed out that GaAs has the potential for higher efficiencies, higher concentration ratios, and superior radiation resistance compared to silicon. Radiation-resistant solar cells may be required to obtain cost-effective solar photovoltaic conversion. If suitable manufacturing techniques are developed, GaAs cells can be made extremely thin before any of the active cell thickness is removed, and efficiency is affected. GaAs solar cells offer the potential for significant weight reduction but raise the serious question of technology and material availability, risk and cost. G.R.

A77-23934 * # **Advanced high efficiency wraparound contact solar cell.** J. A. Scott-Monck, F. M. Uno, and J. W. Thornhill (Spectrolab, Inc., Sylmar, Calif.). *American Institute of Aeronautics and Astronautics, Conference on the Future of Aerospace Power Systems, St. Louis, Mo., Mar. 1-3, 1977, Paper 77-521.* 5 p. 13 refs. NASA-supported research.

A significant advancement in the development of thin high efficiency wraparound contact silicon solar cells has been made by coupling space and terrestrial processing procedures. Although this new method for fabricating cells has not been completely reduced to practice, some of the initial cells have delivered over 20 mW/sq cm when tested at 25 C under AMO intensity. This approach not only yields high efficiency devices, but shows promise of allowing complete freedom of choice in both the location and size of the wraparound contact pad area. (Author)

A77-24201 **Future energy production systems: Heat and mass transfer processes. Volume 2.** Edited by J. C. Denton (American Technological University, Killeen, Tex.) and N. H. Afgan (International Centre for Heat and Mass Transfer, Belgrade, Yugoslavia). New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976. 494 p. S38.

Developments related to geothermal energy production are considered, taking into account heat and mass transfer in the earth, problems of heat and mass transfer in geothermal energetics, the heat transport in geothermal systems, physical understanding and mathematical modeling in the case of free thermal convection in geothermal fields, numerical solutions for steady free convection in island geothermal reservoirs, and the utilization of heat of geothermal springs and waste hot waters in Freon-operated power plants. Attention is also given to aspects of coal energy production, alternative energy production, and the impacts of energy production on the environment. G.R.

A77-24202 **Problems of heat and mass transfer in geothermal energetics.** S. S. Kutateladze (Akademiia Nauk SSSR, Institut Teplofiziki, Novosibirsk, USSR). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 399-403.

The exhaustion of natural resources located at the surface of the earth or in layers close to the surface will make it necessary to exploit mineral deposits available at a greater depth. Problems concerning an exploitation of such resources are partly related to the elevated temperatures encountered. The temperature in the depth range from 7 to 10 km lies between 200 and 300 C. It is pointed out that such temperatures provide the energy basis for a thermodynamic cycle with a rather high efficiency factor. Approaches for utilizing the geothermal heat are discussed, taking into account the possibilities to employ nuclear explosions for the creation of 'dry underground boilers'. G.R.

A77-24203 **Heat transport in geothermal systems.** G. V. Keller (Colorado School of Mines, Golden, Colo.). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 405-416. 8 refs.

In areas of normal heat flow, layers in the depth range from 6 to 12 km must be reached to find temperatures which are sufficiently high for economical energy-providing thermodynamic processes. However, projects involving a utilization of heat at such depths are currently not economical in connection with the great drilling expenses. An investigation is, therefore, conducted concerning the possibility to find the required heat source for geothermal energy utilization in connection with the existence of a magma chamber. It is found that a magma chamber is not an adequate source of heat for geothermal utilization. G.R.

A77-24204 **Free thermal convection in geothermal fields - Physical understanding and mathematical modeling.** S. A. Bories (Toulouse III, Université, Toulouse, France) and M. A. Combarnous (Bordeaux I, Université, Tolence, Gironde, France). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 417-427. 12 refs.

Questions regarding the mathematical modeling of heat transfer in dispersed media are investigated and the significance of experimental data on thermal convection is considered. A description of convective flows is provided, giving attention to the motionless state, the single-cell flow, the stable polyhedral cells, the stable helical coils, the fluctuating convective state, and the wavy helical coils regime. A theoretical interpretation of experimental results on heat transfer is given, taking into account the influence of the parameters on heat transfer, preferential zones for heat transfer between solid and fluid phases, and the influence of the texture of the porous or cracked medium. G.R.

A77-24205 **Numerical solutions for steady free convection in island geothermal reservoirs.** P. Cheng, K. C. Yeung (Hawaii, University, Honolulu, Hawaii), and K. H. Lau (Hawaii, University, Hilo, Hawaii). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 429-448. 12 refs. NSF Grant No. GI-38319.

The problem of steady free convection in an island aquifer, confined by caprock at the top and heated by an impermeable surface from below is considered. The governing nonlinear partial differential equations are approximated by a set of finite difference equations, which are solved numerically by the iteration method. To guarantee convergence of the iteration process, the nonlinear convective terms in the energy equation are approximated by the upwind difference scheme. The effects of thermal conditions at the caprock, the geometry of the reservoir, the variation of Rayleigh number, the length of the heating surface, and the magmatic

intrusion, on fluid flow and heat transfer characteristics in island geothermal reservoirs are discussed. (Author)

A77-24206 Recovery of heat energy from deep or shallow aquifers. A. C. Gringarten and J.-P. Sauty (Bureau de Recherches Géologiques et Minières, Orléans, France). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 449-455. 7 refs.

A mathematical model is developed for investigating the unsteady-state temperatures of production wells during the process of water injection into aquifers with uniform regional flow. It is assumed that the aquifer is horizontal, of uniform thickness, and of infinite extent in the horizontal directions. A description is given of numerical results which were obtained in computer calculations conducted with the aid of a program based on the mathematical model. G.R.

A77-24207 Utilization of heat of geothermal springs and waste hot waters in freon-operated power plants. V. N. Moskvicheva (Akademiia Nauk SSSR, Institut Teplofiziki, Novosibirsk, USSR). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 457-464. 10 refs.

An exploitation of the geothermal heat available in the depth range from 3 to 6 km, at temperatures from 100 to 200 C, for the generation of electrical energy requires the development of special processes which can use the low-temperature energy involved. The current state of development of drilling techniques appears to be also economically adequate for the construction of underground heat boilers in the considered depth range. The state of development of Freon turbines which can utilize such low-temperature heat is discussed. Such turbines could also be employed for the utilization of waste heat. G.R.

A77-24208 Possible applications of geothermal energy in France. R. Aureille and D. Lamethe-Parneix (Electricité de France, Direction des Etudes et Recherches, Chatou, Yvelines, France). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 465-475.

An investigation is conducted regarding the economic feasibility of a utilization of a temperature of 160 C in a geothermal water field for the production of electric power in France, taking into account the employment of a thermodynamic cycle involving the vaporization of isobutane. It is found that the cost of the obtained power would be five times greater than the cost of power provided by a nuclear power plant. Attention is also given to the possibility to utilize the water of the geothermal fields for residential heating and hot-water supply applications. A description is presented of the main characteristics of heat pumps which can be used in connection with geothermal wells. G.R.

A77-24209 Some aspects of heat and mass transfer in geothermal wells. N. Djajic, L. J. Paradjanin, and D. Malic (Beograd, Universitet, Belgrade, Yugoslavia). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 477-485. 19 refs.

It is pointed out that geothermal wells can be divided into two main groups, including wells producing monophase fluid, consisting of either water or steam, and wells which provide a two-phase mixture. The mathematical expressions which describe the characteristics of the flow of the fluid through the porous rocks to the bottom hole are examined. It is found that the temperature change is directly proportional to the flow rate and the viscosity. An investigation is also conducted regarding the vertical fluid flow from the bottom hole to the well head. The obtained information provides a basis for the design of facilities which will make an optimum utilization of the geothermal resources possible. G.R.

A77-24210 Gasification of coal and its future aspects regarding the use of heat from high-temperature nuclear reactors. H. Teggers (Rheinische Braunkohlenwerke AG, Cologne, West Germany). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 489-507. 10 refs.

The gasification of coal for the production of synthetic natural gas, pure hydrogen, or gaseous mixtures of hydrogen and carbon monoxide is considered. The processes of conventional gasification are examined, taking into account processes involving a partial combustion of coal in connection with the addition of oxygen. Procedures which make use of the direct contact with solid, liquid, or gaseous heat-supplying substances are also described along with methods in which heat transferring walls are employed. A description is presented of coal gasification based on the employment of nuclear heat. Attention is given to the further development of the nuclear reactor, the steam gasification process, and the conversion of carbon by means of hydrogen. G.R.

A77-24211 Gasification of coal in high-velocity fluidized beds. A. M. Squires (City College, New York, N.Y.). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 509-522. 19 refs. NSF Grant No. GI-34286.

The Winkler gasification systems are examined, taking into account the original lignite-using system operated in 1929 in Germany, improvements of the original design, and a related process which could make use of bituminous coal. Attention is also given to the Ignifluid gasification system, a gasifier for the total gasification of coal by air, the advantages of processes concerned with the partial gasification of coal, methods for the partial gasification by steam, and a procedure involving partial gasification by flash hydrogenation. G.R.

A77-24212 Analysis of coal particles undergoing rapid pyrolysis. A. F. Mills, D. Antoniuk (California, University, Los Angeles, Calif.), and R. K. James (Science Applications, Inc., El Segundo, Calif.). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 537-547. 11 refs.

Rapid pyrolysis is achieved through the use of pulverized coal in entrained bed gasifiers. An analysis is presented of the thermal response of coal particles undergoing rapid pyrolysis. A reaction scheme is derived from work reported by Chermin and van Krevelen (1956) and the corresponding equations are obtained. The porosity of a particle is governed by a foaming law and the particle can swell or shrink accordingly. The numerical solution procedure for the equation systems is briefly described. Attention is given to the effects of particle size and the heats of reaction. G.R.

A77-24213 Gasification of Rhenish brown coal as mined. F. H. Franke (Rheinische Braunkohlenwerke AG, Cologne, West Germany). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 549-559. *Research sponsored by the Bundesministerium für* Forschung und Technologie.

'Rhenish brown coal' in West Germany is a highly reactive and high-volatile lignite which is available in deposits of about 55 billion tons. A description is presented of the gasification of raw lignite, taking into account a procedure which makes use of an indirectly heated tube. A process description for a commercial plant is provided and questions regarding pilot plant status are discussed. Attention is given to temperature characteristics and coal composition as a function of the tube length, the gas composition as a function of tube length, aspects of tube design, and heating methods. G.R.

A77-24214 Design studies of the hydrogasification of coal. L. Schrader (Rheinische Braunkohlenwerke AG, Cologne, West Germany). In: Future energy production systems: Heat and mass

transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 561-569. 6 refs.

In the gasification process considered, lignite or bituminous coal are made to react with hydrogen to obtain methane, which is to replace natural gas. The heat required in the process is to be supplied by high-temperature nuclear reactors. Tests showed that predried Rhenish lignite could be fluidized under certain conditions. Attention is given to the fluidizing characteristics of coal, basic considerations about hydrogasification, mass transfer coefficients, and questions of heat transfer between coal, gas, and reactor walls. G.R.

A77-24216 Heat and mass transfer problems associated with alternative energy production. A. Ramachandran (Department of Science and Technology, New Delhi, India). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 639-651. 18 refs.

Questions related to the utilization of solar energy are considered, taking into account direct solar radiation, ocean thermal gradients, and aspects of photosynthesis. A description of the characteristics of the geothermal energy source is also presented and techniques for obtaining energy from organic wastes are discussed. Attention is given to hydrogenation, hydrogasification, pyrolysis, bio-conversion, and a number of common heat and mass transfer problems. G.R.

A77-24218 Electricity from the thermal power of the sea. S. D. Winter (Centre National pour l'Exploitation des Oceans, Paris, France). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 687-699. 14 refs.

Some major problems associated with solar energy conversion, using the thermal gradient of tropical seas are discussed, along with technological aspects of selecting the plant site and the working medium. The principles of operation and possible layouts of solar sea power plants are examined, and overall efficiency and other major data are presented. The discussion shows that no long-range developments are needed to construct and operate a solar sea power plant. The economic competitiveness of such plants can be greatly improved by simultaneous production of fresh water for agricultural and industrial needs. The main drawback is seen in geographical limitations which preclude the use of solar sea power plants in practically all of the industrialized countries. (Author)

A77-24219 Heat exchangers for the Ocean Thermal Energy Power Plant. K. J. Bell (Oklahoma State University, Stillwater, Okla.). In: Future energy production systems: Heat and mass transfer processes. Volume 2. New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 701-712. 7 refs. ERDA-supported research.

The Ocean Thermal Energy Plant (OTEP) is to utilize the difference in the temperature of water at the ocean surface (about 25 C) and at depths of 300 m (about 5 C). An efficiency of 6.7% for a Carnot process operating at these temperatures is reduced to a net cycle efficiency in the range from 2 to 3% for the Rankine cycle envisaged for the OTEP. Typical operation conditions for an ammonia OTEP cycle are considered. Attention is given to basic heat exchanger problems, the working fluids, the materials of construction, the multiple flooded bundle evaporator concept, the horizontal tube thin film evaporator concept, the vertical tube falling film evaporator concept, the plate exchanger evaporator concept, the plastic plate evaporator, questions of condenser design, and aspects of cycle optimization. G.R.

A77-24457 # Theoretical and experimental validation of new sources of electrical energy (Contributii la fundamentarea experimentala si teoretica a unei noi surse de energie electrica). M. Marinescu (Institutul de Cercetari si Proiectari pentru Industria Electrotehnica, Bucharest, Rumania). *Studii si Cercetari de Fizica*, vol. 29, no. 2, 1977, p. 125-132. 8 refs. In Rumanian.

New cells designed for generation of electrical energy utilize Ge and CdSb in place of Se in a manner analogous to Se semiconductor thermoelectric cells, with advantages in stability and power output. A thin layer of Se type semiconductor sandwiched between two thin layers of Al or In oxide at uniform or constant temperature yields a permanent current and concomitant electrical energy. Direct conversion of heat to electrical energy in such systems is examined from the vantage point of thermodynamic laws. Doping, load curves, and effects of temperature variations are studied. R.D.V.

A77-24500 Solar retrofit in a large institutional building - An economic analysis. A. M. Khan and H. A. Simon (Illinois, University, Chicago, Ill.). *ASHRAE Journal*, vol. 19, Feb. 1977, p. 32-37. 6 refs.

A life-cycle economic feasibility study is conducted of a retrofit solar energy installation for heating purposes, for the Education and Communication Building on the campus of the University of Illinois at Chicago Circle. The building has 131,864 sq ft of space mostly in the form of offices and study rooms. Heating and cooling is obtained by the circulation of high temperature or chilled water from a central plant. The reported study shows that the investment required for a solar retrofit makes such a proposition at present economically unfeasible when compared with the alternative of using fossil fuels. However, an increase in oil prices to current European levels would make the proposition viable. In addition, advances in solar equipment technology and the application of mass production techniques would reduce the costs for such a retrofit system to make its installation economical. G.R.

A77-24520 Powersat - An astronautical energy solution. *Spaceflight*, vol. 19, Mar. 1977, p. 82-89.

In view of the gradual consumption of the fossil fuel reserves, there is an obvious need for a nondepletable nonpolluting energy source. Such an energy source could be provided by a solar power plant in a geosynchronous orbit which could collect solar energy at maximum efficiency. Applicable ground-based solar power technology is considered along with the power satellite development concepts, space transportation problems in connection with the satellite assembly, the solar Powersat efficiency chain, and aspects of satellite mass distribution and sensitivity. Attention is also given to a microwave power transmission demonstration, the Powersat configuration, the photovoltaic option, and questions concerning the implementation of the project. G.R.

A77-24568 Oxidation of methanol on agitated bed electrodes using non-metallic electrocatalysts. K. J. W. Kurkowski and C. R. Phillips (Toronto, University, Toronto, Canada). *Energy Conversion*, vol. 16, no. 3, 1977, p. 91-94. 9 refs. Research supported by the National Research Council of Canada.

Agitated beds of various finely divided electrocatalysis were evaluated for the electrooxidation of methanol. This electrode configuration offers an extended surface area for applications such as fuel cells. On the basis of current increase per unit cost of catalyst, the catalysts could be ranked in decreasing order of effectiveness as Mo-O-S, W-O-S, Cu2S, and activated carbon. The effective surface area of the finely divided catalyst was much less than the apparent surface area, most likely due to particle agglomeration. (Author)

A77-24569 Fuels via bioconversion. J. D. Keenan (Pennsylvania, University, Philadelphia, Pa.). *Energy Conversion*, vol. 16, no. 3, 1977, p. 95-103. 39 refs.

The potential mechanisms for fuels production by biochemical means are reviewed within the context of the principal metabolic pathways. Engineering options for bioconversion of fuels include the direct use of photosynthetic materials, the photosynthetic production of hydrogen and the fermentation of organic matter. It is concluded that, although biological processing is a feasible renewable energy source, process economics prevent the present-day use of such systems. This problem will be overcome by improving conversion efficiencies and by reducing the cost of harvesting. The application of biochemical engineering techniques to these problems is discussed. (Author)

A77-24570 **Performance analysis of a solar-electrical system with a load and storage batteries.** J. Appelbaum, A. Braunstein, and J. Bani (Tel Aviv University, Tel Aviv, Israel). *Energy Conversion*, vol. 16, no. 3, 1977, p. 105-110.

The operation of a solar power system consisting of a solar cell array, a storage battery, and a load is analyzed over a wide range of battery voltages. The study includes system operation analysis of solar radiation for a battery voltage range corresponding to discharged and fully-charged battery states. Analysis findings for optimal design in terms of desired size of the array and the battery capacity for a given load are discussed. S.D.

A77-24571 **Solar energy and the steam Rankine cycle for driving and assisting heat pumps in heating and cooling modes.** N. Lior (Pennsylvania, University, Philadelphia, Pa.). *Energy Conversion*, vol. 16, no. 3, 1977, p. 111-123. 38 refs. NSF-supported research.

Various methods for reducing the purchased resource energy consumption of vapor-compression heat pumps in both heating and cooling modes are analyzed and compared to conventional systems. The results are presented in detailed system analysis curves for the relevant range of major design parameters. One of the methods studied is the application of a solar-powered fuel-superheated Rankine cycle incorporating a steam turbine. This cycle would drive the heat pump in the cooling mode. Fuel-fired, it would drive the heat pump in the heating mode, with system performance augmented by utilizing the waste heat from the cycle, as well as by solar energy. In the cooling mode, resource energy savings of 50-60% are obtained. In the heating mode, resource energy use is reduced 3 to 4 fold. (Author)

A77-24572 **Generalized analysis of thermoelectric device configurations.** A. Brandstetter (Weizmann Institute of Science, Rehovot, Israel) and E. P. Chock (California, University, Los Angeles, Calif.). *Energy Conversion*, vol. 16, no. 3, 1977, p. 125-131. 9 refs. Research supported by the National Council for Research and Development of Israel.

Performance characteristics of a particular nonstandard configuration thermoelectric generator concept, involving triangular prismatic shaped electrodes, are predicted following a detailed analytical determination of its two-dimensional temperature field. A peculiar result emerging from this analysis, namely the performance characteristics depending on only one configuration parameter lumping together all relevant configurational details, is tentatively generalized on the basis of Osterle's 'unified theory of energy converters'. (Author)

A77-24573 **The long term stability of magnetic liquids for energy conversion devices.** J. Popplewell, S. W. Charles, and R. Chantrell (North Wales, University College, Bangor, Caern, Wales). *Energy Conversion*, vol. 16, no. 3, 1977, p. 133-138. 6 refs. Research supported by the U.K. Atomic Energy Authority; Grant No. DA-ERO-75-G025.

The paper shows how ferromagnetic liquids consisting of small ferromagnetic particles dispersed in a metallic carrier fluid can be used for energy conversion. The energy conversion system is as reliable as the ferromagnetic fluid itself under operating conditions of high temperatures and magnetic fields in the region of 10,000 G. Emphasis is placed on factors affecting the stability of ferromagnetic liquids. Preparation of ferromagnetic liquids by electrodeposition, evaporation, thermal decomposition, and chloride decomposition is outlined. Magnetization measurements of a number of Fe, Ni/Fe, and Co ferromagnetic particles in mercury are discussed. Results suggest that the production of a stable ferromagnetic liquid requires a distribution of particles of diameter less than 30 A in the case of Fe, the particles to be coated to prevent diffusional growth, and preferably some additional repulsion between the particles to prevent aggregation. S.D.

A77-24592 **A methodological survey of energy modeling.** G. De Bartolo (Charles River Associates, Inc., Cambridge, Mass.). In: Summer Computer Simulation Conference, Washington, D.C., July 12-14, 1976, Proceedings. Montvale, N.J., AFIPS Press, 1976, p. 743-746. 8 refs.

A survey of energy modeling is presented which focuses on the special characteristics of the energy sector and discusses the ways in which some of the characteristics are incorporated in four major energy models. These models comprise the MacAvoy-Pindyck model of the natural gas industry, the Brookhaven energy system optimization model and the related dynamic energy system optimization model, the Hudson-Jorgenson model of energy and economic growth, the project independence evaluation system developed by the Federal Energy Administration. Ways in which dynamic adjustment, price elasticity in demand and supply, regulations in energy industry, and depletable resources are modeled are examined. That the 'reasonable' structure of a model is no guaranty of its ability to track the course of economy constitutes a major shortcoming of energy modeling. S.D.

A77-24603 **The ERDA geothermal program.** R. S. H. Toms (ERDA, Div. of Geothermal Energy, Washington, D.C.). *(IEEE, ERDA, NASA, and NBS, Nuclear Science Symposium, 23rd, Scintillation and Semiconductor Counter Symposium, 15th, and Nuclear Power Systems Symposium, 8th, New Orleans, La., Oct. 20-22, 1976.) IEEE Transactions on Nuclear Science*, vol. NS-24, Feb. 1977, p. 29-32.

Problems, guideline criteria, and strategies for development of geothermal resources are outlined, with attention given to funding, resource exploration and assessment, and research and development tasks. Major problems confronted are: the uncertainty of the resource per se, new and untested (or barely developed) technology, and 'institutional impediments.' Importance is assigned to: defining the resources and evaluating their economic growth potential, development of identified geothermal resources for feasibility demonstration, and development and implementation of technologies for exploiting geopressured and hot dry rock resources. Major programs underway encompass: a loan guaranty program, construction of test and demonstration pilot plants, advanced technology, and environmental and institutional studies. R.D.V.

A77-24659 **National Solar Energy Convention, Jadavpur University, Calcutta, India, November 29-December 1, 1976, Proceedings.** Convention sponsored by the Solar Energy Society of India. Edited by A. R. Saha (Jadavpur University, Calcutta, India). Calcutta, Jadavpur University, 1976. 58 p.

This volume contains extended abstracts of papers devoted to various aspects of solar energy research, applications, and technology, covering such areas as national solar energy programs, solar collectors and storage systems, solar energy conversion techniques, and solar power plant systems. Specific topics include prospects for harnessing solar energy as a power source, measurements of global and diffuse solar radiation, a research and development program for the utilization of solar thermal energy, a solar energy reflector consisting of metallized polystyrene, nontracking concentrators for solar cells, the performance of a self-tracking parabolic cylindrical collector and a Winston collector, a double convex spherical liquid lens for concentrating solar energy, the design and performance of a paraboloidal concentrator with a two-axis tracking heliostat, semiconductor materials for solar energy conversion, the energy budget of single-crystal silicon solar cells, and the production of polycrystalline silicon sheets by high-temperature rolling. Other papers discuss evaporated CdS films for heterojunction solar cells, a failure analysis of CdS solar cells, the state of the art of Cu2S-CdS solar-cell technology, factors affecting the efficiency of Schottky-barrier solar cells, and photochemical conversion of solar energy. F.G.M.

A77-24852 **Upgrading coal liquids to gas turbine fuels. II - Compatibility of coal liquids with petroleum fuels.** A. V. Cabal, S. E. Voltz, and T. R. Stein (Mobil Research and Development Corp., Paulsboro, N.J.). *I & EC - Industrial and Engineering Chemistry, Product Research and Development*, vol. 16, Mar. 1977, p. 58-61. 22 refs. Research supported by the Electric Power Research Institute and Mobil Research and Development Corp.

The compatibility of three coal liquids with some petroleum fuels has been determined. Synthoil and H-Coal were incompatible with No. 2 distillate fuel, No. 6 fuel oil, and heavy coker gas oil. Synthoil was compatible with clarified slurry oil (heavy product from catalytic cracking unit); H-Coal was incompatible. The 950-F fractions of Synthoil and H-Coal were completely compatible with the petroleum fuels. Solvent-refined coal was incompatible with all the petrolum fuels. The compatibility results are consistent with the molecular compositions of the coal liquids and petroleum products. (Author)

A77-24853 Upgrading coal liquids to gas turbine fuels. III - Exploratory process studies. T. R. Stein, S. E. Voltz, and R. B. Callen (Mobil Research and Development Corp., Paulsboro, N.J.). *I & EC - Industrial and Engineering Chemistry, Product Research and Development,* vol. 16, Mar. 1977, p. 61-68. 16 refs. Research supported by the Electric Power Research Institute and Mobil Research and Development Corp.

Exploratory process studies were conducted with samples of three coal liquids in a shaker bomb reactor. Blends of solvent-refined coal (SRC) with recycle solvent (from SRC process) or clarified slurry oil (from catalytic cracking process) are desulfurized and deoxygenated under hydroprocessing conditions. Removal of nitrogen is more difficult. Heteroatom removal is greater from H-Coal and Synthoil than SRC blends under similar conditions. Some effects of hydroprocessing on the chemical compositions of the coal liquids were determined. (Author)

A77-24854 Reactions in the ZnSe thermochemical cycle for hydrogen production. R. K. Pearson, O. H. Krikorian, R. E. Elson, R. H. Condit (California, University, Livermore, Calif.), and R. M. Dreyfuss (Hostos Community College, Bronx, N.Y.). *I & EC - Industrial and Engineering Chemistry, Product Research and Development,* vol. 16, Mar. 1977, p. 70-78. 13 refs. Contract No. W-7405-eng-48.

The two key steps in the ZnSe thermochemical cycle for hydrogen production from water have been experimentally studied in some detail. In the more critical step of the two, ZnO is reacted with Se and SO2 to form a mixture of ZnSe and ZnSO4. This reaction has been found to proceed quantitatively at 770 K and to reach approximate equilibrium in 30 min. For the second key step, which requires hydrolysis of ZnSe to give H2Se, both aqueous H2SO4 and HCl were investigated as hydrolysis agents. It was found that HCl is much more effective than H2SO4 for this purpose. Other reactions that were given preliminary consideration were: (1) the thermal decomposition of ZnSO4, (2) the thermal decomposition of H2Se, and (3) the formation of sulfuric acid from SO3. On the basis of these studies, it is concluded that the ZnSe cycle is a scientifically feasible method for production of hydrogen from water. (Author)

A77-24928 Prospects for fusion energy. G. Sinclair (Laser Fusion Investments, Inc., Concord, Ontario, Canada). *Canadian Electrical Engineering Journal,* vol. 2, Jan. 1977, p. 4-8. 12 refs.

A comparison of energy sources is conducted and attention is given to the conditions which according to the Lawson criterion will have to be satisfied to achieve fusion. A description is presented of magnetic confinement and inertial confinement schemes. The conversion of fusion energy to useful form is discussed, taking into account plans to convert the fusion energy to chemical energy. The considered process promises to produce hydrogen at competitive cost. G.R.

A77-24960 The potential for fuel conservation. M. H. Ross (Michigan, University, Ann Arbor, Mich.) and R. H. Williams (Princeton University, Princeton, N.J.). *Technology Review,* vol. 79, Feb. 1977, p. 49-57. 12 refs. Research supported by the Max and Anna Levinson Foundation.

A theoretical framework for estimating the technical potential for large-scale fuel conservation, using the second law of thermodynamics in defining efficiency and emphasizing work available rather than energy per se, is established. Maximizing second-law efficiency and minimizing the absolute minimum expenditure of fuel for a specified task are accepted as goals. Electric power generation is viewed as intrinsically highly efficient (provided the electric power is not misused in inefficient ways); investments in fuel-saving technology may in the future cost less than efforts to increase fuel supplies. The approach is applied to: getting higher mileage from medium-size automobiles; air conditions of high-rise office buildings; fuel conservation in low-quality low-temperature heating; steam generation for industry, with cogeneration of electricity and process steam by the same power plant. R.D.V.

A77-25001 'Low-energy' geothermal heat (La géothermie 'basse énergie'). A. Clot (Bureau de Recherches Géologiques et Minières, Département Géothermie, Paris, France). *La Recherche,* vol. 8, Mar. 1977, p. 213-223. 9 refs. In French.

The history of exploitation of geo-heat in France, the extent of occurrences of geological strata indicative of aquifers with geothermal brines in France (70 per cent of the area; map of proved and probable reserves provided), and suitable applications of 'high-energy' geo-heat (above 120-180 C; electric power) and 'low-energy' geo-heat (utility heat, industrial process heating) are discussed. Spinoff of data and techniques from petroleum reservoir engineering, handling of drilling mud, wellhead and down-hole pumping, gamma-logging/neutron logging/resistivity logging of boreholes, and tests of reservoir exploitability are discussed along with reservoir injection drive with brines from production wells re-injected into the aquifer via injection wells. The need for titanium plate heat exchangers on geothermal brine streams is indicated. R.D.V.

A77-25085 Review - Silicon solar cells for terrestrial applications. L. M. Rouse (Materials and Energy Research Centre, Teheran, Iran). *Journal of Materials Science,* vol. 12, Mar. 1977, p. 602-615. 83 refs.

Advances made in the design and fabrication of high-efficiency solar cells, particularly silicon diffused junctions, are reviewed along with the economics of their application outside the U.S.A. The discussion covers the efficiency of a homojunction device, physical factors which determine the efficiencies of homojunction solar cell, substrate fabrication, junction fabrication techniques, and silicon Schottky barriers. Ways in which solar cell utilization can be made more economical are identified. S.D.

A77-25136 East Mesa Geothermal Component Test Facility. C. R. Cummings (ERDA, San Francisco, Calif.). *Geothermal Energy,* vol. 5, Feb. 1977, p. 8, 9, 11-13.

A description is given of the geothermal component test facility (GTCTF) being built in southern California (USA) to test geothermal components and subsystems and to establish a prototype geothermal power station (to go on line in 1985, delivering 7500 MW). Geothermal brine heat exchangers, power cycles, and geothermal reservoir engineering will be investigated at the GTCTF. Geothermal wells, piping for supply and return of brine streams and cooling water, a holding pond and a cooling tower, electrical power equipment, and a laboratory for chemical analysis are described briefly. Approximate minimum temperatures required of geothermal fluids for specific processes are tabulated. R.D.V.

A77-25137 Net energy delivery from geothermal resources. R. G. Bowen. *(Arizona Geothermal Energy Conference, Phoenix, Ariz., Nov. 21-23, 1976.) Geothermal Energy,* vol. 5, Feb. 1977, p. 15-19.

The efficiency of geothermal power systems is compared to that of other systems with emphasis on concepts of 'net energy' (useful energy output from system less useful energy input - 'useful' referring to ready marketability of the energy form) and overall system efficiency (as contrasted to power plant efficiency in isolation). External energy inputs required to convert energy to the desired form in the system are figured into the efficiency calculations, and input needed for prospecting/exploration/extraction (well drilling, well completions, replacement of wells) is taken into account, as well as energy input to reservoir development and maintenance. In this context, the low geothermal plant energy

conversion efficiency is offset by high system efficiency; chart comparisons are presented with nuclear fission (LWR) plants, coal-fired power plants (at mine mouth), and solar home heating units. R.D.V.

A77-25196 # **Fiat petrol engine performance with a mixture of basil extract with petrol.** D. K. Mishra and R. C. Agrawal (Government College of Engineering and Technology, Raipur, India). *(Institution of Engineers (India), Annual Meeting, Madras, India, Mar. 27, 28, 1976.) Institution of Engineers (India), Journal, Mechanical Engineering Division,* vol. 57, Nov. 1976, p. 160-162.

Basil extract contains mainly hydrocarbons of the paraffin family ranging from CH4 to C10H22, the percentage of octane being larger compared to the other compounds. Results are presented for an experimental study on the use of a mixture of basil extract and gasoline to reduce fuel consumption in a four-cylinder four-stroke water-cooled Fiat gasoline engine. Particular attention is given to determining the optimum ratio of basil extract to gasoline for minimum fuel consumption, the effect of speed on BHP and air consumption, the fuel consumption at varying loads, and the effect of speed and throttle opening on BSFC. Major conclusions are that a minimum fuel consumption of 56.22 cu cm per min is attained when 3 cu cm basil extract is added to 1 liter gasoline, that increase of BHP at varying speeds indicates enhancement in the availability of power, and that substantial reduction in BSFC is possible. S.D.

A77-25224 **Our energy future: The role of research, development, and demonstration in reaching a national consensus on energy supply.** D. E. Kash, M. D. Devine, J. B. Freim, M. W. Gilliland, R. W. Rycroft, and T. J. Wilbanks (Oklahoma, University, Norman, Okla.). Research supported by the National Science Foundation; NSF Grant No. SIA-74-17866. Norman, Okla., University of Oklahoma Press, 1976. 511 p. 253 refs. $19.95.

The role of research, development, and demonstration (RD and D) in the energy supply system is examined and an investigation is conducted regarding the energy supply alternatives and RD and D needs. Solid fuels considered are related to coal, organic waste, and produce of energy farms. A description of gaseous and liquid fuels is presented, taking into account natural gas, gaseous fuel from oil, coal gasification, gaseous fuels from organic materials, domestic crude oil, coal liquefaction, oil shale, tar sands, and the liquefaction of organic materials. Approaches for obtaining energy in the form of electricity are discussed, giving attention to fossil fuels, organic materials, nuclear fission, nuclear fusion, geothermal power, hydroelectric power, solar electric power, and a comparison of electricity supply systems. Aspects of solar heating and cooling are discussed along with hydrogen energy systems. G.R.

A77-25355 # **Method of designing profiles of focusing concentrators and focusing wedges (Metody rascheta profilei fokonov i foklinov).** V. K. Baranov. *Geliotekhnika,* no. 6, 1976, p. 24-28. In Russian.

Techniques are described for rapid and practically exact construction of profiles of paraboloid-toroidal focusing concentrators and parabolo-cylindrical focusing wedges. Values of the radius vectors needed for constructing the profile of the parabola are tabulated. An example of the design of a profile of a focusing concentrator and a focusing wedge with parametric angle of 20 deg is given. P.T.H.

A77-25356 # **Experimental facility for measuring spatial and energy characteristics of solar concentrators (Eksperimental'naia ustanovka dlia izmereniia prostranstvennykh i energeticheskikh kharakteristik solnechnykh kontsentratorov).** B. A. Bazarov and V. M. Kapeliushnikov (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). *Geliotekhnika,* no. 6, 1976, p. 29-34. 5 refs. In Russian.

A77-25357 # **Concentrating power of spherical facets (Kontsentriruiushchaia sposobnost' sfericheskikh fatset).** R. A. Zakhidov (Akademiia Nauk Uzbekskoi SSR, Tsentral'noe Proektno-Konstruktorskoe i Tekhnologicheskoe Biuro Nauchnogo Priborostroeniia, Uzbek SSR) and A. Sh. Khodzhaev (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *Geliotekhnika,* no. 6, 1976, p. 35-37. In Russian.

Formulas are derived for calculating irradiance in the radiation field of a spherical facet. It is shown that the concentrating power of spherical and parabolic facets are identical. P.T.H.

A77-25359 # **Composite concentrators with spherical radiation sources (Sostavnye kontsentratory so sfericheskimi istochnikami izlucheniia).** L. Ia. Paderin (Tsentral'nyi Aerogidrodinamicheskii Institut, Moscow, USSR). *Geliotekhnika,* no. 6, 1976, p. 43-51. In Russian.

The paper describes a method for calculating the distribution of luminous fluxes from spherical sources of radiation on irradiated surfaces of composite concentrators. These concentrators consist of sets of conical or spherical rings of equal width which intersect at their initial and terminal sections ellipsoids of revolution. The distribution of luminous fluxes in the focal plane of the generator of the ellipsoidal surface is then calculated. The results enable making a choice of optimal parameters of composite concentrators. P.T.H.

A77-25360 # **Basis for developing a solar energy inventory (Osnovy razrabotki gelioenergeticheskogo kadastra).** R. B. Salieva (Tashkentskii Elektrotekhnicheskii Institut Sviazi, Tashkent, Uzbek SSR). *Geliotekhnika,* no. 6, 1976, p. 61-77. 12 refs. In Russian.

The paper examines some of the principles of developing a solar energy inventory on the basis of a mathematical model, by the parameters of which it would be possible to determine the productivity of a solar energy facility of any design and establish its effectiveness and suitability for various types of landscapes. The mathematical model is considered from unified viewpoints of stochastic process theory. Modeling algorithms are given and results of computer calculations are given in tables, from which one can deduce the productivity and utilization factor of the rated power of facilities of arbitrary design. P.T.H.

A77-25575 **Energy from the wind.** E. W. Hewson (Oregon State University, Corvallis, Ore.). *American Meteorological Society, Bulletin,* vol. 58, Jan. 1977, p. 33-38.

A survey of the feasibility of large-scale exploitation of wind power in local regions of the U.S. and on a national scale is reported. Wind power is seen as cost-competitive in the Pacific NW area (Oregon coast) as of the present, and possibly 3-12% national electric power needs might be met by wind power energy conversion (WPEC) by 1995. Promise is seen in WPEC adjuncted to conventional power stations, particularly hydroelectric power stations with facilities for power storage. A market is seen for small aerogenerators in small-scale applications (irrigation, water heating, battery recharges). Mapping of wind speed patterns and height profiles of wind speeds is seen as a major task. Minimal environmental impact of WPEC (minimal pollution in terms of noise, waste heat, air and water resources, land use, exhaustion of energy resources) is emphasized. R.D.V.

A77-25591 **Design considerations for high-intensity solar cells.** V. K. Dalal and A. R. Moore (RCA Laboratories, Princeton, N.J.). *Journal of Applied Physics,* vol. 48, Mar. 1977, p. 1244-1251. 29 refs.

Factors affecting the efficiency of Si and GaAs solar cells in the presence of high-intensity sunlight are examined. The theory of efficient solar-cell design is briefly reviewed, focusing on short-circuit current, open-circuit voltage, fill factor, and efficiency degradation. Effects of high intensity on collection efficiency and parasitic losses are investigated. It is shown that the current-collection efficiency of Si cells increases at intermediate levels but may be reduced at very high intensities due to plasma recombination, that open-circuit voltage and fill factor increase with intensity at a faster rate in Si than in GaAs, and that an increase in temperature degrades the efficiency of Si faster than that of GaAs. Appropriate heat-sink designs to minimize such thermal degradation are considered along

with the choice of materials and tracking systems for high-intensity solar cells. It is concluded that there is no significant advantage in choosing GaAs over Si and that temperature rises can be kept as low as 25 C by simple heat-sink designs. F.G.M.

A77-25721 # **Basic research problems in the generation of electrochemical energy for powering small private vehicles (Temeljne raziskave problematike uporabe elektrokemicne energije za pogon osebnih vozil).** P. Palma (Iskra-Industrija Avtoelektricnih Izdelkov, Nova Gorica, Yugoslavia). *Elektrotehniski Vestnik*, vol. 42, May-July 1975, p. 135-140. 7 refs. In Slovene. Research supported by the Iskra-Industrija Avtoelektricnih Izdelkov.

Battery power plants for lightweight two-wheel personal electric vehicles well suited to road and traffic conditions in central Europe are discussed. Advantages and disadvantages of some forms of electrochemical power (storage batteries with various electrolytes and electrodes, metal/air cells, fuel cells) are compared in this application. Ease of re-energizing the power source, optimum motor performance on batteries on the road, motor selection, motor output, and motor maintenance are discussed. R.D.V.

A77-25782 # **Rotor/generator isolation for wind turbines.** L. P. Mirandy (Boeing Vertol Co., Philadelphia, Pa.). In: Structures, Structural Dynamics and Materials Conference, 18th, March 21-23, 1977, and Dynamics Specialist Conference, San Diego, Calif., March 24, 25, 1977, Technical Papers. Volume B. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p. 25-37. Contract No. E(11-1)-2612. (AIAA 77-372)

This paper analyzes the interface dynamics between the rotor and electrical generator for horizontal-axis constant-RPM wind turbine systems. Coupled equations of motion for the rotor, drive shaft, and generator are developed and solved to obtain the system's natural frequency and forced-response characteristics. It is concluded that isolation via a soft drive shaft should be used to keep vibratory torque inputs to the generator within acceptable levels. It is also shown that this isolation can be accomplished with realistic designs. Sample calculations are carried through for a two-bladed 265-foot-diameter 1,000-KW system. (Author)

A77-25824 **Hydrogen technology for energy.** D. A. Mathis. Park Ridge, N.J., Noyes Data Corp. (Energy Technology Review, No. 9), 1976. 302 p. 315 refs. $32.

The production of hydrogen as an energy storage medium appears particularly attractive in connection with schemes for the utilization of primary energy sources for which a storage of the provided energy is vital because of the intermittent nature of operation or the remoteness of the power source location from the points at which the energy is to be used. Primary energy sources considered are related to solar energy, wind energy, fossil energy, and nuclear energy. The technical aspects of storage and transmission systems for a proposed 'hydrogen economy' are examined. Suggestions concerning the integration of the hydrogen economy into the energy system of the U.S. are presented. A description is provided of technological problems related to the handling of gaseous hydrogen, liquid hydrogen, and hydrogen in the form of metal hydrides. Attention is given to the usage of hydrogen for fuel and energy storage, nontechnical aspects of a hydrogen economy, and a listing of hydrogen technology experts. G.R.

A77-25875 **Fuel cells.** A. O. McDougall (University of Manchester Institute of Science and Technology, Manchester, England). New York, Halsted Press, 1976. 157 p. 14 refs. $11.95.

The thermodynamic efficiency of fuel cells is examined and relations concerning the electromotive force of fuel cells are considered. An investigation is conducted regarding the rates of electrode processes, taking into account the types of polarization, the role of electron transfer, surface chemistry reactions, concentration polarization, ohmic polarization, the hydrogen electrode, the oxygen electrode, and questions of overall performance. Attention is given to low temperature hydrogen-oxygen cells, low temperature cells of other types, medium temperature cells, high temperature cells, air depolarized cells, aspects of fuel cell operation, applications of fuel cell systems, fuel cell economics, and the future of fuel cells. G.R.

A77-25896 **Performance of low cost solar reflectors for transferring sunlight to a distant collector.** R. C. Zentner (Boeing Aerospace Co., Seattle, Wash.). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy*, vol. 19, no. 1, 1977, p. 15-21.

Steerable reflectors (heliostats) in a typical central collector solar-electric power plant are intended to transfer ambient sunlight to a central heat absorber. One property critically important in the assessment and selection of candidate plastic film reflectors is their specularity. The paper focuses on describing the instrument and test procedure used to measure the quasi-specularity of candidate reflector materials such as Kapton-H, Tedlar and standard Mylar. Specularity of the sample is determined by illuminating it with a sharply defined incident beam and measuring the reflected energy which is collected by a series of circular concentric openings of increasing size. These discrete points, generalized to a curve, describe the spatial distribution of energy in the reflected beam. Comparison of this distribution with the spatial distribution of incident flux characterizes the sample specularity. All sample data are measured using linear polarized output of a helium-neon gas laser. S.D.

A77-25897 **Simulation and cost optimization of solar heating of buildings in adverse solar regions.** B. D. Hunn, G. J. E. Willcutt, Jr., and T. B. McSweeney (Clarkson College of Technology, Potsdam, N.Y.). *Solar Energy*, vol. 19, no. 1, 1977, p. 33-44. 10 refs.

A model has been developed which simulates the effects of hourly weather conditions on the performance and cost of a combined solar/conventional heating system for buildings in cold, cloudy climates. The model exhibits the effects of several system and cost parameters on combined system cost so that optimal designs can be determined. Performance and cost results are presented for 1971 Ottawa, Ontario, weather data. The economic analysis, which treats both collector and conventional system fuel costs parametrically, shows that solar heating of a typical house in cold, cloudy climates is economically competitive with fuel oil heating only if the price of oil rises to approximately 80 cents per gallon. (Author)

A77-25898 **Storage tanks - A numerical experiment.** A. Cabelli (Commonwealth Scientific and Industrial Research Organization, Div. of Mechanical Engineering, Highett, Victoria, Australia). *Solar Energy*, vol. 19, no. 1, 1977, p. 45-54. 7 refs.

A numerical study has been made of a two-dimensional model of the motion which takes place in storage tanks used for solar water heating applications. Up to two flow circuits have been allowed in the model and the geometric configurations have included horizontal and vertical entry into the tank. The effect of the entrance Reynolds number and the contribution of buoyancy in promoting stratification have been examined. A comparison has also been made with a simple one-dimensional approximation. The discrepancy between the two models has been shown to be small. (Author)

A77-25899 **Operational modes of solar heating and cooling systems.** D. S. Ward, C. C. Smith, and J. C. Ward (Colorado State University, Fort Collins, Colo.). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy*, vol. 19, no. 1, 1977, p. 55-61. ERDA-NSF-supported research.

The paper outlines the design concept and capabilities of a solar energy system for the heating, cooling, and service hot water heating of a residential style building with automatic compensation for variations between solar input and load demand. A system is described which allows for comparative operation in several experimental modes. The piping within the subsystem permits easy switching between the modes. Four operational modes are considered: solar collection through heat exchanger, solar collection directly to storage tank, solar collection directly to cooling load, and an alternate mode involving solar heating with auxiliary boosting.

Suitability and cost effectiveness of each operational mode are highlighted. S.D.

A77-25900 Solar energy for the Australian food processing industry. D. Proctor and R. N. Morse (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 19, no. 1, 1977, p. 63-72. 5 refs.

A77-25901 Cost optimal deployment of mirrors associated with a high temperature solar energy system. J. D. Hankins (Sandia Laboratories, Livermore, Calif.). *Solar Energy,* vol. 19, no. 1, 1977, p. 73-78.

Mirror field optimization is discussed in terms of mirror arrays, optimization method, and effect of mirror reflectivity for an absorbing cavity or collector of solar energy mounted on a tower assumed to be erected over horizontal terrain. Many relatively small mirrors of a given size are located about the tower base, and the bases of the mirror mounts are rigidly attached to the ground. Each mirror during daylight hours is continuously positioned so that the specular component of incident sunlight is reflected into an aperture located in the cavity base. Results are combined with a simple cost model to obtain a lower bound on the minimum cost per unit of redirected energy as a function of the unit mirror cost. S.D.

A77-25902 Design of a solar heating and cooling system for CSU Solar House II. D. S. Ward, G. O. G. Lof, C. C. Smith (Colorado State University, Fort Collins, Colo.), and L. L. Shaw (Solaron Corp., Commerce City, Colo.). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 19, no. 1, 1977, p. 79-85.

This paper describes the design of a solar air heating and night/day exchange cooling system with emphasis on the operational modes. In this type of system the collector absorbs solar energy and converts it to heat for space heating and domestic water heating. Cooling is accomplished by using the cool night air available in dry climates to cool a pebble-bed storage unit and subsequently using the cool pebbles to lower the air temperature in the building during the day. Circulation is from the solar system to the building in the same manner as most modern heating and air conditioning units but uses air as the medium for heat transfer. The air system is particularly suited for climatic regions where heating loads are high and cooling requirements are moderate. The system utilized in Solar House II operates in either the heating or cooling mode as selected through a seasonable change-over switch. Solar preheated hot water is furnished for domestic use in either mode. (Author)

A77-25903 Determination of average ground reflectivity for solar collectors. B. D. Hunn and D. O. Calafell, II (Clarkson College of Technology, Potsdam, N.Y.). *Solar Energy,* vol. 19, no. 1, 1977, p. 87-89. 6 refs.

A systematic method is proposed for determining average ground reflectivities for solar collectors which view a wide variety of landscapes. The objective was to determine a range of representative ground reflectivities for comparison with that given by the simple Liu and Jordan (1963) model. Several photographs in each landspace category are analyzed by classifying all surfaces appearing in the photos into a set of 15 characteristics surfaces. Analysis of each photograph consists of overlaying the print with a circular grid divided into 40 zones below the horizon, representing equal solid angles projected to the plane of the collector. The portion of each zone identified as each of the characteristic surfaces is identified, which helps determine the integrated reflectivity of a landscape. Results are presented for the application of the proposed model to twelve representative winter landscapes, although the method applies equally well to other seasons. For all the landscapes considered, ground reflectivities are found to be quite sensitive to the fraction of field of view in snow cover. S.D.

A77-25904 The advantages of sun tracking for planar silicon solar cells. D. M. Mosher, R. E. Boese, and R. J. Soukup (Iowa, University, Iowa City, Iowa). *Solar Energy,* vol. 19, no. 1, 1977, p. 91-97. 14 refs.

The paper discusses four factors critically important in comparing the output of a tracking solar cell with that of a stationary cell. These factors are the variation of solar intensity on horizontal surfaces due to the spreading of light, the variation of light transmission through the air-solar cell interface at different incident angles, the variation in photon path length near the p-n junction with incident solar angle, and the variation in transmission of solar energy by the atmosphere as a function of time of day. When these factors are considered, a mathematical treatment of the problem agrees remarkably well with the experimental results, predicting only slightly greater gain for the tracking cell than found experimentally, the discrepancy being explained by the lack of perfectly clear days during experimental testing. It is shown that as long as the operation of the tracker can be devised to consume a minute fraction of the output gain realized, sun tracking using planar solar cells is preferable to stationary mounted solar cells. S.D.

A77-25906 Solar-optical analyses of a mass-produced plastic circular Fresnel lens. S. Harmon (Arizona State University, Tempe, Ariz.). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 19, no. 1, 1977, p. 105-108. 5 refs. Contract No. E(11-1)-2590.

Experimental and analytical methods are used to determine the efficiency and intensity variations of a highly inexpensive commercial plastic circular Fresnel lens as a solar concentrator. The experimental part is done using a photovoltaic scan technique and the random radiometer technique. A simulation is constructed to model the behavior of the lens. Results indicate that the lens is an inefficient concentrator with losses that begin at 20% and rise to about 80% as the focal distance decreases. However, the lens is adequate for low concentration purposes with photovoltaic systems. Availability and low cost are major factors deciding the use of this lens as a solar concentrator. S.D.

A77-25999 Reduction of grain boundary recombination in polycrystalline silicon solar cells. T. H. DiStefano and J. J. Cuomo (IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y.). *Applied Physics Letters,* vol. 30, Apr. 1, 1977, p. 351-353. 7 refs.

The possibility of increasing the carrier collection efficiency in polycrystalline silicon by means of a heavily doped region near the grain boundaries is investigated. Phosphorous dopant is preferentially introduced into the grain boundaries of p-type material by a low-temperature diffusion process. A subsequent high-temperature diffusion forms a highly n-doped skin covering each grain. The resulting junction around each grain surface collects electrons which might otherwise recombine at the grain boundaries. This grain boundary doping scheme makes possible an increase in the conversion efficiency of polycrystalline silicon solar cells in which the grain structure is columnar. (Author)

A77-26043 Environmental considerations of converting fossil-fueled power plants from oil or natural gas to coal. H. Roffman and A. Roffman (Westinghouse Research and Development Center, Pittsburgh, Pa.). In: Environmental technology '76; Proceedings of the Twenty-second Annual Technical Meeting, Philadelphia, Pa., April 26-28, 1976. Mount Prospect, Ill., Institute of Environmental Sciences, 1976, p. 152-162. 13 refs.

The paper assesses the incremental environmental impacts that result from the conversion of oil and gas burning power plants to coal burning plants as compared to impacts associated with present conditions. Environmental considerations include potential impacts to land, water, air, and society, as well as occupational hazards associated with fuel production, fuel transportation, and power production. B.J.

A77-26054 Solar heating and cooling of a 25,500 square foot building. R. L. San Martin, S. Diamond (New Mexico State University, Las Cruces, N. Mex.), and F. Bridgers (Bridgers and

Paxton Consulting Engineers, Inc., Albuquerque, N. Mex.). In: Environmental technology '76; Proceedings of the Twenty-second Annual Technical Meeting, Philadelphia, Pa., April 26-28, 1976. Mount Prospect, Ill., Institute of Environmental Sciences, 1976, p. 298-302.

The New Mexico Department of Agriculture building is both solar heated and solar absorption cooled. This project, which had been in preparation for two years, was completed in September 1975. In its preliminary analysis, both a solar heating and solar absorption cooling system and a solar heating and heat pump system were considered. The system utilizes 6,730 sq ft of two different types of solar collectors. One being of flat plate design with a selective surface and the other being a ten-to-one concentrator with an automatic tracking system. This single story building utilizes 30,000 gallons of pressurized water as storage in two underground tanks, allowing for multiple modes of storage. A modeling study indicates that the solar system will provide 79% of the annual heating and cooling requirements of this building. The building is being carefully instrumented to monitor its performance. (Author)

A77-26056 Optimal overall efficiency for a solar radiation collector utilizing a two fluid Rankine Cycle to generate electrical power. M. H. Cobble and P. R. Smith (New Mexico State University; Las Cruces, N. Mex.): In: Environmental technology '76; Proceedings of the Twenty-second Annual Technical Meeting, Philadelphia, Pa., April 26-28, 1976. Mount Prospect, Ill., Institute of Environmental Sciences, 1976, p. 308-313. 8 refs. NSF Grant No. OIP-74-08333.

Equations for concentration, mirror efficiency, and collector efficiency are developed and solved numerically for an absorber tube, enclosed by a partially silvered glass envelope, placed at the focus of a parabolic mirror. Utilizing a thermal storage boiler, an expression for the overall efficiency of a system using the collector, the thermal storage boiler, and a two fluid Rankine Cycle to generate electrical power is derived and solved numerically to determine the optimum operating condition for this system. (Author)

A77-26057 Continuous solar air conditioning with ammonia/water absorption cycle. E. A. Farber, C. A. Morrison, H. A. Ingley, and J. A. Clark (Florida, University, Gainesville, Fla.). In: Environmental technology '76; Proceedings of the Twenty-second Annual Technical Meeting, Philadelphia, Pa., April 26-28, 1976. Mount Prospect, Ill., Institute of Environmental Sciences, 1976, p. 319-321. 8 refs.

The considered cycle involves the replacement of the vapor compression function of a conventional compressor with a generator, absorber, and a circulation pump. The generator utilizes heat to produce a refrigerant vapor at high pressure. This vapor is condensed and expanded for cooling. The refrigerant combines subsequently with an absorbant and is returned to the generator. The ammonia/water absorption cycle may be operated with heat source temperatures much less than 180 F. The design of a solar powered air conditioner which employs the considered cycle is discussed, taking into account also the economic aspects concerning the use of such a system. G.R.

A77-26058 A comparative study of the effectiveness of baseboard convectors versus forced air solar heating at the University of Florida Solar House. E. A. Farber, C. A. Morrison, H. A. Ingley, and F. J. Tarud (Florida, University, Gainesville, Fla.). In: Environmental technology '76; Proceedings of the Twenty-second Annual Technical Meeting, Philadelphia, Pa., April 26-28, 1976. Mount Prospect, Ill., Institute of Environmental Sciences, 1976, p. 322-324.

A77-26070 An analysis of the role of energy in solid waste utilization and disposal. W. H. Jones, P. North, and R. Novosad (West Florida, University, Pensacola, Fla.). In: Environmental technology '76; Proceedings of the Twenty-second Annual Technical Meeting, Philadelphia, Pa., April 26-28, 1976. Mount Prospect, Ill., Institute of Environmental Sciences, 1976, p. 509-515.

System aspects of the solid waste problem are investigated and an investigation is conducted concerning the feasibility of an exploitation of the energy potential of Florida's solid wastes. Solid waste generation rates are considered along with solid waste disposal methods not involving energy recovery, and energy recovery methods. Attention is given to recycling energies, the energy potential of Florida's municipal solid wastes, and the economics of energy and resource recovery. G.R.

A77-26071 Drying of refuse-derived fuel for energy recovery from municipal solid waste. H. P. Sheng (Youngstown State University, Youngstown, Ohio). In: Environmental technology '76; Proceedings of the Twenty-second Annual Technical Meeting, Philadelphia, Pa., April 26-28, 1976. Mount Prospect, Ill., Institute of Environmental Sciences, 1976, p. 516-519. 5 refs. NSF-supported research.

Cost savings and energy savings from drying and utilization of refuse-derived fuel (RDF) from municipal solid wastes (MSW) are discussed. A ternary system is considered, with ash content defined as the third component (after moisture and solids). Shredding for recovery of materials and energy, air classification of MSW fractions by weight, cost penalties from high ash content in RDF, and comparative features of drying techniques are discussed. A hysteresis loop in the moisture absorption and desorption curves for waste paper products (the bulk of the RDF combustible solids) is described. Freeze drying, vacuum drying, chemical drying, and hot-gas drying processes are compared, only the last variant being considered for MSW treatment to produce RDF at reasonably low cost. R.D.V.

A77-26076 Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. Symposium sponsored by the LACES, ANS, AIAA, AIChE, AACE, ISGE, ASCE, IEEE, PMI, WESA, and AIME. Edited by J. W. Robinson (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). North Hollywood, Calif., Western Periodicals Co. (Los Angeles Council of Engineers Scientists Proceedings Series. Volume 2), 1976. 256 p. $35.

Attention is given to alternate fuels (such as methane, solid waste, oil shale, etc.), conservation and the environment, wind power, geothermal/solar/hydraulic/wave energy, and energy economics. Particular papers are on electrical energy as a sulfur dioxide air pollution control strategy, economic considerations in selecting a nuclear vs coal plant, windmill optimization, power production from high salinity geothermal waters, and harnessing the ocean waters, swells and tides. B.J.

A77-26077 Methane gas recovery from sanitary landfills in Southern California. K. K. Hekimian, W. J. Lockman (Lockman and Associates, Monterey Park, Calif.), and J. H. Hirt (Hirt Combustion Engineers, Montebello, Calif.). In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 9-17. 15 refs.

Recent efforts in Southern California to utilize methane gas as a new energy source in an economical and environmentally acceptable way are reviewed. Four basic approaches to utilizing methane gas from landfills are discussed: (1) delivery of low BTU (500 BTU) gas to adjacent interruptible gas consumers, (2) on-site treatment of landfill gas to produce pipeline quality synthetic natural gas, (3) on-site generation of electric power through use of raw landfill gas as fuel, and (4) on-site conversion of landfill methane gas to methanol or to liquefied natural gas. B.J.

A77-26078 Recovery of energy from solid waste - An answer to some of Southern California's problems. L. C. Stuckenbruck (Southern California, University, Los Angeles, Calif.) and C. F. King. In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif.,

May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 18-33. 29 refs.

The state of the art of energy recovery from solid waste is reviewed with attention given to direct combustion or incineration of unprepared solid waste, direct combustion of prepared solid waste, pyrolysis to gaseous or liquid fuel, and biomass conversion to fuel gas. The ten operating systems which come closest to being ready for rapid full-scale implementation are discussed. Sociological questions (public apathy, political aspects, economic factors, and environmental impact) are examined along with system cost considerations. B.J.

A77-26083 Liquefied natural gas for California. E. P. Rocha (Southern California Gas Co., Los Angeles, Calif.). In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 167-173.

Efforts to increase the natural gas supply of California by the transportation of liquefied natural gas are discussed. The scope of the projects, estimated capital and operating costs and system design are covered. Liquefaction process design is described in some detail. (Author)

A77-26084 The high potential of wind as an energy source. U. Coty and M. Dubey (Lockheed-California Co., Burbank, Calif.). In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 181-187.

A recently completed ERDA study shows that the full potential of wind as an energy source is far greater than previously estimated. The paper reviews various aspects of wind energy including wind energy resources, conversion systems, wind turbine applications, and the national potential for wind energy. B.J.

A77-26085 * Flap-augmented shrouds for aerogenerators. A. Seginer (NASA, Ames Research Center, Moffett Field, Calif.; Technion - Israel Institute of Technology, Haifa, Israel). In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 188-196. 15 refs. Research sponsored by the Bat-Sheva de Rothschild Foundation for the Advancement of Science in Israel.

Axisymmetrical shrouds for windmills are augmented by ring-shaped 'flaps' and their performance is studied experimentally. The concept of the shroud as an annular 'wing' is justified, leading to the conclusion that high-lift techniques should be used in shroud design, and that high-lift devices, such as flaps, would increase the power output of the windmill. It is shown experimentally that the ideal power output of a flap-augmented shrouded turbine can be more than 4 times the power of unshrouded turbines of the same diameter. (Author)

A77-26086 Windmill optimization. G. H. Stickney (Missouri-Columbia, University, Columbia, Mo.). In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 197-202. 17 refs.

The windmill law is derived and stated as follows: 'the design output of an ideal windmill increases monotonically with its optimized tip speed ratio beginning with zero and terminating at the asymptotic value of 16/27 of the power in the wind when the tip speed ratio approaches the limiting value of infinity'. The equation for the power surface relating the wind velocity, power, and angular velocity of the rotor is also derived. B.J.

A77-26087 A method for increasing the efficiency of the electric generating process. S. K. Levine (Wind Harness Co., New York, N.Y.). In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 203-208.

A heat source heats air which rises in a duct having at least a one hundred meter vertical rise. Cold air enters the bottom of the duct through one or more horizontal passages containing vanes driven by moving air as a power source. The heat source may be a heat exchanger connected to an atomic reactor, a fossil-fuel plant, a solar collector, or a geothermal heat supply. The heat exchanger may be located in the duct or in the one or more horizontal passages. In some applications, solar energy may directly heat the duct or a grid therein to cause an air flow. (Author)

A77-26088 Analysis of the wind-driven reciprocator. E. M. Nassar (Illinois Institute of Technology, Chicago, Ill.). In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 209-216. 12 refs.

The concept of the reciprocating cascade is proposed as a means for wind energy conversion. Preliminary aerodynamic and performance analyses are conducted. A typical full-scale configuration is selected and estimates of weight and cost are made. A cost comparison between the reciprocator and the conventional rotary propeller under the same conditions indicates potential reduction in the cost per output figure. (Author)

A77-26089 Energy recovery by mini-hydroelectric projects. P. R. Hoffman and G. F. Horowitz (Southern California, Metropolitan Water District, Los Angeles, Calif.). In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 219-229.

The economic impact of fuel shortages and increasing costs requires a reevaluation of hydroelectric potential previously not considered economic. Thus, energy now being wasted in pressure regulating stations of water distribution systems can be recovered through addition of small hydroelectric generating units at the existing 'head breaking' facilities. This paper discusses the development of such mini-hydro projects on a large water system, where the energy thus recovered will save the equivalent of many hundreds of barrels of oil per day. 'Micro'-hydroelectric units, for installation in smaller municipal water distribution systems, are also discussed. Economics and environmental benefits are considered. (Author)

A77-26090 Power production from high salinity geothermal waters. I. Sheinbaum (I. Sheinbaum Co., Pasadena, Calif.). In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 230-239. 13 refs.

Until recently there were three candidate processes for the production of power from the high temperature, high salinity reservoirs of the Imperial Valley: the multi-stage steam flash cycle, the multi-flash binary cycle, and the total flow cycle. The paper describes a fourth candidate: the direct contact binary cycle, compares it to the other cycles, and characterizes it as highly efficient, flexible, and very economical. B.J.

A77-26091 Harnessing the ocean waves, swells and tides. A. J. Dervy. In: Energy LA: Tackling the crisis; Proceedings of the Second Greater Los Angeles Area Energy Symposium, Los Angeles, Calif., May 19, 1976. North Hollywood, Calif., Western Periodicals Co., 1976, p. 250-253. 6 refs.

The feasibility of obtaining electric power from ocean disturbances such as waves, swells, and tides is examined. A basic conversion system of the double acting type (i.e., both the upward and downward motions of the barge are converted into energy) is described. A mathematical treatment of the motions is presented, and some cost estimates are given. B.J.

A77-26093 **Possibility of medium energy neutral beam injection into stellarator reactor.** K. Miyamoto (Nagoya, University, Nagoya, Japan). *Japanese Journal of Applied Physics*, vol. 16, Feb. 1977, p. 317-319. 8 refs.

The energy necessary for neutral particles to penetrate into the plasma center may be of the order of 0.6 to about 1 MeV in the case of a fusion reactor. The conversion efficiency to convert such a high-energy ion beam into a neutral beam is extremely small. The case is studied where fast neutral particles are injected so that the ionized fast ions are trapped in helical ripples of the stellarator field. It is shown that the trapped ions can drift into the plasma center even if the energy is of the order of 100 keV. (Author)

A77-26160 **A direct convertor based upon space charge effects.** S. J. Gitomer (California, University, Los Alamos, N. Mex.). *IEEE Transactions on Plasma Science*, vol. PS-5, Mar. 1977, p. 18-22. 15 refs. ERDA-sponsored research.

A device capable of converting directly the kinetic energy of charged particles into electrical energy is considered. The device differs from earlier ones (such as Post's periodic focus electrostatic direct convertor) in that it makes use of the space charge repulsion in a high density charged particle beam. The beam is directed into a monotonic decelerating electrostatic field of a several stage planar finned structure. The collector fins coincide with vacuum equipotential surfaces. Space charge blowup of the beam directs particles onto various collector fins. The energy efficiency of a 4-stage device has been determined using a numerical simulation approach. We find that efficiencies approaching 75 percent are possible. An approximate scaling law is derived for the space charge based direct convertor and a comparison is made to the periodic focus direct convertor. We find the space charge based direct convertor to be superior in a number of ways. (Author)

A77-26200 * # **The Tethered Balloon Current Generator - A space shuttle-tethered subsatellite for plasma studies and power generation.** P. R. Williamson and P. M. Banks (California, University, La Jolla, Calif.). *Institute of Electrical and Electronics Engineers, International Conference on Plasma Science, Austin, Tex., May 24-26, 1976, Paper.* 40 p. 16 refs. Grants No. NGR-05-009-075; No. NOAA-03-5-022-60.

The objectives of the Tethered Balloon Current Generator experiment are to: (1) generate relatively large regions of thermalized, field-aligned currents, (2) produce controlled-amplitude Alfven waves, (3) study current-driven electrostatic plasma instabilities, and (4) generate substantial amounts of power or propulsion through the MHD interaction. A large balloon (a diameter of about 30 m) will be deployed with a conducting surface above the space shuttle at a distance of about 10 km. For a generally eastward directed orbit at an altitude near 400 km, the balloon, connected to the shuttle by a conducting wire, will be positive with respect to the shuttle, enabling it to collect electrons. At the same time, the shuttle will collect positive ions and, upon command, emit an electron beam to vary current flow in the system. B.J.

A77-26289 **Largest ever liquefaction plant will test H-coal process.** *Coal Mining and Processing*, vol. 14, Mar. 1977, p. 84-86, 88, 90.

The overall design, capabilities, and economic and technological functions of the $90 million coal liquefaction plant being built at Catlettsburg, Kentucky are discussed. The H-coal liquefaction process is described briefly. The process is expected to convert all major types of coal (bituminous, subbituminous, lignite) to clean sweet (low-sulfur) petroleum substitutes, no matter what the sulfur content of the coal feedstock. The process involves direct addition of a hydrogen stream to dried pulverized coal slurried with synthetic oil recycled from the process further downstream. Two flowsheets are provided. R.D.V.

A77-26290 **Coal gasifier projects gather momentum.** R. D. Sheldon and W. H. Day (General Electric Co., Fairfield, Conn.). *Energy International*, vol. 14, Mar. 1977, p. 20-24.

The feasibility of combining gasification of low-BTU coal and high-efficiency combined-cycle power plants is examined. Efforts to develop coal gasification for production of clean fuel for gas turbines are reviewed: a fixed-bed gas generator, a fluidized-bed carbonizer, an entrained-bed project, pressurized gasifiers, the Lurgi fixed-bed gasifier. Parallel research on gas turbines to enable more efficient use of gasified coal streams as fuel are also described: the GE fireside combustion program, the UHT (ultrahigh-temperature) turbine program, and water-cooled bucket concept. Operation with coal-derived liquid fuel, and gas cleanup systems, are also mentioned. R.D.V.

A77-26292 **Underground gasification offers clean safe route to coal energy.** N. Jenkins. *Energy International*, vol. 14, Apr. 1977, p. 28-30.

Prospects for low-cost efficient extraction of energy from coal beds in situ via underground gasification are weighed, with discussion of some new processes reported. The heating value of the product, efficiency of the process, how much coal would be left in the seam unextracted, and exploitation of seams recalcitrant to mining by conventional techniques are considered. Energy transportation costs (of gas by pipeline, of solid coal via road/rail/barge, of electricity generated on site) have to be compared. A packed-bed process, explosive fracturing of coal seams prior to burning, use of hydrogen in place of oxygen to supply reaction heat, and utilization of gasification process residual heat are touched upon. R.D.V.

A77-26392 * # **Status of silicon solar cell technology.** H. W. Brandhorst, Jr. (NASA, Lewis Research Center, Cleveland, Ohio). *Japan Society of Applied Physics, International Conference on Solid State Devices, 2nd, Tokyo, Japan, Sept. 1-3, 1976, Paper.* 17 p. 18 refs.

It is pointed out that during the time from 1970 to 1976 the efficiency of solar cells has increased from 10.5 to 15.5%. Most of the increased output has resulted from increased short circuit current. Advances leading to this improvement in performance are discussed, taking into account a reduction in the area covered by the grid pattern, the use of antireflection coatings, and the employment of surface texturizing. A widespread use of solar cells for nonspace applications requires a reduction in the cost of solar cell arrays from the present $20 per watt to 10 to 50 cents per watt. Approaches for achieving this objective are considered. Attention is given to an automated, high volume production of solar cells made from ribbon silicon or thin film layers. G.R.

A77-26409 # **Chemical cleaning of coal.** S. Friedman and R. P. Warzinski (ERDA, Pittsburgh Energy Research Center, Pittsburgh, Pa.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/APC-2.* 4 p. 13 refs. Members, $1.50; nonmembers, $3.00.

The paper examines various methods for precombustion desulfurization of coal as related to physical depyriting, chemical desulfurization, and coal conversion to low-sulfur liquid and gaseous fuels. Chemical methods of desulfurizing coal are shown to be an alternative which is more selective and thorough than physical coal cleaning, and less costly though less efficient than coal conversion. A preliminary cost estimate indicates that chemical desulfurization may add up to $15 to the cost of a ton equivalent of coal, compared to $15 to $30 for coal conversion to gas or liquid. The steam-air desulfurization process is presently considered the simplest and cheapest concept for removing organic sulfur from coal. S.D.

A77-26411 # **Evaluation of the practical aspects of the use of coal derived synthetic fuels.** E. R. Zabolotny and D. J. McCarthy (Stone and Webster Engineering Corp., Boston, Mass.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/APC-6.* 9 p. 9 refs. Members, $1.50; nonmembers, $3.00.

The coal liquefaction processes are examined, taking into account the H coal process, solvent refined coal, the EXXON donor solvent process, and the Coalcon process. Potential problem areas in synthetic fuel utilization are considered along with power station

retrofitting requirements. A description of fuel handling and storage equipment is presented and an investigation is conducted concerning the potential market for synthetic boiler fuels. G.R.

A77-26430 # **An economic evaluation of small-scale wind powered electric generation systems.** J. L. Obermeier and H. W. Townes (Montana State University, Bozeman, Mont.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Ener-1.* 5 p. 13 refs. Members, $1.50; nonmembers, $3.00.

Presented is an economic evaluation of several commercial wind powered electric generation systems of the type which could be used by an individual home owner. A system includes a wind plant, tower, storage battery and d-c to a-c inverter. The analysis considered a total of 12 different system configurations. The evaluation of energy output was based on wind speed data for several locations in the state of Montana. The analysis can be extended to other locations on the basis of mean annual wind speed. The results of the evaluation indicate that some of the 'home built' systems are competitive economically at the present time in some 'windy' locations. None of the systems which are economic could individually supply the entire power requirement for a single family dwelling. (Author)

A77-26431 # **Tornado-type wind energy system - Basic consideration.** J. T. Yen (Grumman Aerospace Corp., Bethpage, N.Y.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Ener-2.* 11 p. 11 refs. Members, $1.50; nonmembers, $3.00.

A description is presented of a new concept which will make it possible to overcome the severe capacity limitations which prevent the use of conventional wind-energy systems for the large-scale power units required to make an appreciable contribution toward the solution of the energy crisis. The new concept calls for setting up a stationary and omnidirectional tower to collect a very great amount of wind energy. The tower will be fitted with adjustable vertical vanes that will be opened in the windward direction. A vortex or a 'tornado' with a low pressure core will be created and maintained within the tower. A vertical-axis turbine on the tower floor utilizes for its operation the difference in pressure between the low pressure vortex core and a higher pressure bottom inlet. G.R.

A77-26432 # **Hydroretorting of oil shale with nuclear process heat.** L. Green, Jr. (Mitre Corp., McLean, Va.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Ener-3.* 7 p. 13 refs. Members, $1.50; nonmembers, $3.00.

This paper proposes a concept by which utilization of nuclear process heat from a high-temperature gas-cooled reactor (HTGR) for above-ground and in situ hydroretorting of oil shale using the Institute of Gas Technology process can conserve that fraction of the hydrotreated syncrude product which would otherwise have to be burned for fuel. In addition to providing process heat at an estimated cost lower than that projected for shale oil combustion, the HTGR also avoids environmental problems of air pollution and water requirements which attend the mining and burning of coal, the other alternative energy source. When the economic advantage of nuclear heat over oil heat is lost due to the in situ retorting sites moving too far away from the heat source, the process equipment is removed and the process plant converted to a power plant. If the limiting distance from the plant site is 1.5 miles, the useful life of the process plant prior to conversion is estimated to be approximately 20 years, the amortized lifetime of the process equipment. (Author)

A77-26453 # **Coal-in-oil - A substitute boiler fuel.** G. K. Lee and T. D. Brown (Department of Energy, Mines and Resources, Canadian Combustion Research Laboratory, Ottawa, Canada). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Fu-2.* 8 p. 8 refs. Members, $1.50; nonmembers, $3.00.

Pilot-scale combustion experiments have demonstrated that mixtures of coal-in-oil can be successfully burned in industrial oil-fired combustion systems. A lignite slurry comprising 33 percent by weight lignite in No. 2 oil gave combustion efficiencies greater than 90 percent at excess-air levels above 12 percent. On the other hand, combustion efficiencies of the order of 50 percent were measured using a reject bituminous coal having a high content of non-reactive fusinite and semi-fusinite macerals. The degree of burn-out of the coal component was strongly dependent on both the maceral structure of the coal and the aerodynamic patterns in the flame. (Author)

A77-26456 # **Combustion of pulverized, solvent-refined coal.** C. R. McCann, J. J. Demeter, and D. Bienstock (ERDA, Pittsburgh Energy Research Center, Pittsburgh, Pa.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Fu-6.* 4 p. Members, $1.50; nonmembers, $3.00.

Solvent-refined coal (SRC) is a reconstituted material which has been dissolved, filtered, and separated from its solvent with low contents of sulfur and ash, which allows compliance with environmental regulations. Earlier investigations have reported difficulties in pulverization, transport, and burner plugging when the SRC was fired as a solid fuel. The present paper analyzes the handling and combustion characteristics of solid SRC in a direct-fired combustion system that includes a multiburner water-wall furnace capable of burning 500 lb of pulverized coal per hour, closely simulating the operation of a utility unit. No difficulties are experienced in pulverization of SRC in the impact mill employed in the combustion system. Examination of the transport system following the pulverizer revealed no excessive buildup of pulverized SRC. Nitrogen oxide emissions as low as 0.53 lb NO2/MBtu from SRC combustion are observed. S.D.

A77-26457 # **Design criteria for reducing pollutant emissions and fuel consumption by residential oil-fueled combustors.** L. P. Combs and A. S. Okuda (Rockwell International Corp., Rocketdyne Div., Canoga Park, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Fu-10.* 24 p. 12 refs. Members, $1.50; nonmembers, $3.00. Research supported by the U.S. Environmental Protection Agency.

Residential space heating accounts for approximately one-tenth of the United States energy consumption and one-fourteenth of combustion-generated air pollution. Design criteria have been determined experimentally for oil burners and fireboxes, which produce minimum emissions of air pollutants, particularly NOx. Additionally, the criteria are compatible with effecting simultaneous increases in cyclical thermal efficiency by reducing both steady-state and transient heat losses from combustion equipment. Built and tested for a proof-of-concept demonstration, a prototype warm-air furnace incorporating these design criteria has been found to reduce NOx emission to about 35% of the estimated average from comparable existing installed units and to be capable of achieving 10 or more percentage points higher cyclical efficiency than the estimated average for all such existing units. (Author)

A77-26459 # **Recent tests of industrial gas turbine combustors fueled with simulated low heating value coal gas.** P. W. Pillsbury and S. S. Lin (Westinghouse Electric Corp., Generation Systems Div., Lester, Pa.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/GT-3.* 9 p. 6 refs. Members, $1.50; nonmembers, $3.00. Contract No. E(49-18)-1514.

Recent tests of full-scale industrial gas turbine combustors in a high airflow, high pressure rig provide performance trends resulting from operation on simulated low heating value gases and liquid fuel. As combustor primary zone size, configuration, and operating conditions were varied, the effects were noted on ignitability, lean extinction limit, exhaust emissions, metal temperature, and exit temperature pattern factor. Simulated gases tested were typical of those resulting from low temperature desulphurization, which is an alternate method proposed for the Westinghouse-Bechtel-Energy Research and Development Administration coal gasification plant. (Author)

A77-26470 * # **Experimental evaluation of a stationary spherical reflector tracking absorber solar energy collector.** W. G. Steward, J. F. Kreider (ECS, Inc., Boulder, Colo.), P. S. Caruso, Jr. (NASA, Goddard Space Flight Center, Greenbelt, Md.), and F. Kreith (Colorado, University, Boulder, Colo.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-10.* 6 p. Members, $1.50; nonmembers, $3.00. Research supported by the Environmental Consulting Services; NASA Contract No. 54132-A.

This article presents experimental data for the thermal performance of a stationary, spherical-reflector, tracking-absorber solar energy collector (SRTA). The principle of operation and details of thermal performance of such an SRTA have previously been described. These experimental results were compared with the predictions of a thermal analysis previously published. Experimental results were compared with the prediction of Kreider's computer model. Within the range of the temperature of the experiments, the predicted performance of the unit agreed well with experimental data collected under clear sky conditions. In addition, the extrapolation of the efficiency to higher temperature is shown so that the potential of an SRTA solar collector as a means of providing high temperature steam to operate an electric power facility or for process heat can be evaluated. As a result of the tests conducted by NASA, and an economic analysis not yet publicly available, it appears that the SRTA solar collector concept will be economically viable in competition with any other existing solar system in providing electrical energy. (Author)

A77-26473 # **Experimental evaluation of a cylindrical parabolic solar collector.** J. W. Ramsey (Minnesota, University, Minneapolis, Minn.), B. P. Gupta, and G. R. Knowles (Honeywell Energy Resources Center, Minneapolis, Minn.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-13.* 8 p. Members, $1.50; nonmembers, $3.00. NSF-ERDA-supported research.

Results are presented for a series of solar collector experiments in which the incident solar flux was concentrated by a single-axis tracking parabolic trough mirror. The concentrated solar flux was directed onto an absorber tube whose axis coincided with the focal axis of the concentrator. The performance of the collector was evaluated, using three different absorbers, a black painted tube designed to operate near ambient temperature, a heat pipe which had a selective solar absorber coating applied to its surface, and a heat pipe which had its surface coated with a non-selective black paint. The peak efficiency for the collector in the absence of heat losses is approximately 62 per cent, when the incoming solar energy is normal to the collector aperture. The heat losses which occurred at elevated temperatures (300 C) decreased the peak efficiencies to 50 and 30 per cent, respectively, for the selectively coated and black painted tubes. The experimental results establish the technical feasibility of using parabolic trough collectors for applications requiring thermal energy at temperatures up to 300 C. (Author)

A77-26474 # **Solar thermal electric power systems - Manufacturing cost estimation and systems optimization.** W. S. Duff and W. W. Shaner (Colorado State University, Fort Collins, Colo.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-14.* 10 p. 8 refs. Members, $1.50; nonmembers, $3.00. NSF-ERDA-supported research.

The design of a 100 megawatt solar thermal electric power (STEP) plant is considered. In the case of a system operating with 19% efficiency, such a plant would require an area approximately one mile on each side. The cost of the energy provided is on the order of 4.0 cents per kilowatt-hour. Such a cost appears to be competitive if it is compared with the cost of energy provided by conventional peaking plants. Such a comparison appears justified because peak sunshine occurs at approximately the same time as peak electrical demand. The most important disadvantage of the STEP plant is the fact that sunshine is unreliable. Attention is given to different types of STEP systems, a component cost breakdown, aspects of systems optimization, and a collector manufacturing cost estimation. G.R.

A77-26475 # **Optical and thermal performance analysis of three line focus collectors.** W. S. Duff (Colorado State University, Fort Collins, Colo.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-15.* 7 p. 6 refs. Members, $1.50; nonmembers, $3.00.

An analytic approach developed earlier for two-axis tracking collectors is extended to one-axis tracking collectors. The parabolic trough, the linear array of movable curved slots with a fixed absorber, and the circular array of fixed slots with a movable absorber are specifically addressed. The earlier approach developed two measures of concentrator performance that, along with specification of target shape, were sufficient to completely characterize the concentrator in a thermal analysis of a collector. This concise representation of concentrator performance was required to provide computational feasibility to a sequential optimization. The assumption of a constant insolation level in the earlier approach is relaxed. The two measures, effective aperture and image spread, are then developed for the three-line focus concentrators. A derived measure, based on effective aperture, is suggested as an alternative to concentration ratio to more adequately express potential collector performance. (Author)

A77-26476 # **Double-exposure collectors with mirrors for solar-heating systems.** C. W. Savery, D. C. Larson (Drexel Univefsity, Philadelphia, Pa.), and P. M. Anderson. *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-16.* 8 p. 14 refs. Members, $1.50; nonmembers, $3.00.

In connection with the restoration of a building to provide five apartments for graduate student housing, a solar water-heating system is to be installed. The solar system will employ both conventional flat-plate collectors and double-exposure collectors with mirrors. The useful heat output throughout the year for diffuse radiation is about double the value calculated for conventional collectors. Approaches for increasing the effectiveness of the system for solar energy collection are discussed and the thermal performance of the system is evaluated. G.R.

A77-26477 # **A self-contained solar powered tracking device.** E. A. Farber, C. A. Morrison, and H. A. Ingley (Florida, University, Gainesville, Fla.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-26.* 5 p. 6 refs. Members, $1.50; nonmembers, $3.00.

In researching various techniques of obtaining high temperature fluids for use in a domestic cooking system, a simple, maintenance free device for driving a large solar concentrator proved necessary. Several different tracking mechanisms - such as bimetallic, photoelectric cell, and clock - were investigated, and ultimately, a design was formed which can best be characterized as a fluid-mechanical device. The basic tracking system utilizes two sensor bulbs situated on a large parabolic concentrator and connected to two power cylinders opposing each other through a rack and pinion gear arrangement. The pressure differentials, created in the sensor bulbs by unequal shading, drives the power cylinders, thus rotating the large parabolic mirror into a position normal to the sun's rays. This paper presents schematics and photographs illustrating the construction and placement of the solar tracking mechanism. Data are also presented which indicate the accuracy and response of the system in aligning the solar collector with the sun. (Author)

A77-26478 # **Performance of flat-plate collectors with planar reflectors.** S. Kumar and H. S. Liers (InterTechnology Corp., Warrenton, Va.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-27.* 10 p. Members, $1.50; nonmembers, $3.00.

In this paper a set of equations has been presented for calculating the flux enhancement due to the addition of a reflector assembly to a collector assembly for equal collector and reflector heights. Using the equations developed as well, as others developed for horizontal reflectors, series of calculations has been performed which allows a cost comparison between systems with and without

reflectors for equal performance. The findings of these studies indicate that reflector systems are not cost effective unless inexpensive reflector assemblies can be developed. For cost effectiveness, under the best of circumstances studied, the installed reflector cost per square foot needs to be less than 0.09 of the installed collector cost for heating and cooling systems and less than 0.16 of the installed collector cost for heating-only systems. (Author)

A77-26481 # **Design and costs of high temperature thermal storage devices using salts or alloys.** K. W. Kauffman and H. G. Lorsch (Franklin Institute, Research Laboratories, Philadelphia, Pa.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-34.* 11 p. 20 refs. Members, $1.50; nonmembers, $3.00.

Salts and alloys are investigated for application to phase change thermal energy storage for conventional and solar thermal power generation. The total storage cost using alloys is insensitive to the heat exchanger cost per unit area and relatively insensitive to changes in discharge time and temperature between charging and discharging. For the salts, total cost is very dependent on those same parameters. Alloys are substantially lower in cost for charge or discharge times of 12 hr or less. The effect of volume change of fusion on total cost is determined. Costs may be increased up to 37 per cent for salts, 2.5 per cent for alloys. Also discussed are the use of metal foam fillers with salts, corrosion, cost of preparation, and the use of heat pipes and mechanical devices. (Author)

A77-26483 # **Solar heating thermal storage feasibility.** P. Joy and B. Shelpuk (RCA Advanced Technology Laboratory, Camden, N.J.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-36.* 7 p. 7 refs. Members, $1.50; nonmembers, $3.00. Contract No. E(11-1)-2591.

The relative technical and economic merits of various approaches to thermal energy storage for solar heating applications are reported in this paper. A solar heating system was computer modeled, including solar collectors, building demand, and conventional heating system. Several approaches to thermal energy storage including specific heating, phase change, and combinations of the two were modeled and run in the same system model using hourly weather data for a six-month heating season in Albuquerque, New Mexico and New York City. Results show that water thermal energy storage results in lower solar energy annual costs than phase change storage due, in part, to the cost of containment of the phase change materials. It is shown that the theoretical performance advantages of phase change storage over specific heat storage are considerably reduced when operating in a minimum cost solar heating system which delivers about 50 per cent of the total building demand. (Author)

A77-26484 # **A pressurized liquid concept for solar-thermal energy storage for the 24-hour continuous operation of an energy conversion system.** M. E. Talaat (Maryland, University, College Park, Md.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-38.* 9 p. Members, $1.50; nonmembers, $3.00.

An investigation is conducted regarding the feasibility to employ the pressurized liquid concept for solar thermal energy storage applications in connection with a solar energy conversion system for continuous 24-hour operation. It is found feasible to design an energy storage system which will supply continuously a constant thermal power load within cyclic maximum and minimum temperature limits that would be practical for conventional thermomechanical, or direct thermoelectric energy conversion systems. The described concept would be suitable for applications under the climatic conditions found in the southwestern regions of the U.S. G.R.

A77-26489 # **Exploring stability criteria of solar ponds.** S. G. Hauser (Oregon State University, Corvallis, Ore.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-62.* 6 p. 13 refs. Members, $1.50; nonmembers, $3.00.

The thermal energy which can be retained by solar ponds is reduced by convective motions. An investigation is conducted regarding the possibility to prevent such motions by making use of salt water systems with a suitable salt concentration gradient which ensures that the solution is more dense at the bottom even when warmed by solar radiation. Under certain conditions oscillatory motions will set in and destroy the concentration gradient. Attention is given to criteria which provide information concerning the magnitude of the salt concentration gradient required to prevent such oscillatory motions. G.R.

A77-26490 # **A study of the economic feasibility of a thermal energy storage system for solar heating applications using a PCM.** N. M. Schnurr (Vanderbilt University, Nashville, Tenn.), H. D. Walker (Aladdin Industries, Nashville, Tenn.), and D. F. Salmon (Avco Corp., Avco Aerostructures Div., Nashville, Tenn.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-63.* 8 p. 25 refs. Members, $1.50; nonmembers, $3.00.

A numerical method is developed to predict the rate of heat transfer between a plane channel carrying water and a slab of a solid-liquid phase change material (PCM). The two-dimensional melting problem is solved by using an explicit finite difference approach which is applicable to materials having a melting temperature range as well as those having a distinct melting temperature. The numerical results are experimentally verified. A parametric study of the effects of the thermal properties of the PCM, water flow rate and inlet temperature, and geometric parameters on the energy storage rate is carried out in dimensionless form. These results are used in the preliminary design of an economically optimized system using a selected commercial grade PCM. The results indicate that a system of this type would cost more than twice as much as a comparable storage system using the sensible heating of water. Design changes, which would lower the cost of a PCM energy storage system, are discussed. (Author)

A77-26491 # **Description of thermal storage sub-system designs for ERDA's 10-MWe Solar Central Receiver Pilot Plant.** M. U. Gutstein and G. M. Kaplan (ERDA, Div. of Solar Energy, Washington, D.C.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-68.* 9 p. 5 refs. Members, $1.50; nonmembers, $3.00. ERDA-sponsored research.

ERDA's Division of Solar Energy is sponsoring preliminary designs of a 10-MWe Solar Central Receiver Pilot Plant. Incorporated in each plant design is a storage sub-system that will permit extended operation of the Pilot Plant for 6 hr at an output level of 7 MWe. This paper reviews the current design of the thermal storage sub-systems and their integration with the Pilot Plant. The designs of the experimental models of these sub-systems, to be built and tested prior to final design of the Pilot Plant, are likewise described. (Author)

A77-26492 # **The proper use of thermal storages for a solar assisted heat pump heating system.** M. Abbaspour and L. R. Glicksman (MIT, Cambridge, Mass.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-76.* 10 p. 17 refs. Members, $1.50; nonmembers, $3.00.

The proper sizing of components in a solar assisted heat pump system with thermal storage was investigated. The study included both single storage systems with storage at the low temperature side (LTS) of the heat pump, and dual storage systems with one storage at the collector temperature, i.e., the low temperature input to the heat pump, and the other at the high temperature output from the heat pump. It was assumed that whenever the LTS storage is depleted (below ambient temperature), the heat pump used the ambient air as a heat source. Different strategies for operating the heat pump were examined and the optimum case was found. The selection of collector area and the collector cost per square foot were the most important factors in the overall system performance and cost. Proper use of a second storage system improved the overall system performance. (Author)

A77-26494 # **Review of the conceptual design of a doublet fusion experimental power reactor.** C. C. Baker (General Atomic Co., San Diego, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/NE-9.* 9 p. Members, $1.50; nonmembers, $3.00. Research supported by the Electric Power Research Institute.

The results of a two-year, conceptual design study of a fusion experiment power reactor (EPR) are presented. For this study, the primary objectives of the EPR are to obtain plasma ignition conditions and produce net electrical power. The design features a Doublet plasma configuration with a major radius of 4.5 m. The average plasma beta is 10 per cent which yields a thermonuclear power level of 410 MW during a 105-sec burn period. With a duty factor of 0.84, the gross electrical output is 124 MW(e) while the net output is 37. MW(e). The design features a 25-cm-thick, helium-cooled, modular, stainless-steel blanket with a 1-cm-thick, silicon carbide first wall. Sufficient shielding is provided to permit contact maintenance outside the shield envelope within 24 hr after shutdown. An overall plant concept has been developed including a superheated steam cycle power conversion system. Preliminary cost estimates and construction schedules have also been developed. (Author)

A77-26496 # **Tokamak experimental power reactor.** W. M. Stacey, Jr., M. A. Abdou, P. J. Bertoncini, C. C. Bolta, J. N. Brooks, K. Evans, Jr., J. A. Fasolo, J. C. Jung, R. L. Kustom, and V. A. Maroni (Argonne National Laboratory, Argonne, Ill.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/NE-11.* 20 p. Members, $1.50; nonmembers, $3.00. ERDA-supported research.

A plasma physics and performance analysis is conducted for a Tokamak Experimental Power Reactor (EPR) and a description of the EPR magnet system is presented. The EPR magnet system consists of the toroidal-field coil system and the poloidal-field coil system. Questions of plasma heating are discussed, taking into account the design of neutral beam injection systems and radio-frequency wave heating systems. Attention is given to the energy storage and transfer system, the vacuum systems, and the design of the first wall system. G.R.

A77-26506 # **Radiant transmittance of V-corrugated transparent sheets with application to solar collectors.** B. E. Sibbitt (National Research Council, Div. of Building Research, Ottawa, Canada) and K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-1.* 9 p. 9 refs. Members, $1.50; nonmembers, $3.00. Contract No. E(11-1)-2597.

A77-26508 # **Performance measurements of a cylindrical glass honeycomb solar collector compared with predictions.** J. C. McMurrin, N. A. Djordjevic, and H. Buchberg (California, University, Los Angeles, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-3.* 10 p. 11 refs. Members, $1.50; nonmembers, $3.00. NSF-ERDA-supported research.

A glass-tube honeycomb solar collector, composed of a conventional single-glazed flat-plate water-cooled nonselective black absorber with a cylindrical glass honeycomb mounted between the plate and cover glass was designed, fabricated, and tested. The test procedure followed the National Bureau of Standards method of testing for rating solar collectors. The honeycomb consists of individual cylindrical thin-wall glass tubes standing on end on the absorber plate in a hexagonal close-packed pattern. The tubes are made of glass with a mean solar absorptive index of 2.6 millionths per micron, evaluated from spectral transmittance-reflectance measurements on a tubing specimen. The collector performance equaled or surpassed theoretical predictions for measurements made over a broad range of collector inlet temperatures (43 to 116 C) and environmental conditions. Performance comparisons are made with a baseline double-glazed solar collector tested alongside the honeycomb collector. For applications requiring a working-fluid temperature of 65 C above the ambient air temperature, honeycomb collector efficiencies of 35 to 55 percent may be expected for approximately a six-hour period on clear days; for fluid temperature 40 C above ambient air temperature, efficiencies of 50 to 65 percent may be expected. (Author)

A77-26509 # **Heat transfer considerations of a nonconvecting solar pond heat exchanger.** M. S. Hipsher and R. F. Boehm (Utah, University, Salt Lake City, Utah). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-4.* 10 p. 11 refs. Members, $1.50; nonmembers, $3.00.

The heat transfer characteristics for a salt-stratified solar pond with a tube heat exchanger on the bottom are analyzed. Two approaches are utilized. In one, a detailed numerical model incorporates volumetric solar absorption and variable thermal conductivity. The second approach involves a much simpler analytical model. The bulk of the results presented are derived from the latter approach. Results of the analytical model are given to show the effects of tube spacing, heat extraction rate, pond depth, and other pertinent variables on the temperature distribution within the pond. A comparison is also shown between the analytical model and the more accurate numerical model. An experimental facility is being constructed near the Great Salt Lake. Although no experimental results are yet available, design considerations for the experimental verification of the theory are given in the paper. (Author)

A77-26511 # **Solar powered absorption cycle simulation using real and stochastic weather data.** D. K. Anand and R. W. Allen (Maryland, University, College Park, Md.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-6.* 11 p. 18 refs. Members, $1.50; nonmembers, $3.00.

A solar powered absorption cycle is simulated taking into consideration the internal heat transfer characteristics and the floating of the generator/condenser/evaporator/absorber temperatures. The coefficient of performance and capacity delivered at the evaporator is obtained with the use of real weather data as well as synthetically derived weather data. It is concluded that the inclusion of heat transfer characteristics has a significant effect on the system performance and that synthetic weather data yields results that compare favorably with real data. (Author)

A77-26512 # **An economic analysis of thermic diode solar panels.** W. W. Stargardt (Masoneilan International, Inc., Norwood, Mass.) and B. S. Buckley (MIT, Cambridge, Mass.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-7.* 11 p. 10 refs. Members, $1.50; nonmembers, $3.00. Research supported by the Cabot Solar Energy Fund; NSF Grant No. GI-43897; Contract No. E(11-1)-2854.

The objective of this study was to investigate the economic implications of using thermic diode solar panels for residential space heating. A computer model was developed to simulate the hourly heat flows of the system for various configurations and input weather conditions. The significant heat flows of the system are discussed, and the mathematical relationships describing them are represented. The residential structure assumed by the model is defined. Several simulations of one-year duration and for eight localities were made with the model to investigate the effect on heating performance of variations in panel surface area, storage layer thickness, and root angle. The cost of thermic panels was estimated based on high volume production of a manufacturing prototype design. Both conservative and liberal space heating costs were determined for each of electrical, oil, and natural gas heating. The analysis indicates that thermic panels will probably have an economic advantage for providing significant residential space heating in much of the populated portions of the Southwest. (Author)

A77-26513 # **Solar heating in the United States.** J. A. Duffie, W. A. Beckman (Wisconsin, University, Madison, Wis.), and J. G. Dekker (Container Corporation of America, Fernandiana Beach, Fla.). *American Society of Mechanical Engineers, Winter Annual*

Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-8. 10 p. 11 refs. Members, $1.50; nonmembers, $3.00. ERDA-sponsored research.

The f-Chart design method was used to evaluate the annual dollar savings, the collector area, and the fuel savings for an optimized solar energy heating system in 87 locations in North America. The results indicate that the climate in the great plains states and the Rocky Mountain states is the most favorable for solar heating. (Author)

A77-26515 # **The New Mexico Department of Agriculture solar heated and cooled building.** S. Diamond, C. Packard, R. L. San Martin, H. Shaw, P. R. Smith, and W. Stevens (New Mexico State University, Las Cruces, N. Mex.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-10.* 8 p. Members, $1.50; nonmembers, $3.00. Research supported by the Energy Research and Development Program of New Mexico; Contract No. E(29-2)-3652.

This 2369-sq m (25,500-sq ft) building has been in continuous operation since September 1975. Solar heating, cooling, and domestic hot water are provided by an integrated system which utilizes 632 sq m (6800 sq ft) of solar collectors. A lithium bromide absorption chiller is utilized for providing cooling. The system operates in various modes, allowing for the implementation of energy conserving schemes. Two 52,994-l (14,000-gal) pressurized water tanks are utilized for hot and cold storage. A dual loop system is utilized, a water-glycol solution goes through the collectors, and the energy is exchanged to water which is circulated throughout the remainder of the system. The first available performance data on this system is summarized. A cost analysis of the system is also documented. (Author)

A77-26516 # **Development of compound parabolic concentrators for solar thermal applications.** J. Allen, K. Reed, N. Levitz, W. Schertz, A. Rabl, and R. Winston (Argonne National Laboratory, Argonne, Ill.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-11.* 8 p. 5 refs. Members, $1.50; nonmembers, $3.00. ERDA-supported research.

The compound parabolic concentrator (CPC) is a nonfocusing concentrator which achieves maximal concentration with minimal tracking requirements. It allows, for example concentration values up to 10 without any diurnal tracking. The potential applications of the CPC cover space heating and cooling, process heat, solar thermal conversion and photovoltaic power generation. Several CPC collectors for high temperature (up to 200 C) operation have been designed and constructed. A variety of different configurations, materials and fabrication techniques have been tried to determine the best possible design for a given application. The performance with non-selective and with selective (black chrome) absorber coatings is compared. One of the collectors uses an absorber inside an evacuated glass tube. The test procedures are described and preliminary results are presented. (Author)

A77-26517 # **Heat pipes in flat plate solar collectors.** W. B. Bienert and D. A. Wolf (Dynatherm Corp., Cockeysville, Md.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-12.* 11 p. 9 refs. Members, $1.50; nonmembers, $3.00. Contract No. E(11-1)-2604.

The application of heat pipes as heat transport elements in flat plate solar collectors was investigated. This paper summarizes the results of component testing and describes, in detail, the performance of two prototype heat pipe collectors. Heat pipes can be used to separate the transport fluid from the solar absorber. However, special care must be taken to minimize the thermal resistance at the interface between absorber and fluid manifold. An optimized heat pipe collector has approximately the same thermal performance as an equivalent conventional collector. During intermittent insolation, the unidirectional heat transport capability of the heat pipes increases the average collection rate over that of a conventional collector. (Author)

A77-26518 # **A data acquisition, performance evaluation and monitoring system for solar heated/cooled residential dwellings.** G. R. Johnson (Colorado State University, Fort Collins, Colo.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-13.* 11 p. 11 refs. Members, $1.50; nonmembers, $3.00.

A77-26519 # **Experimental measurements and system implications of the performance of flat plate solar collector configurations.** S. R. Swanson and R. F. Boehm (Utah, University, Salt Lake City, Utah). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-14.* 11 p. 15 refs. Members, $1.50; nonmembers, $3.00.

Results are presented for tests performed on three liquid heat exchange, flat plate solar collectors in general accordance with National Bureau of Standards test procedures. The tested collectors were a standard baseline collector, a specially constructed collector using an aluminum rollbond receiver and either two inexpensive window glass or two fiberglass-reinforced plastic covers, and a Solarvak collector employing a single plexiglass cover, a selective surface, both without and with a vacuum for heat loss reduction. System calculations are presented to illustrate how the collector properties influence system design. Calculations are given for the three collector systems located in Salt Lake City, Utah. The results can be used in conjunction with cost data to provide cost effectiveness information. S.D.

A77-26520 # **Design and simulation studies for the Shenandoah Community Center large-scale solar cooling demonstration.** J. I. Craig, J. R. Williams, T. Hartman (Georgia Institute of Technology, Atlanta, Ga)., and S. F. Bruning (Newcomb and Boyd, Consulting Engineers, Atlanta, Ga.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-15.* 16 p. 18 refs. Members, $1.50; nonmembers, $3.00. Contract No. E(40-1)-4942.

A77-26521 # **Performance evaluation on the Owens-Illinois Sunpack solar energy collector.** S. Bloom (Systems Consultants, Inc., Washington, D.C.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-16.* 7 p. 8 refs. Members, $1.50; nonmembers, $3.00.

The energy collection characteristics of an evacuated tubular design solar collector are evaluated. The tubular design considered includes an evacuated space between the absorber surface and the exterior glazing. The test system used in the evaluation study contains an inline flowmeter, a fluid pump, a storage tank, a heat exchanger, and various three-way valves. Performance tests were conducted at ambient temperatures of 20, 50, and 90 F. The tubular collector was found to be superior to flat plate collectors in connection with its minimal losses associated with conduction and convection. G.R.

A77-26522 # **Solar heating and cooling and energy conservation potentials for commercial buildings.** D. L. Evans and B. D. Wood (Arizona State University, Tempe, Ariz.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-17.* 13 p. 17 refs. Members, $1.50; nonmembers, $3.00. Research supported by the Arizona Solar Energy Research Commission.

A case study of the economics of absorption chiller/flat plate solar systems applied to a commercial office building is presented. Computer modeling is used to investigate both energy consumption and energy costs of the solar cooling systems compared to those of a conventional (non-solar) system. The effect of building operation/energy conservation strategies on system performance is considered. Results are combined with an economic model that calculates the maximum solar related capital expenditures consistent with life cycle break even. The economic viability of solar cooling with absorption chillers and flat plate collectors is found to be extremely questionable. Long payback periods are required (in excess of 20 years) along with low interest rates and rapidly increasing utility rates. Strong energy conservation strategies are found to have little effect on solar

system economics. In conjunction with conventional systems, however, energy conservation does offer good alternatives, both in terms of economics and energy consumption. (Author)

A77-26524 # **Optimal mass flow rates through flat plate solar collector panels.** H. C. Hewitt and E. I. Griggs (Tennessee Technological University, Cookeville, Tenn.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-19*. 10 p. 10 refs. Members, $1.50; nonmembers, $3.00.

This study presents the techniques used for optimizing the mass-flow rate through a flat-plate solar collector to obtain maximum collection efficiency. It presents an experimental procedure which can be used to establish an optimal flow rate for a particular configuration. Data are presented for three different collector panels: roll-bond construction, serpentine construction, and manifold-type construction. The three different designs were found to require approximately the same optimal mass-flow rate per unit collector area of 48.8 kg/hr-sq m. The serpentine configuration tested required slightly less than this value. A test similar to the one used here could be used to check the operational characteristics of any individual collector. (Author)

A77-26526 # **Analysis of thermal performance of 'Solaris' water-trickle solar collector.** J. T. Beard, F. L. Huckstep, W. B. May, Jr., F. A. Iachetta, and L. U. Lilleleht (Virginia, University, Charlottesville, Va.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-21*. 11 p. 19 refs. Members, $1.50; nonmembers, $3.00. Contract No. E(40-1)-4927.

Thermal performance testing and evaluation of the Thomason 'Solaris' water-trickle solar collector have been undertaken with the aid of a special outdoor research facility. Results demonstrate the

A77-26527 # **An experimental and analytical investigation of a solar water heater.** E. I. Griggs, H. C. Hewitt, and B. R. Rodgers (Tennessee Technological University, Cookeville, Tenn.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-22*. 11 p. 25 refs. Members, $1.50; nonmembers, $3.00.

A77-26528 # **Thermal simulation of a building with solar assisted closed liquid loop unitary heat pumps.** M. Ucar, E. E. Drucker, J. E. LaGraff, and W. H. Card (Syracuse University, Syracuse, N.Y.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-23*. 11 p. Members, $1.50; nonmembers, $3.00. ERDA-supported research.

An algorithm computational program has been written for determining the thermal performance of commercial buildings. The mechanical system employs a series of water-to-air heat pumps connected in a closed loop, with a flat plate, water cooled solar collector for space and domestic water heating, a large water storage tank, and a cooling tower. Computations have been made for two building models in Washington, D.C., Boston, and Minneapolis for an eight-month heating season and for a full year on an hourly multi-zone basis. A set of empirical weather functions have been devised. The results indicate that moderate-sized collectors and large tanks are most suitable and can provide most of the heating energy necessary in the building. The cost/benefit ratio is most favorable for the cold weather climate typified by Minneapolis. (Author)

A77-26529 # **Indoor test methods to determine the effect of vacuum on the performance of a tubular flat plate collector.** U. Ortabasi (Corning Glass Works, Corning, N.Y.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/Sol-24*. 14 p. 8 refs. Members, $1.50; nonmembers, $3.00.

A description is presented of a relatively simple, but general, semi-empirical method designed to determine the effect of vacuum on the performance of advanced collectors. The collector studied consists of a 4 in. diameter Pyrex tube as the envelope and a flat copper plate absorber of 3.5 in. width, centered in the equatorial plane of the glass tubing. The solar energy absorbed in the plate is transferred to a circulating fluid. The integral form of a differential equation concerning the heat balance is used to obtain a prediction regarding the performance of a tubular collector. The investigation indicates the advantage of having a vacuum equal to or less than 0.0001 Torr. G.R.

A77-26531 # **A preliminary assessment of solar energy technology.** D. P. Garg (Duke University, Durham, N.C.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/TS-1*. 10 p. 30 refs. Members, $1.50; nonmembers, $3.00.

This paper describes the assessment of solar energy technology undertaken by an interdisciplinary team of students over a one-semester period. The methodology evolved by the group consists of problem definitions, a description of the state of technology, technological forecast, areas of impact, action-options, and recommendations. In addition, the paper discusses the solar energy component of the national energy plan, with a view to describe the program design envisioned by ERDA in this area. (Author)

A77-26536 **Research and development of cryoalternators for large-electrical power systems.** J. L. Sabrie (Electricité de France, Clamart, Hauts-de-Seine, France). In: International Cryogenic Engineering Conference, 6th, Grenoble, France, May 11-14, 1976, Proceedings. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1976, p. 41-48. 30 refs.

Advantages of large power systems operating at low temperatures are discussed along with major technical aspects of the development of large cryogenic alternators. Attention is directed to the main modes of operation, requirements for the operator, physical environment of the field winding, and power system operation and control. Technological problems in applying low-temperature techniques to the development of operationally reliable large power systems are examined. Cost effectiveness as related to efficiency and reliability is briefly analyzed. Development programs under way for creating high-power cryoalternators are reviewed. S.D.

A77-26544 **PULSAR - A flux compression stage for coal-fired power plants.** M. Cowan, W. K. Tucker, W. B. Leisher, D. L. Wesenberg, and E. C. Cnare (Sandia Laboratories, Albuquerque, N. Mex.). In: International Cryogenic Engineering Conference, 6th, Grenoble, France, May 11-14, 1976, Proceedings. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1976, p. 211-214. 6 refs. ERDA-supported research.

A generator called PULSAR is described which produces pulsed electric power by magnetic flux compression. Flux compression occurs in a generator coil of normal conductor with the initial flux being provided by a NbTi superconducting magnet. Employed as a topping stage in a coal-fired power plant, PULSAR is projected to increase plant efficiency to 50%. Electric and thermodynamic models of the PULSAR topping stage are discussed. A small-scale generator which employs a 200 kJ superconducting magnet is described, and electrical data from its experimental operation are given and compared to predictions of the numerical model. (Author)

A77-26724 **Solar power from the oceans.** G. Haber. *New Scientist*, vol. 73, Mar. 10, 1977, p. 576-578.

A description is presented of the basic features of the ocean thermal energy conversion (OTEC) scheme. The scheme is to utilize the temperature differences between the warm waters of ocean surfaces and the cool waters found at a greater depth. In one OTEC project a cold-water intake pipe would extend down into the ocean approximately 4000 ft and would bring up cold water. In the upper layers of the ocean, the temperature difference between surrounding surface water and the water in the pipe would be about 20 C. A working fluid, distinct from sea water, is to be vaporized and then converted into its original liquid form for reuse in a closed-cycle or Rankine-cycle system. One of the major problems concerning an implementation of OTEC appears to be related to the design of a

reasonably priced heat exchanger which will have an adequate operational life under the given environmental conditions. G.R.

A77-26790 **The status of instrumentation and process control techniques for in situ coal gasification.** H. M. Stoller, D. A. Northrop (Sandia Laboratories, Albuquerque, N. Mex.), and L. A. Schrider (ERDA, Laramie Energy Research Center, Laramie, Wyo.). In: Advances in test measurement. Volume 13 - Proceedings of the Twenty-second International Instrumentation Symposium, San Diego, Calif., May 25-27, 1976. Pittsburgh, Pa., Instrument Society of America, 1976, p. 117-128. 18 refs.

The paper describes ERDA's Hanna II coal gasification experiment designed to assess linkage techniques, efficiency of gasification, and control of a line drive sweep. The in situ diagnostics includes thermal measurements, gas sampling, and pressure measurements, while the remote sensing techniques used include passive acoustics, induced seismic, surface resistivity, and subsurface resistivity. B.J.

A77-26925 **More about geothermal steam or the hottest energy prospect ever.** R. J. Birsic. Fullerton, Calif., R. J. Birsic, 1976. 176 p. $9.95.

Brief remarks on the nature, extraction, use, and advantages of geothermal steam and heat are followed by a nation-by-nation survey of geothermal resources around the world. Several world maps indicating occurrences of usable geothermal resources; existing geothermal plants, and geological formations propitious to geothermal heat extraction are displayed, in addition to regional maps. Geothermal national regions surveyed include: Japan, Italy, USA, Iceland, Mexico, Hungary, Indonesia, Kenya, New Zealand, Turkey, USSR. R.D.V.

A77-27032 **Principles and application of systems in engineering as rational aid for economy, state, and research; Meeting, Bonn, West Germany, November 9, 10, 1976, Communications (Grundlagen und Anwendung der Systemtechnik als rationales Hilfsmittel für Wirtschaft, Staat und Forschung; Tagung, Bonn, West Germany, November 9, 10, 1976, Mitteilungen).** Meeting sponsored by the Verein Deutscher Ingenieure and Deutsche Gesellschaft für Luft- und Raumfahrt. *VDI-Berichte,* no. 262, 1976. 131 p. In German.

The papers collected here examine the use of systems engineering principles in the planning of complex systems. Topics covered include an introduction to systems engineering, the optimization of availability of transport aircraft, models for power generation plant planning, and an energy model for the Federal Republic of Germany. P.T.H.

A77-27036 **Model formulations for development planning of energy systems (Modellansätze zur Ausbauplanung von Energieversorgungssystemen).** K. Theilsiefje. *(Verein Deutscher Ingenieure and Deutsche Gesellschaft für Luft- und Raumfahrt, Tagung über die Grundlagen und Anwendung der Systemtechnik als rationales Hilfsmittel für Wirtschaft, Staat und Forschung, Bonn, West Germany, Nov. 9, 10, 1976.) VDI-Berichte,* no. 262, 1976, p. 63-70. In German.

The paper discusses some models for use in planning development of power plants. Some of the features of the use of dynamic programming, linear programming, and simulation during planning are examined. The principle of concentration of solutions of the development planning problem to just a few decisions at the beginning of the planning period is illustrated. P.T.H.

A77-27276 # **Political and economic justification for immediate realization of a syn fuels industry.** J. T. Gallagher (American Lurgi Corp.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 23 p. 5 refs.

After a review of the political advantages of syn fuels (both LNG and SNG) as well as their economic (regional and national) benefits, it is concluded that a strong justification exists for the immediate launching of a syn fuels industry. In less than four years, it is maintained, four large SNG plants could be built and operating. B.J.

A77-27277 # **Dilute-phase hydrogasification process for SNG production.** H. F. Chambers, Jr., J. A. Mima, and P. M. Yavorsky (ERDA, Pittsburgh Energy Research Center, Pittsburgh, Pa.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 16 p.

The paper discusses system operability and reliability for the dilute-phase hydrogasification (DPH) process under exploratory development for the production of pipeline quality substitute natural gas. In the DPH process, raw coal is fed directly to the reactor so that the particles free-fall in a dilute cloud through the hydrogen atmosphere. During free-fall, particles are heated very rapidly forming a nonagglomerating and highly reactive char, thus eliminating the requirement for coal pretreatment. Another attractive feature of the process is that nominally 90% of the methane product is produced directly in the reactor, requiring only a light methanation step to remove the roughly 5% CO remaining in the effluent gas. A block diagram of the DPH process is presented. Experimental results demonstrate the successful continuous operation of a single-stage DPH process in a series of long-duration experiments with Illinois hvCb coal and North Dakota lignite. S.D.

A77-27278 # **Applicability of the Meyers Process for desulfurization of U.S. coal /A survey of 35 coal mines/.** R. A. Meyers and J. W. Hamersma (TRW Systems and Energy, Redondo Beach, Calif.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 7 p. 10 refs.

A77-27279 # **SO2 control technologies - Commercial availabilities and economics.** W. H. Ponder, R. D. Stern (U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Research Triangle Park, N.C.), and G. G. McGlamery (Tennessee Valley Authority, Muscle Shoals, Ala.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 30 p. 20 refs.

The principal technologies that will be available for continuous SO2 emission control through 1980 are discussed in terms of commercial availability: (1) the use of coal that occurs naturally with an acceptably low sulfur content, (2) physical and chemical cleaning of coal, and (3) flue gas desulfurization. Other technologies currently being developed that could make significant contributions to SO2 control after 1980 are also discussed, including coal gasification, coal liquefaction, and fluidized bed combustion of coal. B.J.

A77-27284 # **Applications of the Woodall-Duckham two stage coal gasification.** A. J. Grant (Woodall-Duckham /USA/, Ltd., Pittsburgh, Pa.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 12 p.

The Woodall-Duckham (W-D) two-stage coal gasification process separates the volatile matter of coal before subjecting the remainder of the coal to the high temperatures of the gasification reactions. Attention is given to the roles of hot raw gas and desulfurized gas in the process, and gas characteristics are considered. B.J.

A77-27285 # **Fluidised coal combustion - What can be done now.** A. J. Grant (Woodall-Duckham /USA/, Ltd., Pittsburgh, Pa.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 5 p.

A brief review is given of currently practicable lean-bed fluidized combustion technology and fluidized bed combustion of coal as an auxiliary step in heightening the efficiency of coal gasification, coal liquefaction, and coal beneficiation processes. High-sulfur coal fines, char, residual tars and oils, and tailings or reject stream from a coal beneficiation step (with acknowledged low heating value and high sulfur content) can be upgraded by a lean-bed fluidized combustion step with environmental side benefits. Applications of the process at atmospheric pressure and at elevated pressures are discussed. R.D.V.

A77-27286 # **The SYNTHANE process - Current status.** W. P. Haynes, J. P. Strakey, and R. Lewis (ERDA, Pittsburgh, Pa.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 14 p.

The SYNTHANE process is a fairly simple coal gasification process with no major recycle streams and therefore has the potential of operating with a high on-stream factor. It is designed to operate at pressures up to 1000 psi with any of the coals or lignites available in the U.S. and its thermal efficiency has been calculated to be 65-70%. The paper reviews shakedown and orientation tests completed on the gasifier section of the 72 ton per day SYNTHANE pilot plant, along with initial gasification tests with Rosebud subbituminous coal. B.J.

A77-27288 # **Comparison of coal conversion processes for electric power generation.** E. Interess (Arthur D. Little, Inc., Cambridge, Mass.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 19 p. 7 refs.

The relative economic positions of some of the competing technologies for producing electric power from coal and coal-derived fuels are assessed. Economics are presented for new large-scale (1000 MW) installations of commercial availability in the period 1980-1985. Based on pertinent economics and efficiency data, plots of power cost versus load factor (average annual percent of capacity operated) are prepared for each overall conversion scheme. Advanced power systems now under development appear to have only slight potential advantage over conventional steam/electric generation with flue gas desulfurization (FGD). Dispersed fuel cells offer the most promise in the intermediate load range. Gas turbines based on coal-derived distillates are attractive in the peak range. Solvent refined coal for feed to a new conventional power plant is less economical. Heavy coal liquids have a similar position to solvent refined coal. Methanol from coal has little attractiveness for large-scale utility use when compared with other clean fuels from coal and direct fired coal with FGD. S.D.

A77-27289 # **The H-Coal Process.** C. C. Kang and P. H. Kydd (Hydrocarbon Research, Inc., Trenton, N.J.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 14 p. Research supported by the Electric Power Research Institute, Ashland Oil, Inc., Commonwealth of Kentucky, and ERDA.

The H-Coal Process pilot plant, located at Catlettsburg, Kentucky, is designed for two modes of operation: (1) to process 600 tons of coal per day to produce 1,820 barrels of fuel oil containing no more than 0.7 wt % sulfur from coal containing more than 3 wt % sulfur (fuel oil mode), and (2) to process 200 tons of coal per day to produce 705 barrels per day of synthetic crude (syncrude mode). Recent experimental results are discussed including catalyst attrition, and the syncrude mode with hydroclone recycle. Attention is also given to the solid-liquid separation system required for the fuel-oil mode. B.J.

A77-27290 # **Fluidized bed combustion.** D. L. Keairns (Westinghouse Research Laboratories, Pittsburgh, Pa.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 25 p. 33 refs.

Fluidized bed combustion processes discussed involve heat recovery for industrial or commercial use, steam generation, or electric power generation. Basic fluo combustion process features, the main advantages of fluo combustion (reduced volume, modular construction, reduced heat transfer surface requirements, reduced fuel costs, greater flexibility, reduced sulfur or nitrogen oxides emissions, easier maintenance, lesser environmental impact) are discussed. Pressurized and atmospheric-pressure fluidized bed systems are contrasted. R.D.V.

A77-27292 # **The SRC-II process.** B. K. Schmid and D. M. Jackson (Gulf Mineral Resources Co., Denver, Colo.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 27 p. 5 refs. ERDA-sponsored research.

The SRC-II process is such that a portion of the product slurry is recycled as a 'solvent' for the coal rather than using an all-distillate liquid as in the original version of the process. In particular, conversion of a large part of the dissolved coal to liquids makes it possible to eliminate the filtration step, the mineral residue drying step, and the product solidification step of the SRC-I process. A proposed demonstration plant program is discussed relative to investment costs and scale-up problems such as slurry mixing and pumping, slurry preparation, dissolver system, fractionation, pumping and handling of concentrated slurries, hydrogen purification, gasifier, and oxygen compression. S.D.

A77-27293 # **Environmental aspects of coal conversion plant siting and cost of pollution control.** G. N. Reddy (Argonne National Laboratory, Argonne, Ill.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 77 p. 30 refs.

The state of the art of coal conversion technology is reviewed with attention given to the Lurgi gasifier, the Kopper-Totzek gasifier, the Winkler gasifier, the Hygas Process, and the Synthane Process. Potential health effects due to exposure to products from coal conversion facilities are considered with emphasis on health effects of environmental contamination and occupational health implications. Federal and State environmental rules and regulations applicable to coal conversion facilities are examined along with the cost of pollution control. B.J.

A77-27294 # **An overview of the U.S. energy dilemma.** C. A. Stokes (Venture Consultant, Princeton, N.J.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 12 p.

An investigation is conducted concerning the current situation with regard to the commercializable processes which can provide a basis for a considerably enlarged use of coal as a substitute for petroleum and natural gas. Recommendations are made regarding suitable approaches for overcoming the existing difficulties concerning a commercialization of available coal conversion processes. Attention is given to difficulties related to the irrational pricing structure for natural gas and the controlled crude oil price, problems involved in the direct burning of coal, aspects of investment, the employment of the fluid bed boiler, and the use of industrial fuel gas. G.R.

A77-27295 # **A new concept for the manufacture of low sulfur fuels and chemicals from coal.** L. H. Udani, R. R. Maddocks (Catalytic, Inc., Philadelphia, Pa.), and C. A. Stokes (Venture Consultant, Princeton, N.J.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 21 p. 10 refs.

The paper examines the feasibility and profitability of a 'coalfinery and chemicals plant' scheme based on hydroliquefaction of coal, solvent de-ashing, partial oxidation of coal residue containing the bulk of the impurities, and production of ammonia from synthesis gas. It is shown that this kind of a simple coal refinery makes good engineering and economic sense on a commercial scale if one can put the low sulfur fuel into power and the less pure fuel cut into chemicals, just as is done with the analogous petroleum cuts. It is recommended that industry look forward at this approach to commercialize three separate aspects: low sulfur utility fuel from coal to supplant low sulfur petroleum fuel; chemicals from coal to supplant natural gas; and industrial fuel gas from coal to supplant petroleum fuels and natural gas. S.D.

A77-27296 # **HYGAS process update.** K. S. Vorres (Institute of Gas Technology, Chicago, Ill.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 13 p.

The HYGAS process involves hydrogen gasification of coal, with the main product being substitute natural gas. The historical development of the process is reviewed with attention given to

several methods of hydrogen generation, including catalytic steam reforming of natural gas, electrothermal gasification, and steam-oxygen gasification. A total of 37 tests were conducted with lignite, including a total of 5500 tons of lignite processed, and a total of 17 tests were conducted involving a total of 3100 tons of bituminous coal. B.J.

A77-27298 # **The Riley-Morgan gasifier.** T. F. Walsh (Riley Stoker Corp., Worcester, Mass.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 9 p.

The development of the Riley-Morgan coal gasification process is reviewed. Attention is given to the pilot plant in Worcester, built to provide operating experience and to explore problems associated with tar formation from bituminous coals. This unit was operated for over a year on low ash fusion and highly caking varieties of eastern bituminous coals, using both air and oxygen. B.J.

A77-27299 # **Mobil process for the conversion of methanol to gasoline.** J. J. Wise (Mobil Research and Development Corp., Paulsboro, N.J.) and A. J. Silvestri (Mobil Research and Development Corp., Princeton, N.J.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 15 p. 6 refs. Contract No. E(49-18)-1773.

The paper shows that coupling the Mobil Methanol-to-Gasoline Process with coal-to-methanol technology provides a new route for the conversion of coal to gasoline. In the manufacture of gasoline from coal, coal is gasified to form synthesis gas which, after purification, is converted to methanol; crude methanol is then converted to gasoline and water. The equipment used in the Mobil Methanol-to-Gasoline Process is described as a petroleum hydrotreater. Typical process conditions and yields are tabulated. The gasoline produced in the Mobil Process is of very high quality, where the octanes exceed the current requirements for both unleaded regular and leaded premium. Particular attention is given to the coproduction of gasoline and SNG via the Mobil Process. The advantage of coproduction stems from the retention of the methane produced in the gasification step as SNG rather than converting it to additional synthesis gas. The Mobil Process is used to convert the crude methanol to gasoline, LPG, and a small amount of additional SNG. The high thermal efficiency of this combination process is discussed. S.D.

A77-27300 # **Current status of the BI-GAS process.** R. K. Young (Bituminous Coal Research, Inc., Monroeville, Pa.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 20 p. 10 refs. Research supported by the American Gas Association; Contract No. E(49-18)-1207.

In the BI-GAS coal gasification process, coal is introduced into the upper section of the gasifier at pressures of 1000-1500 psi. The coal comes in contact with a stream of hot synthesis gas produced in the lower section of the gasifier and is partially converted into methane and an additional synthesis gas. Experimental results on the stage 2 process equipment development unit show the following conclusions: methane yield depends upon coal rank and processing conditions such as temperature and partial pressure of hydrogen; the direct methanation process is applicable to several different types of coal; yield of methane expressed as percent conversion of carbon in coal increases with coal rank. B.J.

A77-27301 # **Implications of utilizing synthetic fuels in combined cycles.** D. J. Ahner (General Electric Co., Schenectady, N.Y.). *University of Pittsburgh, Annual International Conference on Coal Gasification and Liquefaction, 3rd, Pittsburgh, Pa., Aug. 3-5, 1976, Paper.* 26 p.

It is pointed out that gas turbines operating on oil or natural gas fuels and integrated with heat recovery steam cycles have the highest conversion efficiencies in the industry. The type of fuels to be utilized in combined cycles can have an important effect on the basic equipment configuration employed. Liquid fuels from coal are considered and the significance of fuel properties on gas turbine performance is examined. Ash-forming trace contaminants, chemical properties, and physical properties of gas turbine liquid fuels are discussed. Attention is also given to gas fuels from coal and coal based solid fuels integrated with combined cycles. G.R.

A77-27341 **Fracturing oil shale for in situ retorting experiments.** H. C. Carpenter (ERDA, Laramie Energy Research Center, Laramie, Wyo.). *AIChE Symposium Series,* vol. 72, no. 155, 1976, p. 1-13. 6 refs.

Since oil shale is a rock with little or no permeability, it must be fractured to allow the passage of fluids for retorting by in situ methods. A number of fracturing techniques have been investigated: (1) electrolinking, or electrocarbonization, accomplished by passing high voltages through the shale, (2) hydraulic fracturing, and (3) explosive fracturing. In one experiment, desensitized nitroglycerin was displaced into a naturally occurring porous zone and into a sand-propped hydraulic fracture. B.J.

A77-27342 **Development of the modified in situ oil-shale process.** H. E. McCarthy, C. Y. Cha (Occidental Exploration and Production Co., Bakersfield, Calif.), W. J. Bartel, and R. S. Burton (Occidental Oil Shale, Inc., Grand Junction, Colo.). *AIChE Symposium Series,* vol. 72, no. 155, 1976, p. 14-23. 11 refs.

The modified in situ oil-shale process, the Oxy process, consists of creating underground chimneys of broken oil shale by expanding the oil shale into a previously mined-out void volume utilizing conventional explosives. The process consists of two basic steps: (1) forming the in situ retort by mining approximately 15 to 20% of the oil-shale deposits and expanding the remaining part into the mined-out void volume, and (2) retorting the rubblized oil shale in place using underground combustion. B.J.

A77-27343 **Combustion of oil-shale carbon residue.** L. Dockter (ERDA, Laramie Energy Research Center, Laramie, Wyo.). *AIChE Symposium Series,* vol. 72, no. 155, 1976, p. 24-31. 7 refs.

Oil-shale core samples were used to investigate the oxidation rate of the residual carbon remaining in retorted shale. Results indicate very little effect on the rate from temperature or air-sweeping rate. The oxidation rate is linearly proportional to the square root of the oxidation time and increases linearly with sample Fischer assay. (Author)

A77-27344 **In-place recovery of multiple products from Colorado's saline-mineral-bearing Piceance Basin.** T. N. Beard and J. W. Smith (ERDA, Laramie Energy Research Center, Laramie, Wyo.). *AIChE Symposium Series,* vol. 72, no. 155, 1976, p. 32-38. 14 refs.

The major difficulty of in situ production of oil and associated minerals from oil shale is that the shale has no primary porosity or permeability; consequently, underground void space must be created before the oil shale can be processed in place. With respect to the Piceance Creek Basin, the paper outlines an integrated in situ process for extracting the nahcolite to develop porosity and permeability, generating and recovering oil from the artificially leached chamber, and subsequent leaching of dawsonite products from the processed shale residue. B.J.

A77-27347 **The Asphalt Ridge tar-sand deposits.** R. M. Lowe (Sohio Petroleum Co., Oklahoma City, Okla.). *AIChE Symposium Series,* vol. 72, no. 155, 1976, p. 55-60. 5 refs.

The paper examines recovery processes - extraction methods (water, solvent, and mixed water-solvent) and thermal methods (direct and indirect) - for bitumen from mined oil with reference to tar sand deposits in Asphalt Ridge, Utah. The U.S. Bureau of Mines hot water-solvent oil recovery process is described in detail and current commercial research and development in U.S. tar sands extraction methods are reviewed. B.J.

A77-27348 **Field experiment of in-situ oil recovery from a Utah tar sand by reverse combustion.** C. O. Cupps, C. S. Land, and L. C. Marchant (ERDA, Laramie Energy Research Center, Laramie,

Wyo.). *AIChE Symposium Series,* vol. 72, no. 155, 1976, p. 61-68. 9 refs.

Research in oil recovery from tar sands at the ERDA Laramie Energy Research Center is reviewed. Attention is given to the 1975 field experiment in the Northwest Asphalt Ridge near Vernal, Utah, to test in situ oil recovery by reverse combustion, which has two main advantages over forward combustion for tar sands: (1) vaporized fluids move through the hot, burned-out part of the reservoir with no possibility of plugging, and (2) the oil produced is of higher quality than the original bitumen. B.J.

A77-27349 **Recovery of bitumen from oil-impregnated sandstone deposits of Utah.** A. G. Oblad, J. D. Seader, J. D. Miller, and J. W. Bunger (Utah, University, Salt Lake City, Utah). *AIChE Symposium Series,* vol. 72, no. 155, 1976, p. 69-78. 12 refs. Research supported by the Department of Development Services of Utah and Mobil Foundation; NSF Grant No. AER-74-21867.

The principal distinguishing features of Utah tar sand deposits include the consolidated and anhydrous nature of the sands, the lower bitumen content and the more variable bitumen composition as compared with Canadian deposits, and the general lack of adequate amounts of water for recovery and processing. The paper discusses the extent of Utah tar sand deposits, the physical and chemical properties of the sand and bitumen, current research in recovery (hot water extraction and thermal recovery) technology, and plans for bitumen upgrading studies. B.J.

A77-27351 **Net energy analyses for liquid-dominated and vapor-dominated hydrothermal energy-resource developments.** L. Icerman (California, University, La Jolla, Calif.). *Energy* (UK), vol. 1, Dec. 1976, p. 347-365. 54 refs.

Detailed energy evaluations of the energy requirements for construction and operation of 100-MW-e flashed-stream, binary-cycle and total-flow power plant designs for utilization of liquid-dominated hydrothermal reservoirs indicate that the meaningful net energy ratios range from about seven to eleven. Utilization of dry cooling towers in place of evaporative cooling systems may be required in many locations and may reduce the specified net energy ratios by about 15%. A similar analysis of the energy requirements for the construction and operation of a 100-MW-e power plant utilizing a vapor-dominated hydrothermal reservoir leads to net energy ratios for vapor-dominated electrical power generation as high as 19. B.J.

A77-27352 **Geothermal development and the Salton Sea.** M. Goldsmith (California Institute of Technology, Pasadena, Calif.). *Energy* (UK), vol. 1, Dec. 1976, p. 367-373. 12 refs. NSF Grant No. AER-75-08793.

The paper examines the relationship of the Salton Sea, a key element of the Imperial Valley water system, to potential geothermal development. Both water quantity and quality considerations suggest that the Salton Sea cannot be used as a repository for large amounts of geothermal brine. Diversion of some of the inflow to the Sea will have the beneficial effect of lowering the surface level, but will also tend to increase the salinity level. For the cooling water diversion to a 100 MW power plant, both effects are small; for a 1000 MW power plant, the effects are substantial. The use of Salton Sea water for injection fluid to maintain geothermal reservoir pressure will lower the elevation of the Sea and reduce its salinity. B.J.

A77-27354 **On enthalpy management in small buildings.** A. L. Berlad (New York, State University, Stony Brook, N.Y.), F. J. Salzano, and J. Batey (Brookhaven National Laboratory, Upton, N.Y.). *Energy* (UK) vol. 1, Dec. 1976, p. 429-443. 19 refs. ERDA-sponsored research.

The paper analyzes enthalpy management requirements of residential and small commercial buildings, and integrated approaches to energy-efficient and cost-effective heating and cooling schemes are proposed. The use of Comfort Range Thermal Storage (temperatures in the range 65-75 F) is central to these approaches; fossil-fuel heaters, heat pumps, solar collectors, electric-driven air coolers, all can be used more efficiently when they are effectively interfaced with selected thermal storage systems. A central heated (fossil fuel) and cooled (electric air-conditioner) residence located in Long Island, New York is considered as an example. B.J.

A77-27356 **Parametric studies of applications of controlled thermonuclear reactor fusion energy for food production.** V.-D. Dang and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). *Energy* (UK), vol. 2, Mar. 1977, p. 9-23. 50 refs. ERDA-sponsored research.

Food and energy shortages in many parts of the world in the past two years raise an immediate need for the evaluation of energy input in food production. The present paper investigates systematically the energy requirement for food production and the provision of controlled thermonuclear fusion energy for major energy intensive sectors of food manufacturing. Energy input for fertilizers, irrigation water and food processing have been chosen for detailed study. A controlled thermonuclear power reactor was used to provide electrical and thermal energy for these processes. Conceptual designs of the application of controlled thermonuclear power, water and air for methanol and ammonia synthesis and single cell protein production are presented. Economic analysis shows that these processes can eventually be competitive. (Author)

A77-27607 **The importation of liquefied natural gas.** E. Drake (Arthur D. Little, Inc., Cambridge, Mass.) and R. C. Reid (MIT, Cambridge, Mass.). *Scientific American,* vol. 236, Apr. 1977, p. 22-29.

The safety of tankers and storage tanks for liquefied natural gas (LNG), and fire/explosion hazards, accompanying storage, transfer, and use of LNG, are discussed. Materials for ship and shore tankage, safety measures, and various LNG hazards ('rollover' mixing of tank contents, flameless vapor explosion, methane/water interaction, transport or accidental release of LNG vapor), plus extraneous accidents (sabotage, crashing into tanks, earthquake, fires in vicinity) are discussed. The 1944 Cleveland and 1973 Staten Island (New York) accidents are described. The relevance of available technology for handling rocket fuels is pointed out. Sources of natural gas and large users of LNG are listed. R.D.V.

A77-27722 # **State of the art of controlled fusion (Der gegenwärtige Stand der gesteuerten Kernfusion).** M. S. Rabinovich (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR). *Beiträge aus der Plasmaphysik,* vol. 16, no. 6, 1976, p. 353-367. 22 refs. In German. (Translation).

The development of stationary fusion reactors (Tokamak and stellarator) is reviewed. Yet unsolved Tokamak-development problems are discussed including pseudoclassical electron thermal conductivity, disruptive instability, transport of impurities, and trapped ion instability. Attention is given to the physical diagnostics of Tokamak and stellarator reactors and to the energetic confinement time of plasmas. B.J.

A77-27881 **Geothermal energy development.** H. C. H. Armstead. *Progress in Energy and Combustion Science,* vol. 2, no. 4, 1977, p. 181-238. 134 refs.

In a brief examination of possible new energy sources which can be used to take the place of the rapidly disappearing fossil fuels, it is found that possibly only geothermal approaches can provide energy in sufficient quantity. An investigation is conducted concerning the characteristics of geothermal energy, its current exploitation, and the possibilities for its utilization. Attention is given to applications of geothermal energy, the structure of the earth, the estimated heat reserves of the earth, the nature of geothermal fields, aspects of geothermal exploration, problems of drilling, well characteristics and their measurements, fluid collection and transmission, approaches for geothermal power generation, economic aspects of geothermal energy, chemical and metallurgical problems, and environmental factors. A systematic approach to geothermal development is considered along with the creation of artificial thermal fields, novel drilling techniques, and the direct tapping of volcanoes. G.R.

A77-27882 # **Current problems in energy development and energy sciences (Soucasne problemy rozvoje energetiky a energeticke**

vedy). F. Homola. *Energetika* (Prague), vol. 27, Feb. 1977, p. 62-69. In Czech.

A qualitative survey is presented of worldwide energy problems and opportunities, acknowledging current emphasis on electrical energy as the most universal and most versatile form of usable energy. A brief historical overview and promotion of cybernetics is followed by comparisons of forms of energy sources and energy production in recent decades, with attention to more recent ecological concerns. The finiteness of energy resources, exponentially growing energy demands, and new methods of energy production and energy conversion are outlined; nuclear fission power, thermonuclear fusion research, geothermal heat, utilization of thermal differentials, solar energy, wind power, hydroelectric power, reflection of solar energy via microwaves from satellite orbit, and combustion of wastes are mentioned. Selection of appropriate voltage levels for international power grids is discussed. R.D.V.

A77-27890 Electricity and the energy 'gap'. P. C. Greiner (Edison Electric Institute, New York, N.Y.). *ASHRAE Journal*, vol. 19, Mar. 1977, p. 30-32.

The paper gives a brief summary of some of the main projects being organized and carried out by electric utility companies across the U.S. for investigating the potential of solar energy, geothermal energy, wind power, and fusion power as energy sources of the future. The aims of the Edison Electric Institute conservation and energy management efforts are outlined. The AXCESS energy analysis computer program is mentioned, which is a computerized method for comparing the energy requirements of a building using alternate mechanical/electrical systems. It allows the designer to compare total building energy usage and demand for each such system, using any combination of available energy sources. P.T.H.

A77-27891 Gas-fired heat pumps - An emerging technology. L. A. Sarkes, J. A. Nicholls, and M. S. Menzer (American Gas Association, Arlington, Va.). *ASHRAE Journal*, vol. 19, Mar. 1977, p. 36-41.

The paper estimates the market potential and the economic savings afforded by the use of heat pumps and gas-fired heat pumps in particular. Three gas-fired heat pump designs are studied and evaluated: a Stirling/Rankine system, a Brayton/Rankine system, and a gas absorption heat pump. P.T.H.

A77-28050 # Studies on realization of normal combustion of hydrogen in spark-ignition engines by reduction of temperature of residual burnt gases (Recherches concernant la réalisation d'une combustion normale de l'hydrogène dans les moteurs à allumage par étincelle, par la diminution de la température des gaz brûlés résiduels). C. A. Vasilescu, I. Ianovici, and M. Soiman. *Revue Roumaine des Sciences Techniques, Série Electrotechnique et Energétique*, vol. 22, Jan.-Mar. 1977, p. 135-145. In French.

The possibility of avoiding ignition by hot residual gases upon admission of air-hydrogen fuel mixture in a spark-ignition engine was investigated theoretically and experimentally. One possibility studied is the reduction of the gas temperature in the cylinder by introducing air. The effect of fuel composition as cooling gas and the influence of recirculated burnt gases as moderators of the chemical reactions are studied. Results from an experimental motor are used to investigate these effects. The study shows the advantage of high compression ratios and the effectiveness of cooling the residual gases by introducing air in the cylinder before admitting fresh fuel mixture. P.T.H.

A77-28067 Bibliography on solar cells. G. K. Mahajan (Central Electronics Engineering Research Institute, Pilani, India). *Institution of Electronics and Telecommunication Engineers, Journal*, vol. 22, Oct. 1976, p. 680-688. 341 refs.

A literature search on solar cells was performed and a bibliography of 341 references was compiled for the period 1970 to 1974. The sources consulted, for the compilation, are - Electrical and Electronics Abstracts, Electronics and Communications Abstracts Journal, Engineering Index, Scientific and Technical Aerospace Reports, Government Reports Announcements, and the primary sources available in the libraries of CEERI, Pilani and BITS, Pilani. The bibliography has been classified under 10 headings. Under each heading, the entries have been arranged first in chronological order and then under each year alphabetically. (Author)

A77-28126 * Power Sources Symposium, 27th, Atlantic City, N.J., June 21-24, 1976, Proceedings. Symposium sponsored by the U.S. Army, U.S. Air Force, U.S. Navy, NASA, ERDA, and Communications Satellite Laboratories. Red Bank, N.J., PSC Publications Committee, 1976. 224 p.

A lithium-chlorine rechargeable battery is considered along with an FeS electrode development for a secondary Li5Si-FeS battery, the sodium-sulfur battery, nickel battery systems for electric vehicles, reactions in lithium thionyl chloride cells, progress in the development of lithium inorganic batteries, a stable electrolyte for Li/SO2 reserve cells, and rechargeable lithium transition metal sulfide batteries. Attention is also given to thermal runaway tests on nickel-cadmium aircraft batteries, the development of nickel-zinc batteries for aircraft, an evaluation of sealed lead acid batteries for aircraft applications, the charging of sealed lead-acid batteries,

A77-28148 Development of nickel-zinc batteries for aircraft. W. S. Bishop (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio), D. L. Call, J. K. Wilson, and R. A. Brown (Eagle-Picher Industries, Inc., Joplin, Mo.). In: Power Sources Symposium, 27th, Atlantic City, N.J., June 21-24, 1976, Proceedings. Red Bank, N.J., PSC Publications Committee, 1976, p. 97-99.

Investigations of cell capacity as a function of discharge current and temperature, and of cell discharge behavior at various current levels indicate that the nickel zinc battery has adequate high rate and low temperature performance to make it acceptable for many aircraft applications. Reasonable cycle lives are achieved under simulated aircraft use; however, longer life would make the battery a more attractive option on a total life cycle cost basis. B.J.

A77-28157 Oxygen accumulation and electrolyte loss in nickel hydrogen cells. H. H. Rogers (Hughes Aircraft Propulsion and Power Systems Laboratory, Los Angeles, Calif.). In: Power Sources Symposium, 27th, Atlantic City, N.J., June 21-24, 1976, Proceedings. Red Bank, N.J., PSC Publications Committee, 1976, p. 128-130. Contract No. F33615-75-C-2025.

Stability of the electrodes in a nickel hydrogen cell requires the selection of a stack assembly which minimizes the effects of parasitic failure modes. An investigation was conducted of the influence of electrode stack configuration and materials on two failure modes: (1) the accumulation of oxygen gas exceeding flammable limits, and (2) the loss of electrolyte from the electrode stack during cycling. Attention was given to an asbestos separator stack, a nylon separator stack, a special separator stack, and a recirculating oxygen stack. B.J.

A77-28166 Improved acid electrolytes for the hydrocarbon-air fuel cell. A. A. Adams, R. T. Foley (American University, Washington, D.C.), and G. W. Walker (U.S. Army, Electrochemical Div., Fort Belvoir, Va.). In: Power Sources Symposium, 27th, Atlantic City, N.J., June 21-24, 1976, Proceedings. Red Bank, N.J., PSC Publications Committee, 1976, p. 172-175. 14 refs. Grants No. DAAK02-72-C-0084; No. DAAG53-76-0001.

The electrochemical behavior of helium, hydrogen, hydrogen-carbon monoxide mixtures, various low molecular weight hydrocarbons, and air in CF3SO3H.H2O was investigated at various temperatures on both smooth platinum and platinized electrodes. The results of these adsorption experiments in CF3SO3.H2O indicate little or no formation of the undesirable adsorbed polymeric carbon intermediates during the propane oxidation observed in other electrolytes. From these results it is concluded that continued research on acid electrolytes can lead to fuel cell systems competitive with other energy conversion devices. A.Y.

A77-28168 Hydrocarbon fuel conditioner for a 1.5 kW fuel cell power plant. M. A. Callahan (U.S. Army, Army Mobility

Equipment Research and Development Command, Fort Belvoir, Va.) and W. R. Haas (IIT Research Institute, Chicago, Ill.). In: Power Sources Symposium, 27th, Atlantic City, N.J., June 21-24, 1976, Proceedings. Red Bank, N.J., PSC Publications Committee, 1976, p. 180-182. 9 refs.

A77-28170 Radioisotope power sources in the terrestrial and marine environment. T. J. Holleman (U.S. Navy, Washington, D.C.) and E. J. Wahlquist (ERDA, Div. of Nuclear Research and Applications, Washington, D.C.). In: Power Sources Symposium, 27th, Atlantic City, N.J., June 21-24, 1976, Proceedings. Red Bank, N.J., PSC Publications Committee, 1976, p. 199, 200. 6 refs.

The paper discusses the development of a 1-kWe Stirling radioisotope power system for integration into an unmanned free-swimming submersible demonstration vehicle. The Stirling conversion system is coupled to a Pu-238 heat source whose design is based on the multihundred-watt heat-source technology developed for space generators. The challenge of integrating a nuclear heat source with a dynamic converter is noted along with a study undertaken to evaluate both isotope-fueled and nonisotope-fueled unattended power systems in the 2-kWe range for application in cold regions. Suitable inexpensive isotope fuels considered include Sr-90 and other 'waste' byproducts of plutonium processing. F.G.M.

A77-28171 Low cost dynamic energy conversion systems. J. E. Boretz (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: Power Sources Symposium, 27th, Atlantic City, N.J., June 21-24, 1976, Proceedings. Red Bank, N.J., PSC Publications Committee, 1976, p. 201-205.

Two typical applications of the mini-HEPS are considered. The first is an electric power supply for a portable laser-radar ranging computer for the Stinger missile 'fire and forget' control circuit; the other is a waste-heat-powered mini-HEPS capable of providing 1500 W of continuous electrical power for a long-duration remote-piloted-vehicle mission. Tradeoffs with alternate power systems such as batteries and fuel cells are discussed, and advantages of the mini-HEPS are noted. F.G.M.

A77-28255 # **The application of linear programming methods to the problem of choosing required reserves of energy for controlled plants (Primenenie metodov lineinogo programmirovaniia k zadache vybora potrebnykh zapasov energii upravliaemykh ob'ektov).** V. A. Dolodarenko. In: Some questions of dynamics and motion control. Kiev, Izdatel'stvo Naukova Dumka, 1976, p. 57-68. 7 refs. In Russian.

The paper describes a linear programming method applied to the problem of choosing required energy reserves for a vehicle whose function is to deliver cargo from a given combination of initial points to a given combination of final points. A probabilistic method is used to obtain a target function that accounts for the distribution of distances between points. B.J.

A77-28322 Superalloys - Their use and requirements in advanced energy systems. C. T. Sims (General Electric Co., Gas Turbine Products Div., Schenectady, N.Y.). In: Superalloys: Metallurgy and manufacture; Proceedings of the Third International Symposium, Seven Springs, Pa., September 12-15, 1976. Baton Rouge, La., Claitor's Publishing Division, 1976, p. 1-23. 26 refs.

A description is presented of the major power systems in which superalloys appear to have a significant future, taking into account gas turbines and steam turbines operating in combined cycles, coal gasification and liquefaction processes, the combustion of coal in fluidized bed boilers, high temperature gas reactors, and liquid metal fast breeder reactors. The most provocative developmental challenges in the area of superalloys are found to be related to gas/gas heat exchange service, requirements for materials which can be used in gas streams of high corrosion potential generated from coal combustion, and the necessity to employ very large components. G.R.

A77-28421 # **Gravitationally stabilized satellite solar power station in orbit.** V. A. Chobotov (Aerospace Corp., El Segundo, Calif.). *Journal of Spacecraft and Rockets*, vol. 14, Apr. 1977, p. 249-251.

The concept for a gravitationally stabilized satellite solar power station in synchronous equatorial orbit is presented. A 5-GW solar photovoltaic system consisting of fifty-two 750 x 1500-m panels attached to a 57.75-km tapered cable with a 0.83-km-diam microwave transmitting antenna, with a total mass of about 18 million kg, is proposed. A roll oscillation about the satellite orbital velocity vector is induced to prevent mutual shadowing of the solar segments when the sun is directly above the array. The roll oscillation requirements are calculated, and analysis of tension and restoring torques and the relationship between the roll angle and the roll rate is performed. P.T.H.

A77-28434 Mathematical modeling of in situ oil shale retorting. J. H. George and H. G. Harris (Wyoming, University, Laramie, Wyo.). *SIAM Journal on Numerical Analysis*, vol. 14, Mar. 1977, p. 137-151. 59 refs.

A two-stage mathematical model describing in situ oil shale retorting is developed. The first stage is the description of the pyrolysis of kerogen leading to liberation of oil and gas from the oil shale. The second stage is the treatment of the boundary value problem arising in computing the velocity and temperature profile of the traveling combustion wave. B.J.

A77-28463 Photoelectrochemical energy conversion and storage - The polycrystalline CdSe cell with different storage modes. J. Monassen, G. Hodes, and D. Cahen (Weizmann Institute of Science, Rehovot, Israel). *Electrochemical Society, Journal*, vol. 124, Apr. 1977, p. 532-534. 6 refs.

The general principles connected with storage in a photoelectrochemical cell are discussed, and experimental evidence is presented that, after due development, this mode may be able to compete with the combination photovoltaic cell/storage battery. The experiments involved a polycrystalline layer of CdSe on titanium, obtained by electrolytic codeposition of Cd and Se, which combined in situ to give CdSe. The volt-ampere characteristics of the CdSe cell were measured, and an experimental set-up for testing storage electrode materials (sulfur and alkali containing materials) as a function of time is described. B.J.

A77-28472 Gas-solid heat transfer coefficients in beds of crushed oil shale. T. A. Seese and W. J. Thomson (Idaho, University, Moscow, Idaho). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 16, Apr. 1977, p. 243-248. 15 refs. Research supported by the Union Oil Company of California.

Volumetric gas-solid heat-transfer coefficients in packed beds of crushed oil shale were measured by utilizing transient heating experiments. Results were obtained for three beds of relatively uniform raw oil shale as well as for one bed similar to a commercial consist and one bed of spent shale. It was found that the heat-transfer coefficients were almost twice the values obtained in previous studies with crushed rocks and that internal conductive resistances were not significant. (Author)

A77-28473 Kinetics of heterogeneously catalyzed coal hydroliquefaction. J. A. Ruether (ERDA, Pittsburgh Energy Research Center, Pittsburgh, Pa.; Ottawa, University, Ottawa, Canada). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 16, Apr. 1977, p. 249-253. 14 refs.

The heterogeneously catalyzed hydroliquefaction of coal in a vehicle oil under conditions similar to those employed in the Synthoil process is investigated. The model of Weller et al. (1951) that considers coal liquefaction to occur in two steps, coal to asphaltene to oil, is extended by considering asphaltene to be a hydrogen-donor solvent of variable hydrogen composition. Recent data show that coal conversion occurs via catalyzed and uncatalyzed reactions, which appear to be coupled. (Author)

A77-28520 Tertiary oil production process (Tertiäröl-gewinnungsverfahren). G. Pusch (Deutsche Texaco AG, Wietze, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit*

Brennstoff-Chemie, vol. 30, Jan. 1977, p. 13-25. 30 refs. In German.

The status quo in the field of in situ combustion processes in crude oil reservoirs is demonstrated. Special emphasis is laid on the importance of the combination of water and oxygen injection. A step which points to the future of in situ coal gasification. Initial solutions to the safety problem concerning the use of oxygen or oxygen enriched air in bore holes are shown. The process control parameters - oxygen and water injection rate and the process pressure - allow a flexible design and adjustment of the process to different reservoir conditions. The planning criteria for the field application of a wet in situ combustion project and the economy of the process are discussed. (Author)

A77-28522 # **Description, output and development prospects of a 750 C helium direct cycle nuclear power plant with a single turbomachine and intermediate cooling.** Z. P. Tilliette, B. Pierre, P. Jude (Commissariat à l'Energie Atomique, Département des Etudes Mécaniques et Thermiques, Gif-sur-Yvette, Essonne, France), and J. Chaboseau (Compagnie Electromécanique, Paris, France). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Philadelphia, Pa., Mar. 27-31, 1977, Paper 77-GT-2.* 16 p. 11 refs. Members, $1.50; nonmembers, $3.00.

The concept of a helium cycle nuclear power plant with a single turbomachine located outside the P.C.R.V. in a leaktight basement is being studied. Main features of the system are pointed out, as are the favorable aspects it offers for a satisfactory design of the plant, a high safety level, a good efficiency for electricity generation associated with a dry cooling tower and heat recovery in good conditions for heating or industrial purposes. Above all, the high technological credibility due to the temperature of 750 C is worth being emphasized. In this paper, a 750 C/800 MWe power plant (2000 MWt) with one intercooler is presented as an example of a possible first generation of gas turbine HTGR. Development prospects for higher power levels, 1000/2000 MWe, are also investigated, at first with one but also with two intermediate coolers, taking into consideration the somewhat higher helium temperature. The net plant efficiencies, for electricity generation only, range from 40 to 45 percent. (Author)

A77-28524 # **A new 10,000-hp gas turbine engine for industrial service.** P. W. Pichel (International Harvester Co., San Diego, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Philadelphia, Pa., Mar. 27-31, 1977, Paper 77-GT-4.* 12 p. Members, $1.50; nonmembers, $3.00.

The approach used in the design of the considered gas engine is related to four primary interrelated objectives, including high simple-cycle performance, a useful life of 30 years, maintainability, and producibility. The engine represents a two-shaft design. The compressor incorporates 15 axial stages to achieve a pressure ratio of 16.0 at a mass flow of 80 lb/sec. The combustor is an annular design including a one-piece liner and 21 externally removable fuel injectors located in the liner dome. G.R.

A77-28616 # **Design considerations for heat recovery system for DD-963 class ship.** Y. Katz (Conseco, Inc., Medford, Wis.) and J. L. Boyen. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Philadelphia, Pa., Mar. 27-31, 1977, Paper 77-GT-106.* 10 p. Members, $1.50; nonmembers, $3.00.

The advent of high-speed gas-turbine-powered naval vessels requires that new concepts in energy generation and conservation be employed. This paper describes the heat recovery system designed for the U.S. Navy Spruance Class destroyers as applied to the ships' service generator sets. Among the topics discussed in the paper are the water and steam system, controls, heating surface selection and configuration, water treatment, gas-side fouling, gas-side pressure drop, and heat transfer. The thermal power recovered is used to perform heating, distillation plant operations, and galley services, thereby reducing the fuel consumption required to perform these functions. The use of separately fired boilers to perform the required tasks would significantly increase the fuel consumption rate. (Author)

A77-28676 **Solar collectors - Technology and principles of operation (Solarkollektoren - Technik und Wirkungsweise).** P. Kalischer. *Energiewirtschaftliche Tagesfragen*, vol. 27, Mar. 1977, p. 175-178. In German.

A description is presented of flat plate solar collector systems. Such systems do not require devices for the concentration of solar energy. Another advantage of the considered systems is related to the possibility to utilize also the diffuse solar radiation. All solar flat plate collectors consist basically of devices for the transformation of the received solar radiation into heat, devices for the controlled removal of the obtained heat, and devices for limiting thermal losses of the collector to the environment. Attention is given to the 'classical' collector type, the heat pipe collector, the flat plate collector utilizing evacuated glass tubes for limiting thermal losses, the efficiency of flat plate collectors, suitable approaches for increasing this efficiency, and operational requirements. G.R.

A77-28677 **Plastics in systems of solar technology - A survey (Kunststoffe in Systemen der Solartechnik - Eine Übersicht).** H. Röber. *(Arbeitsgemeinschaft Solarenergie, Tagung auf der Deutschen Bauausstellung, Essen, West Germany, Jan. 29-Feb. 6, 1977.) Energiewirtschaftliche Tagesfragen*, vol. 27, Mar. 1977, p. 181-183. In German.

The main types of plastics which are being considered for solar-technology applications are briefly examined, taking into account foils of polyethylene terephthalate, plates of polymethyl methacrylate or polycarbonate, polypropylene and polyethylene materials for absorbing devices, and PVC for the external device structure. A description is presented of the use of plastics for solar collectors. The employment of plastics for thermal storage applications is also discussed. G.R.

A77-28678 **The MBB solar houses - Design, operation, and experience (Die MBB-Solarhäuser - Aufbau, Betrieb und Erfahrungen).** H. Grallert. *(Arbeitsgemeinschaft Solarenergie, Tagung auf der Deutschen Bauausstellung, Essen, West Germany, Jan. 29-Feb. 6, 1977.) Energiewirtschaftliche Tagesfragen*, vol. 27, Mar. 1977, p. 184-188. In German.

Solar houses have been designed, built, and used by a German company for experimental applications. The solar houses are employed for functional studies and demonstration, the investigation of installation parameters, the study of the long-term behavior of the materials and the constructional designs, and the determination of the relation between the insulation characteristics of the house and the performance of solar heating. Three solar experimental houses are considered. G.R.

A77-28679 **Possibilities and economic limits concerning solar heating (Möglichkeiten und Grenzen der Wirtschaftlichkeit von Solarheizungen).** H. Schweig. *(Arbeitsgemeinschaft Solarenergie, Tagung auf der Deutschen Bauausstellung, Essen, West Germany, Jan. 29-Feb. 6, 1977.) Energiewirtschaftliche Tagesfragen*, vol. 27, Mar. 1977, p. 189-195. In German.

The cost of solar energy installations for heating applications are considered, taking into account the collector system with the pipe connections, the central control unit, tanks for storage applications, expenses for the installation of the heating system, and the total costs for the entire system. Approaches for the improvement of solar heating system efficiency are discussed and an investigation is conducted regarding the heat requirements in the case of one and two-family houses. Attention is also given to technical details and developments concerning solar heating systems and the various factors which affect the economy of solar heating system operation. G.R.

A77-28681 **Solar generators - Utilization of solar energy for supply of electric power (Solargeneratoren - Nutzung der Sonnenenergie zur Stromversorgung).** H.-W. Schümann. *(Arbeitsgemeinschaft Solarenergie, Tagung auf der Deutschen Bauausstellung, Essen, West Germany, Jan. 29-Feb. 6, 1977.) Energiewirtschaftliche Tagesfragen*, vol. 27, Mar. 1977, p. 198-200. In German.

A description is presented of thermal and photovoltaic solar electric generators developed by a German company. The devices

include a thermal solar generator with a maximum power of 10 kW which employs water as operational medium. The applications for solar generators of various capacities are discussed. Solar cells, consisting of unconventional silicon material, with an efficiency of 10% are shown. G.R.

A77-28758 World coal resources and the role of coal in turn-of-the-century energy economy (Ressources charbonnières mondiales et rôle du charbon dans l'économie énergétique de la fin du siècle). J.-C. Sore (Charbonnages de France, Paris, France). *Revue de l'Energie,* vol. 28, Feb. 1977, p. 61-71. In French.

The situation of coal-production and consumption in the recent and current petroleum-consuming picture, current and near-future energy crisis, the relative position of nuclear power in the energy picture, and energy consumption rates and volume in the future are addressed. Policies pursued by the major coal producing nations (USA, USSR, and others) and major coal-consuming industrial nations (above plus Japan, UK, Germany, Benelux) are discussed. A model is sketched for extrapolations to the end of the century, and a separate discussion of coking coal is presented. R.D.V.

A77-28759 Underground gasification of coal (La gazéification souterraine du charbon). P. Ledent (Institut National des Industries Extractives, Liège, Belgium). *Revue de l'Energie,* vol. 28, Feb. 1977, p. 89-101. 13 refs. In French.

The stimulus to capital-intensive mining of coal by gasification given by labor costs and new mining problems associated with greater mine depth, the overall decline of the coal mining industry over the past half-century, and the features and prospects of underground gasification of coal for in situ energy production, are discussed. Advantages of exploiting a dry and leaktight gas-bearing stratum and advantages derivable from direct hydrogenation are explained. Various gasification schemes are outlined and the INIEX (National Institute of Extractive Industries - Liège) project is described. R.D.V.

A77-28760 Unconventional petroleum and natural gas resources. II - Additional gas resources (Les ressources non-conventionnelles de pétrole et de gaz naturel. II - Les ressources additionnelles de gaz). M. Grenon. *Revue de l'Energie,* vol. 28, Feb. 1977, p. 123-128. In French.

Hitherto untapped and/or uneconomical reserves of petroleum and natural gas are surveyed, with geographical location, the status of work on exploitation of these resources, and effects of world energy costs considered. Conventional reserves and resources are indicated for comparison, and tabulated by area. Exploitation of organic shale, some heavy oils and tars, and natural gas locked in low-permeability sandstones is at pilot stage or better, and pilot plant exploitation of asphaltic sands, bituminous shale, and fire-damp (coal mine) methane is indicated. Less accessible reserves of methane in geopressurized zones and formations, in swamp gas, or in hydrate form are discussed. R.D.V.

A77-28776 Theoretical work on reaction sequences in the gasification of coke by carbon dioxide and by steam in conditions remote from equilibrium. J. T. Shaw (Coal Research Establishment, Cheltenham, Glos., England). *Fuel,* vol. 56, Apr. 1977, p. 134-136. 7 refs.

A77-28777 Reactivity heat-treated coals in hydrogen. A. Tomita, O. P. Mahajan, and P. L. Walker, Jr. (Pennsylvania State University, University Park, Pa.). *Fuel,* vol. 56, Apr. 1977, p. 137-144. 24 refs. Contract No. E(49-18)-2030.

The reactivities of 18 40 x 100 mesh U.S. coals charred to a temperature of 1000 C were measured in hydrogen at a pressure of 2.7 MPa and a temperature of 980 C. The char-hydrogen reaction was found to occur in two stages: a slow induction period followed by a constant-rate region. Reactivities of various chars in the initial stage decrease with increasing carbon content of the parent coals, while reactivities in the constant-rate region are essentially independent of the rank of the parent coals. B.J.

A77-28778 Gasification of coals treated with non-aqueous solvents. I - Liquid ammonia treatment of a bituminous coal. M. Matida, Y. Nishiyama, and Y. Tamai (Tohoku University, Sendai, Japan). *Fuel,* vol. 56, Apr. 1977, p. 177-180. 6 refs.

A Japanese bituminous coal was treated with liquid ammonia at temperatures up to 120 C. Extract was separated from the treated coal by washing with benzene-ethanol mixture. The amount of extract was about 2% in a single treatment at 120 C and some additional extract was obtained by successive treatments. Particles of the residue had cracks and showed an increase in surface area. The ammonia-treated coal was found highly reactive toward gasification with hydrogen at high temperature when catalysed by nickel. (Author)

A77-28786 Induction devices - A new type of magneto-hydrodynamic converter (Convertisseurs magnétohydrodynamiques d'un genre nouveau - Appareils à induction). J.-P. Petit and M. Viton. *Academie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques,* vol. 284, no. 9, Feb. 28, 1977, p. 167-169. In French.

The concept of a disk-shaped induction-MHD accelerator with controlled ionization is presented. When equipped with its own electrical supply, the device could become a MHD aerodyne. A scheme for plasma confinement at the wall is described. P.T.H.

A77-28811 Servo positioning power tower collectors for solar heat conversion to electricity. R. S. Parker (Honeywell, Inc., Aerospace Div., St. Petersburg, Fla.). In: Conference on Decision and Control and Symposium on Adaptive Processes, 15th, Clearwater, Fla., December 1-3, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 84-89.

An overview of Honeywell's Power Tower concept for conversion of solar generated heat to electricity is presented. The Solar Collector Subsystem control problem is defined. Operating modes including normal tracking, offset pointing, periodic calibration, stowage, and initialization are explained. Mathematics of sun vector computation and atmospheric refraction compensation are discussed. The process of attitude command generation and communication to the individual heliostats is outlined. Features of the control concept which contribute to cost effectiveness are highlighted throughout. (Author)

A77-28962 The laser solenoid - An alternate use of lasers in fusion power. P. H. Rose (Mathematical Sciences Northwest, Inc., Bellevue, Wash.). In: Industrial applications of high power laser technology; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1976, p. 130-139. 12 refs. Research supported by the Electric Power Research Institute; Contract No. E(45-1)-2319.

The laser solenoid approach to controlled fusion, a hybrid of laser heating and magnetic confinement, involves the use of an efficient long-wavelength laser (such as the CO2 laser) to heat a plasma confined in an axial magnetic field. Attention is given to the principles of laser solenoid fusion and a proof-of-concept experiment, using a large pulsed CO2 laser delivering 10 kJ of energy, is described. The design technology of a 1 km linear laser solenoid fusion reactor is examined and baseline quantities for a laser solenoid fission-fusion parameter study are presented. B.J.

A77-29021 Evaluation of cadmium stannate films for solar heat collectors. G. Haacke (American Cyanamid Co., Chemical Research Div., Stamford, Conn.). *Applied Physics Letters,* vol. 30, Apr. 15, 1977, p. 380, 381. 7 refs. NSF-supported research.

Optical transmission and reflection data are reported for Cd2SnO4 films coated onto transparent substrates or silicon. It is shown that these coatings are candidates for transparent heat reflectors and selective absorber components in solar heat collectors. (Author)

A77-29023 Photovoltaic properties of n-CdS/p-CdTe heterojunctions prepared by spray pyrolysis. Y. Y. Ma, A. L. Fahrenbruch, and R. H. Bube (Stanford University, Stanford, Calif.). *Applied Physics Letters,* vol. 30, Apr. 15, 1977, p. 423, 424. 14 refs. NSF-supported research.

Heterojunction solar cells of n-CdS/p-CdTe have been prepared by deposition of CdS films by spray pyrolysis on single-crystal CdTe to produce solar efficiences greater than 6% without optimization or correction for reflection loss. Cells prepared by this method therefore compare favorably with cells prepared by vacuum evaporation of CdS. In addition, the highest open-circuit voltage (0.74 V) observed to date in an efficient n-CdS/p-CdTe solar cell has been produced by this fabrication process. (Author)

A77-29066 * # **Alternative approaches to space-based power generation.** D. L. Gregory (Boeing Aerospace Co., Seattle, Wash.). *Journal of Energy,* vol. 1, Mar.-Apr. 1977, p. 85-92. 12 refs. Contract No. NAS8-31628.

Satellite Power Stations (SPS) would generate electrical power in space for terrestrial use. Their geosynchronous orbit location permits continuous microwave power transmission to ground receiving antenna farms. Eight approaches to the generation of the electrical power to be transmitted were investigated. Configurations implementing these approaches were developed through an optimization process intended to yield the lowest cost for each. A complete program was baselined for each approach, identifying required production rates, quantities of launches, required facilities, etc. Each program was costed, including the associated launches, orbital assembly, and maintenance operations. The required electric power charges to amortize these costs were calculated. They range from 26 to 82 mills/kWh (ground busbar). (Author)

A77-29067 # **Survey of selective absorber coatings for solar energy technology.** L. Melamed and G. M. Kaplan (ERDA, Washington, D.C.). *Journal of Energy,* vol. 1, Mar.-Apr. 1977, p. 100-107. 51 refs.

Solar photothermal electric powerplants are being conceptualized that will produce turbine-generated electricity from fluids heated to high temperatures by concentrated sunlight. A key research objective is to design coatings for the receiver optics that are highly absorbing in the visible out to about two microns but are highly reflecting (therefore have low emittance) beyond two microns. This dual requirement has generated a research program in composite materials coatings. Past accomplishments and promising new materials will be described. (Author)

A77-29070 # **Aerodynamic design of a conventional windmill using numerical optimization.** G. Vanderplaats and A. E. Fuhs (U.S. Naval Postgraduate School, Monterey, Calif.). *Journal of Energy,* vol. 1, Mar.-Apr. 1977, p. 132-134. 7 refs.

Some numerical optimization techniques useful as effective tools in automated synthesis of windmill designs are singled out. The general nonlinear problem to be solved by the numerical optimization techniques referenced is stated, with constraints. Some design examples are entertained, to demonstrate generality and efficacy. Possible extension to more sophisticated design problems is discussed, with advantages and limitations indicated. R.D.V.

A77-29071 # **Potential application of radial splitter diffuser to shrouded wind turbines.** D. M. Rao (Old Dominion University, Norfolk, Va.). *Journal of Energy,* vol. 1, Mar.-Apr. 1977, p. 134-136.

Application of a new wide-angle conical diffuser concept is discussed. The diffuser uses radial splitters, in order to cope with fabrication difficulties and costs, storm damage, and sensitivity of shrouded rotor output to misalignment with wind direction. Recovery of pressure is reported with up to 40 deg expansion angle, along with uniform exit flow. The wind turbine shroud developed offers competitive aerodynamic performance and cost effectiveness. R.D.V.

A77-29076 **Predicting changes in tidal regime - The open boundary problem.** C. Garrett (Dalhousie University, Halifax, Nova Scotia, Canada) and D. Greenberg (Department of the Environment, Marine Environmental Data Service Branch, Ottawa, Canada). *Journal of Physical Oceanography,* vol. 7, Mar. 1977, p. 171-181. 23 refs. Research supported by the National Research Council of Canada.

Attempts to predict the impact on a tidal regime of large engineering structures are generally based on the use of a numerical model which is calibrated to reproduce the natural tidal regime and then rerun with the structures in place. It is usually assumed that the 'input' tide at the open boundary is unchanged by the structures, though this is clearly wrong in principle. We show how errors in this procedure can be corrected for, or at least estimated, using output from the numerical model and estimates of the impedance of the exterior ocean. The ocean impedance can be expressed as an infinite series in terms of the normal modes of the ocean, with some terms allowing for near-resonant enhancement of particular modes, and the infinite tail corresponding to a local source-like behavior which can be estimated independently. Application of the technique to the problem of predicting the impact of Fundy tidal power suggests that any predicted change may be uncertain to about plus or minus 25% of the change in mass flux across the open boundary. (Author)

A77-29088 **Will electricity power tomorrow's trains.** R. B. Aronson. *Machine Design,* vol. 49, Apr. 7, 1977, p. 20-22, 24, 25.

A comparative study is made of the capabilities of the diesel-electric and all-electric locomotive systems in search of a solution to the problem of cutting costs and improving service. On an engine-for-engine basis, the electric comes out ahead of the diesel-electric on several points; but when considering entire systems, the two come out about equal. Attention is directed to energy efficiency, pollution, maintenance, and initial cost. The electric locomotive offers long-term cost and performance advantages despite the initial cost of converting from diesel power. When train frequency is high, the electric train's potential for lower maintenance, greater ease of automation, and more horsepower per locomotive begin to give it an edge over the diesel-electric system. The basics of the electric locomotive are outlined in terms of current pickup, transformer and rectifier, slip detection, traction motors, brakes, and communication and control. S.D.

A77-29094 **Hydrogen cycle peak-shaving on the New York State Grid using fuel cells.** R. A. Fernandes and H. D. Philipp (Niagara Mohawk Power Corp., Syracuse, N.Y.). *(Institute of Electrical and Electronics Engineers, Summer Meeting, Portland, Ore., July 18-23, 1976.) IEEE Transactions on Power Apparatus and Systems,* vol. PAS-96, Mar.-Apr. 1977, p. 467-475; Discussion, p. 476, 477. 19 refs. Research sponsored by the Empire State Electric Energy Research Corp.

Reduction in fault current levels on the subtransmission network, improved utilization of transmission network and tie transfer capabilities under emergency conditions are extremely desirable in order to reduce capital and operating costs for individual member utilities forming the New York Power Pool. Results are presented of a comprehensive study for dual-mode operation of fuel cells as an intermediate load generation device using coal derived or distillate fuels during certain periods and as peak-shaving units in conjunction with electrolyzers at other times. Several configurations for dual-mode generation/peak-shaving applications are discussed. Possible benefits of fuel cells operating on the New York Power Pool reaching a penetration level of 1800 MW by 1989 are determined using a combination of optimum generation mix programs and analytical techniques. S.D.

A77-29096 **New life for old garbage - Resource and energy recovery from solid wastes.** A. Schlottmann (Tennessee, University, Knoxville, Tenn.). *Journal of Environmental Economics and Management,* vol. 4, Mar. 1977, p. 57-67. 19 refs. Research supported by the U.S. Environmental Protection Agency, Tennessee Valley Authority, and Federal Energy Administration.

National interest has been growing recently in the potential for systems of resource recovery from municipal solid wastes, particularly from those systems associated with energy recovery. A regional model for resource and energy recovery from municipal solid wastes is discussed briefly in this paper. Particular attention is given to the definition of profits and to the question of whether resource recycling could be truly regional in scope or would be limited to a few urban areas. An empirical application of the model to a resource

recovery system in the Tennessee Valley Authority region is summarized. (Author)

A77-29246 Temperature dependence of the 10.6-microns reflectivity of ITO-coated silicon. R. B. Goldner (Tufts University, Medford, Mass.). *Applied Optics*, vol. 16, Apr. 1977, p. 808, 809.

The paper reports results of measurements that have been made on the temperature dependence of the 10.6-micron wavelength reflectivity of tin-doped indium oxide (ITO) coated silicon, from room temperature to 475 C. It is shown that ITO-coated silicon retains its solar selective absorbing properties at least up to 475 C. B.J.

A77-29300 Recent results in the research area 'energetics' with respect to nonnuclear energy research (Neuere Ergebnisse des Forschungsbereichs Energetik zu Problemen nichtnuklearer Energieforschung). T. Just (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Stuttgart, West Germany). *DFVLR-Nachrichten*, Feb. 1977, p. 834-842. In German.

The considered results are related to system analyses for flat plate solar collector systems, approaches utilizing latent-heat storage units for solar-energy heating systems, the development of small solar electric-power systems with an output in the range from 10 kW to 500 kW for an employment in developing countries, and studies of soot formation and oxidation in hydrocarbon combustion. Attention is also given to a high-energy laser, an electrically excited gas-dynamics CO laser, and a plasmadynamic laser. G.R.

A77-29325 A petroleum substitute - Active CO2 (Un substitut du pétrole - le CO2 activé). P. Pineau. *La Recherche*, vol. 8, Apr. 1977, p. 379-381. 6 refs. In French.

Recent progress and future outlook in catalytic polymerization of CO2 are outlined, with carbon dioxide approached as a basic building block in synthetic chemical technology where currently huge volumes of petroleum are consumed in the synthesis of petrochemical products. Coordination complexes of CO2, involvement of CO2 in Grignard reactions and carboxylation/decarboxylation reactions, development of CO2 complexes and appropriate ligands and organic enzymes, and catalytic hydrogenation of CO2 in large volume are discussed. Attempts at artificial photosynthesis, properties of some CO2 base polymers, and some promising organometallic catalysts are described. R.D.V.

A77-29437 * Prospects for pipeline delivery of hydrogen as a fuel and as a chemical feedstock. D. P. Gregory, N. P. Biederman, K. G. Darrow, Jr., A. J. Konopka, and J. Wurm (Institute of Gas Technology, Chicago, Ill.). *American Gas Association Monthly*, vol. 58, Nov. 1976, p. 24-31. 20 refs. Research supported by the American Gas Association, Electric Power Research Institute, and NASA.

The possibility of using hydrogen for storing and carrying energy obtained from nonfossil sources such as nuclear and solar energy is examined. According to the method proposed, these nonfossil raw energy sources will be used to obtain hydrogen from water by three basically distinct routes: (1) electrical generation followed by electrolysis; (2) thermochemical decomposition; and (3) direct neutron or ultraviolet irradiation of hydrogen bearing molecules. The hydrogen obtained will be transmitted in long-distance pipelines, and distributed to all energy-consuming sectors. As a fuel gas, hydrogen has many qualities similar to natural gas and with only minor modifications, it can be transmitted and distributed in the same equipment, and can be burned in the same appliances as natural gas. Hydrogen can also be used as a clean fuel (water is the only combustion product) for automobiles, fleet vehicles, and aircraft. A.Y.

A77-29450 Coal devolatilization and hydrogasification. D. B. Anthony and J. B. Howard (MIT, Cambridge, Mass.). *AIChE Journal*, vol. 22, July 1976, p. 625-656. 79 refs. NSF Grant No. AER-75-13673.

The paper provides a current review of coal devolatilization and hydrogasification, with special emphasis on the interrelationship of these phenomena and on the rapid reactions anticipated to be of most interest commercially. Pertinent experimental techniques are outlined and typical data are described with attention to the method of acquisition and to possible influence of technique on interpretation. Specific results, correlations; and postulated mechanisms of coal devolatilization are analyzed. The apparently important effect of devolatilization on coal reactivity to hydrogen is assessed. Also discussed are commercially viable pyrolysis processes and hydrocarbonization and hydrogasification processes. S.D.

A77-29467 Energy storage propulsion system for advanced concept train. R. W. McConnell (AiResearch Manufacturing Company of California, Los Angeles, Calif.). In: Annual Intersociety Conference on Transportation, 4th, Los Angeles, Calif., July 18-23, 1976, Proceedings. New York, American Society of Mechanical Engineers, 1976. 6 p.

The propulsion system described in the present paper was developed for the Advanced Concept Train (ACT-1) designed to minimize energy consumption of high-speed urban rail vehicles by the inclusion of on-board motor-driven flywheels for recovery and storage of braking energy. This energy source is then used for the next required vehicle acceleration. The discussion covers the power circuit configuration; the start mode; parallel mode acceleration; braking mode; series mode; shutdown mode; the principal system design techniques; the traction and flywheel motors; the energy storage flywheel; and the control components. V.P.

A77-29468 Application of gravitational energy exchange to tracked urban transit systems. T. A. P. S. AppaRao, V. Soots, and J. R. Billing (Ministry of Transportation and Communications, Systems Research and Development Branch, Downsview, Ontario, Canada). In: Annual Intersociety Conference on Transportation, 4th, Los Angeles, Calif., July 18-23, 1976, Proceedings. New York, American Society of Mechanical Engineers, 1976. 6 p.

Gravitational assistance can be obtained both to accelerate and decelerate a train if the stations are located high relative to the portions of the line between the stations. Savings in motor power, energy consumption, and/or travel time may be obtained when such profiles are used, the relative values of these savings being dependent on the 'operational' strategy employed. Minimum-power and minimum-time strategies are formulated, and the train motion under these strategies is studied to determine the dependence of power and energy savings on line depth, grade, and number of vehicles per train. The results are illustrated by two examples; under the minimum-power strategy, the best line depth is 10 meters when 5% grades are used in the track profile, and the corresponding savings in power and energy consumption are 35% and 25%, respectively. Under the minimum-time strategy, the best line depth is 7 meters for 5% grades, corresponding to a saving of 1.5% in station-to-station-time for a station spacing of 1 km. (Author)

A77-29469 Modeling of electric drive systems for KEW /flywheel/ vehicles. A. Kusko, C. M. King (Alexander Kusko, Inc., Needham Heights, Mass.), F. L. Raposa (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.), and C. B. Somuah (MIT, Cambridge, Mass.). In: Annual Intersociety Conference on Transportation, 4th, Los Angeles, Calif., July 18-23, 1976, Proceedings. New York, American Society of Mechanical Engineers, 1976. 9 p. 11 refs.

Computer simulation of a flywheel electric-drive system integrates electromechanical and thermal models of the energy-storage unit and the propulsion plant with the vehicle itself. Using as input the route and speed profiles of the vehicle, the computer program based on the simulation calculates as a function of time the pertinent electrical and mechanical variables, the losses, the component temperatures, and the energy expended by the flywheel. Because it is operating, the Morgantown PRT vehicle and route have been used as the example for the particular flywheel drive system studied. The simulation can be used for selecting electric-machine configurations and ratings in order to optimize the performance of the vehicle and the transit system. Both energy-storage, hybrid and wayside-powered

vehicles can be simulated by the procedures described in this paper. (Author)

A77-29470 A development of high efficiency electric mini-cars. P. R. Shipps (Shipps Engineering Service, El Cajon, Calif.). In: Annual Intersociety Conference on Transportation, 4th, Los Angeles, Calif., July 18-23, 1976, Proceedings.
New York, American Society of Mechanical Engineers, 1976. 9 p. 10 refs.

A currently active development program for electric mini-cars is described. Designed to be powered by today's lead-acid batteries and readily available motors, the cars are intended for low to moderate speed urban uses only. Efficient use of energy being the primary development goal, the designs have eliminated non-essentials, simplified body shapes and have emphasized structural efficiency to attain low vehicle gross weights. Electrical system and power-train efficiencies are also emphasized. Two types of cars and three preliminary designs evolved from the systems engineering study phase: an upright, comfortable, low-performance car and two low-slung, good acceleration, sport-utility designs. Performance predictions and methods are described, as is a test program intended to verify or develop good efficiencies. (Author)

A77-29471 * Energy and economic trade offs for advanced technology subsonic aircraft. D. V. Maddalon and R. D. Wagner (NASA, Langley Research Center, Hampton, Va.). In: Annual Intersociety Conference on Transportation, 4th, Los Angeles, Calif., July 18-23, 1976, Proceedings. New York, American Society of Mechanical Engineers, 1976. 11 p. 23 refs.

Changes in future aircraft technology which conserve energy are studied, along with the effect of these changes on economic performance. Among the new technologies considered are laminar-flow control, composite materials with and without laminar-flow control, and advanced airfoils. Aircraft design features studied include high-aspect-ratio wings, thickness ratio, and range. Engine technology is held constant at the JT9D level. It is concluded that wing aspect ratios of future aircraft are likely to significantly increase as a result of new technology and the push of higher fuel prices. Whereas current airplanes have been designed for AR = 7, supercritical technology and much higher fuel prices will drive aspect ratio to the AR = 9-10 range. Composite materials may raise aspect ratio to about 11-12 and practical laminar flow-control systems may further increase aspect ratio to 14 or more. Advanced technology provides significant reductions in aircraft take-off gross weight, energy consumption, and direct operating cost. (Author)

A77-29472 * Effects of selected R&D options on fuel usage in the commercial air system. F. W. Gobetz and A. P. Dubin (United Technologies Research Center, East Hartford, Conn.). In: Annual Intersociety Conference on Transportation, 4th, Los Angeles, Calif., July 18-23, 1976, Proceedings. New York, American Society of Mechanical Engineers, 1976. 10 p. Contract No. NAS2-8608.

The study on which this paper is based, known as RECAT (Study of Cost Benefit Tradeoffs for Reducing the Energy Consumption of the Commercial Air Transportation System), was sponsored by NASA to establish a basis for assigning priorities in its aircraft fuel-conservation R&D program. The study involved coordinated efforts by four independent contractors to conceive and quantify fuel-conserving technology alternatives, transform these alternatives into viable R&D options, and simulate each option in a general model of the U.S. domestic air transportation system. This paper deals primarily with the latter phase and concentrates on the results of the study, as revealed not only by estimated fuel usage but also by other impacts of the technology options, such as demand growth, operator economics, and fleet composition. However, while the paper focuses on results, the basic assumptions and technology inputs are documented, and a general description of the modeling approach is provided to demonstrate the level of detail considered in the analysis. (Author)

A77-29525 Hydrogenation of lignite with synthesis gas. H. R. Appell, E. C. Moroni, and R. D. Miller (ERDA, Pittsburgh Energy Research Center, Pittsburgh, Pa.). *Energy Sources*, vol. 3, no. 2, 1977, p. 163-175. 9 refs.

Lignite may be hydrogenated to a low-sulfur low-ash heavy fuel oil in the absence of added catalysts by use of synthesis gas and the moisture in the coal as the reducing agent. Conversions of 90-94% and oil yields near 60% (moisture, ash-free basis) have been obtained routinely at temperatures of 425-450 C and pressures of 3000-4000 psig. These conversions and oil yields are higher than those obtained with hydrogen under the same conditions. The effectiveness of carbon monoxide in hydrogenating lignite is, in part, due to the presence of carbonates of alkali and alkaline-earth metals which react with carbon monoxide in the presence of water, yielding formates, the active reducing agents. (Author)

A77-29534 Composition method for constructing guaranteed-output curves of solar- and wind-power plants utilized jointly. R. B. Salieva (Tashkentskii Elektrotekhnicheskii Institut Sviazi, Tashkent, Uzbek SSR). *(Geliotekhnika,* no. 4, 1976, p. 52-56.) *Applied Solar Energy,* vol. 12, no. 4, 1976, p. 39-42. Translation.

An equation of the integral performance probability for combined solar and wind-driven plants, referred to as the performance-confidence curve, is analyzed. The analysis is carried out by a combination method of constructing probability distribution functions, based on operational independence of the two components (the performances of the solar and wind-driven plants). Solutions are obtained from direct observational data on the component performances, without recourse to extrapolation. The resultant curve of the total performance is compared with the same curve plotted by simulation of observational results. Both curves coincide within the error of graphical methods. S.N.

A77-29535 Experience in using bimodal distribution curves to evaluate the reliability of systems supplying energy from renewable sources. R. B. Salieva (Tashkentskii Elektrotekhnicheskii Institut Sviazi, Tashkent, Uzbek SSR). *(Geliotekhnika,* no. 4, 1976, p. 57-62.) *Applied Solar Energy,* vol. 12, no. 4, 1976, p. 43-47. 9 refs. Translation.

Power supply of radio-relay communication lines by solar or wind energy sources is supplemented by accumulators operating during the periods of cloudy or windless weather. An attempt is made to construct a mathematical model of the process for use as a basis in developing automatic control of such power supply systems. The distribution function for the duration of continuous operation of the accumulators is described using the statistical method of moments. The analysis of observational data showed that the curves of the distribution functions have a bimodal shape. A method of analysis for such curves is proposed. Equations describing the curves are derived, a computer algorithm for solving these equations is worked out, and the numerical solutions obtained are analyzed. S.N.

A77-29562 Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports (Grundlagen der Solartechnik I; Tagung, 2nd, Stuttgart, West Germany, October 22, 1976, Tagungsberichte). Meeting sponsored by the Deutsche Gesellschaft für Sonnenenergie. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976. 312 p. In German. $15.85.

Selective behavior and selective layer deposition in the case of light-transparent covers are considered along with the selectivity of absorbing layers, corrosion problems related to the employment of aluminum in collector construction, collectors and heat storage units made of plastics, the physical principles of photoelectric conversion, the consideration of climatic data in the prediction of solar-system performance, and heat transfer problems in flat plate collectors. Attention is given to meteorological data regarding the utilization of solar energy, scientific and technological principles of latent heat storage, energy considerations related to the acquisition and utilization of solar energy, and the determination of the performance characteristics of solar collectors. G.R.

A77-29563 **Meteorological data regarding the utilization of solar energy (Meteorologische Daten zur Sonnenenergienutzung).** P. Valko (Schweizerische Meteorologische Zentralanstalt, Zurich, Switzerland). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 1-43. 37 refs. In German.

A terminology is provided of the radiation parameters which are important for the planning and the design of installations for the utilization of solar energy. A description is presented of statistical information needed, taking into account frequency data concerning meteorological parameter values, composite frequencies of a number of parameters, periods with and without sunshine, and the computation of radiation data. Measurements related to system investigations are also discussed. G.R.

A77-29564 **Selective behavior and selective layer deposition in the case of light-transparent covers (Selektives Verhalten und selektive Beschichtung von lichtdurchlässigen Abdeckungen).** E. Hussmann (Jenaer Glaswerk Schott und Gen., Mainz, West Germany). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 45-64. 11 refs. In German.

Heat losses in connection with the transformation of solar radiation into heat as a basis for the utilization of this radiation are related to three types of heat transfer. The processes involved in this heat transfer in the case of a flat plate solar collector are investigated, taking into account energy losses, due to radiation, conduction, and convection. Approaches for reducing radiation heat losses by means of covers with special characteristics are considered. A description is given of a theoretical study of the effect of individual methods in the case of various air-filled systems, taking into account calculations of the flow of heat through a cover material which is transparent to solar radiation. The study shows the feasibility to use layers which are transparent to solar radiation and reflect radiation in the IR wavelength region. G.R.

A77-29565 **The selectivity of absorbing layers (Selektivität von Absorberschichten).** R. Bär (BASF Farben und Fasern AG, Cologne, West Germany). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 65-74. In German.

An investigation was conducted concerning the feasibility to develop a lacquer with appropriate selective characteristics for a use in solar energy collector systems. Numerical relations concerning the efficiency of a collector as a function of solar irradiation are presented in a graph. It is found that an absorbing layer can be optimally adapted to a certain application by selecting suitable absorption and emission coefficients. The selectivity of absorbing layers made of a lacquer material is discussed. Attention is given to the selection criteria for lacquer binding materials, the relation between the absorption characteristics and the black-pigment content, the dependence of the absorption characteristics on the layer thickness, and the effects of the substrate material. G.R.

A77-29566 **Corrosion problems related to the employment of aluminum in collector construction (Korrosionsprobleme bei der Verwendung von Aluminium im Kollektorbau).** P. Brennecke and E. Justi (Braunschweig, Technische Universität, Braunschweig, West Germany). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 75-95. 23 refs. In German.

The electrochemical principles of corrosion are examined, taking into account anodic and cathodic processes and Pourbaix diagrams. The design and the characteristics of aluminum-oxide protective coatings are discussed along with the behavior of aluminum in the case of corrosive attacks. Attention is given to atmospheric corrosion, attacks involving the material serving as substrate for the black paint or the deposited absorbing layer, corrosion produced by water and aqueous solutions, and the occurrence of contact corrosion. Aspects of passivity and corrosion protection are also considered. G.R.

A77-29567 **Collectors, pipelines, and heat storage units made of plastics (Kollektoren, Rohrleitungen und Wärmespeicher aus Kunststoffen).** A. P. Böckmann (Krauss-Maffei AG, Munich, West Germany). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 97-117. In German.

Advantages concerning an employment of components made of plastics are related to the absence of corrosion, light weight, an absence of toxicologic problems, an absence of painting requirements, low raw material costs, and low manufacturing costs. A description is given of suitable plastics which are currently available. Possibilities regarding the development of new plastic materials are also considered. Attention is given to practical considerations which have to be taken into account in the design and the employment of suitable plastics components. G.R.

A77-29568 **The physical principles of photoelectric conversion (Physikalische Grundlagen der photoelektrischen Wandlung).** G. H. Hewig (Stuttgart, Universität, Stuttgart, West Germany). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 119-148. 14 refs. In German.

An investigation is conducted concerning the area of the terrestrial surface which would be required if the energy currently needed for a person (1.5 kW) is to be provided by solar cells. It is found that the area needed to obtain food for a person is twenty times as large as the area required for the operation of the solar cells (120 sq m). The interior photoeffect in semiconductors is discussed along with the junction characteristics, the general properties of solar cells, considerations regarding solar cell efficiency optimization, and aspects of technology. Attention is given to silicon solar cells, GaAs solar cells, and Cu2S-CdS solar cells. G.R.

A77-29569 **The consideration of climatic data in the prediction of solar-system performance (Berücksichtigung von Klimadaten bei der Leistungsvorhersage von Solarsystemen).** P. Kesselring (Eidgenössisches Institut für Reaktorforschung, Würenlingen, Switzerland). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 149-171. In German.

The efficiency and cost-effectiveness of solar collectors depends to a large degree on the intended application and the given climatic conditions. Approaches for the selection of suitable collectors for a given application are discussed. Basic principles for the selection procedure are considered, taking into account a simple linear equilibrium equation for the collector, the concept of the usable energy density, and the consideration of two correlated climatic parameters in one variable. The described procedure is illustrated with the aid of an example concerning the heat provided by a solar collector which is installed under certain conditions at a location in Switzerland. G.R.

A77-29570 **Heat transfer problems in flat plate collectors (Wärmeübergangsprobleme in Flachkollektoren).** J. C. Francken and M. Sikkens (Institut für technische Physik, Groningen, Netherlands). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 173-203. 17 refs. In German.

A very simplified model of the solar collector is used as a basis for the calculation of the most important collector characteristics. The calculation is mostly concerned with mean parameter values. The thermal resistance network of a flat plate collector is considered and heat balance relations are investigated. Attention is given to radiation losses, heat losses as a consequence of convection processes,

heat losses experienced in connection with wind, and losses at the lower side of the absorber plate. G.R.

A77-29571 Physical, chemical, and technological principles of latent heat storage (Physikalische, chemische und technologische Grundlagen der Latentwärmespeicherung). F. Lindner (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt; Stuttgart, West Germany). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 205-235. 11 refs. In German.

Large fluctuations concerning the available solar radiation made it necessary to use energy storage systems in connection with solar residential heating systems. Storage systems based on a utilization of the latent heat of hydrated salt phase-transition processes require a much smaller volume than hot-water thermal storage systems with the same capacity. There are, however, a number of difficulties which have to be overcome before a use of latent-heat thermal storage systems is feasible. A description is given of a latent-heat thermal storage system based on the use of Glauber's salt and oil. A review is provided of the relevant characteristics of various media for thermal storage applications, taking into account values of phase-transition enthalpies. G.R.

A77-29572 Exergy considerations related to the acquisition, supply, and utilization of solar energy (Exergetische Betrachtungen zur Gewinnung, Einspeisung und Nutzung von Sonnenenergie). P. Suter and T. Nicolescu (Lausanne, Ecole Polytechnique Fédérale, Lausanne, Switzerland). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 237-282. In German.

The exergy concept provides an evaluation measure for chemical and thermal energy in its relation to mechanical and electrical energy. A meaningful application of the exergy concept is related to investigations concerning the replacement of oil-based heating technology by alternative approaches. Attention is given to the exergy equivalence of various forms of energy, the study of exergy chains, the consideration of the system solar collector-water storage tank on the basis of the exergy concept, and an example for the evaluation of energy chains. G.R.

A77-29573 The determination of the performance characteristics of solar collectors (Bestimmung der Leistungscharakteristik von Solarkollektoren). A. Kalt and W. Ley (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Cologne, West Germany). In: Principles of solar technology I; Meeting, 2nd, Stuttgart, West Germany, October 22, 1976, Reports. Munich, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 283-303. 5 refs. In German.

Outdoor and indoor tests can be used for the determination of the performance characteristics of solar collectors. However, outdoor tests require much time and depend on the climatic conditions of the location at which the tests are conducted. The employment of an indoor solar-collector test installation makes it possible to obtain reproducible experimental test values which can be used to compare the characteristics of various solar collector types. G.R.

A77-29574 # Energy-direct-conversion in solar technology (Energie-direkt-Umwandlung in der Solar-Technologie). E. W. Justi (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Sonnenenergie, Tagung über Grundlagen der Solartechnik I, 2nd, Stuttgart, West Germany, Oct. 22, 1976, Paper.* 14 p. In German.

The possibilities which exist concerning the conversion of energy from one form into another are illustrated with the aid of a matrix, which takes into account mechanical, thermal, electrical, chemical, and light energy. The direct conversion of solar heat into electrical energy by means of the thermoelectric Seebeck effect is considered. It is pointed out that low-energy conversion efficiencies in the case of conventional thermocouples have been increased by the factor 100 in connection with studies conducted by Joffe and associates in the Soviet Union and by Justi and associates in West Germany. Attention is given to the use of thermoelectric materials of the type Bi2Te3 and their optimization, the intermetallic alloy 51In49Sn, a hot water/cold water thermogenerator with an efficiency of 4%, Pb-Te materials, Ge-Si alloys, and a solar collector equipped with thermocouples. G.R.

A77-29576 Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Seminar sponsored by the Society of Photo-Optical Instrumentation Engineers. Edited by C. Selvage (Sandia Laboratories, Albuquerque, N. Mex.). Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Volume 85), 1977. 182 p. $34.

Attention is given to the optics of photovoltaics, the optics of selective coatings, solar standards and instrumentation, and the optics of solar concentrators. Particular papers that are considered discuss GaAs solar cells for very high concentrations, improved black nickel coatings for flat plate solar collectors, infrared television measurement of heliostat images, the development of the solar tower program in the United States, and the principles of the fixed mirror solar concentrator. B.J.

A77-29577 The development of a satellite solar power station. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. IX-XXVI. 16 refs.

After brief reviews of the potential of solar energy, the options for converting solar energy in space, and the options for transmitting power to earth, the paper examines the baseline design of the satellite solar power station considered to be most suitable. Attention is given to the photovoltaic conversion system and the microwave power transmission system (power generation, beam transmission, and power reception and rectification). Also considered are station transportation, assembly and maintenance, space manufacturing, environmental implications, and economic and social implications. B.J.

A77-29579 Photovoltaic energy conversion using concentrated sunlight. E. L. Burgess (Sandia Laboratories, Albuquerque, N. Mex.). In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. 9-15. 12 refs. Contract No. E(29-1)-789.

This paper describes a development program which uses sunlight concentration techniques to effect an immediate reduction in cost-per-unit-power for photovoltaic systems in which solar cell cost dominates the total system cost. Current examples of concentrator solar cell technologies are single crystal silicon and gallium arsenide. Implementation of cost reductions by the use of sunlight concentration is not dependent on the development of low-cost, mass-production cell technologies but emphasizes high cell efficiency and low-cost concentrator systems. (Author)

A77-29580 * Consideration of encapsulants for photovoltaic arrays in terrestrial applications. E. F. Cuddihy and W. F. Carroll (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. 16-22. Contract No. NAS7-100.

Long-term survivability of photovoltaic arrays and components in terrestrial environments will require development of adequate protective systems. Highly considered are polymeric encapsulants, a method which was successfully employed in space and aerospace applications to protect critical electrical circuitry. To be employable, however, the polymer encapsulants must themselves be chemically and mechanically resistant to failure in terrestrial service. Chemical resistance includes stability to the degrading actions of ultraviolet light, oxygen, moisture and elevated temperatures in sun rich areas.

Programs are underway to identify and develop chemically stable encapsulant candidates. Chemical considerations aside, mechanical failures of the encapsulants must also be avoided in array designs. This paper discusses design considerations for avoiding mechanical failures of polymeric encapsulants, with emphasis on biaxial properties, thermal fatigue, and anisotropy and nonhomogeneity of material properties. The general principles to be presented evolved from actual failures of polymeric materials in engineering applications. Also included are brief remarks on the permeability of polymer materials to atmospheric gases. (Author)

A77-29581 GaAs solar cells for very high concentrations. L. W. James and R. L. Moon (Varian Associates, Palo Alto, Calif.). In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. 23-29. 11 refs.

On the basis of a study of source characteristics, the required economics, and the relative costs of various system components, it is shown that AlGaAs/GaAs heterojunction concentrator solar cells are a promising choice for terrestrial photovoltaic power generation in areas with a low percentage of cloud cover. Experimental cells have been constructed which operate at 19% conversion efficiency, with an output power density of 1/4 MW/sq m of active cell area at a solar concentration of 1735 times. B.J.

A77-29583 Wavelength-selective surfaces for solar energy utilization. J. C. C. Fan (MIT, Lexington, Mass.). In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. 39-46. 9 refs. USAF-sponsored research.

Wavelength-selective surfaces for solar energy utilization can be divided into two classes: selective-black absorbers and transparent heat mirrors. Selective-black absorbers absorb solar radiation and have low infrared thermal emissivity; transparent heat mirrors transmit solar radiation and reflect thermal radiation. We have used rf sputtering to prepare both selective-black absorbers (Cr-black and MgO/Au on metal substrates) and transparent heat mirrors (TiO_2/Ag/TiO_2, Sn-doped In_2O_3, and Sn-doped In_2O_3 microgrids) with excellent wavelength-selective properties for solar energy applications such as solar heating, solar/thermal/electric conversion, and window insulation. (Author)

A77-29584 A comparison of solar photothermal coatings. P. Baumeister (Rochester, University, Rochester, N.Y.). In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. 47-61. 70 refs.

Various types of coatings are considered as selective surfaces for solar photothermal energy collectors including a semiconductor layer, an antireflected semiconductor layer, an artificial dielectric layer, a lossy cavity, a graded-profile medium, and a super greenhouse. Cost comparisons are presented and attention is given to the following application methods: electroplating, chemical deposition, sputtering, vacuum evaporation, and paint and spray processes. B.J.

A77-29585 * Improved black nickel coatings for flat plate solar collectors. J. H. Lin and R. E. Peterson (Honeywell Systems and Research Center, Minneapolis, Minn.). In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. 62-71. 6 refs. Contract No. NAS8-31545.

A new black nickel formula was developed which had a solar absorptance of 0.92 and an infrared emittance (at 100 C) of less than 0.10 after 14 days at 38 C and 95 percent relative humidity. The electroplating bath and conditions were changed to obtain the more stable coating configuration. The effect of bath composition, temperature, pH, and plating current density and time on the coating composition, optical properties and durability were investigated. (Author)

A77-29591 Development of solar tower program in the United States. L. L. Vant-Hull (Houston, University, Houston, Tex.). In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. 104-110. 9 refs.

The history and development of the solar tower is traced from the conceptual stage in 1969, through first federal funding in 1973, to a program to initiate pilot plant construction in 1976. In this pilot plant, it is intended that 3,000 heliostats will reflect sunlight onto a central receiver, in which steam at a temperature of 500 C will be generated to drive a turbogenerator. B.J.

A77-29592 An educated ray trace approach to solar tower optics. L. L. Vant-Hull (Houston, University, Houston, Tex.). In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. 111-120. 9 refs. NSF Grant No. GI-39456; Contract No. E(04-3)-1108.

We describe an approach to the analysis of the optical system of the solar tower concept, which is designed to provide maximum design information. By inputing all quantities in terms of angles or dimensionless ratios the results remain relatively scale independent. First the power redirected from the heliostat field to the central receiver is computed, then solar images are projected from each heliostat to the central receiver and interception factors are obtained. This information allows us to size the central receiver, to enhance performance by redistributing heliostats in the field, and finally to define the rim angle of the field. The procedure for this step by step definition of the solar tower optical system results in optimal heliostat fields, receiver flux distributions and diurnal power curves. (Author)

A77-29594 Optical and thermal characteristics of a solar collector with a stationary spherical reflector and a tracking absorber. A. M. Clausing. In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. 128-138. 6 refs.

A fixed segment of a concave spherical mirror can be used to concentrate beam radiation onto a tracking absorber which pivots about the center of curvature of the mirror. A possible economic advantage of this solar collector over concentrating collectors with tracking mirrors is reduced mirror cost. The objective of the investigation is to determine the potential of this system for electrical power production. Special emphasis is given to identifying the penalty associated with the fixed reflector. The results showed appreciable cosine losses even at the best times of the year. The overall system efficiency was found to be strongly dependent on the rim angle, the optical efficiency, the absorber temperature, and the degree of selectivity of the absorber surface. (Author)

A77-29596 Solar collectors using total internal reflections. N. S. Kapany (California, University, Santa Cruz; KAPTRON, Inc., Palo Alto, Calif.). In: Optics in solar energy utilization II; Proceedings of the Seminar, San Diego, Calif., August 24, 25, 1976. Palos Verdes Estates, Calif., Society of Photo-Optical Instrumentation Engineers, 1977, p. 146-154.

Various configurations of solar collectors and components utilizing the effect of total internal reflection are discussed. These configurations include a double glazed window using optical ribs, conical wedges for use as energy concentrators, optical valves, and dielectric compound concentrators with flat, parabolic, and elliptical reflecting surfaces. Other applications involving the use of the dielectric concentrator in conjunction with low loss optical fibers are described. B.J.

A77-29618 # Experimental investigation of energy conversion efficiency during the interaction of a conducting-fluid piston

with a magnetic field (Eksperimental'noe issledovanie effektivnosti protsessa preobrazovaniia energii pri vzaimodeistvii porshnia provodiashchei zhidkosti s magnitnym polem). S. S. Pignastii, A. I. Siusiukin, and G. G. Kapustianenko (Akademiia Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR). *Problemy Tekhnicheskoi Elektrodinamiki,* no. 58, 1976, p. 74-78. 9 refs. In Russian.

The paper considers a liquid-metal piston-type MHD generator. It is shown that in the case of strong interaction of a moving piston of a conducting fluid with a magnetic field, the intensity of dissipation depends on the magnetic field, and there is an optimal magnitude of magnetic induction which ensures a maximum energy conversion efficiency. An experimental conversion efficiency to electricity of 36% was determined for this type of MHD system. B.J.

A77-29788 Thermal efficiency of geothermal power. R. James (Department of Scientific and Industrial Research, Taupo, New Zealand) and T. Meidav (Geonomics, Inc., Berkeley, Calif.). *Geothermal Energy,* vol. 5, Apr. 1977, p. 8, 9, 11-13, 15-21. 12 refs.

Curves of power potential and thermal efficiency for three different values of turbine outlet pressure are provided for geothermal fluid of various enthalpies up to that of dry steam. Fluid from discharging wells is considered to be separated in two pressure stages in series which correspond to a turbine entry steam pressure of 65 psia (4.48 bar) and a pass-in point pressure of 15 psia (1.03 bar). Curves are also shown for fluid separated in one-stage at the higher pressure. Enthalpies from 300 to 1200 Btu/lb (700 to 2800 j/g) gave a range of thermal efficiencies from 0.014 to 0.16. Thermal efficiency is not as important as the generating cost of electric energy when designing a geothermal power project. M.L.

A77-29789 New hydrogen process is in the works. V. D. Chase. *Coal Mining and Processing,* vol. 14, Apr. 1977, p. 124, 125, 128 (3 ff.).

To produce synthetic natural gas from coal a hydrogen source is required. The steam-iron process for generating hydrogen, despite being more expensive than the steam-oxygen process, is considered to have several advantages: lower cost of operation; purer product; energy byproduct in the form of pressure and heat. Two reactor towers are required in the cyclic steam-iron process: in the first, coal char is burned with steam and air to create a low Btu producer gas containing hydrogen and carbon monoxide; in the second, the producer gas reduces iron ore to iron; in the second stage of this reactor more steam is introduced and the iron displaces the hydrogen from the steam, yielding free hydrogen. A tower process suitable for producing methane from a wide variety of coals is also described. Coal is converted to a slurry which in the presence of hot gas (methane, carbon oxides, hydrogen, and steam) introduced at the bottom of the tower combines with hydrogen to form methane. M.L.

A77-29892 Photovoltaic properties of five II-VI heterojunctions. F. Buch, A. L. Fahrenbruch, and R. H. Bube (Stanford University, Stanford, Calif.). *Journal of Applied Physics,* vol. 48, Apr. 1977, p. 1596-1602. 25 refs. NSF-supported research.

Five heterojunction systems, involving the II-VI compounds CdSe, CdTe, ZnSe, and ZnTe, have been prepared using the close-spaced vapor transport method. Current transport through these heterojunctions was found to be dominated by recombination at the interface. Using a collection function introduced to describe the voltage dependence of the collection of photogenerated carriers, diffusion potentials were determined, and from them values of the electron affinity of CdSe (4.53 eV) and ZnTe (3.73 eV) relative to CdTe (4.28 eV). (Author)

A77-29893 Preparation of CdS/InP solar cells by chemical vapor deposition of CdS. M. Bettini, K. J. Bachmann, E. Buehler (Bell Telephone Laboratories, Inc., Murray Hill, N.J.), J. L. Shay, and S. Wagner (Bell Telephone Laboratories, Inc., Holmdel, N.J.). *Journal of Applied Physics,* vol. 48, Apr. 1977, p. 1603-1606. 15 refs.

CdS/InP heterojunctions are grown by chemical vapor deposition of CdS on InP in an open-tube H2S/H2 flow system. The importance of H2S admixture for the etching and cleaning of the InP surface is demonstrated. The solar cell has an open-circuit voltage of 0.78 V, fill factor of 0.75, and a power conversion efficiency of 13.5% for AM2 conditions. (Author)

A77-29930 # Methanol - A clean burning fuel for automobile engines. H. B. Mathur and R. K. Bakshi (Indian Institute of Technology, New Delhi, India). *Mechanical Engineering Bulletin,* vol. 6, Sept. 1975, p. 102-108. 11 refs.

Unmodified car engines can use mixtures of methanol and gasoline for fuel, with up to one quarter of the blend being methanol. Engines burning methanol can be made more efficient than gasoline engines since compression ratios can be increased to take advantage of methanol's higher flame speed and good antiknock properties. Comparison of exhaust emissions from automobiles fitted with control devices to keep emission levels within prescribed limits and fueled alternatively by either gasoline or methanol show that engines using methanol produce about half as much carbon monoxide and about an eighth as much of nitrogen oxides as do engines using gasoline. Use of methanol, in comparison with gasoline, results in slightly higher emissions of hydrocarbons, most of which is unburnt methanol. Though methanol has only about half as much energy as gasoline per unit volume, it is less likely to contribute the the formation of photochemical smog than do emissions from gasoline-fueled cars. M.L.

A77-29938 The future with fusion power. F. Hirschfeld. *Mechanical Engineering,* vol. 99, Apr. 1977, p. 22-31.

Several projects for obtaining power from nuclear fusion are discussed. The Fusion Energy Corporation of Princeton, N.J. has been developing a technique whereby an ordered arrangement of high-energy self-colliding ion beams - called a migma - are confined in a single enclosure. In an axially symmetric single enclosure with an appropriate magnetic field the ions will precess about the center in the horizontal plane and be focused to the midplane vertically. The PACER concept, where the source of energy is the thermonuclear burning of deuterium which takes place in a nuclear fusion explosion confined to a large underground salt cavity, is studied in California. Tokamak, mirror, and theta pinch techniques would utilize magnetic fields confining a plasma for either pulsed or steady-state operation. Laser fusion, still in the early stages of research, would use high-energy, short-pulse laser beams focused on suitable fuel pellets to heat and compress the fuel. M.L.

A77-30016 * Solar power satellite transportation. H. P. Davis (NASA, Johnson Space Center, Future Programs Office, Houston, Tex.). *Acta Astronautica,* vol. 4, Jan.-Feb. 1977, p. 201-212. 10 refs.

Preliminary studies and concepts are discussed relative to the feasibility and economics of developing the capability to transport a network of operational 10-GWe solar power satellites into geosynchronous orbit by A.D. 2025. The satellite is briefly described, and its space transportation options are presented. Launch vehicle requirements and concepts are discussed in relationship to the transportation task. (Author)

STAR ENTRIES

N77-16039# Marconi-Elliott Avionic Systems Ltd., Rochester (England).
AIRCRAFT POWER SUPPLIES AND COOLING PROBLEMS: A VIEWPOINT FROM THE POWER CONDITIONER DESIGNER
P. Chapman *In* AGARD Avionic Cooling and Power Supplies for Advanced Aircraft Nov. 1976 16 p refs

Avail: NTIS HC A11/MF A01

The main trade-offs in a modern avionic power conditioner designed to interface between electronic units and aircraft power supplies were detailed. The ability to overcome the major limitations of these supplies was demonstrated and the advantages to be gained by improving them were discussed. It is proposed that a systems approach, rather than the consideration of power supplies and/or power conditioner alone, will produce a better solution to the thermal problems associated with avionic equipment. Author

N77-16433# Environmental Monitoring and Support Lab., Las Vegas, Nev Monitoring Systems Research and Development Lab.
FIRST WORKSHOP ON SAMPLING GEOTHERMAL EFFLUENTS
May 1976 246 p refs Conf. held at Las Vegas, Nev., 20-21 Oct. 1975
(PB-258067/8; EPA-690/9-76-011) Avail: NTIS HC A11/MF A01 CSCL 08I

A compilation of papers are presented at the first in a series of workshops on environmental monitoring of geothermal energy development. The purpose of this workshop was to generate the exchange of ideas and knowledge needed to develop a set of standard geothermal sampling methods with assurance of quality in those methods. Representatives of industry, universities, and government presented 19 technical papers, 12 of which are published in this document. Their content and the discussions which followed the presentations provided guidance for developing a recognized Referenced Sampling Method Handbook. GRA

N77-16442*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
INITIAL TECHNICAL, ENVIRONMENTAL, AND ECONOMIC EVALUATION OF SPACE SOLAR POWER CONCEPTS. VOLUME 1: SUMMARY
31 Aug. 1976 129 p
(NASA-TM-X-74309; JSC-11568-Vol-1) Avail: NTIS HC A07/MF A01 CSCL 10A

The research concerning the use of large solar power satellites in geosynchronous orbit to beam energy to collection stations on earth is summarized. F.O.S.

N77-16443*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
INITIAL TECHNICAL ENVIRONMENTAL, AND ECONOMIC EVALUATION OF SPACE SOLAR POWER CONCEPTS. VOLUME 2: DETAILED REPORT
31 Aug. 1976 908 p
(NASA-TM-X-74310; JSC-11568-Vol-2) Avail: NTIS HC A99/MF A01 CSCL 10A

The SPS concepts which appear to be technically feasible are discussed in terms of the economic viability and competitive costs with other energy sources. The concepts discussed include: power station, microwave reception and conversion, space construction and maintenance, space transportation, and program costs and analysis. The conclusions presented include: (1) The maximum output of an individual microwave transmission link to earth is about 5 GW. (2) The mass of 10 GW SPS is between 47,000,000 and 124,000,00 kg. (3) The silicon solar cell arrays make up well over half the weight and cost of the satellite. (4) The SPS in equatorial orbit will be eclipsed by the earth and by other satellites. F.O.S.

N77-16444*# Kanner (Leo) Associates, Redwood City, Calif.
INVESTIGATION OF ACID-RESISTANT ELECTROCATALYSTS FOR FUEL CELLS
H. U. Meier, U. Tschirwitz, E. Zimmerhackl, and W. Albrecht Jan. 1977 83 p refs Transl. into ENGLISH from West German report, BMVg-FBWT-76-6, 1975 p 1-104
(NASA-TT-F-17367; BMVg-FBWT-76-6) Avail: NTIS HC A04/MF A01 CSCL 10A

The use of polymeric metal phthalocyanines, chiefly those of iron and cobalt, as electrocatalysts is discussed. Their production and various properties (conductivity, catalase effect, acid resistance, electrocatalytic activity for reduction of oxygen in sulfuric acid) are considered. Fe-polyphthalocyanines showed especially high electrocatalytic activity. A model is suggested for the reaction mechanism to explain this finding. Author

N77-16445*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
VELOCITY AND TEMPERATURE DISTRIBUTIONS OF COAL-SLAG LAYERS ON MAGNETOHYDRODYNAMIC GENERATORS WALLS
Carlson C. P. Pian and J. Marlin Smith Jan. 1977 19 p refs
(NASA-TN-D-8396; E-8929) Avail: NTIS HC A02/MF A01 CSCL 10B

Approximate analytical expressions are derived for the velocity and temperature distributions in steady state coal slag deposits flowing over MHD generator walls. Effects of slag condensation and Joule heating are included in the analysis. The transport conditions and the slag temperature at the slag-gas interface are taken to be known parameters in the formulation. They are assumed to have been predetermined either experimentally or from the slag properties and the gas dynamic calculations of the free stream flow. The analysis assumes a power law velocity profile for the slag and accounts for the coupling between the energy and momentum conservation equations. Comparisons are made with the more exact numerical solutions to verify the accuracy of the results. Author

N77-16446*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE DESIGN OF A SOLAR ENERGY COLLECTION SYSTEM TO AUGMENT HEATING AND COOLING FOR A COMMERCIAL OFFICE BUILDING
Robert C. Basford Jan. 1977 43 p refs
(NASA-TM-X-72753) Avail: NTIS HC A03/MF A01 CSCL 10A

Analytical studies supported by experimental testing indicate that solar energy can be utilized to heat and cool commercial buildings. In a 50,000 square foot one-story office building at the Langley Research Center, 15,000 square feet of solar collectors are designed to provide the energy required to supply 79 percent of the building heating needs and 52 percent of its cooling needs. The experience gained from the space program is providing the technology base for this project. Included are some of the analytical studies made to make the building design changes necessary to utilize solar energy, the basic solar collector design, collector efficiencies, and the integrated system design. Author

N77-16447*# Boeing Aerospace Co., Seattle, Wash.
SPACE-BASED POWER CONVERSION AND POWER RELAY SYSTEMS: PRELIMINARY ANALYSIS OF ALTERNATE SYSTEMS *Interim Report, 8 Jul. 1975 - 26 May 1976*
26 May 1976 309 p refs
(Contract NAS8-31628)

(NASA-CR-150171) Avail: NTIS HC A14/MF A01 CSCL 10A

The results are presented of nine months of technical study of non-photovoltaic options for the generation of electricity for terrestrial use by satellite power stations (SPS). A concept for the augmentation of ground-based solar power plants by orbital sunlight reflectors was also studied. Three SPS types having a solar energy source and two which used nuclear reactors were investigated. Data derived for each included: (1) configuration definition, including mass statement; (2) information for use in environmental impact assessment; (3) energy balance (ratio of energy produced to that required to achieve operation), and (4) development and other cost estimates. Cost estimates were dependent upon the total program (development, placement and operation of a number of satellites) which was postulated. This postulation was based upon an analysis of national power capacity trends and guidelines received from MSFC. Author

N77-16449# State Univ. of New York, Buffalo. Research Foundation.

ELECTRIC ENERGY USAGE AND REGIONAL ECONOMIC DEVELOPMENT Final Report

James Harris Savitt (State Univ. of New York, Buffalo) Aug. 1976 178 p refs

(EPRI Proj. 334)

(PB-257544/7; EPRI-ES-187) Avail: NTIS HC A09/MF A01 CSCL 05C

The impact of changes in electricity prices on key economic variables associated with the economic development of the Buffalo SMSA was determined. Electricity demand equations were developed for the three major classes of consumers. They were then embedded into the model of the Buffalo Economy, and simulations of various price assumptions were conducted. GRA

N77-16450# *Federal Energy Administration, Washington, D.C. Office of Economic Impact Analysis.*

REPORT TO CONGRESS ON THE ECONOMIC IMPACT OF ENERGY ACTIONS Semiannual Report

May 1976 58 p refs

(PB-256684/2; FEA/B-76/351) Avail: NTIS HC A04/MF A01 CSCL 05C

The potential impact of the 1973-74 embargo and ensuing energy price increases was evaluated by comparing a simulation of what actually happened during 1975 with a simulation of what could have happened if the oil embargo and rapid increase in energy prices had not occurred. GRA

N77-16452# National Bureau of Standards, Washington, D.C. Center for Building Technology.

THERMAL DATA REQUIREMENTS AND PERFORMANCE EVALUATION PROCEDURES FOR THE NATIONAL SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM Interim Report

E. Streed, M. McCabe, D. Waksman, J. Hebrank, and T. Richtmyer Aug. 1976 86 p refs Sponsored in part by HUD

(Contract E(49-1)-3800)

(PB-257770/8; NBSIR-76-1137) Avail: NTIS HC A05/MF A01 CSCL 13A

The data requirements and performance evaluation factors to be used in the National Solar Heating and Cooling Demonstration Program were determined. Solar energy systems used for heating hot water, space heating, and space cooling were considered and specific measurements and analytical procedures were recommended to determine the thermal effectiveness for daily, monthly, seasonal, or annual operating periods. The sensor accuracy and sampling rate effects on measurement uncertainty for several performance factors are presented. GRA

N77-16453# Mitre Corp., McLean, Va.

PROCEEDINGS OF NATIONAL CONFERENCE ON HEALTH, ENVIRONMENTAL EFFECTS, AND CONTROL TECHNOLOGY OF ENERGY USE Final Report

Feb. 1976 347 p refs Conf. held at Washington, D. C., 9-11 Feb. 1976

(Contract EPA-68-01-3188)

(PB-256845/9; EPA-600/7-76-002) Avail: NTIS HC A15/MF A01 CSCL 10A

Topic areas include: atmospheric transport; measurement and monitoring; environmental health effects; marine ecological effects; fresh water ecological effects; terrestrial ecological effects; energy resource extraction; fuel processing; flue gas technology; energy conservation; and integrated assessment. GRA

N77-16454# Faucett (Jack) Associates, Inc., Chevy Chase, Md.

MACRO-ECONOMIC IMPACT AND OTHER CONSIDERATIONS IN SELECTING ENERGY CONSERVATION MEASURES

16 Jun. 1975 81 p refs Sponsored in part by EPA. Prepared for Peat, Marwick, Livingston and Co., Washington, D.C.

(Contract EPA-68-01-2440)

(PB-257678/3) Avail: NTIS HC A05/MF A01 CSCL 10A

Concepts and numerical estimates required for a complete and objective evaluation of energy conservation are presented. The underlying premise is that conservation, like any government program, has costs and benefits that should be quantified and compared. The objective of the study were to evaluate the macro-economic impacts of energy conservation, and to estimate and present the costs of and benefits from energy conservation. GRA

N77-16455# Federal Energy Administration, Washington, D.C.

SOLAR COLLECTOR MANUFACTURING ACTIVITY, JANUARY-JUNE 1976 Semiannual Report

Richard D. Stoll Sep. 1976 23 p refs

(PB-258865/5; FEA/B-76/403) Avail: NTIS HC A02/MF A01 CSCL 10A

The results of a survey of private firms that manufactured and sold solar collectors during the first half of calendar year 1976, are discussed. Descriptive statistics were obtained on economic activity in the solar heating and cooling area. Production growth rates in this fledgling industry were identified. Results show that production during the first half of 1976 was 60 percent greater than for the last half of 1975 and 155 percent greater than for the first half of 1975. Author

N77-16456# ESB, Inc., Yardley, Pa. Technology Center.

SODIUM CHLORIDE BATTERY DEVELOPMENT PROGRAM FOR LOAD LEVELING Interim Report, 1 Jan. - 31 Dec. 1975

James R. Birk and John Werth Dec. 1975 94 p refs Sponsored by Elec. Power Res. Inst.

(PB-257570/2; EPRI-EM-230) Avail: NTIS HC A05/MF A01 CSCL 10C

A molten sodium chloride battery for load leveling is described which offers considerable promise for lightweight, long life, and low cost. The cell includes a steel-contained molten sodium negative, a separator conductive to sodium ions, a molten sodium chloroaluminate electrolyte, a molten metal chloride positive (typically, but not exclusively antimony trichloride), dispersed carbon powder, and a metallic positive current collector. The cell operates at 200 C and uses silicone rubber instead of glass to seal the molten sodium. The low temperature also favors a longer life for the beta alumina separator before penetration occurs and reduces current collector and seal corrosion. GRA

N77-16457# Environmental Protection Agency, Denver, Colo.

EXISTING AND PROPOSED FUEL CONVERSION FACILITIES. SUMMARY

Jul. 1976 37 p

(PB-258264/1; EPA-R8-TS-5) Avail: NTIS HC A02/MF A01 CSCL 10A

Existing and proposed coal conversion facilities and hydroelectric plants are summarized on a state-by-state basis for the six states (Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming) of EPA Region VIII. The location, facility name, number of units, operating company and other participants, plant capacity, and the fuel type for the various conversion facilities are identified. GRA

N77-16459# Aerospace Corp., El Segundo, Calif. Energy and Transportation Div.

PENETRATION ANALYSIS AND MARGIN REQUIREMENTS ASSOCIATED WITH LARGE-SCALE UTILIZATION OF SOLAR POWER PLANTS

George C. McKoy Aug. 1976 77 p refs Sponsored by Elec. Power Res. Inst.
(PB-257546/2; EPRI-ER-198; EPRI/TPS-75-611) Avail: NTIS HC A05/MF A01 CSCL 10B

Computer simulations of network operation were carried out taking into account the availability for service of both solar and conventional plants as a function of scheduled maintenance and forced outage events. Solar plant capacities up to approximately one-third of the network capacity were examined. GRA

N77-16460# Tetra Tech, Inc., Arlington, Va.
ANALYSIS OF THE TECHNICAL AND COST FEASIBILITY OF SOLAR AND/OR WIND ENERGY SYSTEMS FOR COAST GUARD PUBLIC QUARTERS Final Report
P. E. Arbo, J. J. Reed, A. F. Garcia, and C. W. Hemphill 11 Jun. 1976 92 p refs
(Contract DOT-CG-50960-A)
(AD-A028332; TETRAT-A-463-76-248; USCG-D-80-76) Avail: NTIS HC A05/MF A01 CSCL 13/1

Energy requirements of existing Coast Guard-owned public quarters were assessed based on a survey of energy usage for FY 1975. A computerized solar collector heat gain model was developed to identify regions in which solar heating might be cost beneficial under a conservative scenario and using generalized data. A region containing 45 structures (with 74 public quarters) at 10 sites was identified. Energy requirements and regional insolation and weather data for each specific site were then used in the model to determine solar collector requirements and cost break-even periods. Based on these results, a solar heating applications research project was outlined to capitalize on solar energy. Author (GRA)

N77-16461# Naval Academy, Annapolis, Md. Energy-Environment Study Group.
FEASIBILITY OF HEATING DOMESTIC HOT WATER FOR APARTMENTS WITH SOLAR ENERGY Final Report, 1 Jul. 1975 - 30 Jun. 1976
Billie J. Graham Mar. 1976 16 p refs
(AD-A028418; USNA-EPRD-20) Avail: NTIS HC A02/MF A01 CSCL 13/1

A feasibility study has shown that because of the age and nature of construction of the Wherry Apartments within the Annapolis Complex, the use of solar energy retrofitted to the existing heating system to supply heat for the space heating requirements is not economically justified. However, because the energy requirements for domestic hot water are essentially constant year round, the solar heat collecting system for this application is much more simple in design. For these reasons, the economical use of solar energy to heat the domestic hot water in these apartments appears promising. Author (GRA)

N77-16467# Standard Electrik Lorenz A.G., Stuttgart (West Germany). Fachbereich Werkstoffe und Bauelemente.
ENVIRONMENTAL PROTECTION MEASURING TECHNIQUE. SENSOR FOR AUTOMATIC CONTINUOUS EMISSION CONTROL OF GASES Final Report
Mark Becker, Eike Eckert, Hans-Bernhard Fliege, Christina Leu, Heinz-Werner Lotz, Hans Reiber, and Gerhard Seibold Bonn Bundesmin. fuer Forsch. u. Technol. Jul. 1976 26 p In GERMAN; ENGLISH summary
(Contract BMFT-NTOE-61)
(BMFT-FB-T-76-03) Avail: NTIS HC A03/MF A01; ZLDI, Munich, DM 5.05

For continuous in-situ measurements of exhaust gases a laboratory model of a gas sensor was designed and constructed for maintenance-free operation in adverse environments. The equipment operates by single beam, dual wavelength method thus achieving a high degree of independence from interferences like intensity loss by window contamination or dust within the absorption path. By selecting the SO2 absorption band at 4.0 micrometer and by a unique design of the electronic signal processing circuits, measurements of SO2 concentrations within exhaust ducts are possible which are free from interference of simultaneously existing other gas constituents like CO, O2, CO2, NOx, and water vapor. The measuring range with an absorption path of 10 m covers concentrations from 0.2 to 5 g/normal cu m at a maximum uncertainity of 2.5% of the maximum value. The equipment was tested inside a chimney of a fossil fuel burning 150 MW power plant. Author (ESA)

N77-16470# United Technologies Research Center, East Hartford, Conn.
FUEL GAS ENVIRONMENTAL IMPACT Final Report, Nov. 1974 - Nov. 1975
F. L. Robson, W. A. Blecher, and C. B. Colton Jun. 1976 287 p refs
(Contract EPA-68-02-1099)
(PB-257134/7; EPA-600/2-76-153) Avail: NTIS HC A13/MF A01 CSCL 13B

The technical and economic considerations of atmospheric-pressure, oxygen-blown coal gasifiers and pressurized, air-blown, partial-oxidation residual-oil gasifiers were evaluated. The environmental impact of combinations of: (1) fossil fuel gasification systems, (2) low- and high-temperature fuel gas cleanup processes, and (3) advanced cycle power systems were defined. GRA

N77-16479*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
WIND ENHANCED PLANETARY ESCAPE: COLLISIONAL MODIFICATIONS
Steven A. Curtis and R. E. Hartle Dec. 1976 27 p refs Submitted for publication
(NASA-TM-X-71251; X-621-76-290) Avail: NTIS HC A02/MF A01 CSCL 04A

The problem of thermal escape is considered in which both the effects of thermospheric winds at the exobase and collisions below the exobase are included in a Monte Carlo calculation. The collisions are included by means of a collisional relaxation layer of a background gas which models the transition region between the exosphere and the thermosphere. The wind effects are considered in the limiting cases of vertical and horizontal flows. Two species are considered: terrestrial hydrogen and terrestrial helium. In the cases of terrestrial hydrogen the escape fluxes were found to be strongly filtered or throttled by collisions at high exospheric temperatures. The model is applied to molecular hydrogen diffusing through a methane relaxation layer under conditions possible on Titan. The results are similar to the case of terrestrial hydrogen with wind enhanced escape being strongly suppressed by collisions. It is concluded that wind enhanced escape is not an important process on Titan. Author

N77-17032# Committee on Aeronautical and Space Sciences (U. S. Senate).
AIRCRAFT FUEL EFFICIENCY PROGRAM
Washington GPO 1976 28 p Rept. for Comm. on Aeronautical and Space Sci., 94th Congr., 2d Sess., 17 Feb. 1976
(S-Rept-94-633; GPO-57-010) Avail: US Capitol, Senate Document Room

A technology plan is described for developing fuel-efficient aircraft. Inputs were obtained from industry, NASA research centers, and other governmental agencies. Six major programs are defined: engine component improvement, composite primary structures, turboprops, laminar flow control, fuel conservative transport, and the fuel conservative engine. Funding requirements and benefits are discussed. A.R.H.

N77-17112# Dornier-System G.m.b.H., Friedrichshafen (West Germany). Fachbereich Mechanik.
DEVELOPMENT OF A VERTICAL AXIS WIND TURBINE (PHASE 1) Final Report
Hermann Bankwitz, Albert Fritzsche, Juergen Schmelzle, Dieter Welte, and Chandrasekhara N. N. Swamy Bonn Bundesmin. fuer Forsch. u. Technol. Oct. 1976 128 p refs In GERMAN; ENGLISH summary
(Contract BMFT-ET-4135-A)
(BMFT-FB-T-76-55) Avail: NTIS HC A07/MF A01; ZLDI, Munich, DM 25.85

The aerodynamic, mechanical, operational, and manufacturing aspects of a vertical axis wind energy converter (Darrieus rotor) are dealt with. Design techniques and design studies are described. A prospective, based on the system's advantages (independence from wind direction, simplicity of manufacture, installation, and maintenance), is made to continue the development with the

aim of a series production of this vertical-axis wind turbine in a performance range up to approximately 20 kW. For greater power ranges the disadvantages of this design become predominant (comparatively low rotating speed, large amount of material for the rotor blades). The horizontal rotor axis design with a considerably more advanced state of development has to be preferred in a power range above 20 kW for irrigation purposes and power supply. Author (ESA)

N77-17198*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
CORROSION INHIBITORS FOR SOLAR HEATING AND COOLING SYSTEMS
T. S. Humphries and G. E. DeRamus, Jr. Washington Feb. 1977 22 p
(NASA-TN-D-8409; M-199) Avail: NTIS HC A02/MF A01 CSCL 11F

Problems dealing with corrosion and corrosion protection of solar heating and cooling systems are discussed. A test program was conducted to find suitable and effective corrosion inhibitors for systems employing either water or antifreeze solutions for heat transfer and storage. Aluminum-mild-steel-copper-stainless steel assemblies in electrical contact were used to simulate a multimetallic system which is the type most likely to be employed. Several inhibitors show promise for this application. Author

N77-17216# Case Western Reserve Univ., Cleveland, Ohio.
MATERIALS RESEARCH AND EVALUATION FOR GEOTHERMAL CORROSION ENVIRONMENTS Progress Report, 15 Dec. 1974 - 15 Dec. 1975
A. R. Troiano and R. F. Hehemann Dec. 1975 11 p refs
(Contract E(11-1)-2602)
(COO-2602-2) Avail: NTIS HC A02/MF A01

Bent beam and self-stressed specimens were employed and yielded results consistent with other types of specimens reported in the literature. All tests were conducted in the standard NACE, H2S environment for initial screening and then in a 20 percent NaCl modified NACE solution. Among the higher strength corrosion resistant alloys, K Monel at 135 ksi yield strength did not fail in either environment at temperatures up to 425 F stressed at the yield strength. Age hardenable A286 failed at 325 F when stressed to the 190 ksi yield strength, but did not fail when stressed to an overaged yield strength of 135 ksi. A new NiCoCrMo age hardenable alloy heat treated to 220 ksi yield strength and stressed to this value did not fail in either environment at temperatures up to 420 F. Also, this material was substantially brighter after the tests than either the K-Monel or A286. ERA

N77-17246# Battelle Columbus Labs., Ohio.
ANALYSIS OF CERAMIC MATERIALS FOR IMPACT MEMBERS IN ISOTOPIC HEAT SOURCES
F. A. Simonen and W. H. Duckworth 14 May 1976 46 p refs
(Contract W-7405-eng-92)
(BMI-X-670) Avail: NTIS HC A03/MF A01

Of the ceramics studied, silicon nitride offers the most promise followed by silicon carbide and aluminum oxide. Stress analyses show severe limitations on allowable velocities for impact with granite following reentry for these ceramics. Impact velocities in the 100 to 200 fps regime can be achieved only by the addition of a layer to distribute the high contact stress. Besides impact limitations, application of ceramic materials in heat sources would present problems both in terms of weight and fabrication. The required thickness of a ceramic impact member would be comparable to that for a carbon-carbon composite material, but the least dense of the high strength ceramics are 2 to 3 times more dense than the carbon-carbon composites. Fabrication of a ceramic heat source would require a high strength bond between the fuel and the impact member to achieve reasonable impact velocities. ERA

N77-17255# Naval Civil Engineering Lab., Port Hueneme, Calif.
EXPERIMENTAL POLYURETHANE FOAM ROOFING SYSTEMS Technical Report, Jan. 1973 - Oct. 1975
John R. Keeton, Robert L. Alumbaugh, and Edwin F. Humm Aug. 1976 119 p
(YF5354007)
(AD-A031046; CEL-TN-1450) Avail: NTIS HC A06/MF A01 CSCL 13/13

An experimental roofing installation is described in which polyurethane foam is spray-applied to metal Butler-type roofs and then coated with five different elastomeric coatings. The coating systems included a catalyzed silicone rubber, a moisture-curing silicone rubber, a hypalon mastic, and two catalyzed butyl-hypalons. Temperatures recorded on top of the foam, on the metal roof deck, and in the building attics, reveal the insulating quality of the foam. Fuel usage before and after application of the foam is included - a natural gas savings of 53% is indicated after foaming. The performance of each of the five coating systems over a 22-month period is summarized. Best overall performance was observed with the silicone rubbers; the poorest performance was with one of the catalyzed butyl-hypalons. Hail damage was observed on all of the coating systems except the silicones. Minor roof repairs that were done within the first year after installation are reported. GRA

N77-17372# AEG-Telefunken, Frankfurt am Main (West Germany). Bereich Forschung und Entwicklung.
NON-NUCLEAR ENERGY TECHNOLOGY. LOW TEMPERATURE CABLE FOR POWER TRANSMISSION Final Report
Hermann Franke, Ulrich Hildebrandt (Linde A. G.), Helmut Kuhmann (AEG-Telefunken Kabelwerke A. G.), Ernst Scheffler (Kabel- u. Metallwerke Gutehoffnungshuette A. G.), Heinz Voigt, and Eduard Bochenek Bonn Bundesmin. fuer Eorsch. u. Technol. Aug. 1976 226 p refs In GERMAN; ENGLISH summary
(Contract BMFT-NT-196 (NT-4196A))
(BMFT-FB-T-76-01) Avail: NTIS HC A11/MF A01; ZLDI, Munich, DM 47.05

Cable components were developed for superconducting power transmission lines. Studies were carried out concerning design of a flexible contraction compensated dc cable, terminations, joints, and peripheral equipment. Test cables were manufactured and current-carrying capacity of the cable was tested in an experimental setup. Cable and terminations were installed for making high voltage tests. An energy-economic study was made. ESA

N77-17555# Bureau of Mines, Pittsburgh, Pa. Mining and Safety Research Center.
DEGASIFICATION AND PRODUCTION OF NATURAL GAS FROM AN AIRSHAFT IN THE PITTSBURGH COALBED Report of Investigations 1976
H. H. Fields, Joseph Cervik, T. W. Goodman, and D. C. Oyler Aug. 1976 30 p refs
(PB-258101/5; BM-RI-8173) Avail: NTIS HC A03/MF A01 CSCL 08I

The effectiveness of long holes drilled in solid virgin coal in degasifying an area of the Pittsburgh coalbed was studied. All holes were connected to the piping manifold, and maximum gas flow from the five degasification holes was measured at 994,000 cubic ft/d. After 691 days of degasification, a total of 611 million cubic feet of methane had been exhausted to the atmosphere. GRA

N77-17560*# Memphis State Univ., Tenn. Dept. of Mechanical Engineering.
OPTIMIZATION OF ABSORPTION AIR-CONDITIONING FOR SOLAR ENERGY APPLICATIONS Final Report, 1 Sep. 1974 - 31 Oct. 1976
Edward H. Perry Dec. 1976 68 p refs
(Contract NAS8-31189)
(NASA-CR-150176) Avail: NTIS HC A04/MF A01 CSCL 10A

Improved performance of solar cooling systems using the lithium bromide water absorption cycle is investigated. Included are computer simulations of a solar-cooled house, analyses and measurements of heat transfer rates in absorption system components, and design and fabrication of various system components. A survey of solar collector convection suppression methods is presented. Author

N77-17562*# Kanner (Leo) Associates, Redwood City, Calif.
THE OPTIMUM CONFIGURATION OF ROTOR BLADES FOR

HORIZONTAL WIND ENERGY CONVERTERS
W. Weber Washington NASA Feb. 1977 17 p refs Transl. into ENGLISH from Z. Flugwiss. (West Germany), v. 23, no. 12, 1975 p 443-447
(Contract NASw-2790)
(NASA-TT-F-17379) Avail: NTIS HC A02/MF A01 CSCL 10A

Considerations, procedures and some results relating to the problem of the aerodynamic configuration of rotor blades for wind energy converters are presented. Author

N77-17564*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SOLAR CELL COLLECTOR AND METHOD FOR PRODUCING SAME Patent Application
John C. Evans, Jr., inventor (to NASA) Filed 22 Feb. 1977 16 p
(NASA-Case-LEW-12552-1; US-Patent-Appl-SN-776869) Avail: NTIS HC A02/MF A01 CSCL 10A

A method is described which permits the formation of highly conductive metal channels in a continuous pattern of any desired design within a transparent conductive mixed oxide layer which covers and protects an underlying photovoltaic substrate. The result is a sufficient collector system for the current generated by incident photon radiation. NASA

N77-17565*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
IMPROVED BACKWALL CELL Patent Application
Henry W. Brandhorst, Jr., inventor (to NASA) Filed 19 Jan. 1977 15 p
(NASA-Case-LEW-12236-1; US-Patent-Appl-SN-760771) Avail: NTIS HC A02/MF A01 CSCL 10A

A solar cell is described having a first material of one conductivity type with one face having the same conductivity type more heavily doped to form a field region to receive the radiant energy. A layer of opposite conductivity type or a metallic layer forming a Schottky barrier is applied to the opposite face. A gridded contact pervious to the radiant energy may be applied to the region of the more heavily doped material for electrical contact. The device allows separate control of the junction, either the p-n junction or the Schottky diode junction, and the efficient collection of light. This efficiency is improved, because the high conductivity region has low sheet resistance, and a low surface recombination velocity with enhanced effective diffusion lengths in bulk. NASA

N77-17567# Ames Lab., Iowa.
ENVIRONMENTAL EFFECTS OF SOLID WASTE AS A SUPPLEMENTAL FUEL
J. L. Hall, A. W. Joensen, and H. R. Shanks Mar. 1976 34 p refs
(Contract W-7405-eng-82)
(IS-3852) Avail: NTIS HC A03/MF A01

Procurement and calibration of equipment as well as training of personnel was accomplished, and sampling is in progress to satisfy the objectives of the environmental study. All input and output stream associated with operation of the steam generating units are sampled. Sampling and characterization of fuel (both coal and processed refuse), ash and particulate effluent were accomplished. In addition, the oxides of nitrogen, oxides of sulfur and heavy organics were sampled. Author (ERA)

N77-17570# Battelle Columbus Labs., Ohio.
SYSTEMS STUDY OF FUELS FROM SUGAR CANE, SWEET SORGHUM, AND SUGAR BEETS Quarterly Report
E. S. Lipinsky, Richard A. Nathan, Thomas A. McClure, Willian T. Lawhon, John Warner (C. Brewer and Company), William J. Sheppard, J. L. Otis, A. W. Lemmon, L. M. Curran, and J. H. Litchfield 14 Apr. 1976 149 p refs
(Contract E(11-1)-2762)
(TID-27032; QR-3) Avail: NTIS HC A07/MF A01

Methods to derive fuels economically from sugar cane, sugar beets, and sweet sorghum were suggested, potential feasibility of the various suggestions were evaluated, and means were suggested to convert the potential feasibility into practical feasibility. The sugar cane and sugar beet productivity per acre and the production costs are estimated. The two most promising methods for the thermochemical conversion of the plants into synthesis gas are the Bailie and the Purox process. ERA

N77-17571# Sandia Labs., Albuquerque, N.Mex.
SOLAR TOTAL ENERGY PROGRAM Semiannual Report, Oct. 1975 - Mar. 1976
G. W. Treadwell, ed. and L. E. Torkelson, ed. Jun. 1976 64 p refs
(Contract AT(29-1)-789)
(SAND-76-0205) Avail: NTIS HC A04/MF A01

Highlights of the period, descriptions of the system and its components, including recent modifications, and the results of systems analyses and component testing are included. ERA

N77-17573# Oak Ridge National Lab., Tenn.
POTENTIAL FOR ENERGY CONSERVATION TECHNOLOGY TRANSFER
E. C. Hise 1976 11 p refs Presented at Southern Interstate Nuclear Board Meeting, Winston-Salem, North Carolina, 24 May 1976 Sponsored by ERDA
(CONF-760536-1) Avail: NTIS HC A02/MF A01

The segment of energy consumption related to space conditioning and water heating in residential, commercial, and institutional buildings is discussed specifically. Within this constraint building energy consumption is discussed, considering three choices: drastic alteration of life style; even greater energy operating costs; or relatively large capital expenditures to reduce building energy consumption. It is concluded that the average existing residence can, through insulation, reduce its energy consumption to 60 percent of present for an expenditure of $500 to $1000 and a pay back of 5 to 10 years. The average existing commercial or institutional building can save even more. New construction can show greater energy savings at little or no additional construction cost. It is concluded that the average existing residential heating/cooling system (equipment) can be modified or replaced to reduce its energy consumption to 60 percent or even 40 percent of the present at a cost of a few hundred to $3000 as a function of the problem. ERA

N77-17577# Brookhaven National Lab., Upton, N.Y.
COMPARING THE ELECTRIC LEAD-ACID BATTERY VEHICLE WITH A HYDROGEN FUELED VEHICLE INCORPORATING AN Fe-Ti HYDRIDE STORAGE UNIT
C. H. Waide 26 Jan. 1976 13 p refs Sponsored by ERDA
(BNL-20990) Avail: NTIS HC A02/MF A01

An electric vehicle powered by energy stored in lead-acid batteries is compared with a hydrogen fueled vehicle utilizing an internal combustion engine and iron-titanium hydride for the fuel storage. The comparison shows that for roughly equivalent vehicle types, the iron-titanium storage of hydrogen provides a vehicle with better range, better performance, and fewer operational limitations than an electric vehicle using lead-acid batteries. ERA

N77-17579# Aerojet Nuclear Co., Idaho Falls, Idaho. National Engineering Lab.
CONCEPTUAL STUDY FOR TOTAL UTILIZATION OF AN INTERMEDIATE TEMPERATURE GEOTHERMAL RESOURCE
D. G. Swink and R. J. Schultz Apr. 1976 30 p refs Sponsored by ERDA
(Contract E(10-1)-1375)
(ANCR-1260) Avail: NTIS HC A03/MF A01

A multi-use, integrated project plan has been developed for the combined electrical and direct utilization of an intermediate temperature geothermal resource. This concept addresses an integrated project plan with industrial participation, which could make a significant contribution to the national plan for energy independence, by creating new and realistic energy choices for the immediate future. ERA

N77-17580# California Univ., Berkeley. Lawrence Berkeley Lab.

GEOTHERMAL COMPONENT TEST FACILITY
Apr. 1976 13 p
(Contract W-7405-eng-48)
(TID-27035) Avail: NTIS HC A02/MF A01

A description is given of the East Mesa geothermal facility and the services provided. The facility provides for testing various types of geothermal energy conversion equipment and materials under field conditions using geothermal fluids from three existing wells. ERA

N77-17581# California Univ., Livermore. Lawrence Livermore Lab.
PERFORMANCE TEST OF A BLADELESS TURBINE FOR GEOTHERMAL APPLICATIONS
R. Steidel and H. Weiss 24 Mar. 1976 24 p refs
(Contract W-7405-eng-48)
(UCID-17068) Avail: NTIS HC A02/MF A01

The Possell bladeless turbine was tested to evaluate its potential for application in the total flow process. Test description and performance data are given for 3000, 3500, 4000, and 4500 rpm. The maximum engine efficiency observed was less than 7 percent. It is concluded that the Possell turbine is not a viable candidate machine for the conversion of geothermal fluids by the total flow process. ERA

N77-17582# Michigan State Univ., East Lansing. Div. of Engineering Research.
APPLICATION STUDY OF WIND POWER TECHNOLOGY TO THE CITY OF HART, MICHIGAN
J. Asmussen, P. D. Fisher, G. L. Park, and O. Krauss 31 Dec. 1975 103 p refs
(Contract E(11-1)-2603)
(COO-2603-1) Avail: NTIS HC A06/MF A01

Information is presented concerning wind data collections and analysis; Hart power demand and consumer usage; wind power assessment; hydro power assessment; results of preliminary economics analysis; environmental impact of wind turbines and operation in the Hart, Oceana County, Michigan area; and systems model for the Hart power system with wind turbine. ERA

N77-17584# AEG-Telefunken, Hamburg (West Germany).
EXPERIMENTAL STUDY OF THE THEORETICAL AND TECHNOLOGICAL POSSIBILITIES TO MANUFACTURE SOLAR CELLS USING GaAlAs-LAYERS ON GaAs-STRUCTURES Final Report
Diethard Huber Bonn Bundesmin. fuer Forsch. u. Technol. Aug. 1976 44 p refs In GERMAN; ENGLISH summary
(Contracts BMFT-WRT-2073; GfW-RV-11-TO-3/72)
(BMFT-FB-W-76-10) Avail: NTIS HC A03/MF A01 ZLDI, Munich, DM 8.85

Heterojunction solar cells, consisting of p-Ga(x)A(1-x)As-pGaAs-nGaAs were grown by liquid-phase epitaxy from Zn doped Al:GA:As melts. They exhibit power conversion efficiencies of 13.5% for air mass zero value. These values correspond to conversion efficiencies of 18% for air mass value of 1 or 20 to 22% for air mass value of 2 or more. The AlGaAs solar cells, published in the literature, are restricted with respect to optimizing power conversion efficiencies. These problems are discussed. An alternative structure of an AlAsP-GaAs solar cell has been proposed. Such a solar cell should have nearly no absorption in the window. Power conversion efficiencies of up to 20% for air mass zero value are possible with the proposed structure. Author (ESA)

N77-17593# ICF, Inc., Washington, D.C.
PRODUCTION AND CONSUMPTION OF COAL, 1976 - 1980 Final Report
May 1976 167 p refs
(Contract FEA-C-05-50099-00)
(PB-257441/6; FEA/G-75/375) Avail: NTIS CSCL 21D

Independent forecasts are made for coal production and utility and nonutility consumption. Production relations are shown for consumption forecasts, future distribution patterns are projected, and excess production potential is estimated. GRA

N77-17594# Chem Systems, Inc., New York.
LIQUID PHASE METHANOL Annual Report
Martin Sherwin and David Blum Aug. 1976 112 p Sponsored by Elec. Power Res. Inst.
(PB-257615/5; EPRI-AF-202) Avail: NTIS HC A06/MF A01 CSCL 21D

A three phase fluidized system is described for methanol synthesis. An inert liquid is used as a sink for the exotherm of the synthesis reaction. This temperature control feature allows greater per pass conversion and improved thermal efficiency as compared to presently available technology. Experimental findings from a bench scale apparatus are reported. Thermodynamic calculations and a preliminary economic analysis are presented. This technology has potential as an efficient method of energy storage from coal-based gasification power plants. Another application is in a plant to produce fuel grade methanol for export to power plants for intermediate or peak load use. GRA

N77-17595# Babcock and Wilcox Co., Alliance, Ohio. Research Center.
INVESTIGATING STORAGE, HANDLING, AND COMBUSTION CHARACTERISTICS OF SOLVENT REFINED COAL Final Report
S. M. Barrick, S. J. Vecci, and C. L. Wagoner Aug. 1976 120 p refs Sponsored by Elec. Power Res. Inst. Prepared in cooperation with Babcock and Wilcox Co., Barberton, Ohio
(PB-257557/9; EPRI-1235-3-FR) Avail: NTIS HC A06/MF A01 CSCL 21D

The 1235 series of reports documents the results of the investigation of the storage, handling, and combustion characteristics of solvent refined coal (SRC). Such information would permit boiler manufacturers to design new units for burning SRC and to determine retrofit requirements (if any) for existing units burning coal. The SRC reports summarize activity for a wide range of tasks. Initial work included bench-scale analyses of SRC, such as fuel analysis, pulverizing, and transport. The culmination of the effort was a 2-ton/hour ball-and-race pulverizing and direct-firing test to simulate as closely as possible operating conditions in a utility plant using conventional equipment. GRA

N77-17598# Federal Energy Administration, Washington; D.C. Office of Energy Resource Development.
SUMMARY REPORT OF THREE POWERPLANT PRODUCTIVITY STUDIES
Robert M. Nelson Aug. 1976 86 p refs
(PB-257764/1; FEA/G-76/328) Avail: NTIS HC A05/MF A01 CSCL 10B

A summary of three separate studies of electric powerplant productivity is given. GRA

N77-17599# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
HIGH-EFFICIENCY THIN-FILM GaAs SOLAR CELLS Interim Report, 1 Apr. - 30 Jun. 1976
R. J. Stirn, Y. C. M. Yeh, and F. P. Ernest Jul. 1976 55 p refs
(Grant NSF AER-76-01823)
(PB-258493/6; NSF/RA-760237; IR-2) Avail: NTIS HC A04/MF A01 CSCL 10B

A program was begun to investigate the feasibility of growing large grain polycrystalline GaAs by chemical vapor deposition on recrystallized Ge films, to fabricate AMOS (Antireflection-Coated Metal-Oxide-Semiconductor) solar cells on the films, and to further investigate the physics of AMOS cells on single crystals. Progress was made in obtaining reproductibly high open-circuit voltages on oxidized single-crystal GaAs before contacting with grids or depositing AR coatings. Application of gold to the oxide film results in gold reaction with the film and apparent modification of the relative amounts of As(3+) to As(5+) in the oxide. Baseline *and AMOS Schottky barrier solar cells were fabricated on polished* wafers of polycrystalline GaAs with relatively high doping levels. Ge films recrystallized to date with focused IR line heaters melted over too large an area for zone recrystallization. A 10-watt CW Nd/YAG laser was requested in order to accomplish much finer zones of melting by line focusing with cylindrical lenses. GRA

N77-17600# National Bureau of Standards, Washington, D.C.
A SURVEY OF STATE LEGISLATION RELATING TO SOLAR ENERGY Final Report
Robert M. Eisenhard Apr. 1976 166 p refs Sponsored in part by ERDA and HUD
(PB-258235/1; NBSIR-76-1082) Avail: NTIS HC A08/MF A01 CSCL 10A

Enacted state legislation dealing with solar energy is reviewed. Acts involving tax incentives, reduced property assessments, research and development, solar easements and solar energy promotion are identified and abstracted. The responsible state agency and official are listed. Acts and supporting forms and other information are included. Portions of this document are not fully legible. GRA

N77-17603# Energy Research Corp., Danbury, Conn.
FUEL CELL STACKS *Interim Technical Report, Sep. 1975 - Feb. 1976*
S. G. Abens and Bernard S. Baker May 1976 22 p
(Contract DAAK02-74-C-0367; DA Proj. 1T0-61102-A-34A)
(AD-A030375; ERC-7396-S-3; ITR-3) Avail: NTIS HC A02/MF A01 CSCL 10/3

Processes for the manufacture of phosphoric acid fuel cell components are described. Electrodes, matrices, and bipolar gas distribution plates for use in fuel cells with an active area of about 0.4 sq ft have been fabricated. Initial performance of 10-cell stacks has been studied with pure and CO-containing hydrogen fuel. Life testing has been conducted with pure hydrogen fuel with cell voltage decay rates of 1.5 mV/100 hours over the first 1000 hours of operation at 150 C. Author (GRA)

N77-17605# Ballistic Research Labs., Aberdeen Proving Ground, Md.
SOLAR ENERGY STORAGE
Arthur Gauss, Jr. Jun. 1976 25 p refs
(DA Proj. 1T1-61101-A-91A)
(AD-A028083; BRL-1895) Avail: NTIS HC A02/MF A01 CSCL 10/3

Low temperature processes for solar energy storage have been evaluated. Temperatures are low enough so that relatively inexpensive flat plate solar collectors can be employed. Low temperature reactions are proposed which demonstrate the principles of chemical storage of solar energy. Certain of these reactions could be laboratory tested with little difficulty since they yield products which separate naturally. The most practical low temperature system analyzed to date is the heat of vaporization storage system. The storage capacity for this system, typically about 200 kcal/liter, is close to an order to magnitude better than conventional sensible heat storage in water. Author (GRA)

N77-17647# Environmental Protection Agency, Research Triangle Park, N.C. Emission Standards and Engineering Div.
STANDARDS SUPPORT AND ENVIRONMENTAL IMPACT STATEMENT. VOLUME 1: PROPOSED STANDARDS OF PERFORMANCE FOR PETROLEUM REFINERY SULFUR RECOVERY PLANTS
Sep. 1976 200 p refs 2 Vol.
(PB-257975/3; EPA-450/2-76-016-a-Vol-1) Avail: NTIS HC A09/MF A01 CSCL 13B

A national emission standard for sulfur dioxide and reduced sulfur compound emissions from petroleum refinery sulfur recovery plants is proposed under authority of section 111 of the Clean Air Act. Reduced sulfur compound emissions reaches ambient levels sufficient to produce severe odor problems in the vicinity of a petroleum refinery in the absence of the standard. The proposed standard is to minimize reduced sulfur and sulfur dioxide emissions from refinery sulfur recovery plants to the level attainable with best available control technology. The standard is to have the effect of reduction emissions from a typical refinery sulfur recovery plant by 99.9%. Environmental impact and economic impact statements quantifying the impacts of the proposed standard and alternative control options are included. GRA

N77-17690*# Boeing Co., Houston, Tex.
SPACE SOLAR POWER SYSTEMS **c44**
Curt Toliver *In* NASA. Lyndon B. Johnson Space Center Bioprocessing in Space Jan. 1977 p 191-204
Avail: NTIS HC A01/MF A01 CSCL 10A

Studies were done on the feasibility of placing a solar power station called POwersat, in space. A general description of the engineering features are given as well as a brief discussion of the economic considerations. L. L.

N77-17852*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ESTIMATES OF OPTIMAL GENERATING CONDITIONS FOR HYDROGEN-OXYGEN CESIUM-SEEDED MAGNETO-HYDRODYNAMIC POWER GENERATOR
J. Marlin Smith and Lester D. Nichols Washington Feb. 1977 37 p refs
(NASA-TN-D-8374; E-8828) Avail: NTIS HC A03/MF A01 CSCL 20I

The value of percent seed, oxygen to fuel ratio, combustion pressure, Mach number, and magnetic field strength which maximize either the electrical conductivity or power density at the entrance of an MHD power generator was obtained. The working fluid is the combustion product of H2 and O2 seeded with CsOH. The ideal theoretical segmented Faraday generator along with an empirical form found from correlating the data of many experimenters working with generators of different sizes, electrode configurations, and working fluids, are investigated. The conductivity and power densities optimize at a seed fraction of 3.5 mole percent and an oxygen to hydrogen weight ratio of 7.5. The optimum values of combustion pressure and Mach number depend on the operating magnetic field strength. Author

N77-17872# Energy Research and Development Administration, Washington, D.C.
ASSESSMENT OF THE ROLE OF MAGNETIC MIRROR DEVICES IN FUSION POWER DEVELOPMENT
Apr. 1976 21 p refs
(ERDA-76-74) Avail: NTIS HC A02/MF A01

An assessment of recent progress in the open systems (magnetic mirror) program is presented that considers the general question of which roles the mirror program should play in the national fusion effort. The panel conclusions, planning, and present status of mirror research are also presented. ERA

N77-17883# Energy Research and Development Administration, Washington, D.C. Div. of Controlled Thermonuclear Research.
NEUTRAL BEAM ENERGY AND POWER REQUIREMENTS FOR THE NEXT GENERATION OF TOKAMAKS
J. W. Willis, A. M. Sleeper, D. W. Ignat, and P. M. Stone 1976 35 p refs
(ERDA-76-77) Avail: NTIS HC A03/MF A01

In particular, the following questions are examined: how these requirements are determined, what critical assumptions are being made, how the requirements for the various machines compare, and what the overall cost of such systems is likely to be. ERA

N77-17891# Battelle Pacific Northwest Labs., Richland, Wash.
FUSION ENERGY OPTION
L. C. Schmid [1976] 27 p refs
(Contract E(45-1)-1830)
(BNWL-SA-5802) Avail: NTIS HC A03/MF A01

The potential of fusion energy contributing to the energy needs is discussed. Once feasibility questions are answered and engineering problems are resolved, it should be possible to produce energy in a form that can use current methods of electrical generation to convert it into a useful form. If the fusion system is operated with only deuterium as fuel, the deuterium available from a pail of water would produce energy equivalent to that produced by 600 gallons of gasoline. The water in the ocean could provide energy for billions of years at the current rate of consumption. Experimental results are currently confirming the theoretical predictions and the schedule for fusion development is shown to be completion of feasibility experiments in 1974; physics test reactors appearing in 1983; experimental power reactors being built in 1990; and the demonstration plant on-line in 1994. The process of producing fusion power, fusion research needs, and problems to be solved are reviewed. ERA

N77-17892# Los Alamos Scientific Lab., N.Mex.
ENERGY STORAGE AND TRANSFER WITH HOMOPOLAR MACHINE FOR A LINEAR THETA-PINCH HYBRID REACTOR
H. F. Vogel, M. Brennan, W. G. Dase, K. M. Tolk, and W. F. Weldon Dec. 1975 28 p refs
(Contract W-7405-eng-36)
(LA-61-74) Avail: NTIS HC A03/MF A01

The energy storage and transfer system for the compression coil system of a linear theta-pinch hybrid reactor (LTPHR) is described. High efficiency and low cost are the principal requirements for the energy storage and transfer of 25 MJ/m or 25 GJ for a 1-km LTPHR. The circuit efficiency must be approximately 90 percent, and the cost for the circuit 5 to 6 cents/J. Scaling laws and simple relationships between circuit efficiency and cost per unit energy as a function of the half cycle time are presented. Capacitors and homopolar machines are considered as energy storage elements with both functioning basically as capacitors. The advantage of the homopolar machine in this application is its relatively low cost, whereas that of capacitors is better efficiency. ERA

N77-17947*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
RESULTS OF BASELINE TESTS OF THE LUCAS LIMOUSINE
Richard F. Soltis, Miles O. Dustin, and Noel B. Sargent Jan. 1977 29 p Sponsored in part by ERDA
(NASA-TM-X-73609; E-9075) Avail: NTIS HC A03/MF A01 CSCL 13F

The Lucas Limousine, an electric vehicle, was tested to assess the state-of-the-art of electric vehicles. All tests were made without the regenerative braking system and were conducted at the gross vehicle weight of 7,700 pounds. Over a 30 mph stop and go driving cycle the vehicle went 48.4 miles. The vehicle was able to accelerate to 30 mph in about 15 seconds with a gradeability limit of 16.5 percent. As determined by coast down tests the road power and road energy consumption for the vehicle were 2.92 kilowatts and 0.146 kWh/mi, respectively, at 20 mph. At 40 mph the road power requirement was 11.12 kilowatts and the road energy requirement was 0.278 kWh/mi. The maximum energy economy measured 0.45 kilowatt hours per mile at 30 mph and increased to 0.76 kilowatt hours per mile at 50 mph. Over the 30 mph stop and go driving cycle the energy economy was 0.92 kilowatt hours per mile. Author

N77-18057# Sandia Labs., Albuquerque, N.Mex.
WIND TUNNEL PERFORMANCE DATA FOR THE DARRIEUS WIND TURBINE WITH NACA 0012 BLADES
Bennie F. Blackwell, Robert E. Sheldahl, and Louis V. Feltz May 1976 61 p
(Contract AT(29-1)-789)
(SAND-76-0130) Avail: NTIS HC A04/MF A01

Five blade configurations of a 2-meter-diameter Darrieus wind turbine have been tested in a low speed wind tunnel. The airfoil section for all configurations was NACA 0012. The parameters measured were torque, rotational speed, and tunnel conditions. Data are presented in the form of power coefficient as a function of tip-speed ratio for the various solidities, Reynolds number, and freestream velocities tested. ERA

N77-18230# Naval Academy, Annapolis, Md. Energy, Environment Study Group.
DESIGN DEVELOPMENT OF ADVANCED COMPOSITE FLYWHEELS Final Report, 1 Jul. 1975 - 1 Jun. 1976
Robert A. McCoy 28 Jun. 1976 24 p refs
(AD-A030712; USNA-EPRD-28) Avail: NTIS HC A02/MF A01 CSCL 13/9

This report describes a research project to develop a highly efficient flywheel design based upon advanced filamentary composite materials. After analyzing the interrelationships between the specific energy, shape factor, strength-to-weight ratio, configuration, stress distribution, and fiber directions, the optimal flywheel configuration selected was a rounded tapered disk. Also, a fabrication technique for this flywheel model was proposed. This technique employs a simple wrapping apparatus by which unidirectional prepreg fiber/epoxy tape is wound so that fiber directions coincide with the major stresses within the flywl when spinning. Author (G

N77-18352# Air Products and Chemicals, Inc., Allentown, I
ASSESSMENT AND STUDY OF EXISTING CONCEPTS A METHODS OF CRYOGENIC REFRIGERATION FOR SUPI CONDUCTING TRANSMISSION CABLES Final Report
F. J. Kadi and R. C. Longsworth Feb. 1976 223 p refs
(Contract E(11-1)-2552)
(COO-2552-6) Avail: NTIS HC A10/MF A01

A review of current programs to develop superconduct power transmission shows that current plans require heli refrigerators operating at 5 to 13 K and 3 to 15 atm press with compressor power input in the range of 1,300 to 3,5 HP. Large helium refrigerators and standard nitrogen plants w studied. An average outage frequency of about 18 per yea found to be typical for both. Cost and reliability studies of altern refrigeration systems based on studies of components show t the best current system having a failure rate of once in years consists of two full size oil flooded screw compressors parallel, manifolded to two full size cold boxes and a liq helium back up dewar. Costs are projected as being only sligl greater than preliminary estimates. E

N77-18429*# National Aeronautics and Space Administrati Lewis Research Center, Cleveland, Ohio.
IN-SITU LASER RETORTING OF OIL SHALE Pate Application
Harvey S. Bloomfield, inventor (to NASA) Filed 28 Jan. 19 15 p
(NASA-Case-LEW-12217-1; US-Patent-Appl-SN-763753) Av NTIS HC A02/MF A01 CSCL 20E

Oil shale formations were retorted in-situ and gasec hydrocarbon products recovered by drilling two or more we into an oil shale formation. After fracturing a region of oil sh formation by directing a high energy laser beam into one of t wells and focussing the laser beam into a region of oil sh formation from a laser optical system, compressed gas was forc into the well which supports combustion in the flame front ignit by laser beam, thereby retorting the oil shale and recoveri gaseous hydrocarbon products which permeate through t fractured oil shale from one of the auxiliary wells. Autl

N77-18448# Battelle Pacific Northwest Labs., Richland, Wa
FLYWHEEL-HEAT ENGINE POWER FOR AN ENERG ECONOMIC PERSONAL VEHICLE
W. V. Loscutoff Mar. 1976 48 p refs
(Contract E(45-1)-1830)
(BNWL-2006) Avail: NTIS HC A03/MF A01

A technical and fuel economy assessment of a small persor vehicle powered by a hybrid flywheel/heat engine drive syste is presented. Technical evaluations indicate that a flywheel/he engine system based on improved materials technology cou serve as a practical vehicle drive. While somewhat limited performance, the proposed system could produce significa improvements in fuel consumption rates. Technological advanc ments in materials and power transmission systems would ma flywheel/heat engine systems even more attractive. EF

N77-18511*# New Mexico State Bureau of Mines and Mine Resources, Socorro.
ANALYSIS OF LANDSAT B IMAGERY AS A TOOL FC EVALUATING, DEVELOPING, AND MANAGING TI NATURAL RESOURCES OF NEW MEXICO Final Repo Mar. 1975 - Aug. 1976
David Tabet, Principal Investigator, Michael Inglis (New Mexi Univ., Albuquerque), Stanley Morain (New Mexico Uni Albuquerque), Linda Love (New Mexico Univ., Albuquerqu Sandra Feldman (New Mexico Univ., Albuquerque), and Thom Budge (New Mexico Univ., Albuquerque) Aug. 1976 116 refs Original contains color imagery. Original photography m be purchased from the EROS Data Center, 10th and Dako Avenue, Sioux Falls, S. D. ERTS
(Contract NAS5-20916)

(E77-10090; NASA-CR-149573) Avail: NTIS HC A06/MF A01 CSCL 08F

The author has identified the following significant results. A statewide land use and vegetation map was prepared by visual interpretation of LANDSAT images; geologic structure and metal deposits of the Datil-Mogollon volcanic area were investigated. Computer-enhanced images of the San Juan Basin region were studied for evidence of uranium, oil, and gas deposits. Little success was achieved with the uranium, oil, and gas studies, while roughly half the metal targets picked in the Datil-Mogollon area coincided with known area of mineralization.

N77-18525*# Pennsylvania State Univ., University Park. Office for Remote Sensing of Earth Resources.

INTERPRETATION OF PENNSYLVANIA AGRICULTURAL LAND USE FROM ERTS-1 DATA Interim Report

George J. McMurtry, Gary W. Petersen, Principal Investigators, and A. D. Wilson Dec. 1974 25 p Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS

(Contract NAS5-23133)

(E77-10111; NASA-CR-149284; ORSER-SSEL-TR-20-74) Avail: NTIS HC A02/MF A01 CSCL 05B

The author has identified the following significant results. To study the complex agricultural patterns in Pennsylvania, a portion of an ERTS scene was selected for detailed analysis. Various photographic products were made and were found to be only of limited value. This necessitated the digital processing of the ERTS data. Using an unsupervised classification procedure, it was possible to delineate the following categories: (1) forest land with a northern aspect, (2) forest land with a southern aspect, (3) valley trees, (4) wheat, (5) corn, (6) alfalfa, grass, pasture, (7) disturbed land, (8) builtup land, (9) strip mines, and (10) water. These land use categories were delineated at a scale of approximately 1:20,000 on the line printer output. Land use delineations were also made using the General Electric IMAGE 100 interactive analysis system.

N77-18541# California Univ., Riverside. Inst. of Geophysics and Planetary Physics.

PETROLOGY AND GEOCHEMISTRY OF HYDROTHERMAL ALTERATION IN BOREHOLE MESA 6-2, EAST MESA GEOTHERMAL AREA, IMPERIAL VALLEY, CALIFORNIA M.S. Thesis

James Robert Hoagland Jun. 1976 102 p refs

(Grant NSF AER-72-03551)

(PB-258871/3; IGPP-URC-76-12; NSF/RA-760235) Avail: NTIS HC A06/MF A01 CSCL 08I

Geothermal borehole Mesa 6-2 pentrates 6,000 ft. (1,830 m.) of interbedded sandstone and finer-grained sediment of the Colorado River Delta. Petrologic studies of recovered well cuttings show that the distribution of hydrothermal minerals essentially defines the vertical extent of the geothermal reservoir. A diffuse upper boundary of hydrothermal alteration underlies a thick section of clay-rich sediment. The clay-rich strata constitute a barrier to vertical flow of underlying thermal fluids. Thermochemical evaluation of the distribution of aqueous species in the Mesa 6-2 production fluid combined with the observed sequence of postdepositional alteration shows that the reservoir rocks have been subject to two distinct alteration events. The first involved potassium-silica metasomatism. Silica cementation inhibited continued flow of the initial fluid through the Mesa 6-2 aquifers, and cooler dilute water entered the system. Heating of the latter water caused precipitation of calcite and dissolution of quartz. This dilute fluid is presently produced from the 6-2 borehole. GRA

N77-18547# California Univ., Santa Cruz. Coastal Marine Studies Committee.

PROCEEDINGS OF A SYMPOSIUM ON OFFSHORE OIL POTENTIAL AND RELATED LAND USE IMPACTS IN THE CENTRAL CALIFORNIA COASTAL ZONE

William T. Doyle, ed. 8 Jun. 1975 86 p Conf. Proc. held at Santa Cruz, Calif., 8 Jun. 1975 Sponsored in part by Assoc. of Monterey Bay Area Governments, Calif.

(Grant NOAA-04-5-158-30)

(PB-259074/3; NOAA-76071410; SP-3) Avail: NTIS HC A05/MF A01 CSCL 08I

The following topics are discussed: Tectonic and basin development of the Central California Coastal Area; Estimating potential oil resources in the Central California Coastal Zone; Offshore petroleum extraction and onshore facilities; Potential land use conflicts resulting from offshore drilling in the Central California Coastal Area; and Legal issues of regulating the coast. GRA

N77-18557*# Florida Univ., Gainesville. Dept. of Electrical Engineering.

STUDIES OF SILICON p-n JUNCTION SOLAR CELLS Final Technical Report, 24 Jul. 1975 - 23 Jul. 1976

Fredrik A. Lindholm 23 Jul. 1976 124 p refs

(Grant NsG-3018)

(NASA-CR-149669) Avail: NTIS HC A06/MF A01 CSCL 10A

Single crystal silicon p-n junction solar cells made with low resistivity substrates show poorer solar energy conversion efficiency than traditional theory predicts. The physical mechanisms responsible for this discrepancy are identified and characterized. The open circuit voltage in shallow junction cells of about 0.1 ohm/cm substrate resistivity is investigated under AMO (one sun) conditions. Author

N77-18561# Massachusetts Univ., Amherst. Energy Alternatives Program.

INVESTIGATION OF THE FEASIBILITY OF USING WIND-POWER FOR SPACE HEATING IN COLDER CLIMATES. THE FINAL DESIGN AND MANUFACTURING PHASE OF THE PROJECT Quarterly Progress Report, Sep. - Dec. 1975

A. Chajes, A. Costa, D. E. Cromack, G. Darkazalli, F. J. Dzialo, R. M. Glorioso, W. E. Heronemus, C. A. Johnson, F. C. Kaminsky, R. H. Kirchhoff et al Dec. 1975 165 p refs Sponsored in part by ERDA

(Grant NSF AER-75-00603)

(ERDA/NSF/00603-75/T1; QPR-3) Avail: NTIS HC A08/MF A01

Progress during the third quarter was inadequate. System design and cost analysis are summarized. GRA

N77-18562# California Univ., Livermore. Lawrence Livermore Lab.

GEOLOGY AND POTENTIAL USES OF THE GEOPRESSURE RESOURCES OF THE GULF COAST

J. H. Howard, P. A. House, P. M. Johnson, D. F. Towse, D. G. Bebout (Texas Univ., Austin), M. H. Dorfman (Texas Univ., Austin), O. K. Agagu (Texas Univ., Austin), C. D. Hornburg (DSS Engineers, Inc.), and O. J. Morin (DSS Engineers, Inc.) Jun. 1976 21 p refs Presented at the 1976 Annual Convention of the Am. Assoc. of Petroleum Geologists, New Orleans

(Contract W-7405-eng-48)

(UCID-17163) Avail: NTIS HC A02/MF A01

This program has emphasized finding significantly large sand bodies within the geopressured stratigraphic section in addition to defining the distribution of abnormal fluid pressures and formation temperatures. Regional sand facies analyses conducted thus far indicate five locations in the Frio formation of Central and South Texas where adequately large geopressured geothermal resources may be present. Engineering studies of energy-conversion systems based on total-flow, flashed-steam, and binary-cycle concepts show that development of electric power from the Gulf Coast geopressure resource is technically feasible. Study of use of the resource as process heat in pulp and paper mills and new sugar refineries has shown that these uses also are technically sound. ERA

N77-18564# Southwest Research Inst., San Antonio, Tex.

DEVELOPMENT OF AN ASSESSMENT METHODOLOGY FOR GEOPRESSURED ZONES OF THE UPPER GULF COAST BASED ON A STUDY OF ABNORMALLY PRESSURED GAS

FIELDS IN SOUTH TEXAS Progress Report, 1 Mar. - 31 May 1976
R. K. Swanson, P. Oetking, J. S. Osoba, and R. C. Hagens May 1976 24 p
(Contract E(11-1)-2687)
(COO-2687-4) Avail: NTIS HC A02/MF A01

Effort during the quarter was directed toward (1) locating drillstem and production test results from geopressured formations, (2) determining formation parameters in an additional large number of producing wells, and (3) searching production records for assessment of geopressured production in Brooks and Kenedy Counties. Several unsuccessful completion tests of geopressured water sands (attempted as gas completions) were located, and these give insight into the problems of completing high-volume water wells in that zone. Permeability calculations for a large number of geopressured and normally pressured gas wells throughout the study area were completed. In no case has a producing Rio Grande Valley gas well deeper than 10,000 ft. been identified with effective permeability as great as 10 md. Preliminary investigation of Brooks County production located geopressured production in seven gas fields and in North Kenedy County, an additional three. ERA

N77-18566# Oak Ridge National Lab., Tenn.
BALANCED PROGRAM PLAN. VOLUME 4: COAL CONVERSION
C. R. Richmond, D. E. Reichle, and C. W. Gehrs. May 1976 316 p refs
(Contract W-7405-eng-26)
(ORNL-5123-Vol-4) Avail: NTIS HC A14/MF A01

A description of the biomedical and environmental research necessary to ensure the timely attainment of coal conversion technologies amenable to man and his environment are presented. The document is divided into three sections. The first deals with the types of processes currently being considered for development; the data currently available on composition of product, process and product streams, and their potential effects; and problems that might arise from transportation and use of products. Section II is concerned with a description of the necessary research in each of the King-Muir categories, while the third section presents the research strategies necessary to assess the potential problems at the conversion plant (site specific) and those problems that might effect the general public and environment as a result of the operation of large-scale coal conversion plants. ERA

N77-18567# Argonne National Lab., Ill.
DEVELOPMENT OF NONDESTRUCTIVE EVALUATION METHODS FOR COAL-CONVERSION SYSTEMS
W. A. Ellingson, G. C. Stanton, and N. P. Lapinski 1976 12 p Presented at Symp. on Prevent. of Failures in Coal Conversion Systems, Columbus, Ohio, 21-23 Apr. 1976
(Contract W-31-109-eng-38)
(CONF-760472-2) Avail: NTIS HC A02/MF A01

Coal-conversion processes require the handling and containment of high pressure, high temperature, corrosive and erosive gases, and liquids often containing particulate loadings. These severe environments cause materials failures that reduce successful and long-time operation of coal-conversion systems. The determination of the material and component response and development calls for proper nondestructive examination methods, equipment, and techniques. Briefly described are the nondestructive development efforts in high-temperature, wall-thickness measurements for in-situ erosion data, passive infrared imaging applications for thermal profiles, gamma radiographic applications for crack and erosion detection and acoustic methods for failure prediction. ERA

N77-18568# Oak Ridge National Lab., Tenn.
COAL TECHNOLOGY PROGRAM Quarterly Progress Report, period ending 31 Mar. 1976
Jul. 1976 134 p refs
(Contract W-7405-eng-26)
(ORNL-5159) Avail: NTIS HC A07/MF A01

Progress in coal research programs was made in the following areas: coal gasification and coal liquefaction (hydrocarbonization, residue carbonization, solids removal from coal liquids, pyrolysis, in-situ gasification synthoil process, analytical chemistry (of by-products, effluents, etc.), environmental effects (including study of carcinogens, mutagens, etc.), trace elements, materials technology, nondestructive testing, chemical research, and possible applications of process heat reactors. ERA

N77-18570# Martin Marietta Corp., Denver, Colo.
CENTRAL RECEIVER SOLAR THERMAL POWER SYSTEM, PHASE 1 Progress Report, period ending 31 Dec. 1975
Apr. 1976 486 p refs
(Contract E(04-3)-1110)
(SAN-1110-76-TI; MCR-76-121) Avail: NTIS HC A21/MF A01

The program objective is the preliminary design of a 10 MWe pilot solar power plant supported by major subsystem experiments. Progress is reported on the following task elements: 10 MWe pilot plant; collector subsystem design and analysis; receiver subsystem requirements; receiver subsystem design; thermal storage subsystem; electrical power generation subsystem; and pilot plant architectural engineering and support. ERA

N77-18571# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.
SOLAR PILOT PLANT, PHASE 1 Quarterly Report, Jul. - Dec. 1975
20 Feb. 1976 115 p
(Contract E(04-3)-1109)
(SAN-1109-76-TI; QR-1) Avail: NTIS HC A06/MF A01

A preliminary design baseline for a 10-MW(e) solar pilot plant was generated and analyzed. Subsequently, several changes were made to improve performance and/or reduce cost. Conceptual designs and research experiments were generated for three key subsystems - collector, steam generator, and thermal storage. Limited testing was done to study the problem of removing eutectic salts from vaporizer tubes in the thermal storage subsystem. The program was on schedule at the end of 1975. ERA

N77-18572# Energy Research and Development Administration, Washington, D.C.
UTILIZATION OF SOLAR ENERGY
Werner Kleinkauf 1976 17 p Transl. into ENGLISH from German Report Submitted for publication Sponsored in part by Federal Ministry for Research and Technology
(ERDA-tr-144) Avail: NTIS HC A02/MF A01

The production of high-temperature heat in the Federal Republic of Germany is not cost effective owing to the availability of a duration of sunshine of ca. 1500 h/a. The substitution of previous energy carriers for production of low-temperature heat, nevertheless, is also still available at these latitudes. Especially suited for this are decentralized units with flat collector systems for supplying single and two-family houses. If higher solar energy yields are required owing to the shortage as well as the steadily increasing costs of previous energy carriers or owing to ecological viewpoints, it follows that sunny regions of the south become involved as locations for solar power plants. If the regions of North Africa are included in the considerations, it follows that there is a considerably large energy potential available which could cover the energy requirement of the Federal Republic of Germany as well as that of Western Europe. ERA

N77-18574# Sandia Labs., Albuquerque, N.Mex.
ECONOMIC STUDY OF SOLAR TOTAL ENERGY
R. W. Harrigan 1976 15 p refs Sponsored by ERDA
(SAND-76-5291; Conf-760821-1) Avail: NTIS HC A02/MF A01

The application of solar total energy to a 2,000-dwelling unit mixed-load community is investigated. The community design is consistent with current community planning practices. An energy analysis of the community was performed, and a solar total energy system sized to meet the community demands. The economics of providing a solar total energy system is examined. The effect of dwelling unit density is examined. ERA

N77-18575# California Univ., Livermore. Lawrence Livermore Lab.

DEVELOPMENT SCENARIO FOR LASER FUSION
J. A. Maniscalco, J. Hovingh, and R. R. Buntzen 30 Mar. 1976 57 p refs Presented at the Meeting of the Am. Nucl. Soc., San Francisco, 16 Nov. 1975 Submitted for publication
(Contract W-7405-eng-48)
(UCRL-76980; Conf-751101-91) Avail: NTIS HC A04/MF A01

The relevant engineering and economic aspects of research and development facilities are discussed. Pellet design and gain predictions corresponding to the most promising laser systems are presented for each plant. The results show that laser fusion has the potential to make a significant contribution to our energy needs. Beginning in the early 1990's, this new technology could be used to produce fissile fuel, and after the turn of the century it could be used to generate electrical power. ERA

N77-18576# Sandia Labs., Albuquerque, N.Mex.
STATUS OF THE ERDA/SANDIA 17-METRE DARRIEUS TURBINE DESIGN
Ben F. Blackwell 1976 8 p *Presented at Intern. Symp. on* Wind Energy Systems, Cambridge, England, 7 Sep. 1976
(Contract AT(29-1)-789)
(SAND-76-5683; Conf-760909-2) Avail: NTIS HC A02/MF A01

The present status of the ERDA/Sandia Laboratories 17-meter Darrieus turbine design is summarized. ERA

N77-18578# Oklahoma Univ., Norman. School of Chemical Engineering and Materials Science.
ECONOMIC EVALUATION OF MIXTURE AND PURE FLUID CYCLES IN OCEAN THERMAL ENERGY CONVERSION SYSTEMS M.S. Thesis
Carl Anthony Lawson 30 Apr. 1976 144 p refs
(Contract E(40-1)-4918)
(ORO-4918-8) Avail: NTIS HC A07/MF A01

The results of this research study indicate that the heat exchangers are the principal contributors to the capital cost of the ocean thermal power plant. The sensitivity analysis performed in this research study showed that there are several economic trade-offs associated with the design and performance of the heat exchangers. The trade-offs include such items as the cold water pipe length, the sea water temperature rise and velocity. It was observed that mixtures provide an increasing economic advantage over pure fluids as the temperature rise in the cold sea water is increased. It is postulated that significant economic savings can be experienced with the use of mixtures if the cost of the heat exchanger can be reduced by one-half its present cost. ERA

N77-18579# General Electric Co., Philadelphia, Pa. Space Div.
GENERAL ELECTRIC COMPANY STUDY FOR DEFINING THE NUMBER OF RESIDENTIAL AND NON-RESIDENTIAL PROJECTS, NATIONAL SOLAR DEMONSTRATION PROGRAM
Apr. 1976 17 p
(Contract E(11-1)-2683)
(COO-2683-76/7) Avail: NTIS HC A02/MF A01

The methodology used to perform the parametric study to define a recommended demonstration program involved a decision making process. In this approach, selective solar buying factors were quantitatively evaluated for influencing key decision makers to install solar HVAC equipment. The selection of the recommended demo level also considered the probability of a decision maker actually seeing a demonstration as a function of how far he is located from a demo and how far he is willing to travel to see one. Demonstration levels of 200, 400, 800, 1,600 and 3,200 were assumed to determine the effects on Solar HVAC market penetration. The 800 demo level program is recommended to effectively stimulate the private sector to install solar HVAC systems. ERA

N77-18581# Battelle Pacific Northwest Labs., Richland, Wash.
OCEAN THERMAL ENERGY CONVERSION OPPORTUNITIES
L. D. Perrigo and G. A. Jensen May 1976 31 p refs Symp. on Energy Alternatives, Richland, Wash., 15 May 1976
(Contract E(45-1)-1830)
(BNWL-SA-5808; Conf-760549-1) Avail: NTIS HC A03/MF A01

The thermodynamic efficiencies of the process were found to be very low, and methods for preventing film deposits are mandatory. Heat transfer cannot realistically be improved by increasing pump rates or heat transfer surfaces because of intolerable parasitic power demands or capital expenditures. The development and use of power plants also have political implications that must be accommodated. Operation of such systems must be reconciled with various international agreements, the needs of marine navigation, and national defense requirements. ERA

N77-18582# Joint Center for Graduate Study, Richland, Wash.
INVESTIGATION OF LOW COST SOLAR CELLS BASED ON Cu2O Semiannual Report, 1 Oct. - 31 Mar. 1976
Larry C. Olsen May 1976 62 p refs
(Grant NSF AER-75-20501)
(PB-258583/4; NSF/RANN/AER75-20501/PR-76-1) Avail: NTIS HC A04/MF A01 CSCL 10B

A system was established for controlled oxidation of copper involving a quartz tube heated by an automatically controlled tube furnace, and subjected to an oxygen-nitrogen mixture to oxidize copper. Cu2O films typically have grain sizes greater than 100 micrometers. Thin-film cells have been fabricated with a Cu2O thickness in the range of 2-5 micrometers. Collection efficiency is measured with a high intensity Bausch and Lomb monochromator. After determining the reflection coefficient for a given wavelength, measurement of short-circuit current allows the absolute collection efficiency to be determined. GRA

N77-18583# Joint Center for Graduate Study, Richland, Wash.
INVESTIGATION OF LOW COST SOLAR CELLS BASED ON Cu2O Quarterly Progress Report, 1 Apr. - 30 Jun. 1976
Larry C. Olsen Aug. 1976 33 p refs
(Grant NSF AER-75-20501)
(PB-258746/7; NSF/RANN/AER75-20501/PR-76-2) Avail: NTIS HC A03/MF A01 CSCL 10B

Three approaches have been used to form an ohmic contact to Cu2O: evaporation of Cu, evaporation of In2O3 and by a dipping process. Backwall cell efforts have concentrated on thin-film cell fabrication. Devices have been made with Cu2O layer thicknesses between 1 micrometer and 10 micrometers. The approach used for MIS solar cell calculations has been further improved. Calculations for Cu2O and other materials were done. GRA

N77-18584# Federal Energy Administration, Washington, D.C. Office of Regulation Development.
PROPOSED ENERGY CONSERVATION CONTINGENCY PLAN: EMERGENCY HEATING, COOLING AND HOT WATER RESTRICTIONS. ECONOMIC IMPACT ANALYSIS. ENVIRONMENTAL IMPACT ASSESSMENT Contingency Plan No. 1
Sep. 1976 303 p refs
(PB-258624/6; FEA/H-76/430) Avail: NTIS HC A14/MF A01 CSCL 10A

The economic and environmental impacts of a plan imposing emergency restrictions on heating, cooling, lighting, and hot water temperatures in public, commercial and industrial buildings are described. The proposed plan, as specified for the analysis, would affect an estimated five million buildings. GRA

N77-18589# Grumman Aerospace Corp., Bethpage, N.Y.
SOLAR ASSISTED HEAT PUMP DEMONSTRATION PROJECT, PHASE 1 Final Report
Burt Swerdling 26 Oct. 1976 36 p refs Sponsored by N. Y. State Energy Res. and Develop. Authority
(PB-259289/7; NYSERDA-75/16) Avail: NTIS HC A03/MF A01 CSCL 13A

The design and construction of a solar assisted heat pump system are discussed along with the preparation of an instrumentation plan, instrumentation installation, and preliminary system checkout. GRA

N77-18590# Naval Research Lab., Washington, D.C.
NAVY APPLICATIONS FOR TERRESTRIAL PHOTOVOLTAIC SOLAR POWER Interim Report
R. L. Statler, G. K. Hubler, C. S. Guenzer, and B. J. Faraday Sep. 1976 39 p ref
(NRL Proj. H01-55; RR0120641)
(AD-A030529; NRL-MR-3363) Avail: NTIS HC A03/MF A01 CSCL 10/1

The U.S. Army Mobility Equipment Research and Development Center (MERDC), Fort Belvoir has been tasked by the Assistant Secretary of Defense (Installations and Logistics) with Energy Research and Development Administration (ERDA) funds to prepare a Department of Defense proposal for installing terrestrial solar photovoltaic power in DoD operational systems. This report describes a survey made by the Radiation Effects Branch of the Radiation Technology Division to identify specific terrestrial solar photovoltaic power applications appropriate to DoD operational systems and facilities. GRA

N77-18592# Tetra Tech, Inc., Arlington, Va.
ENERGY FACT BOOK 1976, CHAPTERS 1 THROUGH 21
15 Jul. 1976 433 p refs
(Contract N00014-76-C-0239)
(AD-A028284; TETRAT-A-642-76-254) Avail: NTIS HC A19/MF A01 CSCL 10/1

The Energy Fact Book - 1976 summarizes the present U.S. Energy situation; Energy R and D Legislation; Federal Government Energy R and D; and Foreign Energy R and D. It includes a brief description of the various processes and developments related to hydrocarbon fuels, synthetic fuels, non-hydrocarbon energy sources and energy conservation. GRA

77-18593# Universal Energy Systems, Inc., Dayton, Ohio.
ELECTROFLUID DYNAMICS ENERGY CONVERSION RESEARCH Final Report, 18 Mar. 1973 - 30 Jun. 1975
Ernest F. Fretter and Russell W. Griffith Dec. 1975 128 p refs
(Contract F33615-73-C-4053; AF Proj. 7116)
(AD-A029066; AFAPL-TR-76-35) Avail: NTIS HC A07/MF A01 CSCL 10/2

Electrofluid Dynamics (EFD) is a method of direct energy conversion in which the energy contained in a flowing gas is converted directly into electrical energy. This is generally accomplished by seeding the flowing gas with unipolar charged ions produced by a corona discharge from a sharp grounded electrode. The unipolar ions typically are deposited on particles usually produced by condensation of either a minor component (such as water vapor) of the flowing gas or by condensation of the flowing gas itself. The charged particles are then transported by viscous interaction with the flowing gas to the collector electrode of the generator where at high potential the particles release their charge to the collector. The current thus generated travels through a load to ground. Many references can be cited which describe the basic operation of various EFD generators; several are listed in the Bibliography. GRA

N77-18594# Bonneville Power Administration, Portland, Oreg.
PROCEEDINGS OF THE 3RD ANNUAL ENERGY CONSERVATION MANAGEMENT CONFERENCE Final Report
Mar. 1976 104 p refs Conf. Proc. held at Portland, Oregon, 18-19 Mar. 1976
(PB-258652/7) Avail: NTIS HC A06/MF A01 CSCL 10A

An array of addresses and papers covering various aspects of energy conservation is presented. Topics discussed are: energy management in buildings; heat recovery techniques; heat pumps; energy conservation research and development; automobile energy conservation; and electric vehicles. GRA

N77-18596# Federal Energy Administration, Washington, D.C. Office of Economic Impact Analysis.
REPORT TO CONGRESS ON THE ECONOMIC IMPACT OF ENERGY ACTIONS Semiannual Report
Jun. 1976 64 p
(PB-257697/3; FEA/B-76/384) Avail: NTIS HC A04/MF A01 CSCL 05C

An inflationary impact evaluation is presented as an individual report of the likely impact on energy prices, the consumer price index, and other economic variables, of actions proposed by the administrator of FEA. GRA

N77-18597# National Science Foundation, Washington, D.C.
GEOTHERMAL ENERGY PROGRAM, CURRENT RESEARCH PROJECTS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION
Mar. 1976 40 p
(PB-258948/9; NSF/RA-760090) Avail: NTIS HC A03/MF A01 CSCL 10A

Research projects are described dealing with: Geosciences of geothermal resources; Advanced exploration technology; Geothermal reservoir engineering; Geothermal extraction technology; Geothermal environmental research; and legal and institutional studies. GRA

N77-18601# Stevens Inst. of Tech., Hoboken, N.J. Dept. of Mechanical Engineering.
HYDROGEN ENERGY CONVERSION Semiannual Report, 1 Feb. - 31 Jul. 1975
Richard B. Cole, Robert F. McAlevy, III, and Max Bentele 27 Jul. 1976 139 p refs
(Contract N00014-75-C-0220; ARPA Order 2615)
(AD-A030370; ME-RT-75009; SATR-3) Avail: NTIS HC A07/MF A01 CSCL 21/1

Air-breathing reciprocating engines and gas turbines fueled with hydrogen are treated with special concern for the problems each might encounter if used on a large scale. The potential improvements in performance of each power plant when operated with hydrogen are determined using prior analytical and experimental data and/or new estimates. Particular attention is given to factors which might improve conversion efficiency and discount, at least partially, the relatively high cost of hydrogen energy. Previous operating experience and analysis of gas-turbine operation on hydrogen are considered. Hydrogen-fueled gas turbines are found, unlike reciprocating engines, to offer relatively modest thermodynamic performance gain compared with hydrocarbon fueling, though LH2 fueling has substantial potential (undemonstrated) for power-plant efficiency or reliability improvement through hot-section cooling and/or heat regeneration. LH2 fuel-system problems with transient response as well as inavailability of suitable hardware are most evident, though probably resolvable by substantial state-of-the-art development. GRA

N77-18667# Wyoming Univ., Laramie.
EVALUATION OF WIND-ENERGY SITES FROM AEOLIAN GEOMORPHOLOGIC FEATURES MAPPED FROM LANDSAT IMAGERY. FIRST RESULTS
K. Kolm, R. Marrs, J. Marwitz, and J. Fletcher 1 Dec. 1975 39 p refs Sponsored in part by ERDA
(Grant NSF AER-75-00598)
(ERDA/NSF/00598-75/T1) Avail: NTIS HC A03/MF A01

Aeolian geomorphologic features, interpreted from satellite imagery are related to areas of high-wind-energy potential. Preliminary results, gathered during spring and summer months, were evaluated statistically to determine the critical interrelationships for the Killpecker test area. These tests indicate that the morphology of individual dunes is not a unique indicator of wind velocity or persistance, but the morphology of the dune field is an indicator that can be used to predict areas of high wind-energy potential. These results will be used as a guide to prediction of other areas of high wind-energy potential. Field measurements will then be used to test these predictions. Similar evaluations are being made in the Big Hollow Area where aeolian erosional phenomena dominate the geomorphologic development. ERA

N77-19112*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMPUTER MODELING OF A REGENERATIVE SOLAR-ASSISTED RANKINE POWER CYCLE c44
F. L. Lansing *In its* The Deep Space Network 15 Feb. 1977 p 152-168 refs
Avail: NTIS HC A13/MF A01 CSCL 10A

A detailed interpretation of the computer program that describes the performance of one of these cycles; namely, a

regenerative Rankine power cycle is presented. Water is used as the working medium throughout the cycle. The solar energy collected at relatively low temperature level presents 75 to 80% of the total heat demand and provides mainly the latent heat of vaporization. Another energy source at high temperature level superheats the steam and supplements the solar energy share. A program summary and a numerical example showing the sequency of computations are included. The outcome from the model comprises line temperatures, component heat rates, specific steam consumption, percentage of solar energy contribution, and the overall thermal efficiency. Author

N77-19113*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PRECISION INSOLATION MEASUREMENT UNDER FIELD CONDITIONS
M. S. Reid and R. A. Gardner *In its* The Deep Space Network 15 Feb. 1977 p 169-175 refs

Avail: NTIS HC A13/MF A01 CSCL 03B

Work at the Jet Propulsion Laboratory had resulted in the development of a primary absolute cavity radiometer (PACRAD), which was recently accepted as an international standard of irradiance. The development of an wall-weather, field-worthy solar radiometer based on the PACRAD is discussed, and its calibration stability over a two-year period in the field is described. Author

N77-19275# California Univ., Livermore. Lawrence Livermore Lab.
SUPPLY AND DEMAND OF FUEL SOURCES FOR AUTOMOBILES
Carl J. Anderson 11 May 1976 11 p refs Presented at Proc. of Symp. on Alternate Fuel Resources, Santa Maria, Calif., 25-27 Mar. 1976
(Contract W-7405-eng-48)
(UCRL-78066; Conf-760342-1) Avail: NTIS HC A02/MF A01

A review is given of the state of domestic oil depletion in context of projected world oil production. An optimized strategy for dealing with this problem is discussed. The strategy is based on the development of low cost synfuels and preparation for the introduction and utilization of these synfuels; i.e., smaller more efficient cars are needed that can utilize available synfuels. In addition, advanced batteries are required before electricity from coal and/or nuclear energy can be effectively utilized in transportation. Finally, the result of an economic analysis that indicates the nature of optimization of the overall strategy is given. ERA

N77-19278# Bonner and Moore Associates, Inc., Houston, Tex.
IMPACT OF FUEL PROPERTIES ON JET FUEL AVAILABILITY Final Technical Report, Apr. 1975 - Apr. 1976
Joseph C. Dickson and Louis P. Karvelas Apr. 1976 110 p ref
(Contract F33615-75-C-2022; AF Proj. 3048)
(AD-A029493; AFAPL-TR-76-7) Avail: NTIS HC A06/MF A01 CSCL 21/4

A study was conducted to analyze the effects that relaxing certain jet fuel specification requirements would have on jet fuel availability from domestic and foreign sources. The primary objective of the study was to determine the most critical specification requirements where relaxation could be expected to have an impact on availability, and to estimate the effects that changes in these critical specifications would have on the refining industry's willingness to offer jet fuel for sale. The principal tool used in this study was a confidential survey of the U.S. Refining Industry. Results based on the adjusted survey data indicate that, for domestically produced kerosene-type jet fuels, increases of 20% could be realized by relaxing Freeze Point and Final Boiling Point; and increases of about 28% could be realized by relaxing Aromatics, Smoke Point, Freeze Point, and Final Boiling Point (FBP). For naphtha-type jet fuels, an increase of 24% for relaxing Freeze Point alone is indicated. GRA

N77-19279# Municipal Environmental Research Lab., Cincinnati, Ohio.
FUEL AND ENERGY PRODUCTION BY BIOCONVERSION OF WASTE MATERIALS: STATE-OF-THE-ART
Sylvia A. Ware Aug. 1976 78 p refs
(Contract EPA-68-03-0295)
(PB-258499/3; EPA-600/2-76-148) Avail: NTIS HC A05/MF A01 CSCL 21D

A state of the art summary of biological processes for converting waste cellulosic materials (agricultural, municipal and lumbering wastes) to fuels is presented. It indicates the locations and quantities of suitable wastes and discusses the status of the current processing schemes. The processes discussed are: Acid hydrolysis followed by fermentation; enzyme hydrolysis followed by fermentation; anaerobic digestion of manure and municipal solid waste; and, biophotolysis. GRA

N77-19406# New South Wales Univ., Kensington (Australia). School of Physics.
CRYOGENIC INSTRUMENTATION NEEDS IN THE CONTROLLED THERMONUCLEAR RESEARCH PROGRAM
P. L. Walstrom 10 Oct. 1976 11 p refs Presented at the ISA-76 Conf. and Exhibit, Houston, Tex., 10-14 Oct. 1976
(Contract W-7405-eng-26)
(CONF-761007-1) Avail: NTIS HC A02/MF A01

A survey of potentially applicable instrumentation is presented along with available information on operation in the test environment based on experimental data or on analysis of the physical characteristics of the device. Areas where further development work is needed are delineated. ERA

N77-19425# Sandia Labs., Albuquerque, N.Mex.
SOFT X-RAY LASERS
Michel A. Duguay 1976 23 p refs Presented at Summer Workshop on Synchrotron Radiation Facilities, Quebec, 14 Jun. 1976 Sponsored by ERDA
(SAND-76-5542; Conf-760650-1) Avail: NTIS HC A02/MF A01

Some of the work done to achieve X-ray laser action at wavelengths below 1000 A is reviewed. Four major approaches to X-ray lasers where experimental work was done are discussed. ERA

N77-19469# California Univ., Livermore. Lawrence Livermore Lab.
METHANOL ENGINE: A TRANSPORTATION STRATEGY FOR THE POST-PETROLEUM ERA
H. C. Vantine, J. Chang, L. G. OConnell, B. Rubin, and C. Westbrook 25 Mar. 1976 34 p refs
(Contract W-7405-eng-48)
(UCRL-52041) Avail: NTIS HC A03/MF A01

Several types of heat engines are considered as candidates for a methanol engine. A stratified charge engine optimized for methanol fuel is projected to result in an energy economy advantage of 44 to 71 percent in comparison to an Otto engine operating on gasoline. This advantage arises from (1) the high octane rating of the fuel, which allows a high compression ratio to be used; (2) methanol's fuel-lean combustion characteristics, which allow efficient lean operation; and (3) the low flame temperature, which allows effective control of nitrogen oxide emissions. The design and optimization of a methanol engine are examined in terms of an experimental and calculational program. The socioeconomic impact of methanol fueled transportation is discussed. ERA

N77-19573*# Optical Coating Lab., Inc., City of Industry, Calif. Photoelectronics Div.
RESEARCH, DEVELOPMENT AND PILOT PRODUCTION OF HIGH OUTPUT THIN SILICON SOLAR CELLS Final Report
P. A. Iles [1976] 38 p Prepared for JPL
(Contracts NAS7-100; JPL-954197)
(NASA-CR-149858) Avail: NTIS HC A03/MF A01 CSCL 10A

Work was performed to define and apply processes which could lead to high output from thin (2-8 mils) silicon solar cells. The overall problems are outlined, and two satisfactory process

sequences were developed. These sequences led to good output cells in the thickness range to just below 4 mils; although the initial contract scope was reduced, one of these sequences proved capable of operating beyond a pilot line level, to yield good quality 4-6 mil cells of high output. Author

N77-19574*# Scientific Translation Service, Santa Barbara, Calif.
STORAGE OF THERMAL ENERGY IN MOLTEN SALTS AND METALS
A. Horsthemke and E. Marschall Washington NASA Mar. 1977 20 p refs Transl. into ENGLISH from Brennstoff-Waerme-Kraft (Duesseldorf), v. 28, Jan. 1976 p 18-22
(Contract NASw-2791)
(NASA-TT-F-17412) Avail: NTIS HC A02/MF A01 CSCL 10C

The investigation is concerned with the characteristic properties of a thermal storage system for an operational temperature range from 500 to 800 C, taking into account the conclusions under which a continuous withdrawal of energy at a constant thermal flow density is possible. The mathematical description of an individual storage element is possible. The mathematical description of an individual storage element is considered. The storage element consists of a double-walled tube. The space between the external and the internal wall is occupied by the storage medium. The supply of heat will generally take place at the external tube wall, and the heat will be withdrawn from the interior tube. However, an operation under reversed conditions is also possible. Attention is given to an analytic solution, a numerical solution and an evaluation of the results of the study. Author

N77-19575*# TRW Systems, Redondo Beach, Calif.
A STUDY OF GEOTHERMAL PROSPECTS IN THE WESTERN UNITED STATES ***Final Report***
20 Aug. 1975 148 p refs
(Contracts NAS7-100; JPL-954243)
(NASA-CR-149812; TRW-28455-6001-RU-00) Avail: NTIS HC A07/MF A01 CSCL 10B

The commercial development potential of 13 underdeveloped geothermal prospects in the Western United States was examined, and the prospects were ranked in order of relative potential for development on the basis of investment considerations. The following were considered in the ranking: geotechnical and engineering data, energy market accessibility, administrative constraints, and environmental and socio-economic factors. The primary ranking criterion is the unit cost of energy production expected from each prospect. Secondary criteria are administrative constraints, environmental factors and the quality of the geotechnical data. Author

N77-19577*# New Mexico Univ., Albuquerque.
HYDROGEN ENERGY: A BIBLIOGRAPHY WITH ABSTRACTS. FOURTH QUARTER 1976
31 Dec. 1976 39 p Sponsored by NASA
(NASA-CR-149864) Avail: Issuing Activity CSCL 16B

A bibliography for the 4th qtr. 1976 is presented. Approximately 112 abstracts are listed. Subject and author indexes are included. L.S.

N77-19578*# New Mexico Univ., Albuquerque.
HYDROGEN ENERGY: A BIBLIOGRAPHY WITH ABSTRACTS. THIRD QUARTER 1976
30 Dec. 1976 75 p Sponsored by NASA
(NASA-CR-149863) Avail: Issuing Activity CSCL 10B
For abstract, see N77-19577.

N77-19579*# National Aeronautics and Space Administration. Pasadena Office, Calif.
A NON-TRACKING SOLAR ENERGY COLLECTOR SYSTEM Patent Application
M. Kudret Selcuk, inventor (to NASA) (JPL) Filed 2 Mar. 1977 17 p
(Contract NAS7-100)
(NASA-Case-NPO-13813-1; NASA-Case-NPO-13914-1; US-Patent-Appl-SN-765139) Avail: NTIS HC A02/MF A01 CSCL 10A

A solar energy collector system is described in which an improved concentrator is used for directing incident rays of solar energy on parallel vacuum-jacketed receivers or absorbers. A plurality of individually mounted reflector modules of a common asymmetrical triangular cross-sectional configuration are supported for independent reorientation. A plurality of asymmetric vee trough concentrators is defined. NASA

N77-19580*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SYNCHRONIZATION OF THE ERDA-NASA 100 LkW WIND TURBINE GENERATOR WITH LARGE UTILITY NETWORKS
H. H. Hwang and Leonard J. Gilbert Jul. 1977 17 p refs Presented at the Control of Power Systems Conf., College Station, Tex., 14-16 Mar. 1977; sponsored by IEEE
(NASA-TM-X-73613; E-9096) Avail: NTIS HC A02/MF A01 CSCL 10B

The synchronizing of a wind turbine generator against an infinite bus under random conditions is studied. With a digital computer, complete solutions for rotor speed, generator power angle, electromagnetic torque, wind turbine torque, wind turbine blade pitch angle, and armature current are obtained and presented by graphs. Author

N77-19583# Battelle Pacific Northwest Labs., Richland, Wash.
POTENTIAL NATIONAL BENEFITS OF GEOTHERMAL ELECTRICAL ENERGY PRODUCTION FROM HYDROTHERMAL RESOURCES IN THE WEST
C. H. Bloomster and R. L. Engel 1976 22 p refs Presented at the 11th Intersoc. Energy Conversion Engineering Conf., State Line, Nev., 12 Sep. 1976
(Contract E(45-1)-1830)
(BNWL-SA-5798; Conf-760906-4) Avail: NTIS HC A02/MF A01

This analysis uses a computer simulation of the U.S. electrical economy using a linear programming optimization technique. Under most of the scenarios, the benefits are estimated at $2-$4 billion over the next 50 years on a discounted present value basis. The electricity production from hydrothermal plants reaches 2-4 percent of the national total which will represent 10-20 percent of the installed capacity in the West. Installed geothermal capacity in 1990 is estimated to reach 9,000-17,000 NWe. ERA

N77-19584# Chicago Univ., Ill. Enrico Fermi Inst.
SOLAR ENERGY CONCENTRATION Progress Report, 1 Jul. 1975 - 31 Mar. 1976
R. Winston Mar. 1976 13 p
(Contract E(11-1)-2446)
(COO-2446-7) Avail: NTIS HC A02/MF A01

The optical and thermal properties of ideal concentrators which concentrate radiation by the maximum amount possible for a given range of angular acceptance have been under investigation. This has been done experimentally, analytically and numerically. The following reflector-absorber combinations have been studied: (1) flat receiver, parabolic reflector (compound parabolic concentrator, or CPC), (2) vertical fin receiver inside half-aluminized evacuated glass tube coupled to CPC, (3) vertical fin receiver, circular-parabolic reflector, (4) circular cylindrical receiver, extended involute reflector, (5) convex receiver, lens at entrance aperture, hyperbolic reflectors, (6) arbitrary receiver shape, CPC modified to limit angle of incidence onto receiver, (7) concentrators with a gap between the receiver and the reflector for thermal isolation, (8) concentrators used as a second stage concentrator, formed from a solid dielectric material. ERA

N77-19585# Hittman Associates, Inc., Columbia, Md.
COEFFICIENT OF PERFORMANCE FOR SOLAR-POWERED SPACE COOLING SYSTEMS
H. M. Curran 1976 9 p Presented at Am. Soc. Heating Refrig. and Air-Conditioning Eng. Ann. Meeting, Seattle, 27 Jun. - 1 Jul. 1976 Sponsored by ERDA
(CONF-760618-1) Avail: NTIS HC A02/MF A01

A generalized outline of the energy inputs to solar-powered cooling machines is presented in order to establish a common

basis for computations of coefficient of performance. Although a number of the energy inputs are not commonly included for conventional systems, their inclusion for solar system performance computations is recommended because of the wide range of the ratio of nonsolar to solar energy inputs for the different solar-powered cooling machines. In order to accommodate the variety of solar-powered cooling concepts, the use of a set of conditions which are related to the cooling load is recommended as the basis for comparative computations. ERA

N77-19586# California Univ., Livermore. Lawrence Livermore Lab.

HELICAL-ROTOR EXPANDER APPLICATIONS FOR GEOTHERMAL ENERGY CONVERSION

P. A. House 1 Apr. 1976 26 p refs
(Contract W-7405-eng-48)
(UCRL-52043) Avail: NTIS HC A03/MF A01

The potential exists for expansion efficiencies as high as 70 percent. Engine efficiencies will generally be below 70 percent because of an expansion-ratio limitation of 15 and a maximum pressure differential of 110 psi. Single-stage expansion of self-pumped geothermal fluids from reservoirs at 350 to 752 F gives engine efficiencies in the range from 57.3 to 43.1 percent. Calculated rotor diameters range from 10.5 to 41.6 ft for a range of outputs of 5 to 40 MW. Two-stage expansion of fluid from the 572 F reservoir gives an engine efficieny of 62.3 percent and a 21 percent reduction in the diameter of the larger rotor. Rotor diameters can be held to more reasonable sizes by using the expander in combination with a vapor turbine. ERA

N77-19587# California Univ., Livermore. Lawrence Livermore Lab.

INVESTIGATION OF HEAT EXCHANGER FLOW ARRANGEMENT ON PERFORMANCE AND COST IN A GEOTHERMAL BINARY CYCLE

Warren H. Giedt 15 Jun. 1976 8 p refs Presented at 11th Intersociety Energy Conversion Eng. Conf., State Line, Nev., 12 Sep. 1976
(Contract W-7405-eng-48)
(UCRL-78390; Conf-760906-11) Avail: NTIS HC A02/MF A01

The performance of an idealized geothermal binary-fluid-cycle energy conversion system is shown to be a function of the temperature of brine and working fluid leaving the heat exchanger. System power output, heat exchanger area required and initial well and heat exchanger costs are determined for counterflow, single and multi-pass parallel-counterflow exchangers. Results are presented graphically as functions of the brine and working fluid exit temperatures from the exchanger. Use of the system analysis developed is illustrated by showing quantitatively the advantage of the counterflow over the other flow arrangements considered. ERA

N77-19588# California Univ., Livermore. Lawrence Livermore Lab.

STATUS REPORT: LAWRENCE LIVERMORE LABORATORY WIND ENERGY STUDIES

Joseph B. Knox, D. M. Hardy, and T. J. Sullivan Jun. 1976 20 p ref
(Contract W-7405-eng-48)
(UCID-17157-1) Avail: NTIS HC A02/MF A01

Numerical model calculations of three-dimensional regional wind fields oriented toward identifying the location, intensity and extent of wind energy-rich areas on Oahu are reported. The use of these calculations in planning a field data-collection program to study areas of expected high wind energy is described. Criteria for the selection of wind energy subregions of primary interest are discussed. ERA

N77-19589# California Univ., Berkeley. Lawrence Berkeley Lab.

GEOTHERMAL STUDIES IN NORTHERN NEVADA

Harold A. Wollenberg Jun. 1976 8 p refs Presented at 11th Intersoc. Energy Conversion Eng. Conf., Lake Tahoe, Calif., 9 Sep. 1976
(Contract W-7405-eng-48)
(LBL-4451; Conf-760904-3) Avail: NTIS HC A02/MF A01

Field studies presently being conducted in northern Nevada incorporate an integrated program of geologic, geophysical, and geochemical surveys leading to heat flow measurements, and eventually to deep (1.5 to 2 km) confirmatory drill holes. Techniques evaluated include geophysical methods to measure contrasts in electrical resistivity and seismic parameters. Geochemical studies have emphasized techniques to disclose the pathways of water from its meteoric origin into and through the hydrothermal systems. Geochemical and radiometric analyses also help to provide a baseline upon which the effects of future geothermal development may be superimposed. ERA

N77-19591# Battelle Pacific Northwest Labs., Richland, Wash.

POTENTIAL BENEFITS OF GEOTHERMAL ELECTRICAL PRODUCTION FROM HYDROTHERMAL RESOURCES

C. H. Bloomster and R. L. Engel Jun. 1976 85 p refs
(Contract E(45-1)-1830)
(BNWL-2001) Avail: NTIS HC A05/MF A01

The potential national benefits of geothermal electric energy development from the hydrothermal resources in the West are estimated for several different scenarios. The U.S. electrical economy is simulated by computer using a linear programming optimization technique. Under most of the scenarios, benefits are estimated at $2 to $4 billion over the next 50 years on discounted present value basis. The electricity production from hydrothermal plants reaches 2 to 4 percent of the national total, which will represent 10 to 20 percent of the installed capacity in the West. Installed geothermal capacity in 1990 is estimated to be 9,000 to 17,000 Mw(e). Supply curves were developed for hydrothermal resources based on the recent U.S. Geological Survey (USGS) resource assessment, resource characteristics, and projected power conversion technology and costs. ERA

N77-19597# Los Alamos Scientific Lab., N.Mex.

PRELIMINARY ASSESSMENT OF A GEOTHERMAL ENERGY RESERVOIR FORMED BY HYDRAULIC FRACTURING

Hugh D. Murphy, Robert G. Lawton, Jefferson W. Tester, Robert M. Potter, Donald W. Brown, and R. Lee Aamodt 1976 18 p refs Presented at 51st Ann. Meeting of the Soc. of Petrol. Eng., New Orleans, 3-6 Oct. 1976
(Contract W-7405-eng-36)
(LA-UR-76-1672; Conf-761008-1) Avail: NTIS HC A02/MF A01

Two, 3-km-deep boreholes have been drilled into hot (approximately 200 C) graphite in northern New Mexico in order to extract geothermal energy from hot dry rock. Both boreholes were hydraulically fractured to establish a flow connection. Presently this connection has a large flow impedance which may be improved with further stimulation. Fracture-to-borehole intersection locations and in situ thermal conductivity were determined from flowing temperature logs. In situ measurements of permeability show an extremely strong dependence upon pore pressure--the permeability increased by a factor of 80 as the pressure was increased 83 bars (1200 psi). An estimate of the minimum horizontal earth stress was derived from fracture extension pressures and found to be one-half the overburden stress. ERA

N77-19598# Los Alamos Scientific Lab., N.Mex.

EXTRACTING ENERGY FROM HYDRAULICALLY-FRACTURED GEOTHERMAL RESERVOIRS

R. D. McFarland and H. D. Murphy 1976 12 p refs Presented at 11th Intersoc. Energy Conversion Eng. Conf., State Line, Nev., 12-17 Sep. 1976
(Contract W-7405-eng-36)
(LA-UR-76-848; Conf-760906-10) Avail: NTIS HC A02/MF A01

The governing equations for heat and mass transfer were derived for hydraulically fractured geothermal reservoirs. When converted to nondimensional form it was shown that the equations can be considerably simplified. The resulting equations can be strongly influenced by the effects of buoyancy; the magnitude of the effect is measured by the ratio of the Grashof and Reynolds numbers, and the ratio of the actual permeability of the fracture

and the square of the fracture gap width. Significant quantities of energy can be extracted from hydraulic fractures--even without thermal stress fracturing. The amount is limited by the size of the fracture and the low thermal conductivity of rock. The viscous pressure drop in open fractures is insignificant, and depending upon losses in piping and surface equipment, the entire system could be 'self-pumped' due to buoyancy. Thermal contraction of the rock tends to increase the fracture gap width - thus decreasing viscous pressure drops and increasing the effects of buoyancy. ERA

N77-19600# Energy Research and Development Administration, Washington, D.C.
NATIONAL PLAN FOR ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION: CREATING ENERGY CHOICES FOR THE FUTURE. VOLUME 2: PROGRAM IMPLEMENTATION
1976 409 p
(ERDA-76-1-Vol-2) Avail: NTIS HC A18/MF A01

The Federal energy research, development, and demonstration programs now underway are described along with possible future efforts. Financial data for FY 75, FY 76, and FY 77 are presented. Energy technology programs, supporting technology programs, energy-related supporting activities, special analyses, and an appendix are included. Fossil energy (coal, petroleum, and natural gas), solar energy, and geothermal energy, are discussed together with conservation, fusion power, fission power, and the nuclear fuel cycle. ERA

N77-19602# Bechtel Corp., San Francisco, Calif.
REGIONAL ENERGY SYSTEM FOR THE PLANNING AND OPTIMIZATION OF NATIONAL SCENARIOS (RESPONS). CLEAN COAL ENERGY: SOURCE-TO-USE ECONOMICS PROJECT Final Report
Phiroze J. Nagarvala, G. C. Ferrell, and L. A. Olver Jun. 1976 633 p refs
(Contract E(49-18)-1552)
(ERDA-76-109; FE-1552-18) Avail: NTIS HC A99/MF A01

The result of this effort is a regional linear programming model of an integrated U.S. energy delivery system that will assist the energy planner in analyzing the response of the energy system to a large number of variables. The model may be used for analyzing actual and proposed energy delivery systems in terms of a number of variables, including quality of coal at the mine, energy transportation or transmission modes, the amount and form of the delivered energy, the distance between source and user or processor, coal-energy conversion and cleanup processing methods, and existing and proposed environmental regulations. ERA

N77-19604# Electric Power Research Inst., Palo Alto, Calif.
ENERGY STORAGE: USER NEEDS AND TECHNOLOGY APPLICATIONS
1976 60 p Presented at the Eng. Found. Conf., Pacific Grove, Calif., 8-13 Feb. 1976 Prepared in cooperation with ERDA
(CONF-760212-Summ) Avail: NTIS HC A04/MF A01

Brief summaries of nine papers and topics of seven working groups are presented. ERA

N77-19605# General Electric Co., Philadelphia, Pa. Space Div.
TECHNICAL AND ECONOMIC FEASIBILITY OF THERMAL ENERGY STORAGE Annual Report
D. R. Glenn Feb. 1976 569 p refs
(Contract E(11-1)-2558)
(COO-2558-1) Avail: NTIS HC A24/MF A01

Implicated markets, Energy consumption patterns, TES (Thermal Energy Storage) technologies, and applications are reviewed. Further, several concepts are developed and evaluated in some detail. Key findings are: (1) there are numerous technical opportunities for TES in the residential and industrial market sectors, (2) apart from sensible heat storage and transfer, significant R and D is required to fully exploit the superior heat densities of latent heat-based TES systems, particularly at temperatures above 600 F (3) industrial energy conservation can be favorably impacted by TES where periodic or batch-operated unit functions characterize product manufacturing processes, i.e. bricks, steel, and ceramics; and (4) a severe data shortage exists for describing energy consumption rates in real time as related to plant procees operations - a needed element in designing TES systems. ERA

N77-19607# Idaho National Engineering Lab., Idaho Falls.
GEOTHERMAL R AND D PROJECT REPORT, 1 JANUARY - 31 MARCH 1976
Jun. 1976 69 p refs
(Contract E(10-1)-1375)
(ANCR-1319) Avail: NTIS HC A04/MF A01

The Raft River well developments, reservoir testing, and surface testing; the Boise Space Heating Project; the design and analysis of power conversion concepts for generating electricity from moderate temperature (approximately 150 C or 300 F) resources; advanced heat exchanger research and testing; and studies relating to a variety of direct uses of geothermal heat energy are reported. ERA

N77-19609# Southwest Research Inst., San Antonio, Tex.
OPERATIONAL, COST, AND TECHNICAL STUDY OF LARGE WINDPOWER SYSTEMS INTEGRATED WITH EXISTING ELECTRIC UTILITY
R. T. Smith, R. K. Swanson, C. C. Johnson, C. Ligon (Southwestern Public Service Co., Amarillo, Tex.), J. Lawrence (Tex. Tech. Univ., Lubbock, Tex.), and D. Jordan (Tex. Tech. Univ., Lubbock, Tex.) 1976 7 p Presented at the 11th Intersociety Energy Conversion Eng. Conf., State Line, Nev., 12 Sep. 1976
(Contract E(11-1)-2621)
(CONF-760906-8) Avail: NTIS HC A02/MF A01

A comprehensive study of the operational, cost, and technical aspects of large windpower systems integrated with existing electric utility networks has been carried out for a region of the Texas Panhandle. ERA

N77-19610# Mitre Corp., McLean, Va.
METHODOLOGY FOR RANKING GEOTHERMAL RESERVOIRS IN NON-ELECTRIC INDUSTRIAL APPLICATIONS
O. G. Farah and F. Williams May 1976 95 p refs
(Contract E(11-1)-2693)
(MTR-7241; COO-2693-76-2) Avail: NTIS HC A05/MF A01

A large number of geothermal reservoirs exist and to perform a thorough study of each of these reservoirs to determine those most desirable for demonstration projects can be costly and time consuming. A methodology for assigning rankings to these reservoirs, given a limited amount of data, is presented. The top ranked reservoirs would then be studied more thoroughly. In addition, a methodology for ranking the large number of industries that could possibly utilize geothermal energy in nonelectric applications is given to determine those industries which will have the most impact on national energy demand if converted to geothermal use. ERA

N77-19611# Energy Research and Development Administration, Washington, D.C.
FOSSIL ENERGY RESEARCH PROGRAM OF THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, FY 1977
Apr. 1976 276 p refs
(ERDA-76-63) Avail: NTIS HC A13/MF A01

The research planned and documented is guided by the following overall programs goals: to develop the technology needed to make fossil fuels available in the form and quantity needed, and to assure that the nation's fossil fuels resources are developed at acceptable economic, social, and environmental costs. Funding requirements for the programs discussed are based on the attainment of these major goals. Author

N77-19612# Rogers Engineering Co., Inc., San Francisco, Calif.
MODULAR 5 MW GEOTHERMAL POWER PLANT DESIGN CONSIDERATIONS AND GUIDELINES
May 1976 139 p ref Prepared for Lawrence Livermore Lab. Supported in part by NATO Committee on the Challenges of Modern Society
(Contract W-7405-eng-48)
(UCRL-13684) Avail: NTIS HC A07/MF A01

The design considerations and guideline documents define the prinicipal design requirements for a nominal 5 MW geothermal power plant of a type to permit over-the-road transport of its several modules. The power plant system defined is supplied with steam from a single flash steam separator stage, located at the plant area, and supplied with steam from two wells at nominal pressure of 3.8 Kg per square cm. Guidelines are given for the following: site preparation, collection system, plant installation, assembly, and test; turbine generator module; condenser and noncondensable gas removal module; plant control and switchgear module; cooling water circulation pump module; steam-water separator module; maintenance, office, and lavatory module; reinjection pump module; cooling tower modules; spray pond installation and piping; and auxiliary generator module. GRA

N77-19613# Hamilton Standard, Windsor Locks, Conn.
EXPERIMENTAL AND ANALYTICAL RESEARCH ON THE AERODYNAMICS OF WIND TURBINES Mid-Term Technical Report, 1 Jun. - 31 Dec. 1975
C. Rohrbach Feb. 1976 111 p refs
(Contract E(11-1)-2615)
(COO-2615-76-T-1) Avail: NTIS HC A06/MF A01

Information is presented concerning aerodynamic design and performance technology, wind turbine parametric performance study, selection of model wind turbine configurations, and structural design of wind turbine models. ERA

N77-19614# Idaho National Engineering Lab., Idaho Falls.
PLAN FOR DEVELOPING MODERATE TEMPERATURE/LOW SALINITY GEOTHERMAL RESOURCES
Jay F. Kunze and Judson F. Whitbeck May 1976 91 p refs
(Contract E(10-1)-1375)
(ANCR-1318) Avail: NTIS HC A05/MF A01

The approach to developing moderate temperature (150 to 300 F) geothermal resources so that these can competitively enter the energy market is herein described. The specifics discussed relate to experiments in the Idaho National Engineering Laboratory's program effort. These involve the energy supply and disposal systems, the surface conversion equipment for generating electricity, and supplementary uses of the heat directly for industrial and agricultural applications. The experimental facilities are located in the Raft River Valley area of southcentral Idaho, close to the Utah border, and the document describes the purpose and likely economic benefit to result from this experimental program. ERA

N77-19616# Sandia Labs., Albuquerque, N.Mex.
DARRIEUS VERTICAL-AXIS WIND TURBINE PROGRAM AT SANDIA LABORATORIES
Emil G. Kadlec 1976 11 p refs Presented at Sharing the Sun, Solar Technology in the Seventies Conf., Winnipeg, Canada, 15 Aug. 1976
(Contract AT(29-1)-789)
(SAND-76-5712; Conf-760821-7) Avail: NTIS HC A02/MF A01

The Darrieus Vertical Axis Wind Turbine (VAWT) technology development program is described. The application receiving emphasis utilizes the VAWT operating at constant speed to generate electricity which is fed directly into a utility grid. ERA

N77-19620# Brookhaven National Lab., Upton, N.Y.
RELATIONSHIP OF ENERGY GROWTH TO ECONOMIC GROWTH UNDER ALTERNATIVE ENERGY POLICIES
D. J. Behling, Jr., R. Dullien, and E. Hudson Mar. 1976 247 p refs
(Contract E(30-1)-16)
(BNL-50500) Avail: NTIS HC A11/MF A01

The economic and social impacts of research, development, and demonstration plans of the Energy Research and Development Adminstration were analyzed. Two policy proposals were examined against a base case set of economic and energy projections for the years 1985, 1990, and 2000: (1) the introduction of RD and D-initiated energy supply and end-use conversion technologies to expand domestic energy supply and to improve the efficiency and flexibility of its use; and (2) the imposition of taxes and tariffs on petroleum and natural gas to reduce demand for these primary energy sources. Targets for the amounts of imports of oil and gas were specified. The degree to which the introduction of new energy technologies and/or the imposition of energy taxes could reduce oil and gas imports toward the target levels was identified; and the effects of these policies on the economy and the environment were estimated. These economic and environmental effects are thus a measure of the analytic framework which linked detailed mathematical process engineering and economic models to more aggregate econometric models. The four models employed are described. ERA

N77-19621# Argonne National Lab., Ill.
HIGH-PERFORMANCE BATTERIES FOR OFF-PEAK ENERGY STORAGE AND ELECTRIC-VEHICLE PROPULSION Progress Report, Jul. - Dec. 1975
Apr. 1976 97 p refs
(Contract W-31-109-eng-38)
(ANL-76-9) Avail: NTIS HC A05/MF A01

The battery designs for the two applications differ, particularly in cell configuration and electrode design, because of the differing performance requirements. The present cells are vertically oriented, prismatic cells with two negative electrodes of a solid lithium-aluminum alloy and a central positive electrode of iron sulfide (FeS2 or FeS). The electrolyte is molten LiCl-KCl eutectic, which requires a cell temperature of about 400-450 C. Effort was continued on the development of engineering-scale cells with hot-pressed electrodes assembled in the uncharged state (positive electrode of Li2S-Fe, negative electrode of Al). Studies of electrodes were directed principally toward developing positive electrodes of FeS2 and FeS in carbon-bonded structures and toward improving the performance and lowering the cost of negative Li-Al electrodes. ERA

N77-19624# Oak Ridge National Lab., Tenn.
DEVELOPMENT OF THE ICE-MAKER HEAT PUMP
H. C. Fischer 1976 13 p Presented at the Ann. Meeting of the ASHRAE, Seattle, 27 Jun. - 1 Jul. 1976 Supported in part by HUD
(Contract W-7405-eng-26)
(CONF-760618-2) Avail: NTIS HC A02/MF A01

The development of the ice-maker heat pump provides another tool to reduce the amount of energy it takes to heat and cool buildings. By using both the heating and cooling outputs of the heat pump, great energy savings can be made. The ice (cooling output) can be stored to meet air conditioning loads that occur during utility peak, thus, reducing peak demands as well as saving energy. Design features of the ice-maker heat pump are discussed. ERA

N77-19625# Oak Ridge National Lab., Tenn.
RESIDENTIAL ENERGY USE ALTERNATIVES TO THE YEAR 2000
E. Hirst 1976 16 p refs Presented at National Science Foundation Workshop on Long-run Energy Demands, McLean, Va., 9 Jun. 1976 Sponsored by ERDA
(CONF-760648-1) Avail: NTIS HC A02/MF A01

A comprehensive engineering-economic computer model used to simulate energy use in the residential sector from 1970 to 2000. The purpose of the model is to provide an analytical tool with which to evaluate a variety of conservation policies, technologies, and strategies for their impacts on residential energy use and fuel expenditures over time. The baseline forecast developed shows total fuel use growing from 17.6 GGJ in 1975 to 26.4 GGJ in 2000, with an average annual growth rate of 1.7 percent. The percentage of household fuel provided by electricity grows from 44 percent in 1975 to 56 percent in 2000. ERA

N77-19626# California Univ., Livermore. Lawrence Livermore Lab.
CHANGING ENERGY PERSPECTIVES
1976 13 p refs Presented at the Am. Inst. of Aeron. and Astronautics Symp. on Alternate Fuel Resources, Santa Maria, Calif., 25 Mar. 1976
(Contract W-7405-eng-48)
(UCRL-78153) Avail: NTIS HC A02/MF A01

Several new developments call for a reassessment of the U.S. energy independence strategy: (1) conservation programs have not been effectively implemented; (2) industry is not building synthetic fuel production plants; and (3) a projected world wide expansion of oil production may actually lead to price reductions in the 1980's followed by price increases in the 1990's. The Stanford Research Institute energy market model is used to evaluate these new developments. It indicates that acceleration of research and development on synthetic fuels and on increasing the efficiency of energy use may lead to reductions of over $100 billion in the total annual U.S. energy bill in the year 2000 and to a reduction of $30 billion in the total annual energy import bill. Since transportation is the most inefficient sector in terms of energy use, and more and more Americans seem to prefer suburban living, increasing the efficiency of the automobile is crucial. ERA

N77-19628# Sandia Labs., Albuquerque, N.Mex.
OPTICAL MATERIALS FOR SOLAR ENERGY APPLICATIONS
D. M. Mattox May 1976 43 p refs Presented at the Topical Meeting on Image Processing, Pacific Grove, Calif., 24 Feb. 1976; sponsored by the Optical Soc. of Am., the Am. Vacuum Soc., and the Soc. for Vacuum Coaters Sponsored by ERDA
(SAND-76-5141; Conf-760206-3) Avail: NTIS HC A03/MF A01

It is shown that hundreds of square miles of optical materials, will be required every year for solar energy to have a significant input on the U.S. energy economy. Most of these materials will have to be fabricated at a very low areal cost. Various high volume, low cost production processes applicable to solar optical materials are presented. Major challenges to the optical technologist will be to control the optical properties of materials being fabricated at very high production rates and to develop new cost optical materials. ERA

N77-19632# InterTechnology Corp., Warrenton, Va.
INTERTECHNOLOGY CORPORATION PROPOSED SYSTEMS LEVEL PLAN FOR SOLAR HEATING AND COOLING, COMMERCIAL BUILDINGS. VOLUME 1: NATIONAL SOLAR DEMONSTRATION PROGRAM
May 1976 221 p 3 Vol.
(Contract E(11-1)-2688)
(COO/2688-76/6-Vol-1) Avail: NTIS HC A10/MF A01

Demonstration site matrix development, site selection methodology, test and evaluation plan, information dissemination plan, program management plan, program coordination and implementation for solar heating and cooling systems of non-residential buildings are presented. ERA

N77-19633# InterTechnology Corp., Warrenton, Va.
INTERTECHNOLOGY CORPORATION PROPOSED SYSTEMS LEVEL PLAN FOR SOLAR HEATING AND COOLING, COMMERCIAL BUILDINGS. VOLUME 2: NATIONAL SOLAR DEMONSTRATION PROGRAM
May 1976 284 p 3 Vol.
(Contract E(11-1)-2688)
(COO/2688-76/6-Vol-2) Avail: NTIS HC A13/MF A01

Program function, program structure, specifications for input data, description of calculations performed, output format and lists, brief program outline, storage map, and source program outline and listings for solar heating and cooling system of non-residential buildings are presented. ERA

N77-19634# InterTechnology Corp., Warrenton, Va.
INTERTECHNOLOGY CORPORATION PROPOSED SYSTEMS LEVEL PLAN FOR SOLAR HEATING AND COOLING, COMMERCIAL BUILDINGS. VOLUME 3: NATIONAL SOLAR DEMONSTRATION PROGRAM
May 1976 203 p refs 3 Vol.
(Contract E(11-1)-2688)
(COO/2688-76/6-Vol-3) Avail: NTIS HC A10/MF A01

Development of solar performance data, demonstration site installation schedules, climatic regions and characteristic sites, parametric study alternatives, for solar heating and cooling systems of non-residential buildings are presented. ERA

N77-19635# Score, Inc., Cambridge, Mass.
ENERGY RESOURCES ALTERNATIVES COMPETITION Progress Report, 1 Feb. - 31 Dec. 1975
D. J. Matzke, D. M. Osowski, and Mark L. Radtke Jan. 1976 208 p refs
(Contract E(11-1)-2698)
(COO-2698-1) Avail: NTIS HC A10/MF A01

The objectives and results of the intercollegiate Energy Resource Alternatives competition are described. The goal of the competition was to design and build prototype hardware which provided space heating and cooling, hot water, and electricity at a level appropriate to the needs of homes, farms, and light industry. The hardware projects were powered by such nonconventional energy sources as solar energy, wind, biologically produced gas, coal, and ocean waves. The competition rules emphasized design innovation, economic feasibility, practicality, and marketability. Author (ERA)

N77-19636# Oak Ridge National Lab., Tenn.
RECOVERY OF INACCESSIBLE COAL RESERVES BY IN SITU GASIFICATION
R. C. Forrester, III 1976 17 p refs Presented at the 11th Intersoc. Energy Conversion Eng. Conf., State Line, Nev., 12-17 Sep. 1976
(Contract W-7405-eng-26)
(CONF-760906-5) Avail: NTIS HC A02/MF A01

In-situ gasification of coal offers the possibility of providing a much-needed energy option for the United States and of greatly expanding our available resource reserve. Preliminary experiments suggest that costs will be competitive with those for surface processing techniques and that new technology requirements are not unachievable. These factors, coupled with reduced environmental impacts and associated prospects for improved occupational health and safety, are probably sufficient to ultimately assure proven UCG technology a large share of society's overall energy demand. ERA

N77-19637# Institute of Gas Technology, Chicago, Ill.
RESEARCH AND DEVELOPMENT OF RAPID HYDROGENATION FOR COAL CONVERSION TO SYNTHETIC MOTOR FUELS (RISER CRACKING OF COAL)
Dennis A. Duncan, Justin L. Beeson, and R. Donald Oberle May 1976 39 p
(Contract E(49-18)-2307)
(FE-2307-2) Avail: NTIS HC A03/MF A01

A bench-scale experimental reactor was designed to define the important design parameters in the short residence-time hydrocracking of coal to synthetic motor fuels. The reactor is a 50 foot helical coil of 1/8-in. Incoloy tubing that is heated electrically. Coal feed rates are 5 to 10 lb/hr with residence times of 1 to 10 seconds. The reactor operates up to 2,000 psig at temperatures of 900 to 1500 F. An experimental plan is outlined for Bench-Scale Unit Operations. A detailed operating procedure for the bench-scale unit is included. ERA

N77-19638# Sandia Labs., Livermore, Calif. Combustion Research Div.
COMBUSTION RATES AND MECHANISMS OF PULVERIZED COALS AND COAL-DERIVED FUELS
D. R. Hardesty Jun. 1976 37 p refs
(Contract AT(29-1)-789)
(SAND-76-8229) Avail: NTIS HC A03/MF A01

The rates and mechanisms of coal devolatilization and combustion are extremely sensitive to local details of the combustion process. Similarly, pollutants formed during the process are sensitive to the initial coal composition and local time and temperature histories of individual particles. Very little useful information is available by which the influence of combustion modifications on both the efficiency and pollutant emission characteristics can be predicted. The present understanding of the rates of coal and char combustion is summarized with the conclusion that heterogeneous chemical kinetic rates strongly influence the rates and mechanisms of coal and char combustion. If understood, adjustment and control of the rates and mechanisms by judicious adjustment of the combustion process and the initial fuel character should be possible. A proposal

for a detailed theoretical and experimental study of the combustion rates of pulverized coal and coal-derived fuels is discussed. ERA

N77-19642# Virginia Polytechnic Inst. and State Univ., Blacksburg.
EVALUATION AND TARGETING OF GEOTHERMAL ENERGY RESOURCES IN THE SOUTHEASTERN UNITED STATES Progress Report, 1 May - 30 Jun. 1976
John K. Costain, L. Glover, III, and A. K. Sinha 1976 33 p refs
(Contract E(40-1)-5103)
(VPI-SU-5103-1) Avail: NTIS HC A03/MF A01

A methodology employing geological, geochemical, and geophysical techniques is developed and applied to determine a radiogenic source buried beneath an insulating blanket of sediments of low thermal conductivity, such as the sedimentary rocks of the Coastal Plain of South Carolina, North Carolina, and Virginia. Preliminary determinations of geothermal gradients in Coastal Plain sediments of South Carolina indicate gradients that range from about 20 C/km to at least 45 C/km. Representative average gradients determined from bottom hole temperatures are about 30 C/km. The observed gradients are consistent with those to be expected for an efficient sedimentary insulator with a low thermal conductivity. ERA

N77-19643# Battelle Pacific Northwest Labs., Richland, Wash.
TECHNICAL AND ECONOMIC FEASIBILITY ANALYSIS OF THE NO-FUEL COMPRESSED AIR ENERGY STORAGE CONCEPT
D. K. Kreid May 1976 71 p refs
(Contract E(45-1)-1830)
(BNWL-2065) Avail: NTIS HC A04/MF A01

The analysis uncovered no insurmountable problems to preclude the technical feasibility of the no-fuel compressed air energy storage concept. The results of the economic analysis are sufficiently unfavorable to conclude that no-fuel compressed air energy storage technology could not compete with conventional compressed air energy storage or standard gas turbine peaking facilities for conditions foreseeable at this time. ERA

N77-19645# California Univ., Livermore. Lawrence Livermore Lab.
COMPOSITE FIBER FLYWHEEL FOR ENERGY STORAGE
J. A. Rinde, T. T. Chiao, and R. G. Stone 4 Jun. 1976 21 p refs Presented at 8th Soc. for the Advan. of Mater. and Process Eng. Tech. Conf., Seattle, 12-14 Oct. 1976
(Contract W-7405-eng-48)
(UCRL-78085; Conf-761018-1) Avail: NTIS HC A02/MF A01

Key portable and stationary applications of the flywheel are discussed and examples of those presently under consideration are described in some detail. Design data on key candidate composite material systems are reported and areas that require further extensive study are also discussed. GRA

N77-19647# Sandia Labs., Albuquerque, N.Mex.
PHOTOVOLTAIC ENERGY CONVERSION USING CONCENTRATED SUNLIGHT
E. L. Burgess 1976 7 p refs Presented at 20th Ann. SPIE Technical Symp., San Diego, Calif., 23 Aug. 1976
(Contract E(29-1)-789)
(SAND-76-5759; Conf-760832-5) Avail: NTIS HC A02/MF A01

A development program is described which uses sunlight concentration techniques to effect an immediate reduction in cost-per-unit-power for photovoltaic systems in which solar cell cost dominates the total system cost. Current examples of concentrator solar cell technologies are single crystal silicon and gallium arsenide. Implementation of cost reductions by the use of sunlight concentration is not dependent on the development of low-cost, mass-production cell technologies but emphasizes high cell efficiency and low-cost concentrator systems. ERA

N77-19648# Atlas Corp., Santa Clara, Calif.
DESCRIPTION OF THE SOLAR ENERGY R AND D PROGRAMS IN MANY NATIONS Final Report
F. DeWinter, ed. and J. W. DeWinter, ed. Feb. 1976 298 p refs
(Contract E(04-3)-1122)
(SAN-1122-76-1) Avail: NTIS HC A13/MF A01

Descriptions of the Solar Energy R and D Programs of 32 countries, of the Organization of American States, of UNESCO, and of a number of private organizations are presented. The descriptions were solicited from the most reliable representatives known for the individual countries. ERA

N77-19649# Boeing Co., Seattle, Wash. Engineering and Construction Div.
CENTRAL RECEIVER SOLAR THERMAL POWER SYSTEM. COLLECTOR SUBSYSTEM RESEARCH EXPERIMENTS Quarterly Technical Progress Report, 2 Jan. - 31 Mar. 1976
20 Apr. 1976 92 p refs
(Contract E(04-3)-1111)
(SAN-1111-76-2; D277-10025-1; QTPR-2) Avail: NTIS HC A05/MF A01

A description of the detail design (DD) of research experiment hardware to support the 10 MW/sub e/ pilot plant preliminary design (PD) is presented. Additionally, test plans for assembly, integration, and array tests are summarized along with results of completed component/material tests. Research experiment DD and tests described herein were planned to provide design verification and supporting data, with hardware which either duplicates, or closely simulates the pilot plant PD baseline. ERA

N77-19650# IIT Research Inst., Chicago, Ill.
WEATHERABILITY OF SOLAR ENERGY UTILIZATION MATERIALS: PRELIMINARY DISCUSSIONS
J. E. Gilligan and J. Brzuskiewicz 1976 14 p refs Presented at Sharing the Sun: Solar Technology in the Seventies, Winnipeg, Canada, 15 Aug. 1976
(Contract E(11-1)-0578)
(CONF-760821-11) Avail: NTIS HC A02/MF A01

The initial efforts of a program of research and experimental testing are described in which the optical and physical performance of materials for use in solar energy utilization devices will be determined before and after exposure to outdoor weathering tests. Materials which are currently in use and others which are being considered or developed for these applications will be characterized and exposed to natural solar radiation. The results of these tests, primarily the effects of outdoor exposure on optical and physical properties, will be compiled in a handbook, along with cost, availability and other pertinent information. ERA

N77-19657# Colorado Energy Research Inst., Golden.
NET ENERGY ANALYSIS: AN ENERGY BALANCE STUDY OF FOSSIL FUEL RESOURCES
Apr. 1976 238 p refs
(Contract DI-14-01-0001-2156)
(PB-259158/4; DOI-OMPRA-76/02) Avail: NTIS HC A11/MF A01 CSCL 10A

Fossil fuels from resources in the ground are examined through production processes which deliver usable energy ready for consumption. The complete direct and indirect energies which must be used to produce energy from fossil fuels are considered, including the energies which drive or subsidize the production. Included are those energies used in the production of materials needed to build and operate the industrial production and transportation facilities which either directly produce energy or which indirectly provide energy or materials to the energy production processes. GRA

N77-19658# Colorado Energy Research Inst., Golden.
NET ENERGY ANALYSIS: AN ENERGY BALANCE STUDY OF FOSSIL FUEL RESOURCES. SUMMARY REPORT
Apr. 1976 73 p refs
(Contract DI-14-01-0001-2156)
(PB-259159/2; DOI-OMPRA-76/03) Avail: NTIS HC A04/MF A01 CSCL 10A

Industrial energy production in fossil fuels is examined with emphasis on the Western United States. Complete direct and indirect energies which must be used to produce energy from

fossil fuels are included. These cover direct and indirect energies which drive or subsidize the production. Included are also those energies sequestered in materials needed to build and operate the industrial production and transportation facilities which either directly or indirectly are necessary for energy production. All steps in bringing fossil fuels from reserves in the ground to the point of end use are considered (exploration, extraction, conversion, and transportation). GRA

N77-19659# Air Force Academy, Colo. Dept. of Civil Engineering.
SOLAR HEATING RETROFIT OF MILITARY FAMILY HOUSING Technical Report, Apr. 1973 - Jun. 1976
Marshall W. Nay, Jr., Jon M. Davis, Roy L. Schmiesing, and William A. Tolbert Sep. 1976 293 p refs
(AD-A030843; FJSRL-TR-76-0008) Avail: NTIS HC A13/MF A01 CSCL 13/1

This interim technical report describes the programming, facility, acquisition and initial performance of the first retrofit constructed solar-heated facility in the United States Air Force, the Solar Test House at the United States Air Force Academy. The Air Force civil engineer is responsible today for operating and maintaining approximately 150,000 units of military family housing. As is the case in the private sector, the Air Force civil engineer is experiencing higher operating and maintenance costs due to inflation. Just recently, operating costs have begun to exceed maintenance costs. Higher energy related utility costs are believed responsible for this. Accordingly, Air Force civil engineers are interested in investigating the use of alternate energy schemes such as solar energy for its real property, not only in response to inflation in energy costs but also in response to energy crisis scenarios for a number of reasons which include: providing a mechanism to help offset rising utility costs; providing a mechanism to help guarantee mission continuation at installations that have their normal sources of conventional fossil fuels curtailed; and contributing to the national objective of energy self-sufficiency. Significant work in solar energy is currently on-going in the private sector. This work effort involves the application of solar energy for space heating, domestic hot water heating and air conditioning. However, this work is predominantly in the new construction category. GRA

N77-19662# InterTechnology Corp., Warrenton, Va.
FEASIBILITY OF MEETING THE ENERGY NEEDS OF ARMY BASES WITH SELF-GENERATED FUELS DERIVED FROM SOLAR ENERGY PLANTATIONS Final Report
George C. Szego Jul. 1976 161 p refs
(Contract DACA23-74-C-0009; ARPA Order 2630)
(AD-A031163; ITC-260675) Avail: NTIS HC A08/MF A01 CSCL 10/1

This project thoroughly investigated the possibility of collecting and storing solar radiation in plants especially grown for their fuel value as a source of fuel on U. S. Army bases. The study investigated the merit of producing this fuel at energy plantations at or near the bases. The fuel would be used for directly fired steam generators, hot water heaters, space heaters, and cooking. The research examined the major characteristics of energy plantations; analyzed plant-matter production rates from deciduous plants; and examined fuel consumption in stationary facilities at major troop training centers. The possibilities and requirements of energy plantations at Fort Benning, Fort Leonard Wood, and at Army bases in general were detailed. It was concluded that energy plantations could be feasible at approximately 15 large Army bases and that the cost of solid fuel produced from them would be approximately $1/1 million Btu; the cost of synthetic natural gas produced from plants was determined to be approximately $3.10 to $4.20/1000 standard cu ft. Besides being a perpetually renewable fuel source, it was found that energy plantations could provide independence from other fuel sources, reduction in future environmental problems caused by present fuels, and will productively use land not now in active use.
Author (GRA)

N77-19663# InterTechnology Corp., Warrenton, Va.
FEASIBILITY OF MEETING THE ENERGY NEEDS OF ARMY BASES WITH SELF-GENERATED FUELS DERIVED FROM SOLAR ENERGY PLANTATIONS. APPENDIXES A, B, AND C Final Report
George C. Szego Jul. 1976 325 p refs
(Contract DACA23-74-C-0009; ARPA Order 2630)
(AD-A031164; ITC-260675-App-A; ITC-260675-App-B; ITC-260675-App-C) Avail: NTIS HC A14/MF A01 CSCL 10/1

For abstract, see N77-19662.

N77-19667# Institute of Gas Technology, Chicago, Ill.
WIND-POWERED HYDROGEN ELECTRIC SYSTEMS FOR FARM AND RURAL USE Final Report, May - Dec. 1975
Raymond R. Tison, Nicholas P. Biederman, Timothy Donakowski, Robert H. Elkins, Jon B. Pangborn, Mark A. Turnquist, Richard Young, and Bernie Yudow Apr. 1976 171 p refs Sponsored in part by ERDA
(Grant NSF AER-75-00772)
(PB-259318/4; NSF/RA-760184) Avail: NTIS HC A08/MF A01 CSCL 10B

Two methods of energy storage are evaluated for use and subsequently form the bases upon which each design is optimized. It is shown that wind-energy systems based on battery-storage systems are: (1) simpler to construct and maintain; (2) more efficient; and (3) less expensive than those based on hydrogen-storage systems. Further, the relative economics of each wind-energy system are heavily dependent on wind availability, number of days of energy storage required, and the match between the wind energy available and the energy requirement of the load. Of all the energy requirements characterized, the cash grain operation is shown to be the least adaptable to wind-energy systems. GRA

N77-19683# Booz-Allen Applied Research, Inc., Bethesda, Md.
POTENTIAL ENVIRONMENTAL IMPACTS OF SOLAR HEATING AND COOLING SYSTEMS Final Report
T. J. Consroe, F. M. Glaser, and R. W. Shaw, Jr. Oct. 1976 124 p refs
(Contract EPA-68-01-2942)
(PB-259970/2; BAAR-9075-043-001; EPA-600/7-76-014) Avail: NTIS HC A06/MF A01 CSCL 13A

Potential environmental consequences of solar energy utilization for heating and cooling buildings are discussed. Areas in which both positive and negative impacts are possible are identified, the national research and development program directed toward solar heating and cooling technology is summarized, and a general methodology for estimating the impact on air pollution of solar energy utilization in urban areas is presented. GRA

N77-19708# Center for the Environment and Man, Inc., Hartford, Conn.
REGIONAL VARIATIONS OF SOLAR RADIATION WITH APPLICATION TO SOLAR ENERGY SYSTEM DESIGN Final Report
Marshall A. Atwater and John T. Bal Jul. 1976 127 p refs (Grant NSF AER-75-14536)
(PB-259379/6; CEM-4185-550A; NSF/RA-760196) Avail: NTIS HC A07/MF A01 CSCL 04A

Numerical modeling of solar radiation data was undertaken to compute hourly values of solar radiation and other meteorological elements (temperature, dew point, wind direction, wind speed, and atmospheric radiation) at 50 stations in twelve metropolitan regions for a two-year period. Intra- and inter-regional variations of total solar radiation were analyzed. GRA

N77-19782# Grimes (W. J.) and Co., Hingham, Mass.
PRELIMINARY REPORT ON SIMULATION OF A HELIOSTAT FIELD
G. Bouyssou, A. Giraud, and G. Vialaret Jun. 1976 27 p Transl. into ENGLISH of "Rapport provisoire sur la simulation d'un champ D'heliostats", Toulouse, Natl. Scientific Res. Center, 22 Jul. 1975 Sponsored by ERDA
(ERDA-TR-158) Avail: NTIS HC A03/MF A01

Structuring with specialized subprograms provides a very high degree of flexibility depending on the acquisition of increasingly accurate data for the selected site, the mechanical and optical design of the mirrors, the data on solar radiation, the tower and

boiler, the number of towers, and random disturbances. These data can be integrated into any stimulation in order to obtain results which come closer and closer to reality. ERA

N77-19872# Los Alamos Scientific Lab., N.Mex.
COMMERCIAL APPLICATION OF LASER FUSION
L. A. Booth 1976 26 p refs Presented at Advisory Group Meeting on the Technol. of Inertial Confinement Expt., Dubna, USSR, 19-23 Jul. 1976; sponsored by IAEA
(Contract W-7405-eng-36)
(LA-UR-76-1459; Conf-760723-1) Avail: NTIS HC A03/MF A01

The fundamentals of laser-induced fusion, some laser-fusion reactor concepts, and attendant means of utilizing the thermonuclear energy for commercial electric power generation are discussed. Theoretical fusion-pellet microexplosion energy release characteristics are described and the effects of pellet design options on pellet-microexplosion characteristics are discussed. The results of analysis to assess the engineering feasibility of reactor cavities for which protection of cavity components is provided either by suitable ablative materials or by diversion of plasmas by magnetic fields are presented. Two conceptual laser-fusion electric generating stations, based on different laser-fusion reactor concepts, are described. ERA

N77-19898*# International Business Machines Corp., Hopewell Junction, N.Y. Systems Product Div.
SILICON RIBBON GROWTH BY A CAPILLARY ACTION SHAPING TECHNIQUE Quarterly Progress Report
G. H. Schwuttke, T. F. Ciszek, and A. Kran 15 Mar. 1976 87 p refs Prepared for JPL
(Contracts NAS7-100; JPL-954144)
(NASA-CR-149815; QPR-3) Avail: NTIS HC A05/MF A01 CSCL 20L

The technique of silicon ribbon growth by the capillary action shaping is assessed for applicability to photovoltaic power device material. Ribbons 25 mm in width and up to 0.5 m in length have been grown from SiC dies, and some new characteristics of growth from such dies have been identified. Thermal modifiers have been studied, and systems were developed which reduce the frozen-in stress un silicon ribbons and improve the thickness uniformity of the ribbons. Preliminary spreading resistance measurements indicate that neither surface striations nor twin boundaries give rise to appreciable resistivity variations, but that large-angle grain boundaries cause local resistivity increases of up to 200%. Author

N77-19899*# International Business Machines Corp., Hopewell Junction, N.Y. Systems Product Div.
SILICON RIBBON GROWTH BY A CAPILLARY ACTION SHAPING TECHNIQUE Annual Report
G. H. Schwuttke, T. F. Ciszek, and A. Kran 15 Jun. 1976 74 p refs Prepared for JPL
(Contracts NAS7-100; JPL-954144)
(NASA-CR-149814; ERDA/JPL-954144-76/01; QTPR-4) Avail: NTIS HC A04/MF A01 CSCL 20L

The crystal growth method described is a capillary action shaping technique. Meniscus shaping for the desired ribbon geometry occurs at the vertex of a wettable die. As ribbon growth depletes the melt meniscus, capillary action supplies replacement material. A capillary die is so designed that the bounding edges of the die top are not parallel or concentric with the growing ribbon. The new dies allow a higher melt meniscus with concomitant improvements in surface smoothness and freedom from SiC surface particles, which can degrade perfection. Author

N77-19935# Oak Ridge National Lab., Tenn. Solid State Div.
PRACTICAL REASONS FOR INVESTIGATING ION TRANSPORT IN HIGH TEMPERATURE INSULATING MATERIALS
E. Sonder Jul. 1976 24 p refs Presented at 2. Europhys. Topical Conf., Berlin, 30 Aug. 1976
(Contract W-7405-eng-26)
(CONF-760831-2) Avail: NTIS HC A02/MF A01

Practical problems encountered in a number of advanced technology applications, particularly those related to energy conversion, are discussed. Refractory ionic compounds which are abundant and of high melting point are listed, and technological problems are discussed in terms of specific materials problems. The argument is made that basic information concerning transport properties in refractory compounds is lacking to such an extent that it is difficult to design and assess advanced energy generation systems. Technology applications include; (1) ceramic nuclear fuels for high temperature fission reactors; (2) high temperature gas turbine blades; (3) insulators in controlled thermonuclear reactors, and (4) magnetohydrodynamic generators. Some of the difficulties inherent in making transport property measurements at high temperatures are also listed. ERA

N77-19953# Aerospace Corp., Los Angeles, Calif.
CONTROL OF WASTE AND WATER POLLUTION FROM POWER PLANT FLUE GAS CLEANING SYSTEMS Annual Report, Jan. - Dec. 1975
P. P. Leo and J. Rossoff Oct. 1976 176 p refs
(Contract EPA-68-02-1010)
(PB-259211/1; EPA-600/7-76-018; AR-1; ATR-76(7297-01)-2) Avail: NTIS HC A09/MF A01 CSCL 13B

The state of research and development in the fields of nonregenerable flue gas cleaning (FGC) waste treatment, utilization, and disposal is summarized, as well as water reuse technology, for coal-fired utility power plants. Significant results cover: (1) chemical and physical characterization of wastes from eastern and western U.S. plants using lime, limestone, or double-alkali scrubbing systems; (2) chemical and physical properties and leaching characteristics of treated and untreated wastes; (3) field evaluations of treated and untreated waste disposal; (4) disposal alternatives; (5) cost estimates for ponding and for fixation disposal methods; (6) disposal standards; and (7) potential use of wastes in fertilizer production and Portland cement manufacture. GRA

N77-19956# Tennessee Valley Authority, Chattanooga.
STUDY OF THE FEASIBILITY OF A REGIONAL SOLID WASTE DERIVED FUEL SYSTEM IN THE TENNESSEE VALLEY AUTHORITY SERVICE AREA
Jul. 1976 229 p refs
(Contracts EPA-IAG-D5-0819; FEA-CC-04-50063-00)
(PB-259764/9; PRS-8; FEA/G-76/460) Avail: NTIS HC A11/MF A01 CSCL 13B

The feasibility and economics of establishing a resource recovery system in the TVA region are evaluated. This system would consist of collecting, transporting and processing the municipal solid waste by burning the fuel fraction with coal in a conventional TVA power boiler modified for that purpose. Waste will be converted to a synthesis gas with subsequent conversion to fuel grade methanol for use in TVA's gas turbines modified to accept such a fuel. GRA

N77-20116*# Meckler (Gershon) Associates, Washington, D.C. Consulting Engineers, Washington, D. C.
STUDY OF THE APPLICATION OF SOLAR CHEMICAL DEHUMIDIFICATION SYSTEM TO WIND TUNNEL FACILITIES OF NASA LEWIS RESEARCH CENTER AT CLEVELAND, OHIO
15 Jul. 1976 38 p
(Contract NASw-2920)
(NASA-CR-149886) Avail: NTIS HC A03/MF A01 CSCL 14B

Energy utilization and cost payback analyses were prepared for proposed modifications. A 50,000 CFM standard compact packaged solid desiccant dehumidifier utilizing high temperature hot water (HTHW) for desiccant regeneration was added. The HTHW is generated by utilizing solar energy and is stored in a storage tank. A steam boiler is provided as a back-up for the solar system. A 50,000 CFM standard compact package solid desiccant dehumidifier utilizing high temperature hot water (HTHW) for desiccant regeneration was added. The HTHW is generated by utilizing a steam boiler and a heat exchanger and is stored in a storage tank. Author

N77-20191# Wisconsin Univ., Madison. Mathematics Research Center.

DISCOVERY OF REACTION SEQUENCES FOR THERMOCHEMICAL WATER SPLITTING

D. May and D. F. Rudd Jun. 1976 36 p refs presented at 1st World Hydrogen Energy Conf., 1-3 Mar. 1976
(Contract DAAG29-75-C-0024)
(AD-A029959; MRC-TSR-1636) Avail: NTIS HC A03/MF A01 CSCL 07/4

Waste heat from nuclear reactors could be used to generate hydrogen fuel from water if the proper sequence of thermochemical reactions can be discovered. The authors develop methods for the discovery of thermodynamically and stoichiometrically feasible reaction sequences. This leads towards a graph theory of reaction sequence synthesis. GRA

N77-20197# Bureau of Mines, Amarillo, Tex. Helium Operations.

ANALYSIS OF NATURAL GASES, 1975 Information Circular 1976

B. J. Moore Sep. 1976 88 p refs
(PB-259351/5; BM-IC-8717) Avail: NTIS HC A05/MF A01 CSCL 21D

Analyses and related source data for 234 natural gas samples from wells and pipelines in 21 states and one foreign country are presented. These samples were collected during 1975 as a part of the Bureau of Mines investigations of the occurences of helium. GRA

N77-20393# Army Cold Regions Research and Engineering Lab., Hanover, N.H.

DETECTING STRUCTURAL HEAT LOSSES WITH MOBILE INFRARED THERMOGRAPHY. PART 4: ESTIMATING QUANTITATIVE HEAT LOSS AT DARTMOUTH COLLEGE, HANOVER, NEW HAMPSHIRE

R. H. Munis, S. J. Marshall, and M. A. Bush Sep. 1976 15 p
(AD-A031803; CRREL-76-33-Pt-4) Avail: NTIS HC A03/MF A01 CSCL 13/1

During the winter of 1973-74 a mobile infrared thermography system was used to survey campus buildings at Dartmouth College, Hanover, New Hampshire. This report provides both qualitative and quantitative data regarding heat flow through a small area of a wall of one brick dormitory building before and after installation of aluminum reflectors between radiators and the wall. These data were used to estimate annual cost savings for 22 buildings of similar construction having aluminum reflectors installed behind 1,100 radiators. The data were then compared with the actual savings which were calculated from condensate meter data. The discrepancy between estimated and actual annual cost savings is explained in detail along with all assumptions required for these calculations. Author (GRA)

N77-20401* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

MOUNT FOR CONTINUOUSLY ORIENTING A COLLECTOR DISH IN A SYSTEM ADAPTED TO PERFORM BOTH DIURNAL AND SEASONAL SOLAR TRACKING Patent

Lott W. Brantley and Billy D. Lawson, inventors (to NASA) Issued 15 Mar. 1977 5 p Filed 29 Jan. 1976 Supersedes N76-18679 (14 - 09, p 1153)
(NASA-Case-MFS-23267-1; US-Patent-4,011,854; US-Patent-Appl-SN-653422; US-Patent-Class-126-270; US-Patent-Class-126-271; US-Patent-Class-250-203R) Avail: US Patent Office CSCL 14B

A collector dish is continuously oriented toward the sun in a system adapted to perform both diurnal and seasonal solar tracking. The mount is characterized by a rigid, angulated axle having a linear midportion supporting a collector dish, and oppositely extended end portions normally related to the midportion of the axle and received in spaced journals. The longitudinal axis of symmetry for the midportion of the axle is coincident with a seasonal axis while the axes of the journals are coincident with a diurnal axis paralleling the earth's polar axis. Drive means are provided for periodically displacing the axle about the diurnal axis at a substantially constant rate, while other drive means are provided for periodically indexing the dish through 1 deg about the seasonal axis whereby the position of the dish relative to the axle is varied for accommodating seasonal tracking as changes in the angle of inclination of the polar axis occurs. Official Gazette of the U.S. Patent Office

N77-20443# California Univ., Livermore. Lawrence Livermore Lab.

BATTERY-FLYWHEEL HYBRID ELECTRIC POWER SYSTEM FOR NEAR TERM APPLICATION. VOLUME 2: SYSTEM DESIGN

D. D. Davis, L. G. OConnell, S. E. Warner, A. E. Raynard (AiResearch Mfg. Co., Los Angeles), and B. H. Rowlett (AiResearch Mfg. Co., Los Angeles) 15 Apr. 1976 81 p refs
(Contract W-7405-eng-48)
(UCID-17098-Vol-2) Avail: NTIS HC A05/MF A01

A hybrid system design resulting from an investigation of battery-flywheel power systems for automobiles is presented. Topics include: (1) flywheel design, including sizing and safety; (2) power transmission design with an electromechanical transmission, traction motor, and flywheel motor, (3) control system design; and (4) performance calculations. Using a simplified mathematical model, a comparison is made between the hybrid performance characteristics and those of an all-battery electric vehicle. The hybrid design includes regenerative braking and fly-wheel relief of the drain rate. ERA

N77-20558*# Paragon Pacific, Inc., El Segundo, Calif.

COUPLED DYNAMICS ANALYSIS OF WIND ENERGY SYSTEMS Final Report

John A. Hoffman Feb. 1977 86 p refs
(Contract NAS3-19767)
(NASA-CR-135152; PPI-1014-11) Avail: NTIS HC A05/MF A01 CSCL 10A

A qualitative description of all key elements of a complete wind energy system computer analysis code is presented. The analysis system addresses the coupled dynamics characteristics of wind energy systems, including the interactions of the rotor, tower, nacelle, power train, control system, and electrical network. The coupled dynamics are analyzed in both the frequency and time domain to provide the basic motions and loads data required for design, performance verification and operations analysis activities. Elements of the coupled analysis code were used to design and analyze candidate rotor articulation concepts. Fundamental results and conclusions derived from these studies are presented. Author

N77-20559*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.

AN ECONOMIC AND PERFORMANCE DESIGN STUDY OF SOLAR PREHEATERS FOR DOMESTIC HOT WATER HEATERS IN NORTH CAROLINA

Clay B. Jones and Frederick O. Smetana Washington NASA Mar. 1977 32 p refs
(Contract NAS1-14208)
(NASA-CR-2813) Avail: NTIS HC A03/MF A01 CSCL 10A

The performance and estimated material costs for several solar preheaters for domestic hot water heaters using isolation levels present in North Carolina are presented. The effects of monthly variations in isolation and the direction of incident radiation are included. Demand is assumed at 13 gallons (49.2 liters) per day per person. The study shows that a closed circulation system with 82 gallons (310 liters) of preheated storage and 53.4 cu ft (4.94 cu m) of collector surface with single cover can be expected to cost about $800 and to repay it capital cost and interest (at 8%) in 5.2 years, assuming present electric rates increase at 5% per year. Author

N77-20560*# Meckler (Gershon) Associates, Washington, D. C. Consulting Engineers, Washington, D. C.

APPLICATION OF CHEMICAL DEHUMIDIFICATION SYSTEM TO A ROOF FAN HOUSE AT MICHOUD ASSEMBLY FACILITY AT NEW ORLEANS, LOUISIANA

15 Jul. 1976 38 p ref
(Contract NASw-2920)
(NASA-CR-149888) Avail: NTIS HC A03/MF A01 CSCL 10B

The feasibility of a chemical dehumidification system to reduce the energy consumption associated with dehumidification of the chilled air is assessed. A comparative energy consumption and cost analysis of the chemical dehumidification and existing systems and the savings offered by the proposed chemical dehumidification system over the existing air washer-reheat system are presented. Author

N77-20561*# Meckler (Gershon) Associates, Washington, D. C. Consulting Engineers, Washington, D. C.

APPLICATION OF A RUN AROUND COIL SYSTEM TO A ROOF FAN HOUSE AT MICHOUD ASSEMBLY FACILITY AT NEW ORLEANS, LOUISIANA

15 Jul. 1976 28 p ref

(Contract NASw-2920)

(NASA-CR-149887) Avail: NTIS HC A03/MF A01 CSCL 10B

Analysis of the proposed run around coil system indicates that it offers a decrease in steam, electricity and water consumptions. The run around coil system consist of two coils, a precooling coil which will be located at up stream and a reheating coil which will be located at down stream of the chilled water spray chamber. This system will provide the necessary reheat in summer, spring and fall. At times, if the run around coil system can not provide the necessary reheat, the existing reheat coil could be utilized. Author

N77-20562*# Meckler (Gershon) Associates, Washington, D. C. Consulting Engineers, Washington, D. C.

SUMMARY REPORT OF TECHNICAL DISCUSSION, NASA-ERDA SOLAR ENERGY PROPOSAL

30 Jul. 1976 7 p

(Contract NASw-2920)

Avail: NTIS HC A02/MF A01 CSCL 10A

The impact of the reduced energy requirements and cooling loads of solar collectors is assessed. Energy conservation measures to reduce the energy consumption have been implemented. It is indicated that solar chemical dehumidification was more efficient than solar absorption. Author

N77-20563*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SUMMER PERFORMANCE RESULTS OBTAINED FROM SIMULTANEOUSLY TESTING TEN SOLAR COLLECTORS OUTDOORS

Dean R. Miller Feb. 1977 27 p refs

(NASA-TM-X-73594; E-9066) Avail: NTIS HC A03/MF A01 CSCL 10A

Ten solar collectors were simultaneously tested outdoors. Efficiency data were correlated using a method that separates solar variables (flux, incident angle) from the desired performance parameters (heat loss, absorbtance, transmittance) which are unique to a given collector design. Tests were conducted on both clear and moderately cloudy days. Correlating data in the above manner, a 2-glass, black paint collector exhibited a decrease in efficiency of 5 percentage points relative to the baseline data for an exposure time of 2 years, 4 months. Condensation on the collector glazing was thought to be a contributing factor in this efficiency change. Author

N77-20564*# Old Dominion Univ. Research Foundation, Norfolk, Va.

ANALYSIS OF GaAs AND Si SOLAR ENERGY HYBRID SYSTEMS Final Report

John H. Heinbockel and A. S. Roberts, Jr. Washington NASA Mar. 1977 127 p refs

(Contract NAS1-11707)

(NASA-CR-2800) Avail: NTIS HC A07/MF A01 CSCL 10A

Various silicon hybrid systems are modeled and compared with a gallium arsenide hybrid system. The hybrid systems modeled produce electric power and also thermal power which can be used for heating or air conditioning. Various performance indices are defined and used to compare the system performance: capital cost per electric power out; capital cost per total power out; capital cost per electric power plus mechanical power; annual cost per annual electric energy; and annual cost per annual electric energy plus annual mechanical work. These performance indices indicate that concentrator hybrid systems can be cost effective when compared with present day energy costs. Author

N77-20565*# National Aeronautics and Space Administration. Pasadena Office, Calif.

SOLAR ENERGY COLLECTION SYSTEM Patent Application

Charles G. Miller (JPL) and James B. Stephens, inventors (to NASA) (JPL) Filed 25 Jan. 1977 57 p

(Contract NAS7-100)

(NASA-Case-NPO-13579-2; US-Patent-Appl-SN-762362) Avail: NTIS HC A04/MF A01 CSCL 10A

A fixed, linear, ground based primary reflector having an extended curved sawtooth-contoured surface covered with a metalized polymeric reflecting material, reflects solar energy to a movably supported collector that is kept at the concentrated line focus of the reflector primary. The primary reflector may be constructed by a process utilizing well-known freeway paving machinery. The solar energy absorber is preferably a fluid-transporting pipe. Efficient utilization leading to high temperatures from the reflected solar energy is obtained by cylindrical shaped secondary reflectors that direct off-angle energy to the absorber pipe. A seriatim arrangement of cylindrical secondary reflector stages and spot forming reflector stages produces a high temperature solar energy collection system of greater efficiency. NASA

N77-20566*# National Aeronautics and Space Administration. Pasadena Office, Calif.

LOW COST SOLAR ENERGY COLLECTION SYSTEM Patent Application

Charles G. Miller (JPL) and James B. Stephens, inventors (to NASA) (JPL) Filed 25 Jan. 1977 22 p

(Contract NAS7-100)

(NASA-Case-NPO-13579-3; US-Patent-Appl-SN-762363) Avail: NTIS HC A02/MF A01 CSCL 10A

A fixed, linear, ground based primary reflector having an extended curved sawtooth contoured surface covered with a metalized polymeric reflecting material, reflects solar energy to a movably supported collector that is kept at the concentrated line focus of the reflector primary. The primary reflector may be constructed by a process utilizing well known freeway paving machinery. NASA

N77-20567*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

SOLAR ABSORPTION CHARACTERISTICS OF SEVERAL COATINGS AND SURFACE FINISHES

James R. Lowery Washington Mar. 1977 36 p refs

(NASA-TM-X-3509; M-218) Avail: NTIS HC A03/MF A01 CSCL 10A

Solar absorption characteristics are established for several films potentially favorable for use as receiving surfaces in solar energy collectors. Included in the investigation were chemically produced black films, black electrodeposits, and anodized coatings. It was found that black nickel exhibited the best combination of selective optical properties of any of the coatings studied. A serious drawback to black nickel was its high susceptibility to degradation in the presence of high moisture environments. Electroplated black chrome generally exhibited high solar absorptivities, but the emissivity varied considerably and was also relatively high under some conditions. The black chrome had the greatest moisture resistance of any of the coatings tested. Black oxide coatings on copper and steel substrates showed the best combination of selective optical properties of any of the chemical conversion films studied. Author

N77-20568# General Electric Co., Philadelphia, Pa. Space Div.

GENERAL ELECTRIC COMPANY PROPOSED MANAGEMENT PLAN, COMMERCIAL BUILDINGS, NATIONAL SOLAR DEMONSTRATION PROGRAM

Apr. 1976 123 p

(Contract E(11-1)-2683)

(COO/2683-76/3) Avail: NTIS HC A06/MF A01

The National Solar Demonstration Plan (NSDP) for the solar heating and cooling of non-residential buildings was formulated for a matrix of two hundred (200) commercial demonstration projects. Recommendations for the NSDP pertaining to the management structure, demonstration implementation, schedules, data dissemination, and resources requirements are presented. Closely associated with these major planning elements are the related elements in the other recent General Electric reports submitted under the SHACOB Phase I contract. ERA

N77-20569# General Electric Co., Philadelphia, Pa. Space Div.

GENERAL ELECTRIC COMPANY PROPOSED DEMONSTRATION PROJECTS MATRIX, COMMERCIAL BUILDINGS, NATIONAL SOLAR DEMONSTRATION PROGRAM

Apr. 1976 147 p refs

(Contract E(11-1)-2683)

(COO/2683-76/5) Avail: NTIS HC A07/MF A01

The requirements for selecting commercial demonstrations are derived from the overall goal of the National Program for Solar Heating and Cooling. This goal is to stimulate an industrial and commercial capability for producing and distributing solar heating and cooling (SHAC) systems. The development of the demonstration matrix consists of establishing selection criteria and developing a methodology for applying and evaluating these criteria. The output of this procedure results in a time phased matrix of location SHAC systems, and building types which comprise the recommended National Solar Demonstration projects for commercial buildings. The Demonstration Matrix Definition is comprised of three principle elements; demonstration identification; specific demonstration selection criteria; and architect/engineer selection. ERA

N77-20570# General Electric Co., Philadelphia, Pa. Space Div.

PROPOSED MANAGEMENT PLAN, COMMERCIAL BUILDINGS

Apr. 1976 22 p

(Contract E(11-1)-2683)

(COO/2683-76/8) Avail: NTIS HC A02/MF A01

Recommendations for the National Solar Demonstration Program pertaining to the management structure, demonstration implementation, schedules, data dissemination, and resource requirements are presented. ERA

N77-20571# General Electric Co., Philadelphia, Pa. Space Div.

PROPOSED TEST AND EVALUATION PLAN, COMMERCIAL BUILDINGS

Apr. 1976 20 p

(Contract E(11-1)-2683)

(COO/2683-76/9) Avail: NTIS HC A02/MF A01

The Proposed Test and Evaluation Plan calls for the measurement, collection, and reporting of data from each demonstration site in sufficient detail to evaluate performance of the Solar HVAC system and the associated economic and societal/environmental impacts. Based on the results of systematic trade studies, requirements for an Instrumentation/Data Collection System (IDCS) developed. ERA

N77-20572# General Electric Co., Philadelphia, Pa. Space Div.

PROPOSED DEMONSTRATION PROJECTS MATRIX, COMMERCIAL BUILDINGS

Apr. 1976 16 p

(Contract E(111-1)-2683)

(COO/2683-76/10) Avail: NTIS HC A02/MF A01

Building/location/solar system combinations were selected for the directed level of 200 commercial solar heating and cooling demonstrations. The list of demonstrations was arranged in an effectiveness ranked array. Modeling techniques were applied to the selection process to enable mechanized generation of similar listings at other demonstration levels. Individual demonstration project selection guidelines were developed to provide decision criteria among candidate projects. ERA

N77-20573# Energy Research and Development Administration, Washington, D.C. Div. of Solar Energy.

ERDA SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM STRUCTURE Final Report

15 Apr. 1976 70 p refs

(ERDA-76-81) Avail: NTIS HC A04/MF A01

A total of 600-700 residential and 150-200 commercial demonstrations should be established between 1975-1979. Market penetration stimulated by these demonstrations is forecast to result in an annual solar installation rate approaching 1 percent of new building starts by 1980 and 10 percent by 1985. Annual savings of 0.2 x 10 to the 15th power Btu's of exhaustible energy resources are estimated to accrue by 1985, and 1.4 x 10 to the 15th power Btu's by 2000 The program structure recommended is not complete. An integrated procedure is suggested to enhance confidence in the program structure's definition and to provide an effective tool for planning improvements as the demonstration program proceeds. ERA

N77-20575# Energy Research and Development Administration, Washington, D.C.

SOLAR ENERGY, DFVLR ACTIVITIES

11 Feb. 1976 8 p Transl. into ENGLISH of a German report

(ERDA-TR-143) Avail: NTIS HC A02/MF A01

The research programs of the DFVLR in the area of utilization of solar energy are briefly summarized in terms of systems with focusing collectors, systems with flat collectors, and wind turbines. ERA

N77-20576# Boeing Co., Seattle, Wash.

CENTRAL RECEIVER SOLAR THERMAL POWER SYSTEM, COLLECTOR SUBSYSTEM Quarterly Technical Progress Report

31 Dec. 1975 90 p refs

(Contract E(04-3)-1111)

(SAN-1111-75-1) Avail: NTIS HC A05/MF A01

The preliminary design baseline collector sybsystem for a 10 MW/sub e/solar thermal pilot plant was documented. Supporting data and analyses used in selecting the specific design, and results of research experiments in progress to verify the design are included. Each reflector in the collector subsystem is enclosed within a 7 meter diameters, air supported Tedlar dome. Tedlar for the baseline dome will be 0.15 mm thick and will be specially processed to obtain a smooth surface which will provide high specular (direct) transmittance (86 to 90 percent). The reflector utilizes a commercially-available 0.05 mm thick Mylar film which is coated with vacuum-deposited aluminum on one surface. The drive and control system selected for the heliostats is a computer-controlled openloop system utilizing incremental position feedback from optical encoders on each heliostat drive. Author (ERA)

N77-20577# Applied Nucleonics Co., Inc., Los Angeles, Calif.

PROCEEDINGS OF AN EPRI WORKSHOP ON TECHNOLOGIES FOR CONSERVATION AND EFFICIENT USE OF ELECTRIC ENERGY. VOLUME 1: OVERVIEW

Fritz Kalhammer Jul. 1976 44 p refs Conf. held at San Diego, Calif., 26-30 Jul. 1976 Sponsored by Elec. Power Research Inst.

(PB-261469/1; EPRI-EM-313-SR-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 10A

Economic analysis of energy demand and conservation is discussed with special attention to the solar heating and cooling of buildings. I M.

N77-20578# Argonne National Lab., Ill.

APPLICATIONS AND PROSPECT OF ENERGY STORAGE BATTERIES

N. P. Yao ,1976 4 p Presented at the IEEE Region 6 Conf., Tucson, Ariz., 7-9 Apr. 1976

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

(CONF-760416-2) Avail: NTIS HC A02/MF A01

The major incentive for the U.S. to develop commercial-scale batteries and other efficient storage systems is the potential saving of petroleum and natural gas. Storing the off-peak energy derived from coal and nuclear base generating plants and

discharging it during the periods of high demand is the concept contemplated for electric utility application. Wide use of electric vehicles in big cities and urban areas for the improvement of air quality is another incentive. Three key areas are discussed: the technical and economic requirements of batteries for applications to electric utility and to electric vehicles, the current development status of battery technology in the U.S. and the level of development efforts, and the prospects and the schedule for implementing the advanced battery technology.ERA

N77-20579# Argonne National Lab., Ill.
BATTERIES FOR UTILITY LOAD LEVELING
P. A. Nelson and N. P. Yao 1976 22 p refs Presented at Am. Power Conf., Chicago, 20-22 Apr. 1976
(Contract W-31-109-eng-38)
(CONF-760469-3) Avail: NTIS HC A02/MF A01

A critical need for conservation is to reduce the use of dwindling oil and gas resources in electric energy generation. Leveling or peak shaving electric utility loads by means of off-peak energy storage devices would allow an orderly shift to increased utilization of base-load energy, and thereby decrease the use of oil and gas by turbine generators. The concept of energy storage by batteries is particularly attractive for electric utility applications. Areas discussed include: the technical and economic requirements of batteries for applications to electric utilities, the near-term technology for the lead-acid battery and the prospect for its use in utility applications, and the development status and the incentives for developing advanced battery technology. The Battery Energy Storage Test Facility is also briefly discussed; it will provide a test bed for advanced batteries in a utility network. ERA

N77-20580# Oak Ridge National Lab., Tenn. Energy Div.
ENGINEERING-ECONOMIC MODEL OF RESIDENTIAL ENERGY USE
E. Hirst, W. Lin, and J. Cope Jul. 1976 57 p refs
(Contract W-7405-eng-26)
(ORNL-TM-5470) Avail: NTIS HC A04/MF A01

A comprehensive engineering-economic computer model used to simulate energy use in the residential sector from 1970 to 2000 is described. The model is to provide an analytical tool with which to evaluate a variety of conservation policies, technologies, and stragegies for their impacts on residential energy use and fuel expenditures over time. The present version of the model deals with energy use at the national level for four fuels; six end uses and three housing types. Each of these fuel uses is determined for each year of the simulation as the product of: stock of occupied housing units, fraction of homes using each fuel for each end use, average annual energy requirement for each type of equipment, average thermal integrity for each housing type, and household usage behavior for each fuel and end use. Simulations of energy use from 1960 to 1974 show that the model does an excellent job of forecasting historical fuel use data in aggregate, by fuel, and by end use. ERA

N77-20583# Brookhaven National Lab., Upton, N.Y.
THE 1985 TECHNICAL COEFFICIENTS FOR INPUTS TO ENERGY TECHNOLOGIES
J. Lukachinski and R. G. Tessmer, Jr. Jun. 1976 38 p refs
(Contract E(30-1)-16)
(BNL-50532) Avail: NTIS HC A03/MF A01

Input-output technical coefficients estimated for five new energy supply and conversion technologies were incorporated into a 110-sector Energy I-O Model. The technologies are solvent refining of coal, oil shale mining and retorting, high temperature gas cooled reactor electricity generation, high BTU coal gasification, and COGAS combined-cycle electricity generation. Incorporation of seven existing energy supply and conversion technologies is also described: crude oil and gas extraction, coal mining, refined petroleum products, pipeline gas, fossil electric generation, and hydroelectric generation. Non-energy input coefficients are given in units of 1967 $/million BTU and represent the inputs in constant 1967 dollars from non-energy sectors (e.g. manufacturing, transportation, services) required per million BTU of energy production by each of these energy supply technologies. The 90 non-energy sectors included are based on the Bureau of Economic Analysis 83 sector input-output structure for 1967 with minor disaggregations. Energy input coefficients are given in units of BTU/BTU. ERA

N77-20585# Carnegie-Mellon Univ., Pittsburgh, Pa.
DESIGN AND MODELING OF SOLAR SEA POWER PLANTS BY GEOMETRIC PROGRAMMING
C. C. Wu Apr. 1976 157 p refs
(Contract E(11-1)-2895; Grant NSF GI-39114)
(COO/2895-T1) Avail: NTIS HC A08/MF A01

Geometric programming, a nonlinear optimization technique, is used to design Solar Sea Power Plants (SSPP). The conversion process is described, and the hardware necessary to implement a binary-fluid, closed-Rankine cycle is identified. Steady-state analytical models for the major components are derived. These models are then used as the constraints of a geometric program whose objective function is the minimization of a particular function of the design variables of the SSPP. A variety of problems are solved. On one extreme, they include simply the design of a minimum surface heat exchanger for a SSPP, and on another extreme the selection of the various water pipes for a given ocean site, accounting for all the hydraulic losses. ERA

N77-20589# Brookhaven National Lab., Upton, N.Y. Dept. of Applied Science.
METAL HYDRIDES AS HYDROGEN STORAGE MEDIA AND THEIR APPLICATIONS
J. J. Reilly 14 Jul. 1976 88 p refs
(Contract E(30-1)-16)
(BNL-21648) Avail: NTIS HC A05/MF A01

The four hydride systems of current interest for hydrogen storage applications are the hydrides of magnesium and certain of its alloys, iron titanium alloys, vanadium, and lanthanum pentanickel (or AB5) type alloys. Peak shaving, automotive, thermal storage and solar energy, and pumps and compressors are some of the areas of application. ERA

N77-20590# California Univ., Livermore. Lawrence Livermore Lab.
SOLAR ENERGY: L-DIVISION MISCELLANEA
R. D. Neifert 27 May 1976 11 p refs
(Contract W-7405-eng-48)
(UCID-17177) Avail: NTIS HC A02/MF A01

The capabilities that were developed within L-Division related to the use of solar energy for heating of buildings, electrical generation, and/or process heat are summarized. These capabilities primarily directed towards studies related to the Sohio Process Heat Facility project. A stand-alone data acquisition system was developed to measure instantaneous solar radiation and ambient air temperature. A compact, mobile calibration system is available to cross-calibrate solar instruments in-situ. Solar radiation data was collected and analyzed since January 1974. Several computer codes are available for parametric performance studies of process heat facilities and calculating collection efficiency for a shallow solar pond. ERA

N77-20591# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.
CENTRAL RECEIVER SOLAR THERMAL SYSTEM, PHASE 1, CPRL ITEM 10 Quarterly Progress Report
R. W. Hallet, Jr. and R. L. Gervais Apr. 1976 83 p
(Contract E(04-3)-1108)
(SAN-1108-76-2; MDC-G6382; QTPR-2) Avail: NTIS HC A05/MF A01

The dominant activities during the reporting period have involved the detailed definition of the subsystem research experiments and the design of the test articles and test facilities. Summaries of these activities are presented. Design changes to the 10-MWe pilot plant preliminary design baseline which occurred during the report period are also described. ERA

N77-20592# California Univ., Livermore. Lawrence Livermore Lab.
SOLAR INDUSTRIAL STEAM
A. F. Clark and M. F. Merriam 9 Jul. 1976 7 p refs Presented

at Sharing the Sun: Solar Technol. in the Seventies, Winnipeg, Can., 15 Aug. 1976
(Contract W-7405-eng-48)
(UCRL-77895) Avail: NTIS HC A02/MF A01

An inexpensive low concentration reflector was discussed: a cylinder of inflated plastic film, transparent on top and reflecting on the bottom; a black pipe containing water (and steam) is placed at the focal line. ERA

N77-20593# Argonne National Lab., Ill.
FUEL CELL BENEFIT ANALYSIS
Samuel H. Nelson and John P. Ackerman Jun. 1976 41 p refs
(Contract W-31-109-eng-38)
(ANL/ES-51) Avail: NTIS HC A03/MF A01

The potential benefits resulting from the commercialization of first-generation fuel cells in the early 1980s were studied. Utilization of fuel cells was assessed for electric generation, integrated energy systems, combined production of electricity and industrial process steam, and export markets. The electric utility market was further divided into new capacity for privately-owned utilities, rural electric cooperatives, and for replacement of obsolete units. In addition, the effect of a different growth rate for electricity demand was evaluated. On the basis of these evaluations, it was found that there would be substantial savings of energy and money, as well as substantial increases in exports, if first-generation fuel cells were brought to market in the early 1980s. ERA

N77-20594# Brookhaven National Lab., Upton, N.Y.
TECHNICAL AND ECONOMIC ASPECTS OF POTENTIAL US DISTRICT HEATING SYSTEMS
J. Karkheck, E. Beardsworth, and J. Powell Apr. 1976 21 p refs Presented at 11th Intersoc. Energy Conversion Eng. Conf., State Line, Nev., 12 Sep. 1976
(Contract E(30-1)-16)
(BNL-21287; Conf-760906-7) Avail: NTIS HC A02/MF A01

District heating stands as a means to conserve fossil fuel through more efficient utilization of these resources as a primary source of heat because it can supplant the application of fossil fuels to a great extent by utilizing waste heat from various sources. Of paramount interest as a source of waste heat are the steam electric generating plants, especially those powered by nuclear fission. Utilization of this by-product allows immediate cutback in fossil fuel consumption. It relieves the environment from bearing the burden of huge amounts of excess heat. It opens the supply of fossil fuels to more complex applications where these are used to greater advantage. It raises the energy conversion efficiency of these electric plants considerably and is economical. An analysis of a study of nine urban regions that collectively display a wide variation in the parameters that are the primary determinants of unit heat cost is presented.
(Author) ERA

N77-20598# California, Univ., Livermore. Lawrence Livermore Lab.
SIMPLE HOME HEATING SYSTEM (WHAT CAN BE DONE NOW)
George E. Bush 7 Jul. 1976 5 p refs Presented at Sharing the Sun, Solar Technology in the Seventies, Winnipeg, Canada, 15-20 Aug. 1976; sponsored by the Intern. Solar Energy Soc.
(Contract W-7405-eng-48)
(UCRL-77875; Conf-760821-5) Avail: NTIS HC A02/MF A01

A solar heating system was designed and built as a retrofit on an existing 1,500 square-foot (139 square meter) tract home. The system and the results of the first heating season are reported. Some comments on difficulties encountered during construction and suggestions for future research are offered. The collector is of the water trickle type, with one glazing, and 400 square-feet area. The entire design stresses low temperature operation to minimize fabrication costs. The heat storage is 1,000 gallons of water, and the design was for 53 percent solar heating over the entire year. A brief analysis of this difference between design and measured performance is presented. ERA

N77-20599# Virginia Univ., Charlottesville.
PERFORMANCE AND ANALYSIS OF SOLARIS WATER-TRICKLE SOLAR COLLECTOR
J. T. Beard, F. L. Huckstep, W. B. May, Jr., F. A. Iachetta, and L. U. Lilleleht 1976 18 p refs Presented at Sharing the Sun: Solar Technol. in the Seventies, Winnipeg, Can., 15 Aug. 1976
(Contract E(40-1)-4927)
(CONF-760821-9) Avail: NTIS HC A02/MF A01

An outdoor solar collector test facility was designed and constructed for performance evaluation of Thomason SOLARIS water-trickle solar collector panels. Two full size 1.2m x 4.9m) collector panels are tested simultaneously on each of two test stands, so that various design and operational variables are evaluated under the same ambient conditions. Results are presented to illustrate performance and comparisons relative to published results of other single and double glazed flat plate collectors. A method is developed for using performance results for design applications. Calculations illustrating the method are shown for Washington, D.C. ERA

N77-20601# California Univ., Livermore. Lawrence Livermore Lab.
SHALLOW SOLAR PONDS FOR INDUSTRIAL PROCESS HEAT: THE ERDA-SOHIO PROJECT
W. C. Dickinson, A. F. Clark, and A. Iantuono 17 Jun. 1976 26 p refs Presented at Sharing the Sun, Solar Technology in the Seventies, Winnipeg, Canada, 15-20 Aug. 1976; sponsored by the Intern. Solar Energy Soc.
(Contract W-7405-eng-48)
(UCRL-78288) Avail: NTIS HC A03/MF A01

Shallow solar ponds were developed to supply cost-competitive solar heated water for industrial use. A prototype system has been built and put into operation at the site of the Sohio Petroleum Company's new uranium mine and milling complex near Grants, New Mexico. When operational, a projected full-size system is expected to furnish approximately half of the annual site process heat requirement. A description of the physical features of shallow solar ponds is presented along with a method for analyzing pond performance. An economic analysis of the projected Sohio solar system is provided. ERA

N77-20603# General Electric Co., Philadelphia, Pa. Space Div.
TECHNOLOGY EVALUATION REPORT, COMMERCIAL BUILDINGS
Apr. 1976 192 p refs
(Contract E(11-1)-2683)
(COO-2683-76-1) Avail: NTIS HC A09/MF A01

Criteria are presented which are to be met by solar hardware for inclusion in the demonstration program. Assessments are made, based on a survey made of solar hardware manufacturers and developers, of when components, subsystems, and systems will be available for demonstration according to the technology status categories. Task outlines are provided for development activity recommended to improve available systems or develop advanced systems for later demonstration cycles. ERA

N77-20606# Brookhaven National Lab., Upton, N.Y.
TECHNICAL AND ECONOMIC FEASIBILITY OF US DISTRICT HEATING SYSTEMS USING WASTE HEAT FROM FUSION REACTORS
J. Karkheck, E. Beardsworth, and J. Powell Feb. 1976 156 p refs
(Contract E(30-1)-16)
(BNL-50516; TID-4500) Avail: NTIS HC A08/MF A01

District heating systems were shown to be economically attractive for large scale implementation in the U.S., provided suitable sources of waste heat, such as fusion reactors are available. Since fusion reactors appear to be more environmentally acceptable than fission reactors or coal steam electric plants, they could possibly be located closer to district heat load centers, which should result in substantial cost savings. Distances on the order of 20 miles from urban areas are acceptable in terms of transmission cost. Model district heating systems were designed

for nine regions in the U.S. (New York City, Paterson, N.J., Chicago, Philadelphia, Los Angeles, Baton Rouge, New Orleans, Jersey City, and Newark). The implementation and costs to be expected for district heating systems in the U.S. as a whole were also estimated. The impact of the CRT-district heat option on the U.S. energy system was evaluated. It was concluded that two additional markets exist for district heating, those of process heat and air conditioning. ERA

N77-20607# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Energiewandlung und Elektrische Antriebe.

THE CYLINDRICAL PARABOLIC MIRROR AS REFLECTOR FOR SOLAR COLLECTORS. EFFICIENCIES AND OPTIMIZATION

Rainer Koehne 27 Oct. 1976 36 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-365)

(DLR-FB-76-55) Avail: NTIS HC A03/MF A01 DFVLR, Cologne DM 15.90

After introducing the concentration ratio and intercept factor of focusing collectors with parabolic cylinder mirrors, the energy balance equations were derived to determine the efficiencies under steady state conditions. The components of the collector were varied and optimized with respect to maximum efficiency. The dynamic behavior of the collector was calculated and the average efficiencies compared with the efficiencies in the steady state condition. Author (ESA)

N77-20608# Engelhard Minerals and Chemicals Corp., Union, N. J.

EPA VAN OPERATIONAL MANUAL

Niels E. Scholer Aug. 1976 64 p

(Contract EPA-68-02-1482)

(PB-259177/4; EPA-600/9-76-020) Avail: NTIS HC A04/MF A01 CSCL 13A

The manual generally describes the EPA Van, and discusses both its energy control system and Van operation. The manual includes instructions for the Van's transportation, setup, safety, troubleshooting, and maintenance. The Van is a mobile research unit, designed for testing in various parts of the United States. Its unique energy supply system includes fuel cells, a solar energy collector, a heat pump, and catalytic appliances. An energy control system optimizes the energy consumed by the integrated system. GRA

N77-20610# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.

CLEAN FUELS FROM AGRICULTURAL AND FORESTRY WASTES Final Report, Jun. 1974 - Mar. 1975

J. W. Tatom and A. R. Colcord Apr. 1976 118 p refs

(Contract EPA-68-02-1485)

(PB-259956/1; EPA-600/2-76-090) Avail: NTIS HC A06/MF A01 CSCL 13B

The operating parameters for a mobile waste conversion system based on the Georgia Tech Engineering Experiment Station's partial oxidation pyrolysis process was investigated. The *combination of parameters producing the most char and oil and* the least gas from agricultural and forestry wastes were determined. The dominant influence of air/feed on char and oil yields, and the desirability of low values of this ratio were indicated. A preliminary design of a 200 ton/day mobile pyrolysis system for conversion of agricultural and forestry wastes into clean fuels was made and a simplified economic analysis conducted. GRA

N77-20612# Air Force Academy, Colo.

THE SPATIAL CHARACTERISTICS OF THREE WYOMING FUELS Final Report

Melvin M. Vuk Jun. 1976 60 p refs

(AD-A030873; USAFA-TR-76-15) Avail: NTIS HC A04/MF A01 CSCL 05/3

This paper examines the development patterns of Wyoming's petroleum, natural gas, and coal resources. The emphasis is on the location of the resources and their movements. The author suggests, through the use of a limited number of measurements, that the spatial characteristics of Wyoming fuels have displayed a mutable nature. It is posited that an examination of Wyoming's past experience might provide the state with a better understanding of the state's current position as a major fuel supplier. Author (GRA)

N77-20613# Kentucky Univ., Lexington. Inst. for Mining and Minerals Research.

PRODUCTION OF AMMONIA USING COAL AS A SOURCE OF HYDROGEN Annual Report

W. L. Laukhuf (Louisville Univ.) Oct. 1976 54 p

(PB-259388/7; IMMR12-PD10-76) Avail: NTIS HC A04/MF A01 CSCL 07A

The economic feasibility of using a coal gasifier as the required hydrogen production step in an ammonia synthesis plant was investigated. If such a technique was found to be feasible, large quantities of natural gas (the normal hydrogen feedstock for ammonia synthesis) could be released for other uses. A thermodynamic equilibrium model was used to predict the amount of hydrogen produced from a high-sulfur Western Kentucky coal feedstock for several coal gasification schemes. The hydrogen produced was then used to synthesize 1,200 tons of ammonia per day for economic comparison purposes. At the present, ammonia is selling for $200 per ton and upwards, based on a *natural gas price of $1.00-$1.50 per million* Btu. *Assuming a* coal cost of $20 per ton, it was estimated that several existing gasifiers could produce sufficient hydrogen so that ammonia processed in an integrated coal gasification-ammonia synthesis plant would cost less to produce than the current selling price. Costs to produce the ammonia were as low as $122 per ton. It was also found that other gasifiers, with only slight modifications in operating conditions, could also produce ammonia for less than $200 per ton. Problem areas requiring further study were identified for such an integrated plant. GRA

N77-20616# Dow Chemical Co., Midland, Mich.

SOLAR ENERGY SUBSYSTEMS EMPLOYING ISOTHERMAL HEAT SINK MATERIALS Final Project Report, 18 Sep. 1974 - 18 Mar. 1976

George A. Lane, John S. Best, E. Colin Clarke, David N. Glew, George C. Karris, Steven W. Quigley, and Harold E. Rossow Mar. 1976 65 p refs Sponsored in part by ERDA

(Contract NSF C-906)

(PB-258738/4; NSF/RANN/SE/C-906/FR/76/1; NSF/RA-760202) Avail: NTIS HC A04/MF A01 CSCL 10C

Several encapsulation methods were studied: microencapsulation, encapsulation of powders and granules, and macroencapsulation. Microencapsulation of $CaCl2{\cdot}6H2O$ in polyester resin has been successful, and small wall, floor, and ceiling panels have been prepared and tested. Macroencapsulation in plastic film containers appears promising for hot air systems. Preliminary economic analysis studies of heating systems based on heat-of-fusion storage materials have shown several promising approaches. GRA

N77-20617# Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

EVALUATION OF THE SOLAR HEATING SYSTEM IN THE LOF RESIDENCE, DENVER, COLORADO Final Project Report, Jul. 1974 - 30 Nov. 1975

John C. Ward and George O. G. Lof Apr. 1976 64 p refs Submitted for publication

(Grant NSF AER-74-08566)

(PB-258845/7; NSF/RANN/SE/GI-143921/FR/76/1; NSF/RA-760224) Avail: NTIS HC A04/MF A01 CSCL 13A

The long-term performance of a residential solar air heating system was determined for a system which has been operating continuously since 1975 with no maintenance. The performance of this system was determined so that changes in performance occurring over a period of 15 years could be evaluated. GRA

N77-20618# Houston Univ., Tex. Dept. of Mechanical Engineering.

THE EVALUATION OF SURFACE GEOMETRY MODIFICATION TO IMPROVE THE DIRECTIONAL SELECTIVITY OF

SOLAR ENERGY COLLECTORS Final Report, 1 Dec. 1973 - 31 Dec. 1975
John R. Howell and Richard B. Bannerot 31 May 1976 125 p refs
(Grant NSF AER-73-03357-A01)
(PB-258848/1; UHME/SOL/11; NSF/AER-73-03357/A01/FR/76/1; NSF/RA-760200) Avail: NTIS HC A06/MF A01 CSCL 13A

The radiative performance of directionally selective collectors composed of parallel, east-west oriented, stationary, trapezoidal grooves was examined. Computer simulations for their radiative performance were developed. Experimental models of the collector geometry were constructed and tested. The radiative performance of these models was compared to that predicted, with good agreement achieved, verifying the computer simulations. Computer simulations of radiative behavior with direct beam, non-direct, and various combinations of insolation are presented. GRA

N77-20622# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.
OPTIMIZATION AND CHARACTERISTICS OF A SAILWING WINDMILL ROTOR Final Report, 1 Feb. 1975 - 31 Jan. 1976
Mark D. Maughmer Mar. 1976 90 p refs
(Grant NSF GI-41891)
(PB-259898/5; AMS-1297; NSF/RA-76021) Avail: NTIS HC A05/MF A01 CSCL 10A

A detailed accounting of the development and operational techniques of the Princeton moving-vehicle windmill testing facility is discussed. A complete documentation of the performance build-up of a 12 ft. diameter, two-bladed sailwing rotor is presented. An examination of an exploratory research effort directed toward using a small, first-stage, coaxial rotor to augment windmill performance is included. The results and conclusions of an extensive wind-tunnel test program aimed at a quantitative determination of the aerodynamic penalties associated with numerous simplifications of the basic double-membraned sailwing cross-section are considered. GRA

N77-20639# International Flame Research Foundation, Ijmuiden (Netherlands).
BURNER CRITERIA FOR NOx CONTROL. VOLUME 1: INFLUENCE OF BURNER VARIABLES ON NOx IN PULVERIZED COAL FLAMES Final Report, Jun. 1971 - Jun. 1974
M. P. Heap, T. M. Lowes, R. Walmsley, H. Bartelds, and P. LeVaguerese Mar. 1976 171 p refs
(Contract EPA-68-02-0202)
(PB-259911/6; EPA-600/2-76-061A-Vol-1) Avail: NTIS HC A08/MF A01 CSCL 13B

NO formation can be controlled by optimizing burner design parameters because its rate of formation depends on the detailed mixing history of the fuel, combustion air, and recirculating combustion products. The same parameters also dictate such flame characteristics as stability, length, and luminosity. An explanation of the influence of burner parameters on pulverized coal flames is based on two assumptions: the most significant factor of the total emission is fuel NO, and the emission variation depends on the fate of the volatile nitrogen compounds. Fuel NO formation can be reduced by ensuring that the volatile nitrogen compounds react under oxygen deficient conditions. Maximum emissions occur with radial fuel injects because the coal is rapidly mixed with the total air supply and hot recirculating products. GRA

N77-20656# Fluor Engineers and Constructors, Inc., Los Angeles, Calif.
ECONOMICS OF A FREEZE DESALTING PROCESS USING COLD SEAWATER EFFLUENT OF A LIQUID NATURAL GAS PLANT Final Report
Mar. 1976 61 p
(Contract DI-14-30-3313)
(PB-259272/3; W77-00635; OWRT-S-76/52) Avail: NTIS HC A04/MF A01 CSCL 07A

The technical feasibility and economic attractiveness of using cold sea water from an LNG plant in an adjacent sea water freeze desalting plant are discussed, along with the degree to which this would improve the environmental impact of the LNG plant. The basis for comparison is a secondary refrigerant process, the AVCO crystallex process. GRA

N77-20676# Center for the Environment and Man, Inc., Hartford, Conn.
REGIONAL VARIATIONS OF SOLAR RADIATION WITH APPLICATION TO SOLAR ENERGY SYSTEM DESIGN, USER'S MANUAL
Marshall A. Atwater and John T. Ball Jul. 1976 60 p refs
(Grant NSF AER-75-14536)
(PB-259378/8; CEM-4185-550b; NSF/RA-760197) Avail: NTIS HC A04/MF A01 CSCL 04A

Derived data consisting of hourly values of total and direct-beam solar radiation, temperature, dew point, wind speed, wind direction, and infrared radiation are stored on magnetic tape for use in the design and analysis of solar heating (cooling) systems. The radiation data are derived from surface meteorological observations using a radiation model. GRA

N77-20879# Fusion Systems Corp., Rockville, Md.
ENHANCED ENERGY UTILIZATION FROM A CONTROLLED THERMONUCLEAR FUSION REACTOR Final Report
F. R. Scott Sep. 1976 112 p refs Sponsored by Elec. Power Res. Inst.
(PB-260653/1; EPRI-ER-248) Avail: NTIS HC A06/MF A01 CSCL 18A

Applications of fusion energy to synthetic fuel production, chemical manufacturing, and materials processing were investigated. Computer codes were developed to permit quantitative calculation of the enhancement of energy utilization efficiency for multipurpose Tokamak and mirror reactors. Production of synthetic portable fuels such as hydrogen or methane by neutron radiolysis is identified as the most important near term application. Fuel production offers large advantages for low Q, high circulating power systems such as mirrors, small Tokamaks, theta pinches, and laser pellet reactors. It offers little advantage to high Q, high thermal efficiency systems typified by large Tokamaks. GRA

N77-20880# Brueckner (K. A.) and Associates, Inc., La Jolla, Calif.
ASSESSMENT OF LASER-DRIVEN FUSION Final Report
F. R. Scott Sep. 1976 162 p refs Sponsored by Elec. Power Res. Inst.
(PB-260691/1; EPRI-ER-203) Avail: NTIS HC A08/MF A01 CSCL 18A

The national fusion program as of March 1976 is described. Included are summaries by the Laser Fusion Advisory Committee and the Working Group. Scientific and technical evaluations of the national laser fusion program are presented in four parts: an overall assessment, engineering feasibility, scientific feasibility, and site visits. GRA

N77-20886*# Magnetic Corp. of America, Waltham, Mass. Technical Report, Sep. 1975 - Dec. 1976
DESIGN STUDY OF SUPERCONDUCTING MAGNETS FOR A COMBUSTION MAGNETOHYDRODYNAMIC (MHD) GENERATOR
Richard J. Thome and John W. Ayers Mar. 1977 255 p refs
(Contract NAS3-19885)
(NASA-CR-135178) Avail: NTIS HC A12/MF A01 CSCL 20I

Design trade off studies for 13 different superconducting magnet systems were carried out. Based on these results, preliminary design characteristics were prepared for several superconducting magnet systems suitable for use with a combustion driven MHD generator. Each magnet generates a field level of 8 T in a volume 1.524 m (60 in.) long with a cross section 0.254 m x 0.254 m (10 in. x 10 in.) at the inlet and 0.406 m x .406 m (16 in. x 16 in.) at the outlet. The first design involves a racetrack coil geometry intended for operation at 4.2 K; the second design uses a racetrack geometry at 2.0 K; and the third design utilizes a rectangular saddle geometry at 4.2 K. Each case was oriented differently in terms of MHD channel axis and main field direction relative to gravity in order

to evaluate fabrication ease. All cases were designed such that the system could be disassembled to allow for alteration of field gradient in the MHD channel by changing the angle between coils. Preliminary design characteristics and assembly drawings were generated for each case. Author

N77-20931# Brookhaven National Lab., Upton, N.Y.
DYNAMICS SYSTEMS ANALYSIS OF THE RELATION BETWEEN ENERGY AND THE ECONOMY
David L. Behling, Jr. Jul. 1976 17 p refs Presented at 13th Inst. of Elec. and Electron. Eng. Computer Soc. Intern. Conf., Washington, D. C., 7 Sep. 1976
(Contract E(30-1)-16)
(BNL-21667; Conf-760933-1) Avail: NTIS HC A02/MF A01

An integrated system of energy and economic models is developed for use in assessing the energy and economic impact of a wide range of government energy policies. The system incorporates detailed engineering information for a wide range of potential new energy technologies and relates implementation levels of these new technologies to the structure of the energy sector and to such economic aggregates as the level and rates of change of income, output, employment, and prices. ERA

N77-20957# Air Force Civil Engineering Center, Tyndall AFB, Fla.
WASTE POL DISPOSAL THROUGH ENERGY RECOVERY Final Report, 1 Feb. 1974 - 1 Jan. 1976
Patrick T. Fink and Jerry W. Jackson Jun. 1976 61 p refs
(AD-A031783; AFCEC-TR-76-2) Avail: NTIS HC A04/MF A01 CSCL 13/2

In order to investigate the practical feasibility of combusting waste POLS (petroleum, oil, lubricants) in heating plant boilers, a field testing program was undertaken to obtain actual performance and air pollution data. Since most Air Force heating plants Utilize FS-Grade (No 2, No 5) fuel or natural gas as a primary fuel source, emphasis was placed on the installation of waste POL systems at three separate Air Force bases employing the use of these fuels. Various percentages of waste POL were burned in the test boilers with the corresponding fluctuation in stack emissions documented. Results of this study are reported in terms of quantity and hours of waste POL burned per installation, operational procedures, air pollution data, and recommendations for the safe installation of a compatible waste POL system.
Author (GRA)

N77-20972# National Academy of Sciences - National Research Council, Washington, D. C. Ad Hoc Committee on Technology of Drilling for Energy Resources.
DRILLING FOR ENERGY RESOURCES
1976 84 p refs
(Contract NSF C-310)
(PB-259206/1; NSF/RA-760195) Avail: NTIS HC A05/MF A01 CSCL 08I

Current drilling technology was examined, and areas where additional research and development might significantly increase drilling rates and capabilities were suggested. A strategy for improving drilling technology was investigated. Emphasis is on the equipment and techniques used to drill for petroleum, natural gas, and geothermal resources. Author

N77-21126*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
STATUS OF GOLDSTONE SOLAR ENERGY SYSTEM STUDY OF THE FIRST GOLDSTONE ENERGY PROJECT **c44**
F. L. Lansing *In its* The Deep Space Network 15 Apr. 1977 p 120-140 refs
Avail: NTIS HC A11/MF A01 CSCL 10A

The results reached by the DSN engineering section and private consultants in the review of the initial plan of the Golstone Energy Project are summarized. The main objectives were in the areas of energy conservation and the application of solar-driven systems for power and hydrogen generation. This summary will provide background data for management planning decisions both to the DSN engineering section and other organizations planning a similar program. The review showed that an add-on solar driven absorption refrigeration unit with its associated changes to the existing system was not cost-effective, having a payback period of 29 years. Similar economically unattractive results were found for both a solar-hydrogen and a wind-hydrogen generation plant. However, cutting the hydrogen generation linkage from this plant improved its economic feasibility. Author

N77-21136*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SOLAR POWER SATELLITE: ANALYSIS OF ALTERNATIVES FOR TRANSPORTING MATERIAL TO GEOSYNCHRONOUS ORBIT
William J. Graff and C. J. Huang 1976 265 p refs Prepared in cooperation with Houston Univ.
(Grant NGT-44-005-114)
(NASA-TM-X-74680) Avail: NTIS HC A12/MF A01 CSCL 22A

A systems design study of the alternative methods and relative merits of various approaches to transporting and assembling a solar power satellite in geosynchronous orbit was conducted. State of the art alternatives for chemical and electrical interorbital propulsion were studied, and several possible scenarios for construction were proposed. Author

N77-21204# Central Technical Inst. TNC, Apeldoorn (Netherlands).
HYDROGEN COMBUSTION. PART 1: INVESTIGATION OF HYDROGEN FLAME CONTROL METHODS [WATERSTOFVERBRANDING. DEEL 1: ONDERZOEK NAAR BEVEILIGINGSMETHODEN VAN WATERSTOFVLAMMEN]
J. DeBoer and J. P. A. VanHeteren Mar. 1975 15 p In DUTCH
(CTI-IV-75-C1449) Avail: NTIS HC A02/MF A01

Measurements were carried out on natural gas, H2S and H2 flames in order to determine the possibilities of flame control. The following flame detection principles were tested: optical detection, flame ionization detection, and thermal detection. UV control is possible for natural gas and H2S. Visible detection is applicable only to H2S. IR detection is possible for natural gas, H2S, and, especially, for H2. Flame ionization is applicable only to natural gas. Thermal control is feasible for natural gas and H2. ESA

N77-21257# Federal Energy Administration, Washington, D. C. Office of Energy Information and Analysis.
PROJECTED NATURAL GAS CURTAILMENTS AND POTENTIAL NEEDS FOR ADDITIONAL ALTERNATE FUELS, 1976-1977 HEATING SEASON
Albert Bass Nov. 1976 76 p refs
(PB-260535/0; FEA/B-76/463) Avail: NTIS HC A05/MF A01 CSCL 21D

Impact was reflected in the availability of alternate fuels or emergency gas volumes which can be substituted for natural gas in the event of a shortage. The monthly data enabled the determination of additional gas curtailments projected for the 1976-1977 heating season. All projections and findings in the report related to deliveries, curtailments, and needs for alternate fuels during the 1976-1977 winter are based on assumptions of normal winter weather conditions. GRA

N77-21325# Los Alamos Scientific Lab., N. Mex.
ULTRA HIGH-CURRENT SUPERCONDUCTING CABLES FOR A 2.2-TESLA, 300-KILOJOULE ENERGY STORAGE MAGNET
Gilbert A. Miranda, R. Rhodenizer, P. Rackov, W. F. B. Punchard, and T. A. DeWinter 17 Aug. 1976 5 p refs Presented at Applied Superconductivity Conf., Stanford, Calif., 17 Aug. 1976
(Contract W-7405-eng-36)
(LA-UR-76-1809; Conf-760829-20) Avail: NTIS HC A02/MF A01

These 2.2-T, 300-kJ magnets are to operate at 10 to 12 kA with a safety factor in critical current of about 50 percent at 10 kA. The conductor exhibits low losses in addition to being stable. A flat conductor was designed using 1224 copper-matrix, monofilament wires combined in two stages of cabling followed by two stages of flat braiding. Two of these conductors were constructed, one with wire already on hand and the second

using wire made specifically for this application. Two rectangular conductors were using 315 and 319 mixed-matrix multifilament wires combined in three stages of cabling followed by compaction in a Turk's head. The maximum transport current capabilities of these cables were measured in hairpin shaped samples with the straight section under test in perpendicularly applied fields. ERA

N77-21331# Brookhaven National Lab., Upton, N.Y.
BROOKHAVEN SUPERCONDUCTING CABLE TEST FACILITY
E. B. Forsyth and R. J. Gibbs 17 Aug. 1976 5 p refs Presented at Applied Superconductivity Conf., Stanford, Calif., 17 Aug. 1976
(Contract E(30-1)-16)
(BNL-21780; Conf-760829-27) Avail: NTIS HC A02/MF A01

Construction has started on an outdoor testing station for flexible ac superconducting power transmission cables. The permanent equipment includes a 500 W supercritical helium refrigerator using a screw compressor and multistage turbine expanders. Helium storage for 250,000 cu ft of helium at 250 psi is provided. Initially, the cables will be tested in a horizontal cryostat some 250 ft long. The cable conductor will be energized by current transformers, initially at about 4 kA and later up to fault levels of 40 kA. ERA

N77-21332# Brookhaven National Lab., Upton, N.Y.
STUDIES OF HELICAL CONDUCTOR MODELS FOR SUPERCONDUCTING AC POWER TRANSMISSION
M. Garber, T. Barber, and G. Morgan 1976 4 p refs Presented at Appl. Superconductivity Conf., Stanford, Calif., 17-20 Aug. 1976 Sponsored in part by Elec. Power Res. Inst. and NSF
(Contract E(30-1)-16)
(BNL-21784; Conf-760829-28) Avail: NTIS HC A02/MF A01

In the BNL concept of a superconducting ac power transmission cable the conductors are made of Nb3Sn tapes wound helically on cylinders. Recently, it was decided to make each conductor in the form of a double layer winding in which the layers are of opposite helicity. This reduces undesirable consequences of axial flux generation. After reviewing the considerations which lead to the double helix conductor, experiments with short models (0.8 m long) are described. Results are given for ac loss and quench current measurements. Quench currents in excess of 3,400 A/cm rms have been obtained. Ac losses are higher than those of short samples of the tapes used but are acceptable. Loss calculations for the double helix configuration are discussed. ERA

N77-21356# Energy Development Associates, Madison Heights, Mich.
EVALUATION OF A 1 KWH ZINC CHLORIDE BATTERY SYSTEM Interim Report
P. C. Symons, M. J. Hammond, and J. Birk Sep. 1976 62 p refs Sponsored by Electric Power Research Inst.
(PB-260683/8; EPRI-EM-249) Avail: NTIS HC A04/MF A01 CSCL 10C

A 1kWh zinc-chlorine battery was constructed and evaluated for 100 cycles to determine the technical feasibility of this battery system for utility application. The battery was tested under operating conditions appropriate to the peaking application--approximately a 4 hour charge, 4 hour discharge cycle. The battery system uses zinc and chlorine as the active electrode materials, employs an aqueous circulating electrolyte, and is operated near ambient temperature. The chlorine is stored external to the battery as chlorine hydrate, a frozen ice-like material. The high electrochemical energy efficiency is consistent with the goals for this application. GRA

N77-21467*# Lockheed-California Co., Burbank.
A 100-kW METAL WIND TURBINE BLADE BASIC DATA, LOADS AND STRESS ANALYSIS Final Report
A. W. Cherritt and J. A. Gaidelis Jun. 1975 241 p ref
(Contract NAS3-19235)
(NASA-CR-134956; LR-27153) Avail: NTIS HC A11/MF A01 CSCL 13M

A rotor loads computer program was used to define the steady state and cyclic loads acting on 60 ft long metal blades designed for the ERDA/NASA 100 kW wind turbine. Blade load and stress analysis used to support the structural design are presented. For the loading conditions examined, the metal blades are structurally adequate for use, within the normal operating range, as part of the wind turbine system. Author

N77-21468*# Lockheed-California Co., Burbank.
A 100-kW WIND TURBINE BLADE DYNAMICS ANALYSIS, WEIGHT-BALANCE, AND STRUCTURAL TEST RESULTS Final Report
W. D. Anderson Jun. 1975 102 p refs
(Contract NAS3-19235)
(NASA-CR-134957; LR-27230) Avail: NTIS HC A06/MF A01 CSCL 13M

The results of dynamic analyses, weight and balance tests, static stiffness tests, and structural vibration tests on the 60-foot-long metal blades for the ERDA-NASA 100-kW wind turbine are presented. The metal blades are shown to be free from structural or dynamic resonance at the wind turbine design speed. Aeroelastic instabilities are unlikely to occur within the normal operating range of the wind turbine. Author

N77-21532# California Univ., Berkeley. Lawrence Berkeley Lab. Div. of Energy and Environment.
METHODS FOR GEOTHERMAL RESERVOIR DETECTION EMPHASIZING SUBMERGED ENVIRONMENTS
Charles W. Case and Pat Wilde 21 May 1976 77 p refs
(Contract W-7405-eng-48)
(LBL-4495) Avail: NTIS HC A05/MF A01

A logical progression of specific geologic, geochemical, and geophysical exploration techniques for detecting geothermal reservoirs in various geologic environments with emphasis on submerged lands was developed. Various exploration techniques which can be used to develop specific information in geothermal areas were discussed. The specific geologic situation will control the exploration criterion to be used for reservoir detection. General guidelines are established which may be of use in evaluating such a program, but the optimum approach will vary with each situation. ERA

N77-21547*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
OPERATIONS RESEARCH INVESTIGATIONS OF SATELLITE POWER STATIONS
John W. Cole and John L. Ballard (Nebraska Univ., Lincoln) Dec. 1976 41 p refs
(NASA-TM-X-73372) Avail: NTIS HC A03/MF A01 CSCL 10A

A systems model reflecting the design concepts of Satellite Power Stations (SPS) was developed. The model is of sufficient scope to include the interrelationships of the following major design parameters: the transportation to and between orbits; assembly of the SPS; and maintenance of the SPS. The systems model is composed of a set of equations that are nonlinear with respect to the system parameters and decision variables. The model determines a figure of merit from which alternative concepts concerning transportation, assembly, and maintenance of satellite power stations are studied. A hybrid optimization model was developed to optimize the system's decision variables. The optimization model consists of a random search procedure and the optimal-steepest descent method. A FORTRAN computer program was developed to enable the user to optimize nonlinear functions using the model. Specifically, the computer program was used to optimize Satellite Power Station system components. Author

N77-21549*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
RESULTS OF BASELINE TESTS OF THE EVA METRO SEDAN, CITI-CAR, JET INDUSTRIES ELECTRA-VAN, CDA TOWN CAR, AND OTIS P-500 VAN
Francis J. Stenger, John M. Bozek, and Richard F. Soltis Oct. 1976 78 p
(Contract E(49-28)-1011)

(NASA-TM-X-73638; E-9140) Avail: NTIS HC A05/MF A01 CSCL 10B

Five electric vehicles were tested at vehicle test tracks using the SAE. The tests provide range data at steady speeds and for several driving cycles. Most tests were conducted with lead-acid traction batteries. The Otis Van and the Copper Electric Town Car were also tested with lead-acid and nickel-zinc batteries. The tests showed a range increase of from 82 to 101 percent depending on vehicle, speed, and test cycle. Author

N77-21552# Miami Univ., Coral Gables, Fla.
FIRST WORLD HYDROGEN ENERGY CONFERENCE PROCEEDINGS, VOLUME 1
T. Nejat Veziroglu, ed. Mar. 1976 744 p refs Conf. proc. held at Miami Beach, Fla., 1-3 Mar. 1976 Sponsored in part by ERDA 3 Vol.
Avail: NTIS HC A99/MF A01

Conference preceedings are presented on various methods to produce hydrogen energy, using solar radiation, nuclear reactors, chemical reactions, water splitting, and coal gasification.

N77-21553# Kernforschungsanlage, Juelich (West Germany).
HYDROGEN PRODUCTION PROCESS BY MEANS OF NUCLEAR ENERGY
R. E. Harth and B. Hoehlein *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 15 p refs

Avail: NTIS HC A99/MF A01

The transfer of heat from a nuclear HTGR into a steam reforming plant is considered. The essential problems of such a steam reforming process were studied in a pilot plant EVA, which consists of one single reforming tube with industrial standard dimensions. The heat required for the endothermic process is transferred to the reforming tube by helium flowing under thermodynamic conditions comparable to those prevailing at the nuclear reactor core outlet. Author

N77-21558# Institute of Gas Technology, Chicago, Ill.
COMPETITIVELY PRICED HYDROGEN VIA HIGH-EFFICIENCY NUCLEAR ELECTROLYSIS
W. J. D. Escher and T. D. Donakowski *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 20 p refs
Avail: NTIS HC A99/MF A01

A fully dedicated nuclear electrolytic, hydrogen production facility, based on advanced technology, was synthesized and assessed at the conceptual level. The facility integrates (1) an HTGR operating a binary shaftpower extraction cycle at 980 C (1800 F) top temperature, (2) direct dc electricity generation via acyclic generators, and (3) high current density, high pressure electrolyzers based on the solid polymer electrolyte approach. All subsystems are close-coupled and optimally interfaced. Pipeline pressure hydrogen and coproduct oxygen are produced at 6,900 kPa (1,000 psi). Author

N77-21562# Houston Univ., Tex. Solar Energy Lab.
SOLAR TOWER CHARACTERISTICS
A. F. Hildebrandt and L. L. Vant-Hull *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 12 p refs
Avail: NTIS HC A99/MF A01

The solar tower (or central receiver) studies have shown technical and economic feasibility for large-scale collection and conversion of solar beam radiation. The base line design at present is a 100 MWe unit with six hours of thermal storage. This requires a 1.5 km x 1.8 km array of heliostats with a steam boiler atop a 330 meter tower. A major advantage of the solar tower concept is that high temperatures (1300 K) are attainable at the receiver without excessive reradiation or convection losses and without the use of selective surfaces. This is possible because optical concentration ratios in excess of 1,000 can be achieved using a multiplicity of large, flat mirrors which can be made economically. The design, which utilizes 6.1 m octagonal mirrors assembled from eight triangular facets, allows partial focusing and even higher concentration. Author

N77-21564# Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.
DESIGN OF AN OCEAN THERMAL ENERGY PLANT SHIP TO PRODUCE AMMONIA VIA HYDROGEN
G. L. Dugger and E. J. Francis *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 38 p refs

Avail: NTIS HC A99/MF A01

A baseline design was developed for a 100-MWe ocean thermal energy conversion plant ship that would produce 313 tons per day of ammonia. The cost estimates for this design were extrapolated to 500 MWe plants to produce ammonia (for fertilizers and chemicals) or liquid hydrogen for shipment to the U.S. It was surmised that ammonia will be producible at competitive cost by 1982-85 with reasonable financing arrangements. This would conserve supplies of natural gas or other fossil fuels now used to produce ammonia on shore. Author

N77-21565# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.
SYNTHETIC FUELS FROM SOLID WASTES AND SOLAR ENERGY
M. J. Antal, Jr., R. C. Feber (Los Alamos Scientific Lab., N. Mex.), and M. C. Tinkle (Los Alamos Scientific Lab., N. Mex.) *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 21 p refs

Avail: NTIS HC A99/MF A01

The use of solar process heat for the gasification of organic solid wastes and the production of hydrogen is examined. The hydrogen production potential of solid wastes is calculated, and two gasification processes are discussed and analyzed in detail. Economic projections are favorable. Author

N77-21566# Institute of Gas Technology, Chicago, Ill.
THE MANUFACTURE OF HYDROGEN FROM COAL
C. L. Tsaros, J. L. Arora, and K. B. Burnham *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 24 p refs
Avail: NTIS HC A99/MF A01

As part of a study for the conversion of coal to fluid fuels, three process designs were developed for the conversion of Montana subbituminous coal to hydrogen based on three different gasifier technologies: (1) Koppers-Totzek suspension gasification, (2) U-GAS fluidized-bed gasification, and (3) fluidized steam-iron process. For comparison with methane from coal, a fourth design, based on the HYGAS Process, was prepared. Nominal plant capacities are 250 billion Btu/day of product gas. Overall plant efficiencies for conversion of coal to major gaseous products plus by-products are: Koppers-Totzek 57.0%, U-GAS 66.4%, steam-iron 62.6% (includes 18% by-product electricity), and HYGAS 74.0%. Product liquefaction requirements are presented. Capital and operating costs (mid-1974) are presented for U-GAS and HYGAS. Author

N77-21567# Koppers Co., Inc., Pittsburgh, Pa.
THE K-T PROCESS: KOPPERS COMMERCIALLY PROVEN COAL AND MULTI-FUEL GASIFIER FOR SYNTHETIC GAS PRODUCTION IN THE CHEMICAL AND FERTILIZER INDUSTRIES
R. Wintrell *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 28 p

Avail: NTIS HC A99/MF A01

The K-T gasification process is discussed. The process gasifies the complete range of solid, liquid, and gaseous hydrocarbon fuels. The process from coal grinding through drying and pulverization, to classification, storage and final transfer to storage and feed bins at the gasifier is described. From the feed bins, the process is examined through the screw feeders to fuel entrainment after the mixing head and transfer to the burner. The necessary safety and control precautions are outlined. Within the gasifier, the thermal and equilibrium reactions, together with the benefits of high temperature operation on the final gas composition, are discussed. After exit from the gasifier, gas cooling and recovery of the sensible heat in the gas are proven to be necessary to maintain high process efficiencies. Author

N77-21568# General Atomic Co., San Diego, Calif.
HYDROGEN PRODUCTION FROM COAL USING A NUCLEAR HEAT SOURCE
R. N. Quade *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 14 p refs

Avail: NTIS HC A99/MF A01

A strong candidate for hydrogen production in the intermediate time frame of 1985 to 1995 is a coal-based process using a high-temperature gas-cooled reactor (HTGR) as a heat source. Expected process efficiencies in the range of 60 to 70% are considerably higher than all other hydrogen production processes except steam reforming of a natural gas - a feedstock which may not be available in large quantities in this time frame. The process involves the preparation of a coal liquid, hydrogasification of that liquid, and steam reforming of the resulting gaseous or light liquid product. Bench-scale experimental work on the hydrogasification of coal liquids is being carried out. A study showing process efficiency and cost of hydrogen vs nuclear reactor core outlet temperature was completed, and shows diminishing returns at process temperatures above about 1500 F. Author

N77-21572# Technische Hochschule, Aachen (West Germany). Lehrstuhl fuer Technische Thermodynamik.
FEASIBILITY STUDIES OF CHEMICAL REACTIONS FOR THERMOCHEMICAL WATER SPLITTING CYCLES OF THE IRON-CHLORINE-, IRON-SULFUR- AND MANGANESE-SULFUR FAMILIES
K. F. Knoche, H. Cremer, G. Steinborn, and W. Schneider *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 46 p refs

Avail: NTIS HC A99/MF A01

The number of chemical reactions in water splitting cycles of the iron-chlorine, iron-sulfur, and manganese-sulfur families is quite high from a thermodynamic point of view. Applying chemical engineering criteria to the reactions allows the cancelling of unfavorable steps. The remaining reactions can be systemized to typical groups. Experimental results of these groups of reactions are presented, depending on temperature, ratio of reactants, and reaction performance. The results are discussed with respect to the performance of the chemical reactions in water splitting cycles. Author

N77-21574# Direction des Etudes et Techniques Nouvelles (France).
THERMODYNAMICS OF THERMOCHEMICAL WATER DECOMPOSITION PROCESSES
B. Esteve, A. Lecoanet, and J. P. Roncato *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 22 p refs
Avail: NTIS HC A99/MF A01

Thermochemical and electrolytic methods of hydrolysis are subject to the same theoretical limits, and the choice between them will depend only on the importance of irreversibilities related to their practical use. The irreversibilities of thermochemical processes have thermal, chemical, and mechanical origins. In the case of optimal organization of the circulation of chemicals as well as of matching with a nuclear reactor, a very general estimation of losses of thermal origin shows the considerable influence of the characteristics of the reactions and compounds involved; for average values of these characteristics, it seems that the thermal efficiencies of thermochemical methods are close to those of electric generating plants using the same heat sources. Results of the thermodynamic study are discouraging for the use of thermochemical methods. Only automatic computer analysis permits the determination of cycles which are competitive with electrolysis. Author

N77-21575# Wisconsin Univ., Madison. Dept. of Chemical Engineering.
DISCOVERY OF REACTION SEQUENCES FOR THERMOCHEMICAL WATER SPLITTING
D. May and D. F. Rudd *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 28 p refs

Avail: NTIS HC A99/MF A01

Methods for the synthesis of reaction cycles to decompose water are described. Stoichiometry and thermodynamics, the necessary conditions for every reaction, are the foundation of the proposed approach. Author

N77-21576# Tokyo Univ. (Japan). Dept. of Chemical Engineering.
EFFECTIVE CONVERSION PROCESSES BETWEEN THERMAL AND CHEMICAL ENERGIES: THERMODYNAMIC STUDY OF MULTISTEP WATER DECOMPOSITION PROCESSES
Kunio Yoshida and Hideo Kameyama *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 16 p refs
Avail: NTIS HC A99/MF A01

A systematic search method for thermodynamically feasible multistep processes and evaluation procedures is described, both from the thermodynamic point of view by introducing the concept of exergie, and from the technical point of view, based on the overall thermal efficiency. Author

N77-21578*# Kentucky Univ., Lexington. College of Engineering.
A THERMOCHEMICAL DATA BANK FOR CYCLE ANALYSIS
R. H. Carty, J. E. Funk, W. L. Conger, M. A. Soliman (Riyadh Univ., Saudi Arabia), and K. E. Cox (New Mexico Univ.) *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 6 p refs

(Grant NGR-18-001-086)
Avail: NTIS HC A99/MF A01

The use of a computer program PAC-2 to produce a thermodynamic data bank for various materials used in water splitting cycles is described. The sources of raw data and a listing of 439 materials for which data are available are presented. The use of the data bank in conjunction with two other programs, CEC-72 and HYDRGN, is also discussed. The integration of these three programs implement an evaluation procedure for thermochemical water splitting cycles. CEC-72 is a program used to predict the equilibrium composition of the various chemical reactions in the cycle. HYDRGN is a program which is used to calculate changes in thermodynamic properties, work of separation, amount of recycle, internal heat regeneration, total thermal energy, and process thermal efficiency for a thermochemical cycle. Author

N77-21580# Institute of Gas Technology, Chicago, Ill.
LABORATORY INVESTIGATIONS ON THERMOCHEMICAL HYDROGEN PRODUCTION
J. Pangborn *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 24 p refs Sponsored in part by the Am. Gas. Assoc.

Avail: NTIS HC A99/MF A01

Detailed energy efficiency determinations were made for more than 90 theoretically possible hydrogen production cycles, and the reaction steps of at least 60 cycles were tested. Theoretical studies and laboratory work indicate that important parameters are energy efficiency, energy sources, material corrosivity, hydrogen pressure capability, step rates, reaction kinetics, and material costs. One cycle that is experimentally workable and that exhibits many desirable characteristics - hydrogen pressure capability, high energy efficiency, and noncorrosive components - is based on the high temperature thermal decomposition of CdO. A high temperature solar furnace with a 1000 to 1200 C capability would be a suitable prime energy source. Author

N77-21582# Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany). Inst. fuer Neutronenphysik und Reaktortechnik.

HYDROGEN PRODUCTION BY MEANS OF REACTOR HEAT USING HALOGENS AND REVERSIBLE ELECTROCHEMICAL METHODS IN A CLOSED CYCLE PROCESS

S. Dorner and K. Schretzmann *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 47 p refs

Avail: NTIS HC A99/MF A01

It is shown that the formation of nitrosyl chloride and the transformation into HNO2 and HCl open up a way of reaching the first stage of closed cycle processes for H2 production through a sequence of reactions running at lower reaction temperatures. The HCl branch of the nitrosyl cyclic process was investigated. In theory, less electric energy is needed than with mere electrolysis of water. Cyclic processes incorporating reversible electrochemical processes seem to be simpler. The example cited is the cyclic process with cesium. According to theoretical calculations, the electric energy obtained from the first stage of this cyclic process should be sufficient to meet the electric energy requirements in the third stage. In this way, the cyclic process - although coupled with electric energy - would actually need only reactor heat for operation. The results indicate that new ways of hydrogen production by means of reactor heat are possible. Author

N77-21587# Westinghouse Research Labs., Pittsburgh, Pa.

THE WESTINGHOUSE SULFUR CYCLE FOR THE THERMOCHEMICAL DECOMPOSITION OF WATER

L. E. Brecher, S. Spewock, and C. J. Warde *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 16 p refs

Avail: NTIS HC A99/MF A01

In the Westinghouse sulfur cycle, sulfurous acid and water are reacted electrolytically to produce hydrogen and sulfuric acid. The resultant sulfuric acid is vaporized to produce steam and sulfur trioxide, with the latter compound being subsequently reduced at higher temperatures into sulfur dioxide and oxygen. Following separation of the water and sulfur dioxide for recycle to the electrolyzer, oxygen is available as a process by-product. The cycle has the potential for achieving high thermal efficiencies while using common and inexpensive chemicals. The product hydrogen and oxygen streams are available under pressure and at high purity. As a result, these may be pipelined and used without detrimental environmental effects and without jeopardizing processes which employ the gases. The chemical reactions comprising the cycle proceed at acceptable rates and without the occurrence of side reactions. Conceptual designs and cost estimates indicate that the product gas separations can be done conventionally and economically. Author

N77-21589*# Westinghouse Electric Corp., Pittsburgh, Pa.

HYDROGEN PRODUCTION BY WATER DECOMPOSITION USING A COMBINED ELECTROLYTIC THERMOCHEMICAL CYCLE

G. H. Farbman and L. E. Brecher *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 22 p refs

(Contract NAS3-18934)

Avail: NTIS HC A99/MF A01

A nuclear water decomposition plant was designed which produces electrolytically pure hydrogen at the rate of about 380 million SCF per day, and acquires electric power and thermal energy from a VHTR system of about 3345 MWt. The system is based on the use of sulfur compounds in a hybrid electrolytic - thermochemical cycle, the sulfur cycle water decomposition system. Electric power and heat are used for the electrolytic production of hydrogen and a thermochemical step which closes the cycle and produces oxygen. The combined process operates at an overall thermal efficiency in excess of 45 percent, including the power requirements for plant auxiliaries. The overall economics of hydrogen production by this method were compared to conventional water electrolysis and coal gasification. Costs, prepared on a consistent set of economic ground rules, are presented. It was concluded that nuclear water decomposition plants of the type described show great promise of economic superiority in the time period for which they can practically be developed and put into operation, i.e., the 1990's. Author

N77-21591# Miami Univ., Coral Gables, Fla. Clean Energy Research Inst.

FIRST WORLD HYDROGEN ENERGY CONFERENCE PROCEEDINGS, VOLUME 2

T. Nejat Veziroglu, ed. Mar. 1976 660 p refs Proc. held at Miami Beach, Fla., 1-3 Mar. 1976 Sponsored by ERDA 3 Vol.

Avail: NTIS HC A99/MF A01

The production, delivery, and storage (in vehicles and metal hydride storage) of hydrogen were examined. Electrolytic hydrogen generators, micro-electrolysis, and water electrolysis were some of the methods of production discussed. The alternative production methods mentioned were farm energy systems, microbial production, and photosynthesis.

N77-21592# Teledyne Energy Systems, Timonium, Md.

RECENT DEVELOPMENTS OF LARGE ELECTROLYTIC HYDROGEN GENERATORS

J. B. Laskin and R. D. Feldwick *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 18 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

An overview of the history and market of large electrolysis units is presented. The historical background introduces and explains the thought process behind a design of Teledyne's Electra Cell alkaline electrolysis hydrogen generators. The new cell design enables construction of modules capable of 1.6 tons per day of hydrogen. The cost of hydrogen is used as a criteria for the selection of optimum performing cells as a function of user parameters. Author

N77-21593# Brookhaven National Lab., Upton, N.Y. Dept. of Applied Science.

PROSPECTS FOR HYDROGEN PRODUCTION BY WATER ELECTROLYSIS TO BE COMPETITIVE WITH CONVENTIONAL METHODS

S. Srinivasan and F. J. Salzano *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 15 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

The maximization of surface areas of electrodes, use of thin electrolyte layers, and increase of operating temperature in alkaline water electrolysis cells to about 120 to 150 C were discussed. Selection and evaluation of separator materials, electrocatalysis of the hydrogen and oxygen electrode reaction, mixed oxides as oxygen electrodes, and photoelectrochemical effects were also studied. Author

N77-21594# Miami Univ., Fla.

WATER ELECTROLYSIS UNDER PRESSURE: IMPROVEMENT OF ENERGY EFFICIENCY BY TEMPERATURE INCREASE

L. Mas (SRTI), J. C. Sohm (Domaine Univ.), and A. Damien (EDF) *In its* 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 24 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

A water electrolysis pilot plant (6.5 kW) of the filter-press type was built. The working pressure is 20 bars, the maximum current density 3.5 kA/m2 and the highest temperature 160 C. Serious corrosion problems were encountered due mainly to the caustic embrittlement of steels at temperatures higher than 120 C. At a given current density, the cell voltage hardly decreases when the temperature goes beyond 120 C if non-activated electrodes are used. Author

N77-21595# Oklahoma State Univ., Stillwater. School of Electrical Engineering.

PERFORMANCE CHARACTERISTICS OF A HIGH-PRESSURE, MODERATE TEMPERATURE, ELECTROLYSIS SYSTEM

H. Jack Allison *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 22 p refs 3 Vol.

(Grant NSF GI-39457)
Avail: NTIS HC A99/MF A01

A two kilowatt prototype system, based on a unique electrode design was constructed and tested. The system and the basic theory associated with the electrolytic production of hydrogen are summarized. Data related to the performance characteristics of the prototype cell are presented. Author

N77-21596# Billings Energy Research Corp., Provo, Utah.
DEVELOPMENT OF A LOW CAPITAL COST ELECTROLYZER
B. C. Campbell *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 14 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

An analysis of current large and small capacity electrolyzers indicates that for electrolytic hydrogen to become economically desirable more efficient and lower cost units need to be developed. Author

N77-21597# Energy Research Corp., Danbury, Conn.
HEAT TRANSFER ANALYSIS OF METAL HYDRIDES IN METAL-HYDROGEN SECONDARY BATTERIES
M. Onischak, D. Dharia, and D. Gidaspow (Institute of Gas Technology) *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 14 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

The heat transfer between a metal-hydrogen secondary battery and a hydrogen-storing metal hydride was studied. Temperature profiles of the endothermic metal hydrides and the metal-hydrogen battery were obtained during discharging of the batteries assuming an adiabatic system. Two hydride materials were considered in two physical arrangements within the battery system. The results show that for a typical 20 ampere-hour battery system with lanthanum pentanickel hydride as the hydrogen reservoir the system performs successfully. Author

N77-21598# Brown, Boveri & Cie Aktiengesellschaft, Baden (Switzerland).
MODERN TECHNOLOGY ELECTROLYSIS FOR POWER APPLICATION
R. Bidard (CEM, Paris) and U. LaRoche *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 23 p refs 3 Vol.
Avail: NTIS HC A99/MF A01

The two important means of splitting water, i.e. thermolysis and electrolysis, are studied with an emphasis on the first one. The electrolysis possibilities are examined in regard to the possibilities of market penetration. Author

N77-21599# Stanford Univ., Calif.
HYDROGEN PRODUCTION PLANTS USING ELECTROLYTIC CELLS WITH LOW COST ELECTRODES BUILT INTO PRESSURE TANKS
F. F. Hall *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 32 p 3 Vol.

Avail: NTIS HC A99/MF A01

Electrolytic production method of generating hydrogen gas is briefly reviewed, and critical components of electrolytic hydrogen production plants are listed. Recommended arrangement would be operated at moderate temperatures and gas pipe line pressures. A hypothetical 150 MW hydrogen plant is described, including estimates of cost and performance. Comments are made in regard to several possible generating systems which might be used to power hydrogen production plants. A comprehensive energy policy is appended. Author

N77-21600# Institute of Gas Technology, Chicago, Ill.
A FARM ENERGY SYSTEM EMPLOYING HYDROGEN STORAGE
R. R. Tison and N. P. Biederman *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 27 p refs 3 Vol.
Avail: NTIS HC A99/MF A01

Short-range, small volume storage to integrate the operation of the wind energy conversion systems with fluctuations in wind availability and load requirements appears feasible. In some cases, hot water storage for thermal loads is preferable to hydrogen. Non-optimized costs for power supplied to a 100 head dairy farm discussed in this paper are in the range of 27 cents to 57 cents/kWhr. Optimized costs are anticipated, however, to be as low as 10 cents/kWhr. Author

N77-21601# Western Ontario Univ., London.
MICROBIAL HYDROGEN PRODUCTION
J. E. Zajic and J. Brosseau *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 40 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

Microbial production is one of the four processes available for the production of hydrogen from nonfossil primary energy sources. Autotrophy and heterotrophy, biological oxidation, and respiration, as well as fermentation were studied in regard to the production of hydrogen gas by microorganisms. Author

N77-21602# Adelaide Univ. (Australia).
THE PHOTOSYNTHETIC PRODUCTION OF HYDROGEN
G. Neil (Flinders Univ., Adelaide, Australia), D. J. D. Nicholas, J. OM. Bockris (Flinders Univ., Adelaide, Australia), and J. F. McCann (Flinders, Univ., Adelaide, Australia) *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 8 p refs 3 Vol.
Avail: NTIS HC A99/MF A01

The rate of hydrogen produced from Anabaena cylindrica under an inert atmosphere and light irradiation was examined. An approximate estimate of the area required to produce hydrogen in adequate quantities from Anabaena cylindrica to provide enough energy for the needs of a city of a population of 1 million people was calculated. Author

N77-21603# Miami Univ., Fla. Rosenstiel School of Marine and Atmospheric Science.
BIOCONVERSION OF SOLAR ENERGY IN SALT WATER: PHOTOSYNTHETIC HYDROGEN PRODUCTION SYSTEMS
A. Mitsui *In its* 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 23 p refs Sponsored in part by NSF 3 Vol.

Avail: NTIS HC A99/MF A01

Hydrogen photoproduction via marine photosynthetic systems is reviewed. Special emphasis is placed on the economic and logistical importance of using salt water as the hydrogen (proton) and electron donor in such a system. In addition, the advantages of using marine photosynthetic microorganisms are discussed from the standpoint of maintaining stable mass cultures with high solar conversion efficiencies. A program is outlined for the multiple utilization of hydrogen producing mass cultures, including harvesting cultures for food production, using cellular products for methane production, and isolating metabolically active cellular products for medical use. Author

N77-21604# Flinders Univ., Bedford Park (Australia). School of Physical Sciences.
THE THEORY OF HYDROGEN PRODUCTION IN A PHOTO-ELECTROCHEMICAL CELL
J. OM. Bockris and K. Uosaki *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 30 p refs 3 Vol.
Avail: NTIS HC A99/MF A01

Theoretical expressions for p-type semiconductor electrodes are derived with an assumption that the discharge step is the rate determining step. Computations corresponding to these equations are carried out and show high quantum efficiencies for certain p-type semiconductors and very low quantum efficiencies for n-type semiconductors. Practical high quantum efficiency for TiO2 is explained by considering surface state. The relation between the potential of an individual electrode and a cell is considered, and cell potential-current relationships of a photo-driven cell are calculated for a solar energy. The predicted maximum efficiency of a cell is 4.7%. Author

N77-21605# Allied Chemical Corp., Morristown, N.J. Materials Research Center.
HYDROGEN GENERATION BY PHOTOELECTROLYSIS OF WATER
A. J. Nozik *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 24 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

Photoelectrolysis of water was studied using n-type TiO2, CdS, and GaP semiconducting electrodes. Current-voltage characteristics and the electrode potentials of the semiconductors were obtained as a function of light intensity and wavelength, internal cell resistance and potential, pH, and cathode material. A model was developed which indicates that a two-photon process is involved, so that photoelectrolysis is sensitized to longer wavelengths. Author

N77-21606# Electrotechnical Lab., Tokyo (Japan).
FEASIBILITY OF HYDROGEN PRODUCTION BY DIRECT WATER SPLITTING AT HIGH TEMPERATURE
S. Ihara *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 16 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

Conceptual study on the process of hydrogen production by direct dissociation of water using high temperature solar energy is described. Calculated result of equilibrium composition of water vapor, hydrogen, and oxygen suggests that temperatures above 3000 K are required for the dissociation of water. Considerations are made on a solar furnace for supplying such high temperature energy. Basic ideas on the method for separating hydrogen and oxygen from high temperature water vapor are suggested. Author

N77-21607# Electrotechnical Lab., Tokyo (Japan).
AN INVESTIGATION OF HYDROGEN PRODUCTION FROM WATER AT HIGH TEMPERATURES
T. Nakamura *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 26 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

Possibilities of producing hydrogen and oxygen from water at temperatures over 2000 K are investigated. The process of direct thermal decomposition of water is studied using a conceptual model. A two-step thermochemical water decomposition process using alkali-metal and employing the magnetohydrodynamic effect for separating a chemical component in the process is investigated. The alkali-metal process operates, in principle, at relatively low pressures. A two-step thermochemical decomposition process using iron oxide is investigated. Author

N77-21608# New Mexico Univ., Albuquerque.
THERMODYNAMIC ANALYSIS OF ALTERNATE ENERGY CARRIERS, HYDROGEN AND CHEMICAL HEAT PIPES
K. E. Cox, R. H. Carty (Kentucky Univ., Lexington), W. L. Conger (Kentucky Univ., Lexington), M. A. Soliman (Kentucky Univ., Lexington), and J. E. Funk (Kentucky Univ., Lexington) *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 15 p refs Sponsored in part by NASA 3 Vol.

Avail: NTIS HC A99/MF A01

Hydrogen and chemical heat pipes were proposed as methods of transporting energy from a primary energy source (nuclear, solar) to the user. In the chemical heat pipe system, primary energy is transformed into the energy of a reversible chemical reaction; the chemical species are then transmitted or stored until the energy is required. Analysis of thermochemical hydrogen schemes and chemical heat pipe systems on a second law efficiency or available work basis show that hydrogen is superior especially if the end use of the chemical heat pipe is electrical power. Author

N77-21609# Institute of Gas Technology, Chicago, Ill.
OCEAN THERMAL ENERGY DELIVERY SYSTEMS BASED ON CHEMICAL ENERGY CARRIERS
A. Konopka, A. Talib, N. P. Biederman, and B. Yudow *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 19 p refs 3 Vol.

(Contract NSF C-1008)
Avail: NTIS HC A99/MF A01

Application of chemical energy carriers to deliver ocean thermal energy is reviewed. The technoeconomic requirements to convert thermal gradient produced shaft power into hydrogen and ammonia are discussed. Subsequent offshore chemical energy transmission and onshore terminal costs and technical requirements are also discussed. A preliminary comparison of hydrogen and ammonia, as ocean thermal energy carriers, is made. Author

N77-21610# Oklahoma State Univ., Stillwater. School of Electrical Engineering.
A WIND ENERGY SYSTEM UTILIZING HIGH PRESSURE ELECTROLYSIS AS A STORAGE MECHANISM
H. Jack Allison *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 13 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

An energy system which has an input of solar or wind energy must have some mechanism of energy storage if it is to supply reliable power to its consumers. Conventional energy systems which consume hydrocarbons to produce electricity can use energy storage techniques to smooth their power curves to more acceptable levels. The technique of energy storage which utilizes electrolysis cells to dissociate water into its component gases, then stores the evolved hydrogen as a high pressure gas, or as a liquid, or as a hydride, was widely discussed for the past several years. The OSU system is described. Performance parameters for those components of the system which have reached the prototype stage are presented with a discussion of basic problems and economics which must be satisfied before such a system can become practical on a large scale. Author

N77-21611*# Union Carbide Corp., Tonawanda, N.Y. Linde Div.
A STUDY OF THE EFFICIENCY OF HYDROGEN LIQUEFACTION
C. R. Baker and R. L. Shaner *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 25 p refs Sponsored by ERDA 3 Vol.

(Contract NAS1-13395)
Avail: NTIS HC A99/MF A01

The use of liquid hydrogen as a jet aircraft fuel has a number of environmental and technological advantages over conventional fuels. The liquefaction of hydrogen requires a large expenditure of energy. There are many inefficiencies that are a part of any practical liquefaction process. Current technology was investigated for the best available system. Parametric studies were made to identify where inefficiencies occur and to optimize and integrate the component parts. Flowsheets are presented for a module that produces 250 tons per day of liquid hydrogen. Approximately ten of these modules is needed for a major airport in the 1990's. The advantages of producing a product with a minimum amount of ortho to para hydrogen conversion are pointed out. The optimum degree of conversion was determined for a liquid hydrogen product that will be used within a given time. An assessment was made regarding the potentials for improvement of the processing schemes and equipment over the next 10 to 25 years. Author

N77-21612# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany).
A SYSTEM CONSIDERATION OF THE CRYOGENIC STORAGE TANK FOR LIQUID HYDROGEN FUELED VEHICLES AND THE RESULTING TANK CONCEPT FOR A PASSENGER CAR
W. Peschka and C. Carpetis *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 21 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

Hydrogen as a replacement for fossile hydrocarbons offers excellent possibilities if an overall hydrogen economy is to be

introduced. This depends fundamentally on the development of economic production processes based on thermal or thermoelectrical water splitting using nuclear or solar heat. Within this frame, the use of liquid hydrogen as an alternate fuel will be feasible. Although a number of liquid hydrogen fueled cars were successfully operated, more detailed investigation of the cryogenic system on board a vehicle is necessary. Some essential parameters are considered in order to optimize the cryogenic system. A compact cryogenic fuel tank for a liquid hydrogen powered vehicle integrated to a unit with the fuel processing system is described. Performance data and test results are given. Author

N77-21613# Southern California Gas Co., Los Angeles.
TECHNICAL AND ENVIRONMENTAL ASPECTS OF UNDERGROUND HYDROGEN STORAGE
A. B. Walters *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 15 p refs 3 Vol.

Avail: NTIS HC A99/MF A01
Underground storage of hydrogen is discussed as the most feasible method of matching hydrogen production sources to variable consumer demands. Environmental impact of underground storage is also presented. B.B.

N77-21614# Energy Research and Development Administration, Washington, D.C.
HYDROGEN STORAGE ON HIGHWAY VEHICLES: UPDATE 1976
E. E. Ecklund and F. L. Kester (Inst. of Gas Technol., Chicago) *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 28 p refs 3 Vol.

Avail: NTIS HC A99/MF A01
The operation and problems in the development of a hydrogen operated internal combustion engine are discussed. Research on several storage techniques is reviewed, and a comparison is made of the total vehicle weights and net fuel utilization efficiencies. B.B.

N77-21615# Technion - Israel Inst. of Tech., Haifa. Dept. of Physics.
HYDROGEN VEHICULAR FUEL STORAGE AS A STEP IN A WATER SPLITTING CYCLE
P. S. Rudman *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 9 p refs 3 Vol.

Avail: NTIS HC A99/MF A01
Hydrogen vehicular refueling is generally conceived of as similar to present-day hydrogen refueling. However, for hydrogen produced in a thermochemical water splitting cycle, a unique refueling cycle is possible. Rather than storing hydrogen, other products of the water splitting cycle are stored, and hydrogen fuel is released by their chemical reaction in situ. Preliminary considerations of the comparative advantages and disadvantages of such a hydrogen refueling system are presented. Author

N77-21616# Virginia Polytechnic Inst. and State Univ., Blacksburg.
HYDROGEN-POWERED HIGHWAY VEHICLES: APPLICATIONS AND OPTIMUM FORM OF FUEL STORAGE
R. L. Whitelaw *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 11 p refs 3 Vol.

Avail: NTIS HC A99/MF A01
Twelve different vehicle applications are considered for the future era of hydrogen as fuel. It is shown that seven different stored energy quantities, from 100,000 to 8,000,000 Btu, will accommodate all. Optimum tank sizes and weights for each are then determined, both for liquid hydrogen at 2 atmos., 23K, and for pressurized hydrogen at 102 atmos., 288K. Liquid hydrogen storage, in well-insulated tankage, is shown to be 1/50th the weight and 1/15th the cost of pressurized gas storage, for the same energy, besides being much safer. Author

N77-21617# California Univ., Los Angeles. School of Engineering and Applied Science.
METHODS OF ON-BOARD GENERATION OF HYDROGEN FOR VEHICULAR USE
A. Z. Ullman and W. D. VanVorst *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 10 p refs 3 Vol.
Avail: NTIS HC A99/MF A01
Possible alternative means of storage of hydrogen, both for use as the sole or major fuel, and as a supplementary fuel for enhancement of the combustion behavior is reviewed. Chemical storage means which may prove more attractive than metal hydrides are presented. Author.

N77-21618# Technidyne, Inc., Maspeth, N. Y.
AUTOMOTIVE FUEL SAVING SYSTEM WITH ON-BOARD HYDROGEN GENERATION AND INJECTION INTO IC ENGINES
D. A. Kelly *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 8 p refs 3 Vol.

Avail: NTIS HC A99/MF A01
The automotive fuel saving system with on-board hydrogen generation is advocated as a practical means of reducing automotive gasoline fuel consumption in conventional cars and trucks. The present system is further projected as the forerunner to producing ever higher basic percentages of hydrogen to gasoline mixtures to achieve a relief from constantly increasing gasoline prices. The heart of the system consists of a high efficiency compact electrolysis multi-cell unit which produces the hydrogen gas for injection into the basically unaltered I. C. automotive engine. Author

N77-21620# Kernforschungsanlage, Juelich (West Germany). Inst. fuer Festkoerperforschung.
PHYSICAL METALLURGY OF FeTi-HYDRIDE AND ITS BEHAVIOR IN A HYDROGEN STORAGE CONTAINER
M. A. Pick and H. Wenzel *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 13 p refs 3 Vol.

Avail: NTIS HC A99/MF A01
FeTi samples were prepared and characterized by metallography, X-ray diffraction, neutron diffraction and specific heat measurements. The conditions for the presence of the ordered CsCl structure at room temperature were investigated. This material was used to study FeTi hydrides, especially the structure, phase transition, and the heat of reaction as a function of the hydrogen concentration. The FeTi material was used to build and operate a small hydrogen storage container as an alternative to high pressure hydrogen gas containers. Author

N77-21621# Brookhaven National Lab., Upton, N.Y.
THE BEHAVIOR OF IRON TITANIUM HYDRIDE TEST BEDS: LONG-TERM EFFECTS, HEAT TRANSFER AND MODELING
G. Strickland, J. Milau, and W.-S. Yu *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 31 p refs 3 Vol.
Avail: NTIS HC A99/MF A01
Several types of studies were made with test beds of iron titanium hydride in order to determine their long-term and thermal behavior. This material provides a way of storing hydrogen in relatively dense form at ordinary temperatures and moderate pressures. Its use offers electrical utilities a way of storing low cost off-peak power, to meet costly peak shaving needs, in combination with an electrolyzer and a fuel cell stack. The data obtained is part of that needed for the design of plant scale hydride reservoirs. Accelerated cyclic tests were made with 1-in. diameter test beds to determine changes in their long term behavior, the main result being extensive particle attrition. The thermal behavior of a 6-in. diameter test bed was determined along with the times that various hydrogen flow rates could be sustained during hydriding and dehydriding. Author

N77-21622# Argonne National Lab., Ill.
A THERMODYNAMIC ANALYSIS OF HYCSOS, A HYDROGEN CONVERSION AND STORAGE SYSTEM

Dieter M. Gruen, Felix Schreiner, and Irving Sheft *In* Miami Univ., 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 15 p refs 3 Vol. (For primary document see N77-21591 12-44)
Avail: NTIS HC A99/MF A01

A two metal hydride system for the storage, retrieval, and conversion of thermal energy is described. The system functions heating, cooling, and power production are discussed for solar energy applications. A thermodynamic analysis particularly of the conversion cycle is presented. It is concluded that solar concentrators providing heat transfer fluid temperatures of 140 deg could give conversion efficiencies of 16.5 percent. Author

N77-21624*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A SIMPLE APPROACH TO METAL HYDRIDE ALLOY OPTIMIZATION
Daniel D. Lawson, Charles Miller, and Robert F. Landel *In* Miami Univ. 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 9 p refs 3 Vol.

(Contract NAS7-100)
Avail: NTIS HC A99/MF A01

Certain metals and related alloys can combine with hydrogen in a reversible fashion, so that on being heated, they release a portion of the gas. Such materials may find application in the large scale storage of hydrogen. Metal and alloys which show high dissociation pressure at low temperatures, and low endothermic heat of dissociation, and are therefore desirable for hydrogen storage, give values of the Hildebrand-Scott solubility parameter that lie between 100-118 Hildebrands, (Ref. 1), close to that of dissociated hydrogen. All of the less practical storage systems give much lower values of the solubility parameter. By using the Hildebrand solubility parameter as a criterion, and applying the mixing rule to combinations of known alloys and solid solutions, correlations are made to optimize alloy compositions and maximize hydrogen storage capacity. Author

N77-21625# Rockwell International Corp., Thousand Oaks, Calif. Science Center.
SELECTION OF STRUCTURAL MATERIALS FOR HYDROGEN PIPELINES AND STORAGE VESSELS
Anthony W. Thompson and I. M. Bernstein (Carnegie-Mellon Univ.) *In* Miami Univ., 1st World Hydrogen Energy Conf. Proc., Vol. 2 Mar. 1976 19 p refs 3 Vol.

(Contract N00014-75-C-0265)
Avail: NTIS HC A99/MF A01

Criteria for identification of unsuitable materials, as well as the selection of improved materials for new installations is discussed. The potential dangers of using unsuitable materials are briefly illustrated, using documented examples of pipeline and storage facility failures. The feasibility, both of using present transmission lines for hydrogen, and of developing steels resistant to hydrogen is explored. Author

N77-21626# Miami Univ., Coral Gables, Fla. Clean Energy Research Inst.
FIRST WORLD HYDROGEN ENERGY CONFERENCE PROCEEDINGS, VOLUME 3
T. Nejat Veziroglu, ed. Mar. 1976 646 p refs Proc. held at Miami Beach, Fla., 1-3 Mar. 1976 Sponsored by ERDA 3 Vol.
Avail: NTIS HC A99/MF A01

The use of hydrogen energy and its impact on the economy are discussed. The thermodynamic characteristics and efficiency of hydrogen and liquid hydrogen fuels in aircraft and internal combustion automobile engines are investigated. Industrial, commercial, and residential applications are also explored.

N77-21627*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE THERMAL EFFICIENCY AND COST OF PRODUCING HYDROGEN AND OTHER SYNTHETIC AIRCRAFT FUELS FROM COAL
Robert D. Witcofski *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 28 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

A comparison is made of the cost and thermal efficiency of producing liquid hydrogen, liquid methane and synthetic aviation kerosene from coal. These results are combined with estimates of the cost and energy losses associated with transporting, storing, and transferring the fuels to aircraft. The results of hydrogen-fueled and kerosene-fueled aircraft performance studies are utilized to compare the economic viability and efficiency of coal resource utilization of synthetic aviation fuels. Author

N77-21628*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SOME EARLY PERSPECTIVES ON GROUND REQUIREMENTS OF LIQUID HYDROGEN AIR TRANSPORTS
Peter F. Korycinski *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 24 p refs 3 Vol.

Avail: NTIS HC A99/MF A01

The introduction of liquid hydrogen as a fuel for large, long haul air transports requires an integrated approach involving the air terminal authorities and the liquid hydrogen suppliers, as well as the airline operators and the air transport manufacturers. To illustrate the scope of the requirements necessary to support large air transports at the air terminals, perspectives are drawn to surface some concerns each of the principals may have to face, and to identify those that will require cooperative efforts to obtain integrated solutions. Author

N77-21629*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NEW POTENTIALS FOR CONVENTIONAL AIRCRAFT WHEN POWERED BY HYDROGEN-ENRICHED GASOLINE
W. A. Menard, P. I. Moynihan, and J. H. Rupe *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 28 p refs 3 Vol.
(Contract NAS7-100)
Avail: NTIS HC A99/MF A01

Overall system efficiency and performance of a Beech Model 20 Duke aircraft was studied to provide analytical representations of an aircraft piston engine system, including all essential components required for onboard hydrogen generation. Lower emission levels and a 20% reduction in fuel consumption may be obtained by using a catalytic hydrogen generator, incorporated as part of the air induction system, to generate hydrogen by breaking down small amounts of the aviation gasoline used in the normal propulsion system. This hydrogen is then mixed with gasoline and compressed air from the turbocharger before entering the engine combustion chamber. The special properties of the hydrogen-enriched gasoline allow the engine to operate at ultra lean fuel/air ratios, resulting in higher efficiencies. Author

N77-21630# Boeing Commercial Airplane Co., Seattle, Wash.
FUEL SUBSYSTEM CHARACTERISTICS FOR LH2 AIRCRAFT
A. M. Momenthy *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 16 p 3 Vol.

Avail: NTIS HC A99/MF A01

Design characteristics of the fuel subsystem for subsonic LH2 fueled commercial aircraft are discussed in terms of requirements and technology availability. Some of the differences between LH2 systems developed for space vehicles and those required for commercial aircraft are pointed out. Significant areas of technology requiring advancement and long lead time development testing are identified. Results obtained from a Boeing study covering the development of a candidate fuel subsystem for a 3,000 nautical mile range LH2 fueled commercial airplane are included. Author

N77-21631# Billings Energy Research Corp., Provo, Utah.
WATER INDUCTION IN HYDROGEN-POWERED IC ENGINES
R. L. Woolley and D. L. Henriksen *In* Miami Univ. First World

Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 23 p refs 3 Vol. (For primary document see N77-21626 12-44)
Avail: NTIS HC A99/MF A01

Addition of water to the hydrogen-air mixture in the intake manifold is an effective means of both suppressing the tendency to backflash and reducing the production of oxides of nitrogen. Tests are run on a Dodge 440 CID V8 engine having a compression ratio of 12 to 1. Dramatic reduction in oxides of nitrogen is observed as the water flow is increased, yet essentially no change is observed in either power or efficiency. Exhaust temperature, nitrogen oxide, and equivalence ratio is measured at each exhaust valve. It is found that a large cylinder to cylinder variation in nitrogen oxide production is caused by slight *non-uniformity in mixing of the hydrogen-air streams. It is further* shown that nitrogen oxide production is an exponential function of equivalence ratio, water to hydrogen mass ratio, and engine speed. Author

N77-21632# Musashi Inst. of Tech., Tokyo (Japan).
DEVELOPMENT OF A LIQUID HYDROGEN CAR
S. Furuhama, M. Hiruma, and Y. Enomoto *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol 3 Mar. 1976 32 p refs 3 Vol.
Avail: NTIS HC A99/MF A01

A liquid hydrogen tank with a capacity of 230 liters (61 gal.) at 5 atm/g (71 psi.g) pressure was installed in a Datsun B210 passenger car having a 1.4 liter displacement engine. Because the lower temperature hydrogen gas introduces better performance in the engine, fuel was lead from the rear tank to the front engine through a vacuum insulated pipe and injected into the intake port by a mechanical valve. The performance of the car in a 2,800 km (1730 mi) rally is evaluated as regards energy economy, emission, and safety. Author

N77-21633# Billings Energy Research Corp., Provo, Utah. Hydrogen Engine Research.
DYNAMIC TESTS OF HYDROGEN-POWERED IC ENGINES
R. L. Woolley and G. J. Germane (Brigham Young Univ.) *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 16 p refs

Avail: NTIS HC A99/MF A01

A speed governed, sawtooth, torque time cycle was used in checkout and calibration of computer controlled engine test cells. This cycle makes possible comparison of integrated steady-state data with dynamic test results. Integration of available data *indicates that a factor of 1.5 (50% improvement) is a valid* number for estimation of hydrogen engine efficiency from a knowledge of gasoline efficiency. Vehicle driving dynamics for a transit vehicle are simulated for a simplified road cycle. An example calculation indicates that the efficiency penalty resulting from the addition of a 4,000 lb metal hydride tank is more than offset by efficiency benefits in the hydrogen engine. The energy savings with a heavier, hydrogen-powered transit vehicle was predicted to be nearly 30%. Author

N77-21634# *Idaho National Engineering Lab., Idaho Falls.*
MODIFICATION TECHNIQUES AND PERFORMANCE CHARACTERISTICS OF HYDROGEN-POWERED IC ENGINES: STATE OF THE ART, 1975
F. B. Simpson, J. H. Lofthouse, D. R. Swope, and R. L. Woolley (Billings Energy Research Corp.) *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 22 p refs

Avail: NTIS HC A99/MF A01

Developments in hydrogen-powered engine technology are *summarized. Topics reviewed include: engine parameters,* modifications, operating conditions, running characteristics, and performance. The cost for manpower and materials associated with the modification of one engine is discussed. Author

N77-21635# California Univ., Los Angeles.
CRASH TEST OF A LIQUID HYDROGEN AUTOMOBILE
J. G. Finegold and W. D. VanVorst *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 13 p refs

Avail: NTIS HC A99/MF A01

Details of the conversion of a U.S. Postal Service mail truck *to hydrogen-fueled operation are given. Specific reference is made* to design safety considerations. A traffic accident is described that caused the mail truck (mounted on a trailer) to turn on its side at approximately 20 mph and to finally slide to a stop and turn upside down. No one was injured, and there was essentially no damage to the liquid hydrogen fuel system. The mail truck was driven away from the scene of the accident. Suggestions to insure the safety of hydrogen-fueled experimental vehicles are made. Author

N77-21636# Billings Energy Research Corp., Provo, Utah.
PROTOTYPE HYDROGEN AUTOMOBILE USING A METAL HYDRIDE
D. L. Henriksen, D. B. Mackay, and V. R. Anderson *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 12 p
Avail: NTIS HC A99/MF A01

A 1975 Pontiac Grand Ville was converted to run on hydrogen. Engine conversion, the design of the iron-titanium storage system, and the design of related controls and safety equipment are discussed. Engine modifications include increase in compression ratio, conversion of the carburetor for water induction, and changes in the ignition system. Power control is obtained by throttling the air-hydrogen mixture. Waste heat from the engine exhaust is circulated through the hydride tank to drive off hydrogen. Controls are provided for regulating waste heat and hydrogen pressure. The method for recharging the system is also described. Author

N77-21637# Billings Energy Research Corp., Provo, Utah.
AUTOMOTIVE HYDRIDE TANK DESIGN
Donald B. Mackay *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 11 p

Avail: NTIS HC A99/MF A01

Automotive hydride tanks must be designed as both pressure vessels and heat exchangers. Hydride heat transfer properties are presented using heat exchange data and results from theoretical investigations and prototype testing. Discussion of promising designs and directions for future activity are included. Tabular designs which avoid many previously encountered difficulties are analyzed. Author

N77-21638# Billings Energy Research Corp., Provo, Utah.
A HYDROGEN-POWERED MASS TRANSIT SYSTEM
Roger E. Billings *In* Miami Univ. First World Hydrogen Energy *Conf. Proc., Vol. 3 Mar. 1976 14 p refs*

Avail: NTIS HC A99/MF A01

Hydrogen's application to mass transit systems is considered. A 21-passenger bus is converted to hydrogen using a Dodge engine which has been modified for high compression operation. Backfiring and nitric oxide pollution formation are controlled by a water injection technique. Hydrogen fuel storage for the experimental prototype is accomplished by two metal hydride containers using an iron-titanium alloy. Data are presented regarding equipment conversion and design, energy resource utilization, economics, and safety. Author

N77-21639# *Roorkee Univ. (India).*
USE OF HYDROGEN IN AUTOMOTIVE ENGINES
C. P. Gupta *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 25 p refs

Avail: NTIS HC A99/MF A01

The case of hydrogen as automotive engine fuel is discussed in the context of environment pollution and scarcity of hydrocarbon fuels. The development of the air-breathing, hydrogen IC engine is reviewed. The hydrogen-oxygen high temperature cycle power *plant for automotive applications is also examined. Various* methods of storing hydrogen on automotive vehicles are discussed and the resulting vehicle weights and ranges compared. The

production, transportation, storage and distribution of hydrogen are briefly considered. Author

N77-21640# Los Alamos Scientific Lab., N. Mex.
HYDROGEN SAFETY PROBLEMS
R. Reider and F. J. Edeskuty *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 7 p refs

Avail: NTIS HC A99/MF A01

Consideration of the use of hydrogen as a common fuel is presented. Questions on the matter of safety were raised, and techniques in the field of accident prevention are mentioned. B.B.

N77-21641# Institute of Gas Technology, Chicago, Ill. IIT Center.
COMMODITY HYDROGEN FROM OFF-PEAK ELECTRICITY
K. Darrow, N. Biederman, and A. Konopka *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 29 p refs
Avail: NTIS HC A99/MF A01

The use of off peak electrical power as an energy source for the electrolytic production of hydrogen is considered. The present industrial uses for hydrogen are examined to determine if hydrogen produced in this fashion is competitive with the industry's onsite production or existing hydrogen prices. A technical and economic feasibility analysis of the various components required and of the operation of the system as a whole including production, transmission, storage, and markets is presented. Author

N77-21642# Institute of Gas Technology, Chicago, Ill.
TECHNICAL PROSPECTS FOR COMMERCIAL AND RESIDENTIAL DISTRIBUTION AND UTILIZATION OF HYDROGEN
J. Pangborn, M. Scott, and J. Sharer *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 27 p refs

Avail: NTIS HC A99/MF A01

Hydrogen was suggested as a fuel gas to eventually replace natural gas in commercial and residential heating and cooking applications. After transmission from a production site to a city gate, the delivery of hydrogen would be through the pipelines of conventional (natural gas) distribution systems. It is combusted in appliances with suitably modified burners. Technical assessments for the distribution and utilization of hydrogen were assembled. Author

N77-21643*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ENERGY STORAGE POSSIBILITIES OF ATOMIC HYDROGEN
R. D. Etters (Colorado State Univ., Ft. Collins), J. V. Dugan, Jr. (Science and Tech. Comm., Washington, D. C.), and R. Palmer *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 18 p refs

Avail: NTIS HC A99/MF A01

Several recent experiments designed to produce and store macroscopic quantities of atomic hydrogen are discussed. The bulk, ground state properties of atomic hydrogen, deuterium, and tritium systems are calculated assuming that all pair interactions occur via the atomic triplet potential. The conditions required to obtain this system, including inhibition of recombination through the energetically favorable singlet interaction, are discussed. The internal energy, pressure, and compressibility are calculated applying the Monte Carlo technique with a quantum mechanical variational wavefunction. The system studied consisted of 32 atoms in a box with periodic boundary conditions. Results show that atomic triplet hydrogen and deuterium remain gaseous at 0 K; i.e., the internal energy is positive at all molar volumes considered. Author

N77-21644# Ayra Mehr Univ. of Technology, Tehran (Iran).
AN EXAMINATION OF THE STIRRED REACTOR AS A TOOL FOR THE DETERMINATION OF RATE CONSTANTS OF THE H2-O2 COMBUSTION REACTIONS
M. Rashidi and G. A. Karim *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 16 p refs

Avail: NTIS HC A99/MF A01

An investigation into the uncertainty in the deduced rate constants of H2-O2 reactions resulting from measurement and interpretation errors associated with the stirred reactor apparatus is described. It is suggested that the interpretation and measurement of reactor temperature and heat transfer contributed to the highest uncertainty in the deduced rate constants, while the measurement of equivalence ratio, loading and inlet gas temperature was comparatively less important. By considering uncertainties in the measurements for two reactor operating conditions, it was shown that the rate constants for three elementary reactions can be adjusted successfully. Author

N77-21645# Calgary Univ. (Alberta).
A CONSIDERATION OF CATALYTIC EFFECTS ON Pt-Pt/Rh THERMOCOUPLES IN COMBUSTION SYSTEMS INVOLVING HYDROGEN AS A FUEL
G. A. Karim, M. D. DSouza, S. L. Khanna, and M. Rashidi *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 6 p refs

Avail: NTIS HC A99/MF A01

Sources of error in relation to combustion systems are discussed. Work relating to the serious errors associated with catalytic effects involving the widely used Pt-Pt/Rh thermocouples in combustion systems using hydrogen as a fuel is considered in detail. It is then suggested that the sheathing of the thermocouple junction by a very thin quartz tubing offers the most effective remedy for this error. Author

N77-21646# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany).
ON THE STORAGE OF HYDROGEN BY USE OF CRYO-ADSORBENTS
C. Carpetis and W. Peschka *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 10 p refs

Avail: NTIS HC A99/MF A01

Besides economical production methods it is necessary for a future hydrogen economy to assure storage systems for large quantities of hydrogen. The storage method considered is based on the use of adsorbent materials at cryogenic temperatures (liquid nitrogen range) and at pressures up to 60 bar. The adsorption capability of several materials under these conditions enables hydrogen storage densities comparable to the density of liquid hydrogen. The storage efficiency is estimated, and suggestions are made for the increase of the storage efficiency by means of regenerative heat storage. Research topics necessary for detailed system component design and economic evaluation are outlined. Author

N77-21647# Cornell Univ., Ithaca, N.Y. Sibley School of Mechanical and Aerospace Engineering.
RECIPROCATING PUMP FOR CONVERSION OF LIQUID HYDROGEN TO HIGH PRESSURE GASEOUS HYDROGEN
J. S. Meserole, Jr. and P. C. T. DeBoer *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 15 p refs
Sponsored in part by DOT and NSF

Avail: NTIS HC A99/MF A01

The design, construction and testing of a reciprocating device are presented. The device uses two pistons of different diameter on a common shaft. The small piston compresses the liquid hydrogen, which is then gasified by passing it through a heat exchanger. Part of the resulting mechanical work is used to drive the larger piston. The hydrogen flow is governed by a suitable valving arrangement, controlled by magnetic position sensors together with an electronic logic network. A brief thermodynamic analysis is presented of the expander cycle on which the device is based. The prototype built was tested with liquid nitrogen. Various sealing and design considerations are discussed, as are possibilities for future improvements. The device

has potential application for relatively small scale uses of high pressure hydrogen, such as in vehicles incorporating direct cylinder injection. Author

N77-21648# California Univ., Livermore. Lawrence Livermore Lab.
HYDROGEN ENERGY: ITS POTENTIAL PROMISES AND PROBLEMS
G. D. Sauter *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 1 Mar. 1976 8 p

(Contract W-7405-eng-48)
Avail: NTIS HC A99/MF A01
The author's opinions regarding the potential promises and problems of hydrogen energy are presented. Author

N77-21649# Miami Univ., Coral Gables, Fla.
ANALYSIS OF A DELPHI STUDY ON HYDROGEN
P. Valette, L. Valette, and M. Siebker *In its* First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 14 p

Avail: NTIS HC A99/MF A01
Different technical and economical features and the consumption of hydrogen in 1985 and 2000 are presented. Most of these features have been investigated for the first time in a comprehensive forecasting effort. Author

N77-21650# Energy Research and Development Administration, Washington, D.C.
ERDA'S HYDROGEN PROGRAMS
Albert R. Landgrebe *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 17 p refs (For primary document see N77-21626 12-44)
Avail: NTIS HC A99/MF A01
A brief overview of ERDA's Research and Development activities related to hydrogen technology, as well as some possible future directions in which this technology may lead us are given. Author

N77-21651*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE NASA HYDROGEN ENERGY SYSTEMS TECHNOLOGY STUDY: A SUMMARY
E. A. Laumann *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 15 p refs

(Contract NAS7-100)
Avail: NTIS HC A99/MF A01
The results and conclusions of the study, which found a significant current usage of hydrogen, dominated by chemical-industry needs and supplied mostly from natural gas and petroleum feedstocks are discussed. These needs are expected to increase significantly in the remainder of this century and to largely outgrow the current means of supply. Several hydrogen production methods were evaluated. Those not dependent on fossil resources were found to be presently more costly and technically more difficult than fossil-feedstock-based technologies, but it is clear that they will eventually need to be implemented. Author

N77-21652# Michigan Univ., Ann Arbor.
PERSPECTIVES ON THE EVOLUTION INTO A HYDROGEN ECONOMY
L. W. Jones *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 9 p refs

Avail: NTIS HC A99/MF A01
The optimal trajectory of patterns in energy metabolism over the next fifty years is explored in the context of desirable goals and evolutionary strategies. It is argued that we must ultimately develop a totally cyclic energy economy in which hydrogen plays a prominent role, and that progress towards that end point is most efficiently achieved without extensive excursions into technological blind alleys. The conclusion is reached that apparent short-term non-optimal solutions where hydrogen is introduced early may in fact be the most economical in the long term. Author

N77-21653# Stanford Research Inst., Menlo Park, Calif.
TECHNOLOGY IMPACT ASSESSMENT OF THE HYDROGEN ECONOMY CONCEPT: KEY FINDINGS
E. M. Dickson *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 12 p refs Sponsored by NSF

Avail: NTIS HC A99/MF A01
Key findings of technology impact assessment of the hydrogen economy concept are presented. The manner in which the standard business practice of evaluating alternative investments in terms of a discounted future works to hydrogen's disadvantage is discussed. The effects of neutral-, pro-, and anti-hydrogen federal energy policies are outlined. A prioritized list of R&D requirements that will ensure the continued development of an appropriate data base about hydrogen for use in formulating federal energy policy is given. Author

N77-21654# California Univ., Livermore. Lawrence Livermore Lab.
WILL THE LARGE-SCALE PRODUCTION OF HYDROGEN BE PART OF THE ENERGY PROBLEM OR PART OF ITS SOLUTION?
G. D. Sauter *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 16 p refs

(Contract W-7405-eng-48)
Avail: NTIS HC A99/MF A01
The energy dynamics of nuclear reactors as a means of generating hydrogen, the rate of expansion of the reactor network and the ratio of the energy required to build a reactor to the energy it produces are analyzed. A specific scenario--the development by the year 2000 of the capacity to generate annually the amount of hydrogen which has the heat content of the natural gas consumed in the U.S. in 1970--is examined. For this scenario, it appears that the reactors, rather than the hydrogen, will be the energy storage mechanism. Author

N77-21655# Brown, Boveri & Cie Aktiengesellschaft, Baden (Switzerland).
THE GREENLAND HYDROPOWER AS A SOURCE OF ELECTROLYTIC HYDROGEN
U. LaRoche *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 10 p refs

Avail: NTIS HC A99/MF A01
A preliminary assessment of the Greenland hydropower potential, which appears to reach size of between 100 GW to 1 TW ultimately recoverable annual mean output at electricity costs well comparable with nuclear off-peak power ratings, is presented. This potential has similar characteristics to mineral and fossil fuel resources in so far as it may best be described by indicating different categories of assuredness (proven, reasonably assured, ultimately recoverable). Besides energy needed in Greenland itself a major energy exportation appears completely feasible. One of the best solutions is shown to be the well known project energy depot concept, namely in situ synthesis of ammonia on the basis of liquefied air and electrolytic hydrogen. This then will be transported by LNG-tankers in liquid form overseas. Expected costs indicate a market penetration capability to be considered seriously. Author

N77-21656# Oceanic Inst., Waimanalo, Hawaii.
HYDROGEN IN THE SEAWARD ADVANCEMENT OF INDUSTRIAL SOCIETIES
J. A. Hanson *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 12 p refs

Avail: NTIS HC A99/MF A01
The feasibility of offshore urban/industrial complexes, as future development, is investigated. They could thus serve as test and demonstration beds for the eventual adoption of hydrogen as the storable, transportable and ecologically sound fuel base of highly efficient urban/industrial complexes everywhere. Author

N77-21657# Florida International Univ., Miami.
ENERGY AND THE FUTURE

T. Gonen, P. M. Anderson (EPRI), and D. W. Bowen (MAPP Coordination Center, Minneapolis) *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 24 p refs

Avail: NTIS HC A99/MF A01

The entire energy field is covered, with special emphasis on electric power. The causes of the current and the future energy problem and, projected energy demand to the year 2000 on the basis of statistical data are reviewed, and a survey of U.S. energy forecasts are made in order to make a comparison between the projections. Some energy-related issues are discussed in light of the projections. Author

N77-21658*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
HYDROGEN USE PROJECTIONS AND SUPPLY OPTIONS
R. Manvi and T. Fujita *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 25 p refs

(Contract NAS7-100)
Avail: NTIS HC A99/MF A01

Reference and expanded use projections were developed to estimate future hydrogen demand. The rationale in the development of these projections, which estimate the growth of hydrogen usage of approximately 1 X 10 to the fifteenth power Btu in 1973 to approximately 5.5 X 10 to the fifteenth power for reference use and 22 X 10 to the fifteenth power Btu for expanded use projections in year 2000. Primary energy sources required to produce these demands are discussed in the light of transition from a low merchant to high merchant supply option. Author

N77-21659# Miami Univ., Coral Gables, Fla.
ECONOMICS OF NUCLEAR - ELECTROLYTIC HYDROGEN
S. Kakac and T. N. Keziroglu *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 19 p refs

Avail: NTIS HC A99/MF A01

The economic status of nuclear energy is discussed; in this connection, the economic comparison of two power plants, namely coal-fired and nuclear power plants, is given. The production of hydrogen from nuclear energy with the method of water electrolysis is discussed. The economics of nuclear-electrolytic hydrogen transmitting to a large distance from the plant are considered. The importance of hydrogen as an energy storage element is indicated. Author

N77-21660# Special Studies Group TNO, Apeldoorn (Netherlands).
HYDROGEN IN THE ENERGY SYSTEM OF THE NETHERLANDS
A. J. Bogers and W. VanDeelan *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 19 p

Avail: NTIS HC A99/MF A01

The optimization of a hydrogen using energy system and the problem of the production of hydrogen are discussed. It will be argued that the process of electrolysis will be preferable to the thermochemical method, not only for reasons of cost, but also because of safety and reliability aspects, while also the purity of the gas produced, having consequences for the possibilities of both fuel cells and catalytic combustion, can be seen as an advantage. Author

N77-21661# Harvard Univ., Cambridge, Mass. John Fitzgerald Kennedy School of Government.
US OPTIONS FOR A TRANSITION FROM OIL AND GAS TO SYNTHETIC FUELS
A. S. Manne *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 8 p

Avail: NTIS HC A99/MF A01

Some of the options by which the U.S. may move away from its present heavy dependence upon oil and gas toward a more diversified energy economy are discussed. Through nonlinear programming, the model incorporates both own- and cross-price elasticities of demand. In this way, it allows for price-induced interfuel substitution and energy conservation. Among the supply options studied are: (1) direct combustion of coal to generate electricity, (2) conversion of coal to synthetic fuels, (3) nuclear energy - first from the light water reactor and later from the fast breeder, (4) hydrogen via an efficient production process; and (5) distant future technical options such as fusion and central station solar power (aggregated together and described only as an advanced technology). Author

N77-21662# Miami Univ., Coral Gables, Fla.
A SIMPLIFIED EQUILIBRIUM MODEL OF THE US ENERGY-ECONOMIC SYSTEM AND ITS USE IN COMPARING ALTERNATIVES
H. J. Plass, Jr. *In its* First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 24 p refs

Avail: NTIS HC A99/MF A01

A simplified model of the U.S. energy-economic system is developed using published data on energy flows, labor employed, and dollar flows. The energy system, usually divided into the sectors of industry, electric power, residential-commercial, and transportation, is restructured into a three-sector model including extraction and production of energy resources, production of goods and services, and consumption of fuels, goods and services. Effects on fuel used, employment, and standard of living of various alternatives are examined, including high prices of imported fuel, technological improvements, solar energy for space and water heating, and hydrogen fuel for transportation. Author

N77-21663# Academia R. P. R., Bucharest. Inst. de Fizica Atomica.
HYDROGEN ECONOMY ANALYSIS USING DECISION THEORY
Rasin Georgescu *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 14 p refs

Avail: NTIS HC A99/MF A01

Several articles and different studies reveal the increasing interest in hydrogen as a nonpolluting multipurpose fuel. The problem of the development of the research and the adoption of the best solution for the main problems of hydrogen economy is very actual for each country. The possibilities offered by the decision theory to analyze and adopt the best decision to introduce, organize and develop a hydrogen economy are investigated. An example of the utilization of the decision theory in the analysis of a set of strategies concerned with the structure of the hydrogen economy is presented. Author

N77-21664# Southampton Univ. (England).
POSSIBLE POLLUTION AND COST ANALYSIS FROM WIDE USE OF HYDROGEN FUEL IN TRANSPORTATION
S. P. Chakravarty and K. S. Varde (Michigan Univ., Dearborn) *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 13 p refs

Avail: NTIS HC A99/MF A01

The potential of hydrogen as a fuel for powerplants used in highway vehicles is investigated from the point of pollution, efficiency of the powerplant and the cost of using hydrogen on a wide scale. It is found that hydrogen will be a good competitor against present fuels with respect to vehicle performance. The potential of hydrogen from cost point is difficult to determine readily; it requires knowledge of inter-industry exchanges involved in hydrogen production by various techniques and the effect of future cost of petroleum fuel. An approach is set-up to predict cost of producing hydrogen; the approach requires that various data be fed into the model which can be developed with this approach. The output of the model study can be used to make a decision about belting on hydrogen fuel. Author

N77-21665# Papanicolaou Cancer Research Inst., Riverside, Calif.
OPERATION COUGH DROP
R. M. Zweig *In* Miami Univ. First World Hydrogen Energy Conf. Proc., Vol. 3 Mar. 1976 11 p refs

Avail: NTIS HC A99/MF A01

A review of air pollution trends and health effects is presented, comparing data from the United Kingdom and the United States. An outline of chemical analysis of pollutants is given, and a description of an increased incidence of various disease entities resulting from these chemical toxins is analyzed. In-depth analysis of the pollution in the eastern zone of the south coast air basin of California is presented, along with a projection of pollution trends in this same area, utilizing hydrogen as a fuel for vehicular and stationary sources. A working model for this strategy is described, utilizing the city of Riverside, California as the site for implementing the Hydrogen Economy. Author

N77-21668# *Martin Marietta Corp., Denver, Colo.*
CENTRAL RECEIVER SOLAR THERMAL POWER SYSTEM, PHASE 1 Quarterly Progress Report, period ending 30 Jun. 1976
Jul. 1976 128 p
(Contract E(04-3)-1110)
(SAN/1110-76/T2) Avail: NTIS HC A07/MF A01

The major program activities were aimed toward the fabrication of the three major research experiments and continued evaluation of the pilot plant performance and operating modes. The detail designs were completed. Both warm and hot starts from thermal storage were evaluated as was a cold start from the receiver. In the collector subsystem experiment the heliostat structures and drive mechanisms were completed and delivered. The sensor and associated electronics for the first heliostat were completed as were installation and checkout of the PDP-11 computer and control console for the entire collector experiment. The first twenty-five mirror heliostat was erected and was operational. The detail design of the 5 MW receiver experiment was completed. In the thermal storage subsystem the detail design of the experiment was completed early in the period. A final selection of the heat transport media was made with Hitec selected as the molten salt and Caloria HT-43 selected as the hydrocarbon oil. GRA

N77-21669# DSS Engineers, Inc., Fort Lauderdale, Fla.
PRELIMINARY RESEARCH ON OCEAN ENERGY INDUSTRIAL COMPLEXES, PHASE 1
C. D. Hornburg, B. Lindal, and N. Elramly Apr. 1976 342 p refs
(Contract E(40-1)-4915)
(ORO-4915-3) Avail: NTIS HC A15/MF A01

A preliminary market analysis covering 30 possible energy intensive products classified 12 as high demand, high growth rate. Costs of shipping bulk solids and liquids to and from the ocean site will amount to 1 to 5 percent of the product sales price. A total of 25 individual plants or processes are analyzed. The main process selected for concentration and crystallization in the sea chemicals complex was the freezing process. The main process used in the organic chemicals and plastic complex is the electric arc process. Ammonia will be produced from by-product hydrogen. Detailed capital and operating cost information is presented. It was concluded that producing energy intensive products at integrated OEICs is technically sound and economically viable. ERA

N77-21670# Colorado State Univ., Fort Collins. Solar Energy Applications Lab.
DESIGN, CONSTRUCTION, AND TESTING OF A RESIDENTIAL SOLAR HEATING AND COOLING SYSTEM
Dan S. Ward and George O. G. Loef Jun. 1976 113 p Prepared for the NATO Committee on the Challenges of Modern Society
(Contract E(11-1)-2577)
(COO-2577-10) Avail: NTIS HC A06/MF A01

The NSF/CSU Solar House I solar heating and cooling system became operational on 1 July 1974. The results of one full year of operation of the house are analyzed. ERA

N77-21671# California Univ., Berkeley. Lawrence Berkeley Lab.
COVERED ENERGY FARMS FOR SOLAR ENERGY CONVERSION
James A. Bassham Apr. 1976 20 p Presented at Conf. on Capturing the Sun Through Bioconversion, Washington, D. C., 10 Mar. 1976
(Contract W-7405-eng-48)
(LBL-4844; Conf-760354-1) Avail: NTIS HC A02/MF A01

The reasons for the low efficiency of solar energy conversion in plants are described in order to clarify the economic factors affecting the development of biomass on energy plantations. A proposal is made for an energy plantation in the desert covered with inflatable plastics to prevent water loss. The crop suggested is alfalfa as it can be harvested ten or twelve times a year, and a very high nutritional value protein can be extracted from the leaves by pressing. The residue would be burned to generate electricity. The combined profits from the sale of protein and from the sale of electricity might make this concept economically feasible in a society with expensive energy and food. ERA

N77-21673# California Univ., Los Angeles. School of *Engineering and Applied Science.*
TRANSPARENT GLASS HONEYCOMB STRUCTURES FOR ENERGY LOSS CONTROL Final Report
H. Buchberg, D. K. Edwards, and J. D. Mackenzie. Mar. 1976 97 p refs
(Contract AT(04-3)-1084)
(SAN/1084-75/1; UCLA-ENG-7625) Avail: NTIS HC A05/MF A01

Stacked arrays of thin walled glass tubes and corrugated thin glass sheets were fabricated and demonstrated to be feasible honeycomb constructions for solar collector heat loss control. Likely design values of honeycomb length and diameter were identified within a region limited by temperature difference across the honeycomb, by excessive infrared emittance and conduction, and by deficient solar transmittance. Experimental and analytical performance studies showed that, under comparable conditions, glass honeycomb collectors achieve the highest thermal efficiencies when compared with single glazed selective black and single and double glazed nonselective black collectors and are the most effective when the inlet temperature above ambient air temperature is greater than approximately 30 C. ERA

N77-21674# Sandia Labs., Livermore, Calif.
OPTICAL AND THERMAL CHARACTERISTICS OF A SOLAR COLLECTOR WITH A STATIONARY SPHERICAL REFLECTOR AND A TRACKING ABSORBER
A. M. Clausing (Ill. Univ., Urbana) Aug. 1976 14 p refs Presented at 20th Ann. SPIE Tech. Symp., San Diego, Calif., 23-27 Aug. 1976
(Contract E(29-1)-789)
(SAND-76-8663; Conf-760832-12) Avail: NTIS HC A02/MF A01

A fixed segment of a concave spherical mirror can be used to concentrate beam radiation onto a tracking absorber which pivots about the center of curvature of the mirror. A possible economic advantage of this solar collector over concentrating collectors with tracking mirrors is reduced mirror cost. The objective of the investigation is to determine the potential of this system for electrical power production. Special emphasis is given to identifying the penalty associated with the fixed reflector. The results showed appreciable cosine losses even at the best times of the year. The overall system efficiency was found to be strongly dependent on the rim angle, the optical efficiency, the absorber temperature, and the degree of selectivity of the absorber surface. ERA

N77-21675# Texas Univ., Austin. Center for Energy Studies.
PROCEEDINGS OF SECOND GEOPRESSURED GEOTHERMAL ENERGY CONFERENCE. VOLUME 4: SURFACE TECHNOLOGY AND RESOURCE UTILIZATION Final Report
Gary K. Underhill, Ronald A. Carlson, William A. Clendinning, Jozsef Erdos, John Gault, James W. Hall, Robert L. Jones, Herb K. Michael, Paul H. Powell, Carl F. Riemann et al 1976 396 p refs Conf. held at Austin, Tex., 23-25 Feb. 1976
(Contract E(40-1)-4900)
(CONF-760222-P4) Avail: NTIS HC A17/MF A01

The efficiency of geothermal electric generation plants is known to be low while water resources in most geothermal regions are known to be fully committed. Presented is a survey of the water resources of the Texas Gulf Coast. The impact of meaningful amounts of geothermal generation on the water resources is assessed in terms of subregion and county water resources. ERA

N77-21676# Energy Research and Development Administration, Oak Ridge, Tenn. Technical Information Center.
GEOTHERMAL RESOURCES: EXPLORATION AND EXPLOITATION. A BIBLIOGRAPHY
Jul. 1976 400 p
(TID-3354-R1) Avail: NTIS HC A17/MF A01

This comprehensive bibliography contains 5476 citations of foreign and domestic research reports, journal articles, patents, conference proceedings, and books concerned with the exploration and exploitation of geothermal resources. The coverage dates back as far as useful references could be obtained and extends through June 1976. References are arranged in broad subject categories and are made up of complete bibliographic citations. These are followed by a listing of subject descriptors used to describe the subject content of each reference. Four indexes are included: Corporate, Personal Author, Subject, and Report Number. Also included is a list of journals from which articles were selected. ERA

N77-21677# Texas Univ., Austin. Center for Energy Studies.
PROCEEDINGS OF SECOND GEOPRESSURED GEOTHERMAL ENERGY CONFERENCE. VOLUME 2: RESOURCE ASSESSMENT
D. G. Bebout 1976 36 p refs Conf. held at Austin, Tex., 23-25 Feb. 1976
(Contract E(40-1)-4900)
(CONF-760222-P2) Avail: NTIS HC A03/MF A01

Techniques being used in the assessment of geopressured geothermal resources along the Texas Gulf Coast are described and geologic procedures for test- or industrial-site selection are defined. These approaches have been proven in petroleum exploration and are applicable in geothermal exploration here in the Gulf basin and in other sedimentary basins. ERA

N77-21678# Texas Univ., Austin. Center for Energy Studies.
PROCEEDINGS OF SECOND GEOPRESSURED GEOTHERMAL ENERGY CONFERENCE. VOLUME 3: RESERVOIR RESEARCH AND TECHNOLOGY Final Report
A. L. Podio, K. E. Gray, O. F. Isokrari, R. M. Knapp, I. H. Silberberg, and T. W. Thompson 1976 388 p refs Conf. held at Austin, Tex., 23-25 Feb. 1976
(Contract E(40-1)-4900)
(CONF-760222-P3) Avail: NTIS HC A17/MF A01

Separate abstracts were prepared for the 4 included sections plus the 5 included appendices. ERA

N77-21679# Battelle Pacific Northwest Labs., Richland, Wash.
GEOTHERMAL WATER AND GAS: COLLECTED METHODS FOR SAMPLING AND ANALYSIS: COMMENT ISSUE
J. G. Douglas, R. J. Serne, D. W. Shannon, and E. M. Woodruff Aug. 1976 89 p refs
(Contract E(45-1)-1830)
(BNWL-2094) Avail: NTIS HC A05/MF A01

Compilations of analytic options for constituents in water and gases are given. Also, a survey of published methods of laboratory water analysis is included. It is stated that no recommendation of the applicability of the methods to geothermal brines should be assumed since the intent of the table is to encourage and solicit comments and discussion leading to recommended analytical procedures for geothermal waters and research. ERA

N77-21680# Oak Ridge National Lab., Tenn. Chemistry Div.
PRECIPITATION AND SCALING IN DYNAMIC GEOTHERMAL SYSTEMS
E. G. Bohlmann, A. J. Shor, and P. Berlinski Oct. 1976 50 p refs
(Contract W-7405-eng-26)
(ORNL/TM-5649) Avail: NTIS HC A03/MF A01

A dynamic loop facility for studying scaling in simulated geothermal brines, under conditions such as will be encountered in engineering scale heat transfer equipment, is being constructed. The first phase of the program consists of two principal efforts: modification of an existing 100 gpm titanium loop to provide the engineering scaling test facility, and operation of an approximately 1 gph once-through (experimental) system to provide design data for titanium loop modifications to provide experience with scale formation and characterization. This experience is being used in planning the scaling studies to be conducted in the dynamic loop facility. ERA

N77-21681# California Univ., Livermore. Lawrence Livermore Lab.
WIND POWER STUDIES: FIELD MEASUREMENT PRIORITIES FOR NUMERICAL ANALYSIS OF WIND ENERGY Progress Report, Apr. - Jun. 1976
Donald M. Hardy 15 Jun. 1976 8 p refs
(Contract W-7405-eng-48)
(UCRL-50034-76-3) Avail: NTIS HC A02/MF A01

Results of initial numerical studies and their role in planning the July-August 1976 field program are presented. The acquisition, calibration, and deployment of meteorological instruments for the field program are reviewed. ERA

N77-21683# Mitre Corp., McLean, Va.
GEOTHERMAL ENERGY RESOURCE UTILIZATION PROGRAM PLANNING
F. T. Grover Mar. 1976 44 p
(Contract E(11-1)-2693)
(MTR-7137; COO-2693-76-1) Avail: NTIS HC A03/MF A01

ERDA's basic strategy for creating alternative energy supplies is to conduct a program of research, development, and demonstration of energy technology which induces and aids private exploitation of geothermal energy resources (commercialization). So that the existence of (user) choice is demonstrated, and as a means of channelizing efforts for the mitigation of the nation's gathering crisis in energy supply, specific commercialization goals were set by ERDA. A procedure is described for planning the achievement of the commercialization goals established for geothermal energy resources. It was prepared for the consideration of the Office of Resources Utilization, of ERDA's Division of Geothermal Energy. ERA

N77-21684# Oak Ridge National Lab., Tenn.
MIUS SYSTEMS ANALYSIS: INITIAL COMPARISONS OF MODULAR-SIZED INTEGRATED UTILITY SYSTEMS AND CONVENTIONAL SYSTEMS
G. Samuels, R. C. Robertson, W. J. Boegly, Jr., L. Breitstein, R. E. Gant, W. L. Griffin, J. T. Meador, A. J. Miller, H. R. Payne, and C. L. Segaser Jun. 1976 266 p refs Sponsored in part by HUD
(Contract W-7405-eng-26)
(ORNL-HUD-MIUS-6) Avail: NTIS HC A12/MF A01

Several methods of supplying electricity, space heating, domestic hot water, and air conditioning services at sites were analyzed. A total of eleven models are considered. Nine of the models studied are garden apartment complexes; eight have 720 dwelling units, and one has 1080 units. All units have a floor area of 900 square feet units in a high-rise apartment building containing 130 dwellings. Gas engines were selected as the prime mover for the total energy systems in the study. The utility grid in the conventional system models is assumed to consist of an equal number of coal-fired and nuclear large base-loaded plants. Emissions of NO/sub x/, SO2, and particulates from the central power station were based on recent federal standards for coal- and oil-fired steam generators ERA

N77-21685# Rockwell International Corp., Downey, Calif. Space Div.
ECONOMIC AND TECHNICAL FEASIBILITY STUDY FOR ENERGY STORAGE FLYWHEELS Final Report

Dec. 1975 421 p refs
(Contract E(04-3)-1066)
(ERDA-76-65; SD-75-SA-0166) Avail: NTIS HC A18/MF A01

Flywheel energy storage systems (FESS) for energy conservation in the residential, commercial, industrial, transportation, and utility sectors were studied. Emphasis was placed on utility system applications. Results of the study show that FESS are technically feasible for all sectors examined. It was established that the cost of energy storage is the more important factor in the feasibility of FESS applications. ERA

N77-21686# Sandia Labs., Albuquerque, N.Mex. Advanced Energy Projects Div.
SANDIA VERTICAL-AXIS WIND TURBINE PROGRAM Technical Quarterly Report, Jan. - Mar. 1976
Lawrence I. Weingarten, ed. and Ben F. Blackwell, ed. Aug. 1976 55 p refs
(Contract E(29-1)-789)
(SAND-76-0338) Avail: NTIS HC A04/MF A01

Status of general design efforts in the areas of aerodynamics, structures, systems analysis, and testing is reviewed. Preliminary design details of the proposed 17-m turbine/60-kW generator system for power grid application are given along with structural analysis and operational test results for the existing 5-m turbine. ERA

N77-21687# Brookhaven National Lab., Upton, N.Y. Dept. of Applied Science.
ENERGY MODEL DATA BASE PROGRAM
Murrey D. Goldberg, Walter A. Sevian, Ann W. Reisman, and Paula Newhouse Jun. 1976 20 p
(Contract E(30-1)-16)
(BNL-21545) Avail: NTIS HC A02/MF A01

Models developed by the National Center for Analysis of Energy Systems (NCAES) at Brookhaven were developed principally to provide a descriptive or normative overview of the technological aspects of the national energy system in order to permit analysis and intercomparison of the impact of future technological options. To meet the needs of the NCAES for high-quality numeric data, a flexible, open-ended and model-independent computerized data system was developed and named the Energy Model Data Base (EMDB). It was designed to accept files of numeric quantities useful in energy systems modeling, together with the documentation which indicates the source and quality of the numbers. As noted, the EMDB is independent of any particular model, but choices made in both content and format reflect the requirements of the NCAES modeling programs. A non-technical description of the content of the EMDB is given, and its linkage to Brookhaven optimization and network flow models is indicated. ERA

N77-21688# Sandia Labs., Albuquerque, N.Mex.
VERTICAL-AXIS WIND TURBINE TECHNOLOGY WORKSHOP
Jul. 1976 523 p refs Proc. held at Albuquerque, New Mex., 18-20 May 1976
(Contract AT(29-1)-789)
(SAND-76-5586; Conf-7605511) Avail: NTIS HC A22/MF A01

Separate abstracts are included for twenty-nine of the thirty papers presented concerning vertical axis wind turbines. One paper has previously been abstracted and included in the ERDA Energy Data Base and Energy Research Abstracts journal. ERA

N77-21689# Houston Univ., Tex. Dept. of Chemical Engineering.
TWO-PHASE FLOW IN GEOTHERMAL ENERGY SOURCES Progress Report, 1 Oct. 1975 - 30 May 1976
A. E. Dukler Jun. 1976 45 p refs Prepared for Denver Res. Inst.
(Contract E(11-1)-2729)
(TID-27129; PR-1) Avail: NTIS HC A03/MF A01

A geothermal well, comprised of single and two phase sections, was modeled based on two phase flow principles and selected available correlations. A computer algorithm was written in a versatile form that incorporates any desired void fraction correlation and frictional pressure drop correlation as subroutines. The algorithm was used to assess the effects of important parameters on the overall pressure profile in the well in order to identify the pertinent problems that require further experimental and theoretical investigation. In addition, it was used to evaluate the applicability of pertinent two phase flow correlations to geothermal wells. The results of the parametric study indicated the importance of heat losses, mass flow rate, and void fraction effects on pressure profile and well performance. Components of field data that must be obtained from a test well in order to firm up a reliable design and performance code were identified. The theoretical background of critical two phase flow and minimum vapor velocity required for continuous removal of the liquid from the well was made in order to formulate methods of attack. ERA

N77-21690# Maryland Univ., College Park. Dept. of Mechanical Engineering.
OPTIMIZATION STUDIES OF SOLAR ABSORPTION AIR CONDITIONING SYSTEMS Final Progress Report
Redfield W. Allen and Frederick H. Morse Jan. 1976 102 p refs
(Grant NSF GI-39117)
(NSF/RANN/SE/GI-39117/PR/76/2) Avail: NTIS HC A06/MF A01

The objectives of this study were: (1) to perform a detailed thermodynamic cycle analysis of the basic and various modified absorption air conditioning systems under steady state and transient conditions, for a variety of absorbent-refrigerant combinations; (2) to study the effects of deviations of actual process from ideal processes due to temperature differences and pressure drops in various components and irreversibilities due to mixing and separation of the absorbent-refrigerant pair; (3) to exchange information with absorption air conditioning industry engineers; (4) to consider both fixed and tracking collectors, and to use the results of a detailed collector model and develop a simplified model of reasonable accuracy for use in the combined system simulation; and (5) to study and optimize the performance of the combined collector-absorption system on a thermodynamic basis. ERA

N77-21692# Thermo Electron Corp., Waltham, Mass.
TECHNICAL AND ECONOMIC FEASIBILITY OF SOLAR AUGMENTED PROCESS STEAM GENERATION Final Report
1976 195 p refs
(Contract E(11-1)-2732)
(COO-2732-1) Avail: NTIS HC A09/MF A01

The technical and economic feasibility of solar augmented process steam generation were studied. This approach is analogous to a heat pump that extracts heat from a low temperature reservoir (provided by solar energy) and raises its temperature to a useful level via mechanical work. The shaft power required in the compressor is only one third to one quarter of total steam enthalpy for low pressure process steam (100 psig). This approach permits the use of low cost flat plate collectors. It was concluded that these systems have the potential of yielding payback periods of 5 to 8 years and 10 to 15 years for collector costs of $2/sq ft and $5/sq ft, respectively, depending upon the location. ERA

N77-21697# Pennsylvania State Univ., University Park.
EXPERIMENTAL RESULTS FOR A HEAT PUMP SYSTEM WITH THERMAL STORAGE
M. W. Wildin, S. F. Gilman, E. R. McLaughlin, and F. H. Bridgers 1976 28 p refs Presented at Conf. on Improving Efficiency and Performance of HVAC Equipment and Systems for Com. and Ind. Buildings, Lafayette, Ind., 12 Apr. 1976
(Contract E(11-1)-2704)
(COO-2704-3; Conf-760488) Avail: NTIS HC A03/MF A01

Data were obtained for a brief winter period from a heat pump system with thermal storage. The heat pump system is comprised of a seven and one-half ton water chiller with reciprocating compressor and five water-to-air heat pumps having a total cooling capacity of six and one-half tons. The heat rejected

by the heat pumps during cooling mode operation is stored in 6000 gallons of water and withdrawn during heating mode operation. The energy recovered and stored during daytime operation was more than adequate to satisfy nighttime heating needs during the period of observation. ERA

N77-21699# Sandia Labs., Albuquerque, N.Mex.
RANKINE CYCLE ENERGY CONVERSION SYSTEM DESIGN CONSIDERATIONS FOR LOW AND INTERMEDIATE TEMPERATURE SENSIBLE HEAT SOURCES
J. P. Abbin, Jr. Oct. 1976 18 p ref
(Contract E(29-1)-789)
(SAND-76-0363) Avail: NTIS HC A02/MF A01

Design considerations are described for energy conversion systems for low and intermediate temperature sensible heat sources such as found in geothermal, waste heat, and solar-thermal applications. The most cost effective designs for the applications studied did not require the most efficient thermodynamic cycle, but that the efficiency of the energy conversion hardware can be a key factor. ERA

N77-21701# European Space Agency, Paris (France).
PRODUCTION OF CHEMICAL ENERGY CARRIERS BY NON-EXPANDABLE ENERGY SOURCES
Joachim Nitsch Feb. 1977 74 p refs Transl. into ENGLISH of 'Die Erzeugung chem. Energietraeger mittels regenerativer Energiequellen', DFVLR, Hardthausen, West Ger. Report DLR-FB-76-32, 8 Jun. 1976 Original report in GERMAN previously announced as ESA-98163 Original German report available from DFVLR, Cologne DM 22.40
(ESA-TT-338; DLR-FB-76-32) Avail: NTIS HC A04/MF A01

The different forms of energy (radiation, high-temperature heat, and electricity) arising from non-expendable energy sources like solar energy can be used for the production of chemical energy-carriers. Possible methods are the splitting of water by means of photolysis, thermochemical cycles and electrolysis, and the storage of energy in closed loop chemical systems. These methods are described, and efficiencies and costs of the production of these energy carriers are specified. Special problems of the long-distance transportation of hydrogen produced by solar energy are described, and the resulting costs estimated. Author (ESA)

N77-21702# Stanford Univ., Calif. Dept. of Materials Science and Engineering.
PHOTOVOLTAIC II-VI COMPOUND HETEROJUNCTIONS FOR SOLAR ENERGY CONVERSION Ph.D. Thesis
Fredrik Buch Jun. 1976 133 p refs
(Grant NSF AER-75-1679)
(PB-259195/6; NSF/RANN/SE/AER75-1679/76; NSFIRA-760209) Avail: NTIS HC A07/MF A01 CSCL 10B

Several cells of each type were made and tested, and it was found that the current transport mechanism is thermal activation and tunneling into the heterointerface, where recombination takes place. To describe the current-voltage behavior in light, a collection function that represents the bias voltage dependence of the collection of photogenerated carriers, was introduced. From the collection function, the cell diffusion potentials have been determined, and using the film and substrate carrier densities, the election affinities for CdSe (4.58 eV) and ZnTe (3.74 eV) were calculated relative to the electron affinity of CdTe. GRA

N77-21706# Stanford Research Inst., Menlo Park, Calif.
A WESTERN REGIONAL ENERGY DEVELOPMENT STUDY: ECONOMICS. VOLUME 1: SRI ENERGY MODEL RESULTS Final Report
Nov. 1976 277 p Sponsored in part by EPA, ERDA and Dept. of Interior
(Contract EQ5AC007; EQ5AC008; SRI Proj. 4000)
(PB-260835/4) Avail: NTIS HC A13/MF A01 CSCL 21D

The economics of 38 energy resource development scenarios are examined. The supply analysis looks at capital investments and operating costs for extracting, converting, and transporting all forms of energy. The data were placed in a computer model along with a projection of U.S. energy demands to the year 2000. Vol. 1 presents the results and the Executive Summary. GRA

N77-21709# Stanford Univ., Calif.
WORKSHOP ON GEOTHERMAL RESERVOIR ENGINEERING
Paul Kruger and Henry J. Ramey, Jr. 1976 278 p refs Workshop held at Stanford, Calif., 15-18 Dec. 1975
(Grant NSF AER-72-03490)
(PB-261319/8; NSF/RA-760172; SGR-TR-12) Avail: NTIS HC A13/MF A01 CSCL 08I

The major areas covered in the program consist of reservoir physics (studies to evaluate the physical processes occurring in geothermal systems), well testing (techniques used in specific and generic fields to determine the columeric and extractive characteristics of a reservoir), field development of producing fields, well stimulation (techniques for improving energy recovery from marginal hydrothermal and dry geothermal resources), and modelling (mathematical methods to study geothermal reservoirs). Summaries of 50 technical papers from the five sessions are included in these proceedings. GRA

N77-21711# Lear Motors Corp., Reno, Nev.
GEOTHERMAL HOT WATER PUMP Technical Report, Sep. 1974 - Apr. 1976
Apr. 1976 114 p
(Grant NSF AER-74-18753)
(PB-261741/3; LMC-760504-A; NSF/RA-760379) Avail: NTIS HC A06/MF A01 CSCL 08I

A high-speed electric motor driven submersible pump which can operate at depths of 1,000 feet or more, and at temperatures up to 450 F, was developed. Presented are the motor and pump design, and the results of all testing performed to date on the engineering prototype system. GRA

N77-21712# HOLT/PROCON, Pasadena, Calif.
ENERGY CONVERSION AND ECONOMICS FOR GEOTHERMAL POWER GENERATION AT HEBER, CALIFORNIA, VALLES CALDERA, NEW MEXICO, AND RALT RIVER, IDAHO: CASE STUDIES Topical Report no. 2
Ben Holt and Edward L. Ghormley Nov. 1976 124 p Sponsored by Electric Power Research Inst.
(PB-261845/2; EPRI-ER-301) Avail: NTIS HC A06/MF A01 CSCL 10B

The compatibility of various power conversion options with real geothermal reservoirs was investigated and the economics of power generation was analyzed. Conversion technologies considered for the near term were flashed steam, binary, and hybrid (flashed steam/binary). GRA

N77-21716# National Academy of Sciences - National Research Council, Washington, D. C.
ENERGY FOR RURAL DEVELOPMENT: RENEWABLE RESOURCES AND ALTERNATIVE TECHNOLOGIES FOR DEVELOPING COUNTRIES
1976 306 p refs
(PB-260606/9) Avail: NTIS HC A14/MF A01 CSCL 10A

A summary of the state of the art of alternative technologies frequently suggested as solutions to rural or individual-family energy needs is provided. It informs both the technologist and the planner where to go for more detailed information and what kinds of research and development are needed before a particular device or process is ready for use. GRA

N77-21718# Charles River Associates, Inc., Cambridge, Mass.
LONG-RANGE FORECASTING PROPERTIES OF STATE-OF-THE-ART MODELS OF DEMAND FOR ELECTRIC ENERGY. VOLUME 2: ANNOTATED BIBLIOGRAPHY Final Report
William H. Hieronymus Dec. 1976 47 p refs Sponsored by Electric Power Res. Inst. 2 Vol.
(PB-261766/0; EPRI-EA-221-Vol-2) Avail: NTIS HC A03/MF A01 CSCL 10A

An annotated bibliography of long-term electric energy forecasting models is presented. GRA

N77-21721# Atlas Corp., Santa Clara, Calif.
PROCEEDINGS OF FIRST SEMIANNUAL EPRI SOLAR PROGRAM REVIEW MEETING AND WORKSHOP. VOLUME 1: SOLAR HEATING AND COOLING OF BUILDINGS
P. Bos 12 Mar. 1976 124 p refs Proc. held at San Diego, Calif., 8-12 Mar. 1976 Sponsored by EPRI
(PB-260594/7; EPRI-ER-283-SR-Vol-1) Avail: NTIS HC A06/MF A01 CSCL 13A

A brief description of the ERDA solar program covering current and projected activities in the thermal applications and electric applications, solar heating and cooling of buildings requirements, definition and impact analysis, individual load center-solar heating and cooling residential project, an investigation of methods to improve heat pump performance and reliability in a northern climate, solar materials and components test program, and solar data verification project are discussed. GRA

N77-21722# Atlas Corp., Santa Clara, Calif.
PROCEEDINGS OF FIRST SEMIANNUAL EPRI SOLAR PROGRAM REVIEW MEETING AND WORKSHOP. VOLUME 2: SOLAR ELECTRIC POWER
P. Bos 12 Mar. 1976 239 p refs Proc. held at San Diego, Calif., 8-12 Mar. 1976 Sponsored by EPRI
(PB-260595/4; EPRI-ER-283-SR-Vol-2) Avail: NTIS HC A11/MF A01 CSCL 10B

Environmental assessment of solar energy power plants, requirements definition and impact analysis of solar thermal power plants, closed cycle high temperature central receiver concept for solar electric power, open cycle gas turbine solar electric system, preliminary system analysis of a solar power central station, requirements for utility systems of large-scale utilization of solar power plants, requirements assessment of photovoltaic electric power systems and thermophotovoltaic project are discussed. GRA

N77-21725# Geothermal Resources Council, Davis, Calif.
PROCEEDINGS OF 2ND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS
1976 132 p refs Proc. held at El Centro, Calif., 16-18 May 1975
(Contract DI-BM-P0152088)
(PB-261349/5; BM-OFR-128-76) Avail: NTIS HC A07/MF A01 CSCL 11F

The proceedings of the second workshop on materials problems associated with the development of geothermal energy systems are reported. Topics covered include scale formation, corrosion, and fabrication problems. Materials developed for chloride environments are also described. GRA

N77-21726# Hawaii Univ., Honolulu. Dept. of Mechanical Engineering.
NUMERICAL SOLUTIONS FOR TRANSIENT HEATING AND WITHDRAWAL OF FLUID IN A LIQUID-DOMINATED GEOTHERMAL RESERVOIR
Ping Cheng and Lall Teckchandani Aug. 1976 26 p refs
(Contract E(04-3)-1093; Grant NSF GI-38319)
(PB-261562/3; HGP-TR-17; NSF/RA-760376) Avail: NTIS HC A03/MF A01 CSCL 08I

The transient responses in a liquid-dominated geothermal reservoir resulting from the sudden heating and withdrawal of fluids are studied numerically. The two-dimensional rectangular reservoir is confined by caprock at the top, heated by bedrock from below, and recharged continuously from the vertical boundaries. With appropriate approximations, the governing equations are combined and reduced to two non-linear partial differential equations in terms of dimensionless temperature and pressure. The finite difference form of the temperature is solved numerically by the alternating direction implicit method while that of the pressure equation is solved by the Crank-Nicholson method. GRA

N77-21727# Bechtel Corp., San Francisco, Calif. Research and Engineering.
ENGINEERING DESIGN AND COST ANALYSIS OF CHLORINE STORAGE CONCEPTS FOR A ZINC-CHLORINE LOAD-LEVELING BATTERY Final Report
R. F. Battey Nov. 1976 118 p refs Sponsored by Elec. Power Res. Inst.
(EPRI Proj. 731-1)
(PB-262016/9; EPRI-EM-259) Avail: NTIS HC A06/MF A01 CSCL 10C

Alternate chlorine storage approaches were evaluated and compared in terms of the key technical, safety, economic, and environmental aspects. It is demonstrated that for an ambient pressure zinc-chloride battery the chlorine hydrate approach is a simpler and less expensive storage system than liquid chlorine. Absorption of chlorine in carbon tetrachloride was ruled out because adequate energy efficiencies could not be obtained for the battery system using this chlorine-storage concept. An analysis of the chlorine storage systems studied indicates that safety hazards are moderate and that no extraordinary hazards exist. GRA

N77-21728# National Conference of State Legislatures, Denver, Colo.
STATE POLICIES FOR GEOTHERMAL DEVELOPMENT. UNCOVERING A MAJOR RESOURCE Final Report
Douglas M. Sacarto Nov. 1976 105 p refs
(Grant NSF ISR-74-1152)
(PB-261744/7; NSF/RA-760230) Avail: NTIS HC A06/MF A01 CSCL 08I

Research results from numerous specialists are summarized, and present state and Federal policies affecting the geothermal industry are outlined. Key policy areas are identified, and several specific actions suggested for the states. Six appendixes are included: (1) state laws and regulations regarding geothermal resources; (2) Federal geothermal leasing and development regulations; (3) Federal geothermal lease summary; (4) Federal geothermal steam act; (5) Federal geothermal energy research, development, and demonstration act; and (6) regulations for the geothermal loan guaranty program. GRA

N77-21731# Pennsylvania State Univ., University Park. Dept. of Geosciences.
PRELIMINARY STUDY OF THE IMPORTANCE OF HYDROTHERMAL REACTIONS ON THE TEMPERATURE HISTORY OF A HOT, DRY ROCK GEOTHERMAL RESERVOIR M.S. Thesis
James R. Morris Jul. 1975 90 p refs
(Grant NSF AER-74-08473)
(PB-262391/6; NSF/RA/N-75-353) Avail: NTIS HC A05/MF A01 CSCL 08I

A theoretical computer model, based upon the finite element method, of a two-dimensional fracture in a hot, dry rock geothermal reservoir was developed and tested. Hydrothermal reactions occurring between water and a granitic source rock were subdivided into two categories: dissolving reactions and alteration reactions. It was found that the quartz dissolving reaction had little or no direct effect on reservoir temperatures for any combination of flow and fracture parameters. The location of maximum quartz dissolving was obtained as a function of time. Detailed studies of the time dependence of rock and water temperatures with and without alteration were determined. GRA

N77-21732# Sperry Rand Research Center, Sudbury, Mass. Systems Requirements and Applications Lab.
GEOTHERMAL DOWN-WELL PUMPING SYSTEM Final Report
R. H. Fuller 16 Aug. 1976 35 p refs
(Grant NSF AER-74-08874)
(PB-261857/7; SCRC-CR-76-46; NSF/RA-760342) Avail: NTIS HC A03/MF A01 CSCL 08I

The results of the turbo pump laboratory tests including the measured performance of the 900 gpm pump impeller are documented. A small quantity of working fluid (1% to 2% of brine flow) is sent down to the pumping unit through a down-hole heat exchanger, which consists of two annuli formed by the well casing and two concentric lengths of standard oil field tubing. The working fluid flows down the inner annulus, and

the hot brine flows up the outside annulus. Thus heat is transferred from the brine across the wall of the boiler tube and into the working fluid. The working fluid vapor is used to drive a turbine, which in turn drives the pump impeller. GRA

N77-21739# Central Technical Inst. TNO, Apeldoorn (Netherlands).

LITERATURE SURVEY OF ATMOSPHERIC POLLUTANT EMISSIONS BY NATURAL PROCESSES IN THE NETHERLANDS [LITERATUURONDERZOEK NAAR EMISSIES VAN STOFFEN IN DE ATMOSFEER DOOR NATUURLIJKE PROCESSEN IN NEDERLAND]

G. Annokkee 27 Feb. 1975 35 p refs In DUTCH (CTI-IV-75-01448) Avail: NTIS HC A03/MF A01

The processes under consideration occur in land or water, or in vegetation, without human interference. Some examples are bacterial decomposition of organic material in the ground and syntheses of organic compounds in plants. For each process, an indication is given of the source(s), order of magnitude of the emission, and atmospheric background concentration of the emitted pollutants. ESA

N77-22005*# *National Aeronautics and Space Administration.* Lyndon B. Johnson Space Center, Houston, Tex.

DESIGN TECHNIQUES FOR MODULAR INTEGRATED UTILITY SYSTEMS

Barry M. Wolfer Feb. 1977 78 p refs (NASA-TM-X-58189; JSC-10747) Avail: NTIS HC A05/MF A01 CSCL 05A

Features basic to the integrated utility system, such as solid waste incineration, heat recovery and usage, and water recycling/treatment, are compared in terms of cost, fuel conservation, and efficiency to conventional utility systems in the same mean-climatic area of Washington, D. C. The larger of the two apartment complexes selected for the test showed the more favorable results in the three areas of comparison. Restrictions concerning the sole use of currently available technology are hypothetically removed to consider the introduction and possible advantages of certain advanced techniques in an integrated utility system; recommendations are made and costs are estimated for each type of system. Author

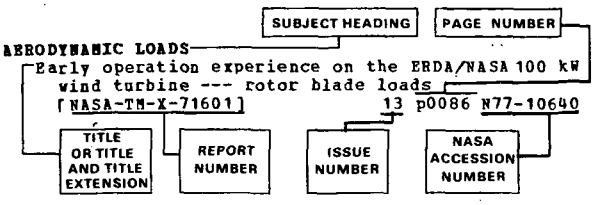
N77-22016# Illinois State Dept. of Business and Economic Development, Springfield. Div. of Energy.

ENERGY RECOVERY FROM SOLID WASTE: A REVIEW OF CURRENT TECHNOLOGY Final Report

Dugald O. Black Jul. 1976 68 p refs (PB-260633/3; NSF/IDOE-76-05) Avail: NTIS HC A04/MF A01 CSCL 10A

Processes for converting and utilizing energy from solid wastes are described along with the economic factors and relative advantages of each process. GRA

Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title or title and title extension provides the user with a brief description of the subject matter. The report number helps to indicate the type of document cited (e.g., NASA report, translation, NASA contractor report). The issue page and accession numbers are located beneath and to the right of the title e.g., *13 p0086 N77-10640*. Under any subject heading the accession numbers are arranged in sequence with the *IAA* accession numbers appearing first.

A

B

C

D

E

F

G

H

J

K

M

N

O

P

Q

R

S

SOLAR ENERGY ABSORBERS

SOLAR HEATING

T

U

V

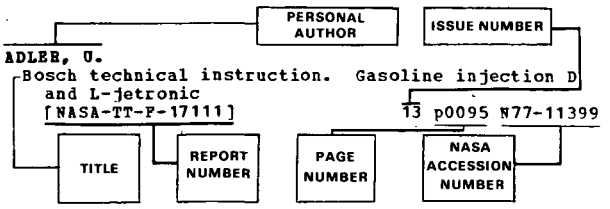
W

X

Z

PERSONAL AUTHOR INDEX

Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The issue, page and accession numbers are located beneath and to the right of the title, e.g., 13 p0095 N77-11399. Under any one author's name the accession numbers are arranged in sequence with the *IAA* accession numbers appearing first.

A

B

C

D

E

F

G

H

I

J

K

M

N

O

P

Q

R

S

T

U

V

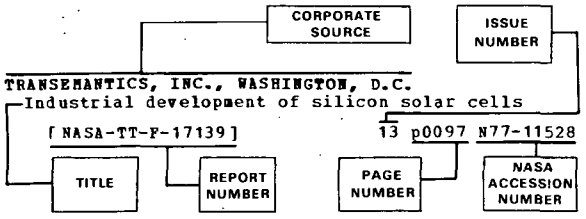
W

Y

Z

CORPORATE SOURCE INDEX

Typical Corporate Source Index Listing



The title of the document is used to provide a brief description of the subject matter. The issue, page number and NASA or AIAA accession number are included in each entry to assist the user in locating the abstract in the abstract section of an individual supplement of *Energy*. If applicable, a report number is also included as an aid in identifying the document.

A

ABCOR, INC., CAMBRIDGE, MASS.
Growth effects of major land use projects. Volume 2: Compilation of land use based emission factors
[PB-255302/2] 13 p0092 N77-10709

ACADEMIA R. P. R., BUCHAREST.
Hydrogen economy analysis using decision theory
14 p0247 N77-21663

ACE-FEDERAL REPORTERS, INC., WASHINGTON, D. C.
Creating energy choices for the future
[CONF-751228-P1] 13 p0087 N77-10647

ACRES AMERICAN, INC., BUFFALO, N. Y.
Underground pumped storage research priorities
[PB-254413/8] 13 p0089 N77-10667

ADAPT SERVICE CORP., READING, MASS.
Effect of mechanical cooling devices on ambient salt concentration
[PB-256679/2] 13 p0125 N77-14631

ADDIS TRANSLATIONS INTERNATIONAL, PORTOLA VALLEY, CALIF.
Underground fuel gasification
[UCRL-TRANS-10998] 13 p0088 N77-10659
Hybrid drive with kinetic energy store as vehicle drive
[UCRL-TRANS-11018] 13 p0120 N77-14486

ADELAIDE UNIV. (AUSTRALIA).
The photosynthetic production of hydrogen
14 p0239 N77-21602

AEG-TELEFUNKEN, FRANKFURT AM MAIN (WEST GERMANY).
Non-nuclear energy technology. Low temperature cable for power transmission
[BMFT-FB-T-76-01] 14 p0210 N77-17372

AEG-TELEFUNKEN, HAMBURG (WEST GERMANY).
Experimental study of the theoretical and technological possibilities to manufacture solar cells using GaAlAs-layers on GaAs-structures
[BMFT-FB-W-76-10] 14 p0212 N77-17584

AEROJET NUCLEAR CO., IDAHO FALLS, IDAHO.
Geothermal R and D project report
[ANCR-1283] 13 p0124 N77-14605
Conceptual study for total utilization of an intermediate temperature geothermal resource
[ANCR-1260] 14 p0211 N77-17579

AEROSPACE CORP., EL SEGUNDO, CALIF.
Personal rapid transit research conducted at the Aerospace Corporation
[PB-256846/7] 13 p0111 N77-12946
Research plan for achieving reduced automotive energy consumption
[PB-255929/2] 13 p0121 N77-14495
Penetration analysis and margin requirements associated with large-scale utilization of solar power plants
[PB-257546/2] 14 p0208 N77-16459

AEROSPACE CORP., LOS ANGELES, CALIF.
Control of waste and water pollution from power plant flue gas cleaning systems
[PB-259211/1] 14 p0227 N77-19953

AIR FORCE ACADEMY, COLO.
Solar heating retrofit of military family housing
[AD-A030843] 14 p0226 N77-19659
The spatial characteristics of three Wyoming fuels
[AD-A030873] 14 p0233 N77-20612

AIR FORCE AERO PROPULSION LAB., WRIGHT-PATTERSON AFB, OHIO.
The impact of JP-4/JP-8 conversion on aircraft engine exhaust emissions
[AD-A026546] 13 p0112 N77-13234

AIR FORCE CIVIL ENGINEERING CENTER, TYNDALL AFB, FLA.
Waste POL disposal through energy recovery
[AD-A031783] 14 p0235 N77-20957

AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.
An exploratory study to determine the integrated technological air transportation system ground requirements of liquid-hydrogen-fueled subsonic, long-haul civil air transports
[NASA-CR-2699] 13 p0083 N77-10033
Assessment and study of existing concepts and methods of cryogenic refrigeration for superconducting transmission cables
[COO-2552-6] 14 p0214 N77-18352

AIRESEARCH MFG. CO., PHOENIX, ARIZ.
Study of small turbofan engines applicable to single-engine light airplanes
[NASA-CR-137944] 13 p0093 N77-11054

ALLIED CHEMICAL CORP., MORRISTOWN, N.J.
Hydrogen generation by photoelectrolysis of water.
14 p0240 N77-21605

AMERICAN AIRLINES, INC., NEW YORK.
Future aircraft requirements: A notebook of airline thoughts
13 p0117 N77-13976

AMERICAN CYANAMID CO., BOUND BROOK, N.J.
Concept for fluidized bed combustion of Consol char using a closed-cycle helium power plant with an estimate of the price of electric power
[ERDA-76-69] 13 p0130 N77-15506

AMERICAN CYANAMID CO., STAMFORD, CONN.
Cadmium stannate selective optical films for solar energy applications
[PB-254879/0] 13 p0090 N77-10678

AMERICAN INST. OF MINING, METALLURGICAL, AND *PETROLEUM ENGINEERS, INC., WASHINGTON, D. C.*
Proceedings of the Mineral Economics Symposium: Winning the high stakes at the critical commodity game
[PB-255607/4] 13 p0105 N77-12502

AMERICAN UNIV., WASHINGTON, D.C.
Research on electrochemical energy conversion systems
[AD-A023689] 13 p0090 N77-10681

AMES LAB., IOWA.
Environmental effects of solid waste as a supplemental fuel
[IS-3852] 14 p0211 N77-17567

APPLIED NUCLEONICS CO., INC., LOS ANGELES, CALIF.
Proceedings of an EPRI Workshop on Technologies for Conservation and Efficient Use of Electric Energy. Volume 1: Overview
[PB-261469/1] 14 p0230 N77-20577

APPLIED PHYSICS LAB., JOHNS HOPKINS UNIV., LAUREL, MD.
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships
[PB-255639/7] 13 p0109 N77-12552

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

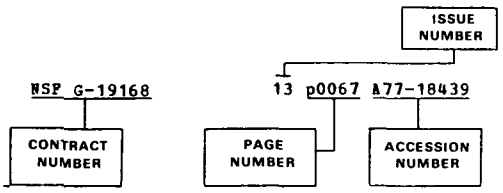
U

V

W

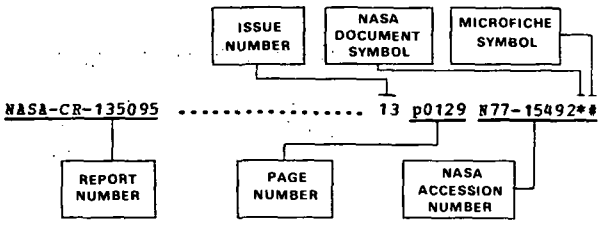
CONTRACT NUMBER INDEX

Typical Contract Number Index Listing



stings in this index are arranged alphanumerically by contract number. Under ich contract number, the accession numbers denoting documents that have ien produced as a result of research done under that contract are arranged ascending order with the *IAA* accession numbers appearing first. The cession number denotes the number by which the citation is identified in ther the *IAA* or *STAR* section. Preceding the accession number are the issue id page number in the particular supplement in which the citation may be und.

Typical Report/ Accession Number Index Listing



Listings in this index are arranged alphanumerically by report number. The issue and page number indicate the actual Supplement and page where the citation may be located. The accession number denotes the number by which the citation is identified. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche. A plus sign (+) indicates a document that cannot be microfiched but for which one-to-one facsimile is available.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA SP-7043 (14)		

4. Title and Subtitle	5. Report Date
ENERGY A Continuing Bibliography (Issue 14)	July 1977
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, D. C. 20546	11. Contract or Grant No.
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This bibliography lists 1000 reports, articles, and other documents introduced into the NASA scientific and technical information system from April 1, 1977 through June 30, 1977.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Bibliographies Energy Conversion Energy Policy Solar Energy Wind Energy	Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	408	$9.00 HC

*For sale by the National Technical Information Service, Springfield, Virginia 22161

*U.S. GOVERNMENT PRINTING OFFICE: 1977 - 735-078/71

PUBLIC COLLECTIONS OF NASA DOCUMENTS

DOMESTIC

NASA distributes its technical documents and bibliographic tools to eleven special libraries located in the organizations listed below. Each library is prepared to furnish the public such services as reference assistance, interlibrary loans, photocopy service, and assistance in obtaining copies of NASA documents for retention.

CALIFORNIA
University of California, Berkeley
COLORADO
University of Colorado, Boulder
DISTRICT OF COLUMBIA
Library of Congress
GEORGIA
Georgia Institute of Technology, Atlanta
ILLINOIS
The John Crerar Library, Chicago
MASSACHUSETTS
Massachusetts Institute of Technology, Cambridge
MISSOURI
Linda Hall Library, Kansas City
NEW YORK
Columbia University, New York
OKLAHOMA
University of Oklahoma, Bizzell Library
PENNSYLVANIA
Carnegie Library of Pittsburgh
WASHINGTON
University of Washington, Seattle

NASA publications (those indicated by an "*" following the accession number) are also received by the following public and free libraries:

CALIFORNIA
Los Angeles Public Library
San Diego Public Library
COLORADO
Denver Public Library
CONNECTICUT
Hartford Public Library
MARYLAND
Enoch Pratt Free Library, Baltimore
MASSACHUSETTS
Boston Public Library
MICHIGAN
Detroit Public Library
MINNESOTA
Minneapolis Public Library
MISSOURI
Kansas City Public Library
St. Louis Public Library
NEW JERSEY
Trenton Public Library
NEW YORK
Brooklyn Public Library
Buffalo and Erie County Public Library
Rochester Public Library
New York Public Library
OHIO
Akron Public Library
Cincinnati Public Library
Cleveland Public Library
Dayton Public Library
Toledo Public Library
TENNESSEE
Memphis Public Library
TEXAS
Dallas Public Library
Fort Worth Public Library
WASHINGTON
Seattle Public Library
WISCONSIN
Milwaukee Public Library

An extensive collection of NASA and NASA-sponsored documents and aerospace publications available to the public for reference purposes is maintained by the American Institute of Aeronautics and Astronautics, Technical Information Service, 750 Third Avenue, New York, New York 10017.

EUROPEAN

An extensive collection of NASA and NASA-sponsored publications is maintained by the British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England. By virtue of arrangements other than with NASA, the British Library Lending Division also has available many of the non-NASA publications cited in *STAR*. European requesters may purchase facsimile copy of microfiche of NASA and NASA-sponsored documents, those identified by both the symbols "#" and "*", from: ESA - Space Documentation Service, European Space Agency, 8-10 rue Mario-Nikis, 75738 Paris CEDEX 15, France.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

SPECIAL FOURTH CLASS MAIL
Book

POSTAGE AND FEES PAID
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION
NASA-451

U.S.MAIL

POSTMASTER: If Undeliverable (Section 158 Postal Manual) Do Not Return

NASA CONTINUING BIBLIOGRAPHY SERIES

NUMBER	TITLE	FREQUENCY
NASA SP-7011	AEROSPACE MEDICINE AND BIOLOGY Aviation medicine, space medicine, and space biology	Monthly
NASA SP-7037	AERONAUTICAL ENGINEERING Engineering, design, and operation of aircraft and aircraft components	Monthly
NASA SP-7039	NASA PATENT ABSTRACTS BIBLIOGRAPHY NASA patents and applications for patent	Semiannually
NASA SP-7041	EARTH RESOURCES Remote sensing of earth resources by aircraft and spacecraft	Quarterly
NASA SP-7043	ENERGY Energy sources, solar energy, energy conversion, transport, and storage	Quarterly
NASA SP-7500	MANAGEMENT Program, contract, and personnel management, and management techniques	Annually

Details on the availability of these publications may be obtained from:

SCIENTIFIC AND TECHNICAL INFORMATION OFFICE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C. 20546

GPO 944-370