TAC STPG 78-001

(NASA-CR-158591) SOLAR THERMAL POWER GENERATION. A BIBLIOGRAPHY WITH ABSTRACTS Quarterly Update, Jan. - Mar. 1978 (New Mexico Univ.) 155 p

N79-76989

Unclas

00/44 25002

Solar Thermal Power Generation

Quarterly Update January-March 1978

TECHNOLOGY APPLICATION CENTER
THE UNIVERSITY OF NEW MEXICO
ALBUQUERQUE, NEW MEXICO 87131

MAY 1979
RECEIVED
NASA STI FACILITY
ACCESS DEPT.

NASA

SOLAR THERMAL POWER GENERATION

A BIBLIOGRAPHY WITH ABSTRACTS

QUARTERLY UPDATE JANUARY-MARCH 1978

PREPARED BY THE

ENERGY INFORMATION PROGRAM

of the

TECHNOLOGY APPLICATION CENTER

JUNE 1978

THE UNIVERSITY OF NEW MEXICO
ALBUQUERQUE, NEW MEXICO

A DIVISION OF THE INSTITUTE FOR APPLIED RESEARCH SERVICES (IARS)

The Technology Application Center (TAC) is one of six NASA-sponsored, nonprofit, regional centers for the transfer of technology to industry, local government, and the private sector in general. Through TAC, access to most of the world's available technical information is conveniently and inexpensively provided to potential users, regardless of their size or technical interest area.

Through its professional staff, TAC offers a wide variety of technical information and technological support services.

You are invited to contact the center directly for details and a discussion of how we can further serve your needs.

Technology Application Center
University of New Mexico
Albuquerque, New Mexico 87131
(505) 277-3622

This material is disseminated under the auspices of the National Aeronautics and Space Administration in the interest of information exchange. Neither the United States government nor the University of New Mexico assumes any liability for its content or the use thereof.

NASA
National
Aeronautics and
Space
Administration

INTRODUCTION

In this, the first quarterly update of a new year, we have initiated several changes to improve the Solar Thermal Power Generation bibliography and make it a more user-oriented work. With the ever-increasing number of available citations which reference anything remotely solar in nature, we have become somewhat more selective in the editing of the abstracts. We have modified our indexing method away from "permuted title" and strictly towards "keywords" (subject terms), since experience has shown that the relevance of titles to actual content can be very inconsistent. Our author index has been retained. In addition, TAC's ability to supply American source documents has been streamlined to provide faster service and turnaround time on document orders.

In this bibliography, one of the most interesting articles is entitled: Daedalophia: Diagnosis and Prognosis (ST78-11031), and addresses the Canadian hesitation to initiate widespread residential solar heating and cooling. Various economic, legal, and energy overviews have been abstracted with particular emphasis on Canadian and German authors, while American overviews of state legislation provide a valuable source of current financial incentives to the solar homeowner/builder.

The typically low quantity of relevant literature on Thermoelectic Science (Section 14,000) suggests that this section either be broadened in scope or consolidated into the section on Solar Thermal Power (13,000). For Ocean-Thermal Energy Conversion (15,000), the question of biofouling has again arisen in terms of ecological-impact evaluation. Other citations in this section deal with the modelling of such devices to determine heat transfer capability and operation. The section on Wind Energy (16,000) has a large number of abstracts, representative of the heavy research being carried on in this area. The citations concerning the vertical-axis machine are of particular note here. The section on Residential Power (18,000) is small, but an interesting abstract on the solar-cell shingle (ST78-18003) has direct application to the concept of decentralized elecric power, a significant implication for such new technology.

With this issue, we introduce a new editor of the Solar Thermal series. John Peck's academic background lies in the fields of physics and electrical engineering, and he worked in the field of architecture for the two years prior to coming to TAC. He has replaced Geoffrey Bell, who has moved into a position as TAC's Energy Information Program coordinator. In the interests of further improving this bibliographic series, we welcome any and all reader criticism, negative and positive. Our final goal is to build a truly user/reader-oriented bibliography.

Technical Co-Editors:
John Peck
Geoffrey Bell

GUIDE TO USE OF THIS PUBLICATION

A number of features have been incorporated to help the reader use this document. They consist of:

-- A TABLE OF CONTENTS listing general categories of subject content and indexes. More specific coverage by subject title/keyword and author is available through the appropriate index.

-- CITATION NUMBERS assigned to each reference. These numbers, with the prefix omitted, are used instead of page numbers to identify references in the various indexes. They are also used as TAC identifier numbers when dealing with document orders; so please use the entire (prefix included) citation number when corresponding with TAC regarding a reference. An open ended numbering system facilitates easy incorporation of subsequent updates into the organization of the material. In this system, numbers assigned to new citations in each category will follow directly the last assigned numbers in the previous publication. The citation number of the last reference on each page appears on the upper right-hand corner of that page to facilitate quick location of a specific term.

-- A REFERENCE FORMAT containing the TAC citation number, title of reference, author, corporate affiliation, reference source, contract or grant number, abstract and keywords. The reference source tells, to the best of our knowledge, where the reference came from. If from a periodical, the reference source contains the periodical's title, volume number, page number and date. If for a report, the reference source contains the report number assigned by the issuing agency, number of pages and date.

-- An INDEX OF AUTHORS alphabetized by author's last name. A reference's author is followed by the reference's citation number. For multiple authors, each author is listed in the index.

-- An INDEX OF PERMUTED TITLES/KEYWORDS affords access through major words in the title and through an assigned set of keywords for each citation. A reference's title is followed by the reference's citation number. In the indexes, all the words pertaining to a reference are permuted alphabetically. Thus, the citation number for a reference appears as many times as there are major title words or keywords for that reference. The permuted words run down the center of an index page. The rest of the title or keywords appear adjacent to a permuted word. Since a title or set of keywords is allowed only one line per permuted word the beginning, the end, or both ends of a title or set of keywords may be cut off; or, if space permits, it will be continued at the opposite side of the page until it runs back into itself. A # indicates the end of a title or set of keywords while a / indicates where a title or set of keywords has been cut off within a line.

CONTENTS

SECTION NUMBER	COVERAGE	Page
	INTRODUCTION	iii
10,000	Energy Overviews	1
11,000	Solar Overviews	13
12,000	Economics and Law	27
13,000	Thermal Power	36
14,000	Thermionic/Thermoelectric	55
15,000	Ocean Thermal Differential	57
16,000	Wind Power Conversion	65
17,000	Biomass	81
18,000	Residential Power	89
19,000	Large Scale Photovoltaic, Hydrogen Production, and Other	90
	AUTHOR INDEX	103
	SUBJECT TERM INDEX	119

10000 ENERGY OVERVIEWS

ST78 10000 ENERGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES, Issue 12

(NASA, Washington, D.C.), NASA-SP-7043(12), 335 pages, N77-31602
Avail:NTIS
This bibliography lists 584 reports, articles, and other documents introduced into the NASA scientific and technical information system from October 1, 1976 through December 31, 1976.

(ENERGY-POLICY, NASA, WIND)

ST78 10001 ENERGY CHANGES - A CHALLENGE TO INDUSTRY, 1976

(Adhes. and Sealant Council, Des Plaines, IL), J. Adhes. Sealant Counc., Energy Changes-A Challenge to Ind., Spring Semin., Philadelphia, PA, V 4, N1, 144 pages, March 1-3, 1976
This paper contains proceedings of a meeting containing 12 papers devoted to energy in general and energy conservation in the adhesive and sealant industry. Topics discussed include energy legislation's impact on adhesives/sealants and solar energy use for low-temperature applications.

(ADHESIVES-MANUFACTURE)

ST78 10002 ENVIRONMENTAL TECHNOLOGY '77, INSTITUTE OF ENVIRONMENTAL SCIENCES ANNUAL TECHNICAL MEETING PROCEEDINGS, 23rd, 1977

(Inst. of Environ. Sci., Mt. Prospect, IL), Inst. of Environ. Sci. Ann. Tech. Meeting Proceedings, 23rd, Los Angeles, CA, 437 pages, April 25-27, 1977, Inst. of Environ. Sci., Mt. Prospect, IL
The Proceedings contains 73 papers covering the many different aspects and fields of environmental engineering. Topics covered include air and water quality assessment, management aspects of environmental studies, waste management, solar energy utilization, conservation of energy, reliability, testing specifications and standards, climate test methods and facilities, environmental testing, environmental education, and nuclear power.

(ENVIRONMENTAL-ENGINEERING, ENVIRONMENTAL-TESTING, SYSTEMS-ENGINEERING)

ST78 10003 FEDERAL ENERGY INFORMATION LOCATOR SYSTEM - ENERGY INFORMATION IN THE FEDERAL GOVERNMENT

(Federal Highway Administration, Washington, D.C.), 384 pages, FEA-B-76-492, PB-262331-2 N77-31661
This 1976 update has been prepared from a source survey conducted between August and November 1976. "Feils" allows the user to identify federal agencies collecting specific kinds of energy data and, therefore, to locate that data. The system itself does not contain the data available in the federal government; it is a directory for that data.

(INDEXES, INFORMATION-SYSTEM)

ST78 10004 IEEE STUDENT PAPERS, 1975

(IEEE, New York, NY), IEEE Stud. Pap., 331 pages, 1975, IEEE, New York, NY, Cat. no. TT0101-6
This is the first annual publication of worldwide student-authored papers, judged best in the IEEE Student Paper Contest. The 27 papers are on a variety of topics, from an electronic communication aid for the handicapped, to modeling the flow of energy through a salt marsh ecosystem, to a high voltage solar cell.

(SOLAR-CELL)

ST78 10005 INTEGRATED UTILITY SYSTEMS: FEASIBILITY STUDY AND CONCEPTUAL DESIGN AT CENTRAL MICHIGAN UNIVERSITY

(Department of Health, Education, and Welfare, Washington, D.C.), (NBS), 120 pages, PB-266044-7, N77-29628
Avail:NTIS
The technical feasibility and the economic benefits of an integrated utility system (IUS) at Central Michigan University are addressed, as are the environmental and institutional factors. The recommended IUS incorporates a total energy system wherein all of the required electric power is generated on-site with full utilization of the waste heat from the power cycle for heating and cooling purposes. System integration is achieved through incineration with heat recovery of solid waste from both the university and the city of Mount Pleasant.

(ECONOMIC, ENVIRONMENTAL, INSTITUTIONAL-FACTORS)

ST78 10006 INTEGRATED UTILITY SYSTEMS: FEASIBILITY STUDY AND CONCEPTUAL DESIGN AT THE UNIVERSITY OF FLORIDA

(Department of Health, Education, and Welfare, Washington, D.C.), (NBS), 170 pages, PB-266043-9, N77-29627
Avail:NTIS

The technical feasibility and the economic benefits of an integrated utility system (IUS) at the University of Florida are addressed, as are the environmental and institutional factors. The recommended IUS alternates include select energy systems wherein one fourth to three fourths of the required electrical power is generated on-site with full utilization of the waste heat from the process for heating and cooling purposes. Full integration of the systems is achieved through incineration of solid waste for its heat content, and partial reuse of the effluent from the existing sewage treatment plant for equipment make-up water and for irrigation.

(ECONOMIC, ENVIRONMENTAL, INSTITUTIONAL-FACTORS)

ST78 10007 INTER-PLAN COMMUNICATION AND MOTIVATION STUDY, Final Report, Florida Background Study

(Sperry Urban Science Center, Washington, D.C.), W77-00098, PB-242-181
Avail:NTIS

This six-month study looked into factors which diminish success of innovative public programs and inhibit private investment in helping to solve public sector problems. Study concludes that success of innovative programs in inhibited by lack of understanding of the overall effort and unclear definitions of responsibility, lack of packaging individual innovations into decision alternatives, lack of support for innovations, and lack of input by end-product users. Examples of each of these are given including regional development efforts, solar energy projects, planned unit developments, and legislation efforts. An experiment with the goal of promotion of innovation in the public sector is described. Joint public-private sector committee to improve evaluation methods, an office of experiment management charged with technical control of the entire experiment, and introduction of certain brokerage functions. A successful brokerage undertaking would involve bringing together appropriate technology, planning and defining responsibilities of key people, supporting available innovation, and communicating meaningful information. Results of the experiment may provide useful information for policy guidance in areas of land use planning, environmental protection, revenue sharing, comprehensive planning and regionalism, and federal-state relationships.

(INSTITUTIONAL-CONSTRAINTS, LAND-USE)

ST78 10008 INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, 12th, Washington, D.C., Aug. 28-Sept. 2, 1977

American Nuclear Society, Inc., La Grange Park, IL, V 1:1007, V 2:986, A77-48701, A77-48702, A77-48909, Sponsored by ANS, SAE, ACS, ASME, AIAA, IEEE, and AICHE

The papers in this collection deal with continuing advances in the search for and development of new sources of energy and more efficient processes that consume energy. The topics cover a wide range, including advanced auto propulsion, alternative fuels, Brayton cycle engines, fluid bed combustion, geothermal and solar power systems, rankine cycle engines, thermionics, and wind power.

(ENERGY-TECHNOLOGY, GEOTHERMAL, WIND)

ST78 10009 INTRODUCTION: MAN AND HIS TOTAL ENVIRONMENTAL

(NASA, Marshall, Huntsville, AL), In its NASA Workshop on Solar-Terrest. Studies from a Manned Space Station, 5 pages, N77-32554, N77-32549 23-42
Avail:NTIS

Environmental changes and the utilization of finite resources are analyzed. Beyond the satisfaction of basic physical needs, the advancement of civilization toward an ever-improving quality of life is likewise dependent upon man's interaction with his entire environment. This larger system is controlled externally by electromagnetic and particle energy from the sun and internally by the dynamic interchange of energy between the solid earth, oceans, the atmosphere, and the magnetosphere. This exchange of energy that determines the structure of the earth's environmental system is evaluated.

(EARTH-RESOURCES, ENVIRONMENTAL-CONTROL)

ST78 10010 NATIONAL RESEARCH COUNCIL COMMITTEE ON NUCLEAR AND ALTERNATIVE ENERGY SYSTEMS, Interim Report

(National Academy of Sciences-National Research Council, Washington, D.C.), 56 pages, TID-27435, EX-76-C-10-3784, PB-263-595, N77-31655
Avail:NTIS

The need for and direction of nuclear power development, the various nuclear options being considered in detail, including breeder reactor and associated fuel-cycle technologies were studied. But decisions regarding nuclear energy cannot be made in a contextual vacuum. The time scale and the context in which these decisions should be made depend not only on the technical, social, and economic status and impacts of other energy-supply technologies, but also on assumptions concerning future levels of demand for energy conservation through changes in consumption patterns and improved efficiency of the supply and end-use systems. The study, therefore, seeks to relate the many important factors that impinge on ERDA's and the nation's energy decisions and thereby on the ultimate role of nuclear power.

(CONSUMPTION, ECONOMIC, ENERGY-POLICY, SOCIAL-FACTORS)

ST78 10011 PROJECT INDEPENDENCE EVALUATION SYSTEM (PIES) DOCUMENTATION, Volume 15, STANDARD DATA TABLES FOR PIES

(FEA, Washington, D.C.), FEA-N-77-116, PB-265195-8, N77-29629
Avail:NTIS

The standard tables given are an adjunct to the documentation of the project independence evaluation system. The standard tables provide a rigid format for the presentation of data to be used in generation of the linear program matrix. The tables are the synthesis of all raw data used in the matrix after arithmetic operations have been performed. In general, there are three categories of standard tables: facilities, materials, and transportation. Units for each entry are in standard PIES physical quantities.

(DATA-ACQUISITION, ENERGY-POLICY)

ST78 10012 SITE ENERGY HANDBOOK, Volume 1, METHODOLOGY FOR ENERGY SURVEY AND APPRAISAL

(ERDA, Washington, D.C.), 172 pages, Oct. 1976, E(49-1)-3853, ERDA-76-131-1

The United States Energy Research and Development Administration ENERGY HANDBOOKS present guidelines to investigate and analyze energy usage, to identify energy saving opportunities, and to recommend and evaluate energy conservation measures at ERDA facilities. The SITE ENERGY HANDBOOK (2 volumes), covers site energy and utility distribution systems, and the BUILDING ENERGY HANDBOOK (to be published) pertains to the interior systems. The scope of the SITE ENERGY HANDBOOK includes primary site energy distribution systems and utilities. The site energy survey and appraisal methodology and forms, as well as the site energy conservation opportunities presented in the HANDBOOK, cover energy entering the site, energy generated on site, energy distributed and consumed on the site, and waste energy recovery.

(CONSUMPTION, DEMAND-FACTORS, UTILITIES)

ST78 10013 SITE ENERGY HANDBOOK, Volume II, FORMS FOR ENERGY SURVEY AND APPRAISAL

(ERDA, Washington, D.C.), 255 pages, Oct. 1976, E(49-1)-3853, ERDA-76-131-2

Volume 2 of the SITE ENERGY HANDBOOK contains the site energy survey and appraisal forms within the following categories: Site Description Forms presented in Chapter 2, Site Energy Survey Forms presented in Chapter 3, Site Energy Appraisal Forms presented in Chapter 4. The site description forms provide the major characteristics of the site (name, location, acreage, facilities) as well as data concerning future buildings and other planned modifications. Separate forms are provided for the following site energy, utility, and recoverable waste energy systems: natural gas, fuel oil, LPG, coal, electricity, steam, hot water, chilled water, compressed air, water supply, steam condensate, wastewater, and solid waste. Additional graphic material such as pie or bar charts may be prepared to present overall site energy configuration.

(CONSUMPTION, DEMAND-FACTORS, RESEARCH-PROGRAMS, UTILITIES)

ST78 10014 TECHNICAL GUIDELINES FOR ENERGY CONSERVATION, Final Report, Dec. 1975-March 1977

(NBS, Washington, D.C.), 404 pages, AD-A041668, NBSIR-77-1238, AFCEC-TR-77-12, N77-32596

This report provides detailed technical material on various energy conservation actions for existing Air Force facilities and utility systems. It is specifically tailored to serve as a working document for base engineers and technical personnel. The report covers energy conservation for Air Force facilities, including the equipment for providing hot water, space heating and cooling, lighting, and humidification. It also covers central plant systems and underground distribution systems (hot water, steam, and chilled water). This volume includes the following topics: energy conservation measures for exterior building envelopes, modifying mechanical systems and operating practices for energy conservation, conducting the building survey, measurements for identifying energy conservation potential, economic analysis, and appendices: heat transfer fundamentals, solar energy systems for Air Force applications, heat and chilled water distribution systems, and survey of computer-programs for evaluating building and system performance.

(AIR-FORCE-FACILITIES, COMPUTER-PROGRAMS, CONSUMPTION)

ST78 10015 THERMAL ENERGY MANAGEMENT TECHNIQUES IN SPACECRAFT DESIGN AND THEIR POTENTIAL FOR TERRESTRIAL APPLICATIONS

Ahmed, S., Wehrle, V.A., (Department of Communications, Communications Research Centre, Ottawa, Canada), Engineering Institute of Canada, Annual Congress, 90th, Halifax, Nova Scotia, Canada, 32 pages, Oct. 5-8, 1976, A77-47969

Thermal energy management schemes derived from aerospace applications, including multilayer insulation, heat pipes, hollow glass microsphere insulation, and surface finishes are discussed. The operation of conventional, variable conductance and thermal diode heat pipes is described. Terrestrial uses of heat pipes, such as stabilization of permafrost adjacent to Arctic oil pipelines, cooling of high-power electronic components, increasing the efficiency of domestic and commercial appliances and applications in solar energy collectors, are considered. The manufacture of multilayer blanket insulation for cryogenic to room temperature applications is described, and use of multilayer insulation in storage containers for liquefied gases is mentioned. Glass microsphere insulation for use in underwater environments, and surface finishes employed in solar heating and cooling of buildings are also discussed.

(ENERGY-TECHNOLOGY, INSULATION, RESEARCH-PROGRAMS)

ST78 10016 FUTURE ENERGY OPTIONS, ETHICS, AND A CASE FOR CONSERVATION

Armstrong, J.E., Water, Air, Soil Pollut., V 7:187-194, N2, Feb. 1977, EDB-77:127566

Up to 1990 the US must rely upon four major sources for additional energy to meet the expected continued growth in energy use: (1)expanded coal and the associated synthetics fuels derived from it, (2)expanded production of Continental Shelf and Alaskan oil and gas, (3)nuclear, and (4)imported petroleum. After 1990, solar and oil shale could play increasingly important roles as additional sources. These major energy options are compared at a national level in their broad environmental, economic, social, and political implementation impacts. In view of the disadvantages that all of these choices entail, the necessity to continue energy use growth into the indefinite future is explored with special emphasis on major effects of economic soundness, employment, food supply, national defense, and the emerging social unrest that characterizes the 1970's in the USA. An inevitable conclusion urges that a major energy conservation program would be a wise and prudent course for the USA to follow, with the stipulation that its gradual implementation over something like a 10-year period is necessary.

(CONSERVATION, ENERGY-POLICY)

ST78 10017 ROLE OF THE TECHNICAL SERVICE CONTRACTING INDUSTRY IN THE ENERGY PROGRAM

Armstrong, W.C., (Northrop Services, Inc., Anaheim, CA), Energy LA: Tackling the Crisis, 1976, Ed: Robinson, J.W., Western Periodicals Company, North Hollywood, CA, EDB-77:139759

The technical service contracting industry is comprised of companies, usually att attached to and derivative from aerospace and related industry. In testimony before congress it has been estimated that contracts held by this industry exceed $3.5 billion per year. The purpose of these contracts is to provide scientific, technical, and technically related services, usually to federal agencies. This paper describes typical roles that have been or are now being performed by the industry. These include descriptions of support in the following areas: testing of solar collectors, integration and analytical support of solar heating and cooling programs, development of modular integrated utility systems, evaluation of hydrogen and other advanced energy systems, collection of climatic data, local government energy conservation and resource management programs, energy-related invention analysis, program management-technical administrative services, and potential future support of federally sponsored demonstration projects.

(DATA-COMPILATION, DEMONSTRATION-PROGRAMS, EDUCATION, ENVIRONMENTAL, MIUS, RESEARCH-PROGRAMS, TECHNOLOGY-ASSESSMENT)

ST78 10018 APPROACHES LEADING TO AN EFFICIENT USE OF ENERGY, ILLUSTRATED WITH THE AID OF EXAMPLES CONCERNING THE RAIL TRAFFIC AND LOW-TEMPERATURE HEAT REQUIREMENTS

Bauermeister, K., (Deutsche Bundesbahn, Frankfurt Am Main, West Germany), Brecht, C., (Ruhrgas Ag. Essen, West Germany), Schaefer, H., (Muenchen, Technische Universitaet, Munich, West Germany), Stoy, B., (Rheinisch-Westfaelisches Elektrizitaetswerk Ag, Essen, West Germany), Brennstoff-Waerme Kraft, V 29:347-352, Sept. 1977, In German, A77-51153

An improvement of the efficiency of processes involved in obtaining, converting, distributing, and employing energy makes it possible to lower specific energy requirements. An improvement of this efficiency implies in most cases that expenses for increased cap capital investment take the place of a part of the costs for energy. The economic aspects of such a replacement improve with increases in the cost of fuel. Savings related to lower energy consumption must also be taken into consideration. Attention is given to heat conservation approaches employed in the case of new houses and buildings in West Germany, the utilization of solar radiation, the reduction of the heat losses of hot-water storage, the employment of heat pumps, an extended use of electric locomotives, the use of natural gas in gas heat pumps, and various approaches leading to a minimization of traffic-related energy requirements.

(CONSERVATION, ENERGY-POLICY, ENERGY-TECHNOLOGY)

ST78 10019 FUTURE ENERGY SOURCES

Beattie, D.A., (ERDA, Washington, D.C.), Prepr., Div. Pet. Chem., Am. Chem. Soc., V 22: 101-104, N1, Feb. 1977, EDB-77:145988
Prospects of the following future energy sources are discussed: fusion energy, geothermal energy, and solar energy.

(FORECASTING)

ST78 10020 IMPROVED SYSTEMS FOR ENERGY CONVERSION AND CONSERVATION AS POLLUTION CONTROL ALTERNATIVES: USEPA PROGRAM

Bostian, H.E., Skovronek, H.S., Mournighan, R.E., (US Environmental Protection Agency, Industrial Environmental Research Laboratory, Cincinnatti, OH), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:600-606, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48771
This paper is an overview of a USEPA research program on energy conversion and conservation. The program emphasis is on environmental problems or benefits of more efficient energy systems or ones using more abundant domestic energy resources. More efficient energy systems can generally be considered as environmentally attractive alternatives but their relative environmental-economic benefits need to be determined. On the other hand, some systems could have unique pollution control problems because of different operating conditions, use of higher sulfer fuels and feedstocks, or possible generation of hazardous pollutants. The program coverage includes the environmental aspects of waste energy utilization and other energy conservation measures, advanced power systems such as magnetohydrodynamics, ones using high-temperature turbines, and solar and geothermal energy conversion.

(ECONOMIC, ENVIRONMENTAL, POLLUTION-CONTROL)

ST78 10021 FUTURE ENERGY SYSTEMS OF INDIA - A DELPHI STUDY

Bowonder, B., Rohatgi, P.K., (Indian Inst. of Science, Bangalore Dept. of Industrial Management, Bangalore, India), J. Sci. Ind. Res., V 35:335-351, N6, June 1976, EDB-77:112530
The results of a Delphi study conducted in India to forecast the energy systems that are likely to be developed at different times in the future and their relative impacts are reported. The likely dates of occurrence and potential impacts of 96 events have been assessed on the future energy systems in India. The respondents indicate that fast growth in nuclear power systems, installing superthermal power stations, establishing 300,000 community biogas plants, reducing national transmission losses, and completion of Ganga-Cauvery Canal are some of the events which will have maximum impact. Alternatively, they are the most desirable events. Certain policy imperatives derived from this study have been listed. A comparison of the dates of occurrence of certain events predicted by different Delphi studies has been made. Five possible scenarios are derived for the energy sector.

(BIBLIOGRAPHIES, COMPARATIVE-EVALUATIONS, ECONOMIC, FORECASTING)

ST78 10022 ASSESSING OUR ENERGY ALTERNATIVES

Budenholzer, R.A., Lavan, Z., (Ill. Inst. of Technol., Chicago, IL), Consult. Eng., Barrington, IL, V 48:97-102, N5, May 1977, EDB-77:140022
The nation's energy needs and resources are reviewed. A table shows the distribution of primary and electric energy usage. Of the total annual energy consumption of 71 quads, 72 percent is in the form of direct energy consumption, and the remaining 28 percent is in the form of electric generation and electric generation losses. Table 3 shows that there is enough recoverable oil from shale to furnish our petroleum needs at present rates of consumption for about 75 years and that more dilute shales yielding from 10 to 25 gal. per ton could extend this several fold. Projected energy consumption patterns from 1960 to 1000 in quads and estimated energy consumption projected for the year 2000 in quads are also tabulated.

(CONSUMPTION, ECONOMIC, ENERGY-POLICY, FORECASTING, TECHNOLOGY-ASSESSMENT)

ST78 10023 HARD TRUTH ABOUT OUR ENERGY FUTURE

Bueche, A.M., (General Electric Co., Schenectady, NY), March 1977, NP--22052, EDB-77:112939
After an examination of energy consumption data in the US, the role of conservation, opportunities for heat pumps, the status of US energy sources, and energy supplies beyond the year 2000 are discussed. Then, in summary, Dr. Bueche lists seven things that have to be done now to safeguard our future energy supply. They are: rapidly accelerate the construction of the safe, efficient, clean light-water nuclear reactor power stations we have shown we can make, start a vast program of digging new coal mines, move at once to build the transportation systems required to move the huge amounts of coal to where they

are needed and to build the required power and conversion plants; hasten development of the breeder reactor and of new technology for converting coal into synthetic fuels to replace scarce oil and gas; support basic research in fusion, solar electricity, and solar fuel generation as an investment in the longer-range future; continue, of course, an all-out exploration for new oil and gas supplies, which means new ways to identify sources of these fuels and far better methods of getting all that is there out of the ground for our use; and inaugurate and promote intelligent, realistic energy conservation programs.

(CONSERVATION, DEMAND-FACTORS, FORECASTING)

ST78 10024 RESEARCH AND DEVELOPMENT IN THE ENERGY SECTOR

Chatterjee, K.S., (Dept. of Sci. and Technol., New Delhi, India), Electr. India, V 16:9-12, N19, Oct. 15, 1976

The development trends of the energy sector in India suggest that the socio-economic conditions in the country do not permit highly sophisticated technologies. Further research and development should be oriented towards exploration of the huge deposits of Indian coal, although its ash content is high. The possibilities of developing alternative energy resources, e.g. solar energy, wind power, geothermal energy, and tidal power are also discussed.

(GEOTHERMAL, INDIA, TIDAL-POWER, WIND)

ST78 10025 OVERVIEW OF CANADIAN ACTIVITIES IN RENEWABLE ENERGY RESOURCES

Cockshutt, E.P., (National Research Council, Ottawa, Canada), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 1: 79-82, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:118174, A77-48912, A77-48910 23-44

The Canadian Federal Government Energy Research and Development Program is outlined. Major projects, arranged in order of priority are (1)energy conservation, (2)maintenance of adequate oil and gas supplies, (3)use of coal as an oil and gas substitute, (4)use of nuclear power, and (5)development of renewable energy sources. More specifically, the development of renewable energy sources is divided into several program topics, such as hydraulic and tidal, solar biomass, wind, and geothermal. International and national cooperative efforts in research programs are briefly noted.

(CANADA, ENERGY-POLICY)

ST78 10026 POWER-ENERGY: HIGH MARKS FOR TECHNOLOGY

Friedlander, G.D., IEEE Spectrum, V 14:62-65, N1, Jan. 1977

A solar energy conversion scheme has been developed which is described as a floating "eyeball" staring at the sun.

(ELECTRIC-INDUSTRY, POWER-PLANTS)

ST78 10027 COMEBACK FOR REDDY KILOWATT

Friedlander, G.D., IEEE Spectrum, V 9:44-50, N4, April 1972, EDB-77:132012

Depletion of fossil fuels and the lag in building nuclear plants is spurring the search for other generating techniques and fuels. This article discusses magneto-hydrodynamic generation, fuel cells for dispersed power generation, a lithium-sulfur battery plant for power peaking, fast breeder reactors, and solar cells for terrestrial power.

(FUEL-CELLS, LITHIUM-SULFUR BATTERIES, SOLAR-CELLS)

ST78 10028 EARTH, INC.

Fuller, R.B., Anchor Press, Garden City, NY, 1973, EDB-77:139834

The author seeks "through comprehensive anticipatory design science and its reductions to physical practices to reform the environment instead of trying to reform humans." He portrays the net physical wealth accomplishments of man's civilized history from 1250 to 1970, particularly following the significance in the rate of man's acquisition of the 92 elements. The author observes that the "space vehicle earth and its life-energy-giving sun and the tide-pumping moon can provide ample sustenance and power for all humanity's needs to be derived from our direct energy income without further robbing our fossil fuels energy savings account." He completes the volume by describing 10 proposals for improving the world, "world-around problems that have to be solved by bloodless design science revolution."

(EARTH-RESOURCES, ECONOMIC, GLOBAL-ASPECTS, SOCIAL-IMPACT, SOCIO-ECONOMIC, TIDAL-POWER)

ST78 10029 SOUTH KOREA FORESEES CLIMB IN ENERGY NEEDS

Furukawa, T., Energy User News, V 2:21, N22, June 6, 1977, EDB-77:119735
South Korea is projecting a parallel five-year economic and energy growth rate of 9.2 percent while maintaining the present 60-40 ratio of imported and domestically produced energy. Domestic efforts will emphasize coal and hydroelectric, as well as nontraditional forms such as tidal energy. Economic strategies will include diverse energy sources and direct investment in Middle East refineries. Nuclear power will be available after 1981 and will take on an increasing share of the $6 billion domestic power projects budget. Fifty new oil wells and expanded refining capacity, exploration, and drilling for coal are among the projects. Electrical demand, which has increased each year by 17.2 percent, is expected to continue at a somewhat reduced level. Energy conservation efforts are considered a success by officials. A boost in exports and foreign investments for domestic developments are needed.

(ECONOMICS, ENERGY-DEMAND, FORECASTING, KOREA, TIDAL-POWER)

ST78 10030 AN ENVIRONMENTAL OVERVIEW OF UNITED STATES ENERGY FUTURES

Gage, S.J., (EPA, Washington, D.C.), In Proceedings of National Conference on Health, Environmental Effects, and Control Technology of Energy Use, Report no. 600-7-76-002, p. 15-25, Fig. 15, 1976, W77-02650
A general discussion and prediction of the environmental impacts of energy production in the United States. Briefly treated are the impacts of petroleum production in the maring environment; coal mining, especially surface mining; coal utilization, including fluidized EED combustion; oil shale development; geothermal energy development; and solar energy.

(ENERGY-PRODUCTION, ENVIRONMENTAL-EFFECTS, GEOTHERMAL, POLLUTION)

ST78 10031 SANDIA ENERGY TITLES

Gardner, J.L., Ed., (Sandia Labs., Albuquerque, NM), June 1977, SAND-77-0921, EDB-77:127444
This bibliography of reports, periodical articles, and conference papers represents research carried out by Sandia Laboratories in energy and conservation. Within each of the approximately 300 entries, authors are listed alphabetically in each subject category. The following subjects are covered: conservation, drilling technology, environment and safety, fossil energy, geothermal energy, nuclear energy, and solar energy.

(BIBLIOGRAPHIES, ENVIRONMENT, GEOTHERMAL, RESEARCH-PROGRAMS)

ST78 10032 ALTERNATIVE ENERGY STRATEGIES: CONSTRAINTS AND OPPORTUNITIES

Hagel, J., III, Praeger Publishers, Inc., New York, NY, 1976, EDB-77:139908, $17.50
The current status and future direction of energy research and development and investment strategies are summarized in the context of several possible scenarios regarding the availability and cost of crude oil imports. While focus is on trends in the United States, consideration is also given to the two other primary energy-consuming areas of the non-communist world, Western Europe and Japan. In order to evaluate the variations in policy that may arise in these areas as a result of differing conditions and to anticipate the impact of these policies on the world energy market. The first chapter summarizes recent trends in the world energy market in order to provide a framework for the analysis that follows. Following chapters review the status of current development programs in alternative energy sources and suggest energy strategies that might be implemented using three different sets of assumptions regarding the availability and cost of crude oil imports. Chapter 2 particularly reviews the status of tar sands and oil shale R and D. Chapter 3 reviews coal and coal conversion processes, while Chapter 4 reviews nuclear energy. Chapter 5 investigates geothermal and solar energy, electric battery traction systems, fuel cells, and hydrogen fuels. General considerations of effective energy policies, energy conservation strategies, and constraints on energy strategies are covered in the next three chapters. Chapter 9 establishes energy strategy scenarios, high-priced, and total embargo on crude oil imports. Energy strategy options in Western Europe and Japan, evaluation of energy strategies, and a summary on constraints and opportunities in alternative energy strategies complete the book.

(ENERGY-POLICY, FEASIBILITY-STUDIES, FUEL-CELLS, GEOTHERMAL, HYDROGEN, JAPAN, EUROPE, MARKET, RESEARCH-PROGRAMS, UNITED-STATES)

ST78 10033 SPINOFF 1977; An Annual Report

Haggerty, J.J., (NASA, Washington, D.C.), NASA-TM-74908, 117 pages, N77-34049
Direct and indirect benefits of space technology are reviewed. Applications in medicine, agriculture, solar energy technology, transportation, and other fields are discussed.

(AEROSPACE-TECHNOLOGY, NASA-PROGRAMS)

ST78 10034 NEW POWER GENERATION SYSTEMS

Hauser, L.G., Coal Age, V 81:41, N7, July 1976, EDB-77:125026
Only 12 new power generation systems are feasible using existing technology and capable of competing in cost with systems now in use. Since intensive development is needed to make any of the 12 successful, efforts should concentrate on the five that will "most benefit society over the next 25 years." These are: (1)coal gasification with gas and steam-turbine generators in combined cycles, (2)the breeder reactor, (3)municipal wastes with steam-turbine generators, (4)wind power with wind-turbine generators, and (5) electrolytes with storage batteries. Coal gasification with a combined-cycle generating plant is potentially the most efficient, lowest cost, and most environmentally desirable way of making electricity from vast US coal resources. Various combinations of 12 types of electric generating equipment with 19 known energy sources gives a total of 53 technically feasible electrical energy systems for the last quarter of the 20th century. However, a question arises in the value judgement of "most benefit society..." with options 1 and 2.

(COMPARATIVE-EVALUATIONS, ECONOMICS, ELECTRIC-POWER, FEASIBILITY-STUDIES, WIND)

ST78 10035 ANALYSIS OF ET, Four surveys

Hill, R.F., (Government Institutes, Inc., Washington, D.C.), Energy Technology IV: Confronting Reality, 1977, Ed: Hill, R.F., EDB-77:139905
Three surveys were conducted during the conference. Attendees were asked to give their opinions on matters of importance to the nation's energy future and the development of the necessary energy technology. Between 254 and 481 of the 1,200 attendees responded to each of the questionnaires. In addition to expressing their opinions on energy and technology policy, they were asked to forecast the mix of energy sources and the total amount of energy to be used in the year 2000, and to describe how they believe energy research and development money should be spent in 1978. The results indicate an average forecast of 128 quadrillion BTU of energy use in the year 2000, an annual growth rate of 2.4 percent compared with a pre-1973 annual growth rate of about 3.5 percent. The respondents forecast a slight decline in domestic oil production, a small but continuing increase in oil imports, a decrease in natural gas, almost a tripling of coal use, a seven-fold increase in nuclear, and about 10 percent of the total coming from the new or emerging technologies in oil shale, biomass, geothermal, solar, wind, and fusion. The respondents also see a need for increasing research and development programs with the emphasis on conservation, solar, fusion, synthetic fuels, breeder reactors, conventional coal, and conventional nuclear.

(COMMERCIALIZATION, ECONOMICS, ENERGY-POLICY, FORECASTING, RESEARCH-PROGRAMS, SOURCE-DEVELOPMENT)

ST78 10036 LONG TERM OUTLOOK FOR ENERGY PROBLEMS IN JAPAN

Hirota, H., (Resources and Energy Agency, Secretariat, Japan), Denki Kyokai Zasshi, V 640: 8-15, Feb. 1977, In Japanese, EDB-77:111282
New energy technology related to the renewable energy resources such as solar, geothermal, marine, liquefied coal, and hydrogen energy must be strongly promoted due to the rapidly dwindling supplies of conventional fuels. These technologies can reasonably be expected to be developed by the 21st century, leading the way to energy independence. Although research is now well developed in most of these technologies, the application of solar air-conditioning in ten percent of Japanese homes and the installation of solar and geothermal power generating equipment could save about 5×10^7 tons of petroleum, about five percent of the primary energy consumed in Japan. It is to be desired that these technologies be well developed within the period of 20 to 30 years after the year 2000.

(ENERGY-POLICY, GEOTHERMAL, JAPAN)

ST78 10037 BETTER ENERGY CONVERSION DEVICES ARE NEEDED

Jones, R.A., Keeler, J.S., SAE J., V 68:30-33, Jan. 1960, EDB-77:131877
Major conversion devices discussed are batteries, fuel cells, chemical dynamic systems, nuclear power systems, and static solar systems.

(FUEL-CELLS, SOLAR-CELLS)

ST78 10038 ENERGY OPTIONS, I, ENERGY OVERVIEW, II, ALTERNATIVE ENERGY SOURCES

Kratner, K.L., (Environmental Education Group, Los Angeles, CA), 1973, EDB-77:139911
Part I is a brief overview of the current state of energy utilization and the nature of the energy crisis. The paper notes that "the real crisis is in finding the means of replacing a combustion energy system, based on nonrenewable resources, with a system that will sustain the world populations with a clean, continually replenished fuel." Part II is a presentation of the alternative sources of energy that are neglected, are of possible

aid in the near future, or are modifications of current energy sources. Part II also endeavors to analyze each alternative with respect to economic feasibility and environmental impact.

(ENVIRONMENTAL-IMPACTS, GEOTHERMAL, HYDROGEN-BASED-ECONOMY, WIND)

ST78 10039 ALTERNATE ENERGY SOURCES

Kyle, M.L., (Illinois University, Chicago, IL), 1976, CONF-7609132, EDB-77:117229
Most people are aware of the problems attendant in increasing utilization of our national coal reserves. We need more people, more capital, more railroads, and better technology. If we view the other energy options, however, the problems seem equally severe. Our energy options are limited. This nation will rely more heavily on imported oil until our coal and nuclear capabilities are increased. This will not be easy, but there does not seem to be any alternative energy options significantly changing this conclusion. The problems involved in meeting our energy needs are too broad for technologists to solve. The public and our political system must become involved. Until we have set goals and outlined means for achieving those goals, the present state of confusion in energy will continue to exist. A national energy policy would also bring to focus many of the nontechnical issues involved in bringing supply and demand in balance.

(COAL, COMPARATIVE-EVALUATIONS, FORECASTING, GEOTHERMAL)

ST78 10040 ENERGY RESOURCES AND THE ENVIRONMENT

Lenihan, J., Fletcher, W.W., Eds., Blackie and Son Ltd., London, 1975, EDB-77:119676, Also see ST77-10203
Exploitation of energy has some impact on the environment. Six essays are presented to examine the variety of problems: (1)Sir Samuel Curran, in Energy and the Needs of Man, concludes that techniques to produce new energy sources will be found, but conservation and the population explosion must be seriously examined, (2)Dr. Earl Cook, in Flow of Energy Through Technological Society, shows where energy comes from, how it is used, and how it returns to the environment. He emphasizes the inefficiency of many energy conversion processes in consequence of the second law of thermodynamics. (3)Dr. Andrew Parteous, in Economical Use of Energy and Materials, explains energy not only used in heating, lighting, and transport, but in industry. His accounting of energy shows waste, and he stresses recycling and recovering the energy in domestic waste. (4)Sir Frank McFadzean, in Energy, The International Scene, examines the interplay of economics, technology, and politics in the oil industry. He suggests that more mature international leadership is needed to overcome the current difficulties facing producers and consumers. (5)J.D. Dunster, in The Atom and the Environment, examines the environmental impact of nuclear energy where the safety standards are more strenuous, but are feared more. He is a proponent of nuclear energy, but says an overall energy policy, balancing environmental factors against economic and political considerations, is needed. (6)Dr. B.J. Brinkworth, in Direct Use of Solar Energy, reminds us that the sun is the ultimate source of energy, and says solar energy can be exploited globally without damaging the environment.

(DEMAND-FACTORS, ECONOMICS, ENERGY-BALANCE, ENVIRONMENTAL-IMPACTS, INTERNATIONAL-COOPERATION)

ST78 10041 IMPACT ON THE PETROLEUM INDUSTRY OF DEVELOPING ALTERNATE SOURCES OF ENERGY

McKetta, J.J., Scott, R.W., Lambert, D.F., Ponder, T.C., Hoffman, H.L., Wall, J.D., (Gulf Publishing Co., Houston, Tx), Ninth World Petroleum Congress, V 5, 1975, Applied Science Publishers, Ltd., London, England, EDB-77:136679
The exploration, drilling, and production for oil and gas will continue to increase greatly world-wide, regardless of the increased production of alternate sources of energy. The distribution systems of petroleum will also increase greatly between now and the year 2000, but there will be a marked effect of the alternate sources on this phase of the industry. The processing portion of the petroleum industry will undergo changes to handle the varied feedstocks which will be supplied to it. The petroleum processing may be forced to redistribute its products to get more efficient end use of all forms of energy. The petrochemical industry will continue its great growth but feedstocks for the increased production will be based more on heavier oils and solids. The developing alternate sources of energy will not provide sufficient material to make up for the increased demand of feedstocks for the natural gas, processing, and petrochemical industries.

(ECONOMETRICS, GEOTHERMAL)

ST78 10042 ALTERNATIVE ENERGY TECHNOLOGIES IN BRAZIL

Miccolis, J.M.F., (George Washington University, Washington, D.C.), 1977, EDB-77:140023
It is imperative that Brazil consider alternative energy production and conservation techniques in order to cope with the energy crisis. Brazil imports about 650,000 bbl/day of petroleum, which accounts for more than 78 percent of total consumption. Oil amounts

to 50 percent of the total energy utilized in Brazil. After a brief review of the energy resources in Brazil (water power, coal reserves, shale deposits, uranium reserves, petroleum and natural gas reserves), alternative energy production technologies are summarized. These include solar energy, bioconversion, a hydrogen economy, and fossil-fuel alternative technologies (coal gasification, shale oil). Incentives for the use of alternative energy sources include not only the gradual replacement of gasoline and other liquid fuels by ethyl alcohol, but also the more efficient use of other natural resources. Recently, the government imposed very tough conservation regulations (Jan. 1977). These are listed; they are expected to substantially change the energy consumption pattern in the country.

(BIOMASS, ETHANOL, FEASIBILITY-STUDIES, HYDROGEN-BASED-ECONOMY, SOCIO-ECONOMIC)

ST78 10043 ROLE OF RENEWABLE ENERGY TECHNOLOGIES IN DEVELOPING COUNTRIES

Palmedo, P.F., (Brookhaven National Lab., Upton, NY), 11 pages, BNL-22311, EY-76-C-02-0016, N77-33638
Avail:NTIS

Some of the implications of the choice between renewable, decentralized technologies and nonrenewable, centralized technologies as applied to developing countries are presented. In order to clarify the significance of the distinction between renewable and depletable resources, two qualifications are made. The resource and its feasible system to use that resource is of primary interest. The second qualification is that some resources that are finite have such large abundance that they can be considered renewable. Some specific steps that can be taken to give renewable energy resources an opportunity to compete on a more equal footing with conventional fossil and nuclear technologies are stimulate and support energy planning in developing countries, include appropriate technology in developed country R and D programs, and develop and demonstrate technologies.

(DECENTRALIZED, ENERGY-TECHNOLOGY, RESOURCES-MANAGEMENT)

ST78 10044 DEVELOPMENT STATUS AND ENVIRONMENTAL HAZARDS OF SEVERAL CANDIDATE ADVANCED ENERGY SYSTEMS

Penny, M.M., Bourgeois, S.V., (Lockheed Research Engineering Center, Huntsville, AL), Cain, W.C., (US Environmental Protection Agency, Industrial Environmental Research Laboratory, Cincinnatti, OH), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:646-654, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, US Environmental Protection Agency, EPA-68-02-1331, A77-48776, A77-48701 23-44

This paper present a review of the development status and anticipated primary environmental hazards of nine advanced energy systems. A summary of federally-funded R and D for these energy systems is also presented. Each of these energy systems has a negligible or mild direct environmental impact when compared with conventional fossil fuel and nuclear systems. Indirect impacts for some of the energy systems could be severe, however, and these systems need further study to quantify their impacts. Considering both expected environmental impact and period of technology breakthrough-commercialization, the systems are ranked in order of decreasing research priority as follows: high temperature turbines, ocean thermal gradients, windmills, magnetohydrodynamics, metal vapor rankine topping cycles, hydrogen fuel cells, thermionics, electrogasdynamics, and thermonuclear conversion.

(ENERGY-TECHNOLOGY, ENVIRONMENT EFFECTS, FUEL-CELLS, HAZARDS, OCEAN-WT, RANKINE-CYCLE, THERMOELECTRIC, THERMIONIC, WIND)

ST78 10045 DESIGN GUIDELINES FOR ENERGY CONSERVING SYSTEMS, Final Report

Qureshi, A.S., Moeller, G.L., Gore, E., (Baker (Michael Jr.) of New York, Inc., New York, NY), 131 pages, VA-99-R070-2, V-1010-266, PB-268989-1, N77-33670
Avail:NTIS

Analysis of design guidelines and design limitations for the selection, evaluation and design of solar energy systems, total energy and selective energy systems, continuous duty standby systems, engine-driven chiller-heat pump systems, and solid waste boiler systems are preserved.

(EVALUATION, SYSTEMS-ENGINEERING)

ST78 10046 RESEARCH, DEVELOPMENT, AND ENGINEERING ASSOCIATED WITH RENEWABLE ENERGY RESOURCES

Ramachandran, A., Sci. and Cult., India, V 42:384-397, N8, 9 refs, Aug. 1976

Short and long term industrial and domestic needs for energy in India are reviewed. Sources discussed include solar, geothermal, and organic wastes.

(INDIA, GEOTHERMAL)

ST78 10047 ENERGY RESOURCES, TECHNOLOGIES OF THE FUTURE, I, STATEMENT OF PROBLEMS AND STRATEGY

Reynolds, G.F., (Univ. of Reading, Reading, England), Electrotechnology, V 5:43-45, N2, 3 refs, April 1977

The author examines today's complex energy situation in perspective and likely courses of action for the "carbohydrate" and "solar" eras of tomorrow.

(FORECASTING)

ST78 10048 ENERGY SOURCES OF THE FUTURE

Sanders, J.P., (Oak Ridge Associated Universities, Inc., Oak Ridge, TN), (Oak Ridge National Lab., Oak Ridge, TN), Energy Sources for the Future, April 1977, Eds: Duggan, J.L., Cloutier, R.J., CONF-760744, EDB-77:139891

In evaluating the choices for possible energy sources of the future, it is important first to realize that we have come to the end of an era, the era of cheap fossil fuel. A study of the history of energy usage in his country will indicate a "take-off" occurred in our energy consumption rate in the mid-1950's. This was followed by an increase in the use of electricity as a more convenient energy source in the mid-1960's. Associated with the generation of increasing amounts of electricity were the conversion losses that are inherent in normal steam cycles. Our future needs can be projected on the basis of the population growth and the energy consumption rate per capita. An extrapolation of these needs minus the amount of fossil fuel that we can obtain or afford to import shows clearly the demand placed on domestic supplies. After an allowance is made for the remaining fossil reserves plus optimistic projections for energy from geothermal, hydroelectric, oil shale, and solar resources, a deficit remains. It appears that nuclear fission energy is the only developed source that has a possibility of filling this deficit between the present and the year 2000. Past that date, there is hope that nuclear fusion energy or some other of the developing technologies will be available to supply the need.

(CONSUMPTION, DEMAND-FACTORS, ECONOMIC, FORECASTING, GEOTHERMAL, POPULATION-DYNAMICS, SOCIAL-IMPACT, UNITED-STATES)

ST78 10049 EPA VAN OPERATIONAL MANUAL

Scholer, N.E., (Englhard Minerals and Chemicals Corp., Union, NJ), Aug. 1976, PB-259177, EDB-77:144666

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.

(COLLECTORS, EDUCATION, FUEL-CELLS)

ST78 10050 ENERGY ADVISORY SERVICE, Second Quarterly Report, September 1, 1976-November 30, 1976

Shelley, E.F., (New York Inst. of Tech., Old Westbury, NY), Dec. 10, 1976, TID-27521, EDB-77:119646

Energy conservation tips are being dispensed by telephone, television, and mail service from the New York Tech. Energy Hot Line. It is service of the center for energy, policy, and research of the New York Institute of Technology, Old Westbury, NY, and is under contract with the US ERDA. Information on energy conservation and management, energy policy and legislation, and solar energy are available from telephone number (576) 686-7744. The activities to Dec. 31, 1976 are summarized.

(ENERGY-POLICY, INFORMATION-DISTRIBUTION)

ST78 10051 NATIONAL ENERGY POLICY FOR ISRAEL

Sonnino, T., (Soreq Nuclear Research Centre, Yavne, Israel), Energy, Oxford, V 2:141-148, N2, 22 refs, June 1977, EDB-77:139924

A brief outline of a plan for energy supply for Israel to the year 2000 is presented. The utilization of energy (as petroleum) and the growth of population and GNP from 1948 to 1975 are examined. Some guidelines for the future uses of energy and the diversification of supply, i.e. the use of coal, nuclear energy, solar heat, and the modest role of hydroelectric power, are examined.

(DEMAND-FACTORS, FORECASTING, POPULATION-DYNAMICS)

ST78 10052 ENERGY ALTERNATIVES WITHIN NATO

Sudarskis, M., (NATO, Brussels, Belgium), Energy Policy, V 5:165-167, N2, June 1977, EDB-77:131979

The aim of the NATO committee on the challenges of modern society (CCMS) pilot studies on energy is to provide nations with as many as possible of the technical options available. The CCMS strategy is to suggest which technologies may be relevant and to accord priorities, recognition of the finite nature of the earth's energy resources has created a new awareness of the importance of alternative sources such as solar and geothermal energy. CCMS pilot study on geothermal energy is currently underway. The study covers most of the main technical and scientific aspects which arise from geothermal energy exploitation: improvement of techniques for hot water uses, reservoir technology, brines reinjection, dry-hot rocks experiments. Among the projects the study of a small, portable and modular geothermal power plant up to 5 mv may provide interesting results. The CCMS pilot study on solar energy exchanges information on the performance of solar heating and cooling projects being undertaken by many countries. The CCMS review would accelerate the international solar house surveys which aim at cataloging all the existing solar houses or solar heating systems. The CCMS study reports upon experiments in NATO and non-NATO countries, e.g., Brazil, Jamaica, Israel, Saudi Arabia, the Bahamas, El Salvador, and the Philippines. Better utilization of energy is as important as the production of alternative sources. Presently the CCMS projects deal with energy use in the steel, cement, and plastics industries. Energy consumption in the brewing industry is under investigation.

(ENERGY-POLICY, FORECASTING, GEOTHERMAL, GLOBAL-ASPECTS, INTERNATIONAL COOPERATION, NATO, TECHNOLOGY-TRANSFER)

ST78 10053 OUR ENERGY FUTURE: THE CASE FOR INTENSIVE R AND D

Sussman, S.S., (California Univ., Livermore, CA), Energy and Technology Review, March 1977, Eds: Selden, R.W., Crawford, R.B., Cummings, K.L., Prono, J.K., UCRL-52000-77-3, EDB-77:119692

The Stanford Research Institute energy model was used to examine and evaluate the potential benefits to the US of an intensive energy R and D program implemented over the time frame 1975 to 2025. Two of the six scenarios studied are reported: the LLL nominal case in which no additional energy R and D is undertaken, and the end-use supply R and D case in which research and development is applied to all phases of the energy picture, from exploiting primary resources to developing new energy technologies, and greater end-use efficiencies. Results show that a vigorous energy R and D program could be of tremendous economic benefit.

(ECONOMICS, ENERGY-MODELS, FORECASTING, RESEARCH-PROGRAMS, UNITED-STATES)

ST78 10054 ENERGY AND THE ENVIRONMENT

Theodore, L., Rolinski, E.J., McCarthy, W.N.Jr., Buonicore, A.J., Earley, D.E., Servais, R.A., Eds., (American Institute of Chemical Engineers, Dayton, OH), (Eugene W. Kettering Center, Dayton, OH), 1976, EDB-77:127493, $20.00

All papers from the proceedings have been entered individually in EDB and ERA; fourteen were selected for EAPA. Five papers had been received earlier and processed. The papers are concerned with coal gasification, energy policy, energy conservation, filters and electrostatic precipitators, solar energy, energy from wastes, air pollution measurement and control, coal preparation, environmental effects, etc.

(ENERGY-POLICY, ENVIRONMENTAL-IMPACTS, MEETINGS)

ST78 10055 INDUSTRIAL VIEW OF ENERGY PLANNING

Vetter, E.O., Technol. Rev., V 79:11, 75, N8, 1977, EDB-77:139902

All elements of society in the US bear responsibility for the energy dilemma, the author says. He further adds, "President Carter should launch a media blitz of the magnitude displayed in connection with the program announced on April 20, to eliminate arbitrary and unbalanced regulatory requirements that constrain energy production and conversion initiatives. It is unfair for one sector of our society to pay unnecessarily high energy prices because another sector unreasonably withholds the opportunity to increase energy supplies." An energy plan for the United States must be conceived in terms of two moments in time. One is the year 1985, chosen because until then we are almost locked into present energy sources and, almost to the same extent, demand patterns. The other is the year 2000, when initiatives taken in the next few years might reach full fruition to change our patterns of supply and demand. There are only four strategies that will affect our outlook for 1985 and 2000 in a major way: conservation, optimal development of domestic oil and gas resources, optimum conversion to coal, and optimum development of nuclear energy. There are two additional strategies that will play an important role in the year 2000 and beyond: development of such alternate (exotic) energy sources as solar and geothermal, and increasing reliance on new systems, such as co-generation, for achieving major increases in the efficiency of fuel and/or energy utilization.

(CO-GENERATION, ECONOMICS, ENVIRONMENTAL-EFFECTS, FORECASTING, ENERGY-POLICY, SOURCE-DEVELOPMENT, UNITED-STATES)

ST78 10056 THOUGHTS ON THE ENERGY CRISIS OF THE USA, II, (STEAM GENERATION, NUCLEAR FUSION, AND SOLAR ENERGY

Wolf, P.C., Waerme, Germany, V 82:97-102, N5, Oct. 1976, In German, for Part I see Ibid., V 82:25-28, N2, 1976

This document discusses energy generation by nuclear fusion and solar energy sources, hydrogen as a primary source of energy, and as an extremely flexible, easily transportable energy carrier costing some 2.5 times as much as the equivalent energy in natural gas to transport, but cheaper than transport or electrical energy.

(HYDROGEN-BASED-ECONOMY, UNITED-STATES)

ST78 10057 ENERGY: SOLUTIONS FOR THE LONG TERM

Yasharoff, N., Power Plant South Africa, pp. 11, 13, 15, July 1976, EDB-77:118475

"Power towers" operated by sunlight, vertical-axis, windmills capable of generating electricity, breeder reactors producing more uranium than they consume, and power plants fuelled by nuclear fusion - these are some of the exotic energy sources to be created as long-term alternatives under the US Government's plan for energy and research development. International co-operation, which has already begun, could permit other nations to share with America the fruits of this investment in the future.

(ENERGY-POLICY, SOUTH-AFRICA, THERMAL-POWER, WIND)

11000 SOLAR OVERVIEWS

ST78 11000 INTERNATIONAL CONFERENCE ON SOLAR ELECTRICITY, 1976

(Cent. Nat'l d'Etud Spat., Toulouse, France), International Conf. on Solar Electr., Toulouse, France, 1029 pages, March 1-5, 1976, Cent. Nat'l d'Etud Spat., Toulouse, France, In French

The proceedings contain 93 papers by various authors discussing solar energy in developing countries. Calculations of energy, insolation, and thermodynamic constraints, as well as plate collectors, are also addressed. Papers on photoelectrochemical generation, hydrogen production, thermal storage, sea thermal energy, solar electric power generation, climatology of solar resources, and comparisons with nuclear energy are also part of the proceedings.

(PHOTOVOLTAICS, THERMOELECTRIC)

ST78 11001 NONWATER-INTENSIVE ENERGY RESOURCES

In Energy, Water, and the West, Albuquerque, NM, p. 73-76, Append. 5, Nov. 2-5, 1975, May 1976, W77-00549, W77-00542

Water requirements for solar energy production are analyzed and compared with water consumption patterns for other fossil fuel types of electricity generation. Possible techniques include the use of mirrored surfaces and the photovoltaic approach where sunlight is converted directly to electricity using solar cells, the latter requiring no water. Economic feasibility and possible refinements of the solar cell are discussed. Wind generation is another solar-energy prospect with no water requirement. Geothermal energy has been used commercially only under geologic conditions where heat from the earth's interior is transported to the surface by convective circulation of steam or very hot water. Natural hydrothermal systems may produce dry steam, or, more often, superheated water which contains great quantities of thermal energy. Dry hot rock energy utilization is discussed as a system which may improve as energy is withdrawn from it. More air-cooled power plants may also be developed in the future.

(COOLING, ECONOMIC, ELECTRIC POWERPLANTS, GEOTHERMAL, HYDROTHERMAL)

ST78 11002 SHARING THE SUN: SOLAR TECHNOLOGY IN THE SEVENTIES, 1976

Boer, K.W., Ed., (Univ. of Delaware, Inst. of Energy Convers., Newark, DE), Sharing the Sun: Solar Technol. in the Seventies, Joint Conference of the Int. Solar Energy Soc., Am. Section and Solar Energy Soc. of Canada, Inc., Winnipeg, Manitoba, Canada, V 10, Aug. 15-20, 1976, Int. Solar Energy Soc., Am. Sect., Cape Canaveral, FL

The report contains 329 papers and abstracts by various authors discussing government agencies, solar flux, flat-plate concentrating collectors, heating, cooling, and heat pumps. Also discussed are passive and retrofit systems; simulation design; low, intermediate, and high temperature thermal energy; ocean thermal systems; photovoltaics; materials; agricultural and industrial process applications; bioconversion; wind; chemical storage; education; socio-economic and cultural aspects; and the business and commercial implications. Papers are indexed separately.

(BIOCONVERSION, COOLING, FLAT-PLATE, HEATING)

ST78 11003 SOLAR TOTAL ENERGY PROGRAM PLAN

(Sandia Labs., Albuquerque, NM), (ERDA), 43 pages, Aug. 1976, SAND-76- 0167(Rev.)
The goal of this Solar Total Energy Program is to attain by the end of fiscal year 1982 a total installed capacity of 30 Mw, consisting of approximately 5 mw of electrical capacity and 25 Mw of thermal capacity. These systems are also to include differing technical designs and be applied to a variety of electrical and thermal loads in a number of different locations. This Program Plan describes a coordinated research and development effort necessary to achieve this goal.

(COOLING, HEATING, SPACE, THERMAL POWER)

ST78 11004 SUN-SEEKERS' NEW ENERGY SOURCES?

Radio Elektron, Schau, Austria, V 52:61, N11, 1976, In German
A brief report on the automatically sun-seeking solar cell sphere, a football-sized, gas-filled unit which is always facing the sun by means of a magnetic alignment system, operated by the expanding gas, developed by the British ITT laboratories is given.

(SOLAR-CELLS, TRACKING)

ST78 11005 APPLIED FOCUS AND PERSONAL EXPERIENCE IN UNDERGRADUATE EDUCATION IN SOLAR ENERGY THEORY

Aitken, D.W., Boer, K.W., (Center Solar Energy Applications, San Jose State Univ., San Jose, CA), Int. Solar Energy Soc., Solar Energy Soc. Canada, Sharing the Sun: Solar Technology in the Seventies, V 10:235-244, 2 refs, Aug. 15-20, 1976, Winnipeg, Canada, Pergammon, Oxford, England
The use of a "solar dream house" design project to serve as a 15-week thread with an applied focus is described to illustrate the handling of this concept in a large introductory class format featuring a very large disparity in age, academic background, and technical facility of attending students.

(HEATING, RESIDENTIAL)

ST78 11006 "SOLAR SWITCHBOARD:" AN INTERIM ANALYSIS OF AN EXPERIMENT IN THE DISSEMINATION OF SOLAR ENERGY INFORMATION TO THE PUBLIC

Aitken, D.W., Rozell, D.K., Niland, P., (San Jose State Univ., San Jose, CA), Sharing the Sun: Solar Technol. in the Seventies, Jt. Conf. of the Int. Solar Energy Soc., Am. Sect. and Solar Energy Soc. of Canada, Inc., Winnipeg, Manitoba, Canada, V 8:318-332, 2 refs, Aug. 15-20, 1976, Int. Solar Energy Society, Am. Sect., Cape Canaveral, FL
An analysis of the first eleven weeks of a state-supported solar-energy information service at San Jose State University is derived from 654 telephone calls, the dependence of the public response upon staffing hours and media coverage, the experience of the Solar Switchboard staff, and the subsequent experience of some of those served by the switchboard, as learned from follow-up calls initiated out of the funding agency's office. Conclusions which support the social and educational value of this activity are drawn, but suggestions for improvements in activity, mode of operation, and information and evaluation capabilities are also made.

(EDUCATION)

ST78 11007 SOLAR ENERGY COLLECTION AT ARIZONA STATE UNIVERSITY

Beecher, M.E., (Arizona State Univ., Tempe, AZ), Sharing the Sun: Solar Technol. in the Seventies, Jt. Conf. of the Int. Solar Energy Soc., Am. Sect. and Solar Energy Soc. of Canada, Inc., Winnipeg, Manitoba, Canada, V 8:315-317, Aug. 15-20, 1976, Int. Solar Energy Soc., Am. Sect., Cape Canaveral, FL
The article addresses the former Research Collection of the ISES, which now constitutes the nucleus of the Solar Energy Collection at the Arizona State University Library. Its history is discussed and suggestions for the use of publicly available services are made.

(LIBRARIES)

ST78 11008 COMPARATIVE ANALYSIS OF SOLAR ENERGY APPLICATIONS TO THE YEAR 2000 AND BEYOND

Bennington, G., Scholl, M., (Mitre-Metrek, McLean, VA), Trans. Am. Nucl. Soc., V 26:2, June 1977, EDB-77:124728
No abstract available

(AGRICULTURE, COOLING, HEATING, PROCESS-HEAT)

ST78 11009 ANALYSIS OF THE CALIFORNIA SOLAR RESOURCE

Berdahl, P., Grether, D., Martin, M., Wahlig, M., (Univ. of California, Lawrence Berkeley Lab., Berkeley, CA), Sharing the Sun: Solar Technol. in the Seventies, Jt. Conf. of the Int. Solar Energy Soc., Am. Sect. and Solar Energy Soc. of Canada, Inc., Winnipeg, Manitoba, Canada, V 8:333-335, Aug. 15-20, 1976, Int. Solar Energy Soc., Am. Sect., Cape Canaveral, FL

The quality and quantity of available solar data for California are compared with the present and future requirements of various data users. An assessment is made of the value of additional data stations and improved cooperation among the active parties in data handling.

ST78 11010 COMMERCIAL APPLICATIONS OF SOLAR TOTAL ENERGY SYSTEMS

Boobar, M.G., McFarland, B.L., Nalbandian, S.J., (Rockwell International Corp., Atomics International Div., Canoga Park, CA), Smith, K.E., (Rockwell International Corp., Space Div., Downey, CA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1693-1699, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48904, A77-48701 23-44

A methodology has been developed by atomics international under contract to the Energy Research and Development Administration to define the applicability of solar total energy systems (STES) to the commercial sector (e.g., retail stores, shopping centers, offices, etc.) in the United States. Candidate STES concepts were selected to provide on-site power generation capability, as well as thermal energy for both heating and cooling applications. Each concept was evaluated on the basis of its cost effectiveness (i.e., as compared to other concepts) and its ability to ultimately penetrate and capture a significant segment of this market, thereby resulting in a saving of fossil fuel resources. The photovoltaic STES appears favorable for applications under 800 kwe, whereas the organic rankine STES would be more cost effective for larger energy demand applications. Initial penetration of these systems are expected to occur in the northeast for large shopping centers in the 1985-1995 time period.

(ECONOMICS, RANKINE CYCLE)

ST78 11011 SOLAR ENERGY INFORMATION SYSTEM, A PROPOSAL

Borovansky, V.T., (Arizona State Univ., Tempe, AZ), Sharing the Sun: Solar Technology in the Seventies, V 8, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:131079

The proposal is to establish an information analysis center whose objectives would be to develop solar energy information essentially to national energy needs and to provide a highly effective information service for solar energy researchers, investigators, and federal, state, and local authorities.

(ARIZONA)

ST78 11012 SOLAR TECHNIQUES IN THE USA AND IN CANADA

Bossel, U., Summary of Conference held in Winnipeg called "Sharing the Sun '76," Mitteilunglsbl. Dtsch. Ges. Sonnenenergie, V 1:20-23, N5, Sept. 1976, In German, EDB-77:111138

The article presents a survey of the meeting called "Sharing the Sun '76," held in Winnipeg, Canada. The following focal points are briefly discussed: solar collectors, photo cells, thermal energy storage equipment, marine heat, power plants in orbit, wind energy, biomass, and architecture.

(ARCHITECTURE, BIOMASS, ECONOMICS, FLAT-PLATE, PHOTOVOLTAIC, POWER SATELLITES, STORAGE)

ST78 11013 SOLAR ENERGY POTENTIAL IN PENNSYLVANIA

Bostic, C.E.Jr., (ERDA, Pittsburgh, PA), Solar Energy in Pittsburgh: A Look at Reality and Prospects, May 25, 1976, Eds: Peters, W.C., Mulvihill, J.W., CONF-760522, EDB-77:119789

The need and desirability of utilizing the solar energy technology in the state of Pennsylvania are addressed. Plans for developing solar energy in the state are discussed.

(ENERGY POLICY)

ST78 11014 SOLAR ENERGY USE FOR LOW TEMPERATURE APPLICATIONS

Bowen, J.C., (Ametek, Inc., Hartfield, PA), J. Adhes. Sealant Counc., V 4:133-144, N1, 1976, EDB-77:144759

Solar energy can be used in a number of different ways. A brief review of the use of solar energy to generate electricity is followed by discussions of solar energy applications

in the following three areas: hot water for domestic use, heating and living space, and heating and air conditioning of living space. The components needed to achieve solar energy utilization are discussed in some detail. They are a means of capturing the sun's rays and converting the solar energy into heat - a solar collector, a heat storage device, and a means of transporting the heat into and out of storage as needed.

(ADHESIVES, COOLING, FLAT-PLATE, HEATING, INSULATION, STORAGE)

ST78 11015 SUNNY SIDE OF THE FUTURE

Calvin, M., (Univ. of California, Berkeley, CA), Chemtech, p. 352-363, June 1977, EDB-77:118207

We are rapidly using up the products (coal, oil, natural gas) of ancient sunshine and will have to harvest energy annually in a renewable manner. Solar radiation can be collected in two ways: as heat (inefficient), or in photochemical processes (photosynthesis, etc.). Sugar cane can be fermented to produce alcohol and thence other chemicals. The need for biological nitrogen fixation to counteract the high cost of fertilizer is pointed out. This might involve the transfer of a bacterial gene into the protoplast of a higher plant. Plants producing hydrocarbons (rubber, etc.) are next considered. The photosynthetic processes that result in carbohydrates and hydrocarbons are modelled. The chloroplast structure is discussed, and it is hypothesized that the low oxidation catalysts that generate O are on opposite sides of the chloroplast lamellae. The possibility of constructing a photochemical system for generating H from water is suggested. Such a synthetic membrane is under development.

(BIOMASS, CHLOROPLASTS, HYDROGEN PRODUCTION, MEMBRANES, PHOTOCHEMISTRY, PHOTOSYNTHESIS)

ST78 11016 APPLICATIONS OF SOLAR ENERGY

Catania, P.J., Ed., Appl. of Solar Energy, Proc. of the Solar Energy Seminar, Univ. of Regina, Saskatoon, March 26, 1976, and Univ. of Saskatoon, Saskatoon, March 27, 1976, 165 pages, Univ. of Regina, Can. Plains Res. Center, (Can. Plains Proc. N3), Saskatoon

The proceedings include nine papers plus discussions dealing with radiation climatology of Southern Saskatchewan of relevance to solar energy engineers and state-of-the-art of solar heating, cooling, and grain drying. Solar demonstration homes and a mini-utility dwelling concept with the use of solar energy are also addressed.

(CANADA, INSOLATION)

ST78 11017 INTEGRATING SOLAR ENERGY CONCEPTS INTO CHEMISTRY-SCIENCE CURRICULUM

Centrell, J.S., (Miami Univ., Oxford, OH), Sharing the Sun: Solar Technol. in the Seventies, Jt. Conf. of the Int. Solar Energy Soc., Am. Sect. and Sol. Energy Soc. of Canada, Inc., Winnipeg, Manitoba, Canada, V 8:279-287, 10 refs, Aug. 15-20, 1976, Int. Solar Energy Society, Am. Sect., Cape Canaveral, FL

This paper contains samples of curriculum modification for informing the public on solar energy concepts and is based on the thought that an informed public is more likely to support research and development of solar technology.

ST78 11018 DIRECT UTILIZATION OF SOLAR ENERGY

Chard, R.A., (Institute of Chemical Engineers, Rugby, England), 14 refs, 1977, EDB-77:144785

Some actual and proposed projects for large scale solar utilization are reviewed. The solar energy received by the United Kingdom is compared with the actual energy used. The use of flat-plate collectors for water heating is described, together with their construction. Focusing collectors are compared and contrasted with flat-plate collectors. The siting of collectors for maximum collection is described, as are methods of connecting the collectors into domestic hot water circuits. Materials of construction, corrosion problems, and space heating are described briefly. A method of estimating the financial saving which may be expected is given, with an example of how this may be put into perspective with other fuel costs and conventional energy saving methods.

(CONCENTRATORS, FLAT-PLATE, HEATING, UNITED KINGDOM)

ST78 11019 SOLAR ENERGY PROGRAMMES OF THE UNITED NATIONS SYSTEM

Chatel, B., (United Nations, New York, NY), Sharing the Sun: Solar Technology in the Seventies, V 1, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:118172

The United Nations system is conducting programs for the application of science and technology to development. Solar energy applications are of particular relevance to the economic and social progress of the developing countries. Some of the programs currently undertaken in the United Nations system are reviewed, particularly in the United Nations, UNESCO, WMO, UNIDO, the Regional Economic Commissions, the global projects, UNEP, the Office for Technical Cooperation, and the financial institutions.

(DEVELOPING COUNTRIES, ECONOMIC, WIND)

ST78 11020 ERDA AND ITS ROLE IN SOLAR ENERGY

Cherry, W.R., (ERDA, Washington, D.C.), Solar Energy: Fuel and Food Workshop, 1976, Ed: Jensen, M.H., CONF-760492, EDB-77:144665

The ERDA program in solar energy is outlined briefly; funding is mentioned. Under the ERDA-USDA Solar Thermal Agricultural Program, five major areas are being investigated: solar grain drying, solar crop drying, solar heating of greenhouses and rural residences, solar heating of animal shelters, and solar agricultural food processing,

(AGRICULTURE, ECONOMICS, GREENHOUSES, HEATING, HOUSES)

ST78 11021 ERDA-USDA AGRICULTURAL SOLAR THERMAL ENERGY PROGRAM

Cherry, W.R., Auer, W.W., (ERDA, Division of Solar Energy, Washington, D.C.), Sharing the Sun: Solar Technology in the Seventies, V 1, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:118301

A five-year interagency agreement between the Division of Solar Energy of ERDA and the Agricultural Research Service for USDA is designed to research, experiment, and develop solar energy systems which will be suitable for application to on-farm thermal energy needs. Annually, proposals are evaluated and recommended for funding by the USDA-ARS to ERDA in the areas of grain and crop drying, heating of greenhouse-rural residences, and livestock shelters. Over 40 projects are currently underway showing how solar energy can provide significant amounts of the heat for the drying of corn, sorghum, soybeans, wheat, rice, tobacco, and peanuts and the warming of greenhouse-rural residences and shelters for poultry, swine, and dairy cattle. Some of the systems are already showing economic soundness when compared with conventional fuels, while others, such as grain drying, will require that the solar systems are used for multiple purposes to justify their initial investment cost.

(AGRICULTURE, BUILDINGS, GREENHOUSES, HEATING, SOLAR DRYING)

ST78 11022 ARIZONA SOLAR UPDATE - 1970-1976: ACTIVITY IN THE PRIVATE SECTOR

Cook, J., Wade, H., (Arizona State Univ., Flagstaff, AZ), Sharing the Sun: Solar Technol. in the Seventies, Jt. Conf. of the Int. Solar Energy Soc., Am. Sect. and Solar Energy Soc. of Canada, Inc., Winnipeg, Manitoba, Canada, V 10:1-7, Aug. 15-20, 1976, Int. Solar Energy Soc., Am. Sect., Cape Canaveral, FL

Historically, Arizona has been closely involved in solar energy development and utilization and this committment of the private citizens and small businessmen is discussed. Private home builders, contractors, and experimenters have produced a number of solar installations, and these developments are reviewed.

ST78 11023 COMPARISON OF CANDIDATE SOLAR ARRAY MAXIMUM POWER UTILIZATION APPROACHES

Costogue, E.N., Lindena, S., (Jet Propulsion Lab., Pasadena, CA), American Inst. Chem. Engrs., American Nucl. Soc., Soc. Automotive Engrs., et al, 11th Intersociety Energy Conversion Engineering Conference, State Line, Nevada, V 2:1449-1456, 4 refs, Sept. 12-17, 1976, American Inst. Chem. Engrs., New York, NY

A study is made of five potential approaches to detect the maximum power point of a solar array while sustaining operations at maximum power and without endangering stability or causing array voltage collapse. The approaches studied include dynamic impedence comparator, reference array measurement, detection of array foltage collapse, parallel tracker, and direct measurement. Feasibility and adaptability of these approaches to a future solar electric propulsion (SEP) mission, and, specifically, to a comet rendezvous mission are analyzed. The dynamic impedence approach was a found to have the highest figure of merit, while the reference array approach followed closely. The results are applicable to terrestrial solar power systems as well.

(DETECTION, ECONOMICS, SOLAR-CELL ARRAYS, TRACKING)

ST78 11024 STATUS REPORT ON THE USAFA SOLAR ENERGY PROGRAM

Davis, J.M., Nay, M.W.Jr., Schmiesing, R.L., Tolbert, W.A., (US Air Force Academy, Colorado Springs, CO), Sharing the Sun: Solar Technol. in the Seventies, Jt. Conf. of the Int. Solar Energy Soc., Am. Sect. and Solar Energy Soc. of Canada, Inc., Winnipeg, Manitoba, Canada, V 4:53-66, 1 ref, Aug. 15-20, 1976, Int. Solar Energy Soc., Am. Sect., Cape Canaveral, FL

The project involves applying solar energy to a retrofitting mode unlike the present construction in the private sector. Notable aspects of this project include: roof and ground mounted collector arrays, variable collection fluid flow rate, reinforced concrete storage tank, variable slope adjustment for the ground array, retrofit application, on-site weather monitoring capability, and a unique instrumentation and control system. An extensive system data base has been developed and significant work has been accomplished with regard to developing solar system control techniques.

(FLAT-PLATE, INSOLATION)

ST78 11025 SOLAR ENERGY IN THE UNITED STATES: A REPORT ON CURRENT DEVELOPMENTS AND THEIR RELEVANCE FOR GERMANY

Denton, R., (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung E.V., Karlsruhe, Germany), Nov. 1974, NP-22242, EDB-77:131115
Avail:NTIS US Sales Only

This report gives a qualitative, non-technical description of the latest developments and thoughts of American scientists in the field of solar energy as a result of a journey to the Annual Meeting of the Int. Solar Energy Society, US Section on Aug. 19-23, 1974 in Fort Collins, Colorado, and as a result of visits to several solar-energy houses and schools and additional talks in the US. The report aims at giving the reader a "feeling" for the level of the developments without overpowering him with technical details. The bibliography and the appendix might be useful for those needing information of a more technical sort. The central topic of the report is solar space and water heating except for one important point (solar-thermal central receiver power station). The development of this field is given highest priority in the US since solar heating systems are most likely to be introduced commercially. A similar priority might be expected in Germany. Solar technology is economically able to compete in the US today. Nevertheless, there are some reasons hindering its general introduction. These reasons cover a wide range of non-technical problems. Some of them are dealt with in this report. Some conclusions of the first NSF-NASA Solar Energy Report of 1972 are included as a short introduction since most of the latest developments tend to confirm this analysis.

(CONCENTRATORS, FLAT-PLATE, HEATING, HEAT STORAGE)

ST78 11026 SOLAR ENERGY HAPPENINGS IN OTHER COUNTRIES

De Winter, F., (Atlas Corp., Santa Clara, CA), Passive Solar Heating and Cooling, 1976, Ed: Keller, M.H., LA-6637-C, EDB-77:118169

Recent changes in energy costs have made solar energy appear to offer a viable alternative in many parts of the world. R and D programs in solar energy have hence been started in many nations to see if the apparent potential of solar energy can be realized. R and D programs and other activities in solar energy are discussed for a number of nations.

ST78 11027 STATUS AND PROSPECTS FOR WIDESPREAD UTILIZATION OF SOLAR ENERGY AS A NATIONAL ENERGY RESOURCE

Eggers, A.J.Jr., (National Science Foundation, Washington, D.C.), Solar Energy Storage Subsystems for the Heating and Cooling of Buildings, 1975, Eds: Lilleleht, L.U., Beard, J.T., Iachetta, F.A., American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., New York, NY, EDB-77:144669

Solar energy research and development has been organized programmatically under six areas as follows: bioconversion to fuels, ocean thermal conversion, wind energy conversion, photovoltaic conversion, solar thermal conversion, and solar heating and cooling of buildings (including agricultural applications). The objectives, and achievements in each area are discussed.

(BIOMASS, COOLING, HEATING, OCEAN-THERMAL, PHOTOVOLTAIC, WIND)

ST78 11028 POSSIBILITIES OF SOLAR ENERGY USE IN YUGOSLAVIA DISCUSSED

Festic, S., Translation of Eastern Europe Scientific Affairs no. 551, July 11, 1977, JPRS-69396, EDB-77:111141
Avail:NTIS

Solar energy utilization in Yugoslavia at the present is summarized and the prospects for the future are discussed.

ST78 11029 RENEWABLE ENERGY HANDBOOK

Fine, R., Energy Probe, Toronto, Canada, 1976, EDB-77:140025

The potential for renewable energy use in Canada is examined. It is pointed out that Canada can choose to begin to diversify its energy supply now, moving rapidly and smoothly towards an efficient energy society based on renewable energy sources, or it can continue on its present course and face the possibility of being forced by necessity to make a later transition to renewable sources, probably with a great deal of economic and political disruption. The handbook begins with a discussion on major issues and options available. This second section deals with the technology, applications, and costs of direct solar energy utilization, solar thermal electricity generation, photovoltaic conversion, wind energy, biomass energy, tidal power, wave energy, ocean thermal energy, geothermal energy, heat pumps, and energy storage. Section three discusses how renewable energy might realistically supply Canada's energy requirements within a reasonable period of time. Some issues on how government, industry, and the individual may become involved to make this happen are suggested. A list of resource people and renewable energy businesses is provided in the last section. A recommended reading list and bibliography complete the handbook.

(BIOMASS, CANADA, GEOTHERMAL, HEAT-PUMPS, INSOLATION, OCEAN THERMAL, PHOTOVOLTAIC, STORAGE, WAVE-POWER, WIND)

ST78 11030 SOLAR CHALLENGES TO CONSULTING ENGINEERS

Flack, P., (Flack and Kurtz, New York, NY), Energy Technology IV: Confronting Reality, 1977, Government Institutes, Inc., Washington, D.C., Ed: Hill, R.F., EDB-77:140032

A visible solar industry is possible if ERDA programs for research and development of solar collectors and solar concentrators for heating and cooling result in products that demonstrate a high performance and are economically and aesthetically acceptable. Consulting engineers must coordinate the selection of solar components with mechanical and electrical equipment so that each installation provides optimum efficiency at the lowest cost. Examples of solar projects, such as the Madeira School of Greenway, Virginia, are used to describe the government's involvement in demonstrating solar feasibility for solar systems in houses and government buildings, although economic incentives are still needed to implement the use of solar components. Engineering studies are needed for solar collection systems, storage sub-systems, and improved heat pump and absorption chiller designs. Charts and graphs are used to illustrate recommended applications and compare expected performance levels and costs of flat-plate collectors at various angles and temperatures.

(BUILDINGS, DEMONSTRATION, ECONOMICS, FLAT-PLATE, HEAT-PUMPS, STORAGE)

ST78 11031 DAEDALOPHOBIA: DIAGNOSIS AND PROGNOSIS

Foster, H.D., Sewell, W.R.D., (Univ. of Victoria, Victoria, British Columbia), Sharing the Sun: Solar Technology in the Seventies, V 9, 8 pages, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:118263, A77-49121

Solar space heating has numerous environmental, social, and political advantages over conventional temperature-control systems. Yet, despite the benefits that would result from widespread Canadian adoption, diffusion of this innovation has been extremely slow. Daedalophobia, a fear of the sun's energy, has been identified as the major cause. Symptoms recognized at the federal and provincial levels include an unrealistic investment in research and development. Locally, adoption is hindered by a multiplicity of building codes, regulations, and restrictions. Undercapitalization in manufacture and in unwillingness to take risk by the building industry are also indicative of the endemic nature of this disease. Prospective home owners display symptoms of Daedalophobia that include fear of the price and ignorance of the nature of the technology. This disease can be best eradicated by a federal program of insurance of solar-heated homes and financial support of large-scale prefabrication.

(CANADA, COOLING, ECONOMICS, HEATING)

ST78 11032 DETERMINISTIC INSOLATION ESTIMATES FOR SOLAR TOTAL ENERGY SYSTEMS

French, E.P., (Rockwell International Corp., Space Div., Downey, CA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1231-1237, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, E(04-3) E(04-3)-1210, A77-48847, A77-48701 23-44

A simple method of evaluating the solar energy available to a collector is described. Radiation at cloudless times is estimated from the calculated solar position and the seasonally varying properties of a standard atmosphere. Local atmospheric effects are incorporated into two empirical coefficients, a clearness number and a cloud factor, which can be derived from long-term average insolation. The method successfully predicts variations in incident energy as a function of collector orientation and tracking strategy. Net collector energy gains are also well-estimated if cloud factors are based on observed average percent possible sunshine.

(COLLECTORS, COMPUTERIZED SIMULATION, INSOLATION, MATHEMATICAL MODELS, TRACKING)

ST78 11033 SOLAR PRIMER

Gorham, R.S.Jr., (Construction Engineering Research Lab., Champaign, IL), IF, Ind. Forum, V 7:59-62, N2-3, 1976, EDB-77:124850

Most non-nuclear forms of energy are solar in origin. Direct solar energy systems must have a collector, a means of insulation, a scheme for extracting the energy, and provision for storing energy. Passive solar energy systems involve selecting appropriate construction materials and forms, and proper siting. Hybrid systems use modifiable built elements. Active systems involve the four subsystems (listed above). Collectors range from low-temperature to high-performance. Energy extraction is usually by air or water. Energy storage is by sensible or latent heat. Energy utilization can be for water heating or space heating and cooling. Heat exchangers are often advantageously used.

(COOLING, HEAT-EXCHANGERS, HEATING, STORAGE, WATER HEATERS)

ST78 11034 SOLAR TOTAL ENERGY SYSTEM TEST FACILITY PROJECT, Semiannual Report, April 1976-Sept. 1976

Harrison, T.D., Ed., (Sandia Labs., Albuquerque, NM), April 1977, SAND-76-0662, EDB-77:111212

The primary objective of the Sandia Solar Total Energy System Test Facility Project is to determine and demonstrate the technical and economic feasibility of solar total energy systems for a variety of sites and loads. In support of this, additional objectives are (1) to construct a solar total energy system which is sufficiently versatile to be used as an engineering evaluation center or test bed for further development of individual components or other solar energy subsystems, (2) to encourage private sector participation in the program and in the development of components for the system, (3) to determine those areas of research and development that offer the greatest payoffs, and (4) to develop and validate a systems analysis computer program capable of evaluating the great number of possible combinations of total energy system configurations. The solar total energy system will operate as follows: a heat transfer fluid (therminol 66) is heated in the receiver tubes of the solar collectors by reflected and focused solar radiation. This fluid is pumped to the high-temperature storage subsystem. On a demand basis, fluid is extracted from this storage and pumped to the heat exchanger which produces superheated toluene vapor to power the turbine-generator. The boiler can also be operated from a fossil-fuel-fired heater to insure continuity of operation during extended cloudy periods. Turbine concenser components of the system, recent research activities, and progress are reported.

(ECONOMICS, FRESNEL LENS, HEAT EXCHANGERS, HEATING, STORAGE, TESTING, TRACKING)

ST78 11035 LOOK AT VOCATIONAL TRAINING FOR THE SOLAR ENERGY INDUSTRY

Heath, S.D., (Mitchell-Webb Assoc. Inc., San Diego, CA), Sharing the Sun: Solar Technol. in the Seventies, Jt. Conf. of the Int. Solar Energy Soc., Am. Sect. and Solar Energy Soc. of Canada, Inc., Winnipeg, Manitoba, Canada, V 8:298-310, 3 refs, Aug. 15-20, 1976, Int. Solar Energy Soc., Am. Sect., Cape Canaveral, FL

A training program processes trainees through structured solar system instruction and at the same time, continues to evaluate the trainees' response to solar system exposure. A comprehensive look at one training program now in operation in the Southwest United States is presented. The training facility is operated by the San Diego County Construction Laborers Training and Retraining Trust. The program provides basic training applicable to the building trades in the installation and maintenance of a wide variety of solar energy systems.

(EDUCATION)

ST78 11036 SUMMARY OF THE ROLE OF PLANNING AND ANALYSIS IN THE DEVELOPMENT OF THE FEDERAL SOLAR ENERGY PROGRAM

Herwig, L.D., (ERDA, Washington, D.C.), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 1:189-210, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, A77-48923, A77-48910 23-44

The main purpose of this paper is to describe the scope of planning and analysis and summarize the projects that have guided the growing federal efforts to develop solar energy technologies. Planning and analysis includes studies involving mission analysis, comparative system evaluation, application selection, preliminary system design, and engineering and economic evaluation. As planning methodology has evolved and expanded over the past three to five years, the results of the planning studies have influenced direction, content, schedule, and goals of the federal solar energy program. A review is given of planning projects in each of a large number of important subprogram areas of solar technology research, development, and demonstration. References to the results of these planning studies are given as they are now available.

(ECONOMICS, PLANNING METHODOLOGY)

ST78 11037 REPORT ON UNITED STATES INTERNATIONAL COOPERATION IN SOLAR ENERGY TECHNOLOGY DEVELOPMENT

Herwig, L.D., Yim, H.C., (ERDA, Washington, D.C.), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 9:213-228, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:119794, A77-49132, A77-48910 23-44

The International Cooperative Exchange Program administered by the Division of Solar Energy of ERDA are discussed. The chief areas of concern in the solar energy exchange programs, including thermal and solar electric applications, the conversion of biomass to fuels, and technological support and information services, are considered. Multilateral agreements arranged under the auspices of the International Energy Agency, including exchanges of information on solar heating, cooling and hot water system components, the mechanical testing of solar collectors, and measurements of solar radiation, are mentioned. Bilateral agreements with the USSR, Japan, France, and other nations which have dealt with topics such as desalinization schemes, large-scale water heating plants, and photovoltaic devices are also reviewed.

(BIOMASS, DEVELOPING NATIONS, ENERGY POLICY, FRANCE, HEATING, JAPAN, USSR)

ST78 11038 OVERVIEW OF THE FEDERAL SOLAR ENERGY PROGRAM AND CURRENT TECHNOLOGY STATUS

Herwig, L.O., (ERDA, Washington, D.C.), Trans. Am. Nucl. Soc., V 26:1, June 1977, EDB-77:124727
No abstract available

(DEMONSTRATION PROGRAMS, ECONOMICS, GOVERNMENT POLICIES, US ERDA)

ST78 11039 ERDA's SOLAR ENERGY RESEARCH AND DEVELOPMENT PROGRAM

Hirsch, R.L., Marvin, H.H., Blasy, J.A., (Government Institutes, Inc., Washington, D.C.), Energy Technology IV: Confronting Reality, 1977, Ed: Hill, R.F., EDB-77:140026
A description of the characteristics of solar energy conversion and an outline of ERDA solar research and development efforts is illustrated with diagrams and photographs of several projects. While technically feasible, the cost of collecting significant amounts of solar energy remains the major problem. ERDA, optimistic that heating and cooling are close to commercialization, is making continuing progress in the identification of solar energy applications and potential fuel substitutes. Research programs include direct thermal, thermal power, photovoltaic, biomass-derived fuels, wind power, and ocean temperature gradient systems.

(BIOMASS, COOLING, DEMONSTRATION, ECONOMICS, CONCENTRATOR, HEATING, OCEAN-THERMAL, PHOTOVOLTAICS, PROGRAMS, WIND-POWER)

ST78 11040 WILL THE SUN SAVE US FROM THE ENERGY CATASTROPHE

Hungerbuehler, E., Ed., Maier, Ravensburg, Germany, F.R., 1975, In German, EDB-77:119684
This book with many illustrations is addressed to readers interested in energy policies and informs in a popularized way about energy generation by nuclear fission and fusion and dangers resulting from these means, as well as of the possibilities of obtaining practical amounts of energy from solar, geothermal, wind, and tidal power.

(BOOK, ENERGY-POLICY, GEOTHERMAL, NUCLEAR-ENERGY, SOLAR-FURNACES, TIDAL-POWER, WIND-POWER)

ST78 11041 EARTH, AN OPEN SYSTEM - THE USE OF SOLAR ENERGY

Jaumotte, A.L., (Bruxelles, Universite Libre, Brussels, Belgium), In Space and Energy: Proceedings of the 26th International Astronautical Congress, Lisbon, Portugal, page 3-27, Sept. 21-27, 1975, Pergamon Press, Oxford and New York, 1977, A77-46788, A77-46787 22-12
The article provides a survey of the possible utilizations of solar energy, both in terms of immediate targets and long range goals. Two applications of low-temperature thermal energy are described: the heating and cooling of solar dwellings, and the solar irrigation pump. Possible improvements for agricultural science applying solar energy to photosynthesis are suggested. Recommendations for combining solar energy with optical concentrations are presented, such as the development of heliostats, and long range prospects for satellite solar power stations (SSPS). The article concludes with a few notes on pollution caused by solar energy, and the contribution of such research to space technology.

(HEATING, HELIOSTATS, IRRIGATION, PHOTOSYNTHESIS, PUMPS, SATELLITE-POWER-STATIONS)

ST78 11042 DIRECT UTILIZATION OF SOLAR ENERGY

Jirsak, T., Cesk. Cas. Fis., Czechoslovakia, V 26:527-529, N5, 1976, In Czech
This report discusses developments of solar power conversion equipment in the USA, USSR, and West Germany. It illustrates a fixed-type spherical solar concentrator of 5 m diameter with 60 glass mirrors, a mobile "solar kitchen" consisting of a parabolic metal mirror, and solar collectors employing glass absorption tubes with silver mirrors and IN_2O_3 heat losses reducing filters.

(CONCENTRATORS, KITCHEN, PARABOLIC-REFLECTORS, SPHERICAL-COLLECTOR)

ST78 11043 PRESENT STATE AND FUTURE OF NEW ENERGY TECHNOLOGY DEVELOPMENT

Kitamura, N., Netsu Kanri to Kogai, V 28:10-18, N8, Aug. 1976, In Japanese, EDB-77:111281
The sunshine project was begun in 1973 by the Japanese Ministry of Industry to investigate all alternative energy sources other than nuclear. The project is subdivided into four separate areas, those being solar energy, geothermal energy, liquefaction and gasification of coal, and hydrogen fuel. This article describes the present state of these technologies and their probable future development. Although hydrogen fuel and coal liquefaction-gasification are still in the basic research stage, solar and geothermal technologies are already well developed.

(GEOTHERMAL, GOVERNMENT-POLICIES, HYDROGEN-FUEL, JAPAN)

ST78 11044 SOLAR-THERMIC SYSTEMS

Kleinkauf, W., Mitteilungsbl. Dtsch. Ges. Sonnenenergie, V 2:11-12, 14, N1, Jan. 1977, In German, EDB-77:144707

A brief survey of various solar-thermic plants is given. Essential criteria for the use of solar energy plants are the costs of secondary energy and the usable potentials. Results of the costs estimate are given in a table. The generation of high-temperature heat will probably not be profitable in the Federal Republic of Germany, because of available sunshine. However, low-temperature plants with solar collectors are suitable for the supply of one or two-family houses. Only Southern European regions or North Africa are suitable for larger solar power stations. In this case the problem of power transmission is to be solved satisfactorily.

(CONCENTRATORS, ECONOMICS, FLAT-PLATE, REFLECTORS, REVIEWS, TOWER-FOCUS-POWER, TRACKING)

ST78 11045 HARNESSING THE SUN: THE STORY OF SOLAR ENERGY

Knight, D.C., (William Morrow and Co., New York, NY), 1976, EDB-77:111137

The amount of energy received by the earth from the sun is discussed. Some of ancient man's early attempts at using solar energy are described. Solar cookers, water heaters, and houses in existence today are discussed.

(BUILDINGS, HEATING, SOLAR-COOKERS, SOLAR-FURNACES, WATER-HEATERS)

ST78 11046 COMMENTS ON ENERGY TECHNOLOGY TRANSFER

Maninger, R.C., (California Univ., Livermore, CA), June 22, 1977, UCRL-79627, EDB-77:111135

The ERDA Solar Technology Transfer Program at the Lawrence Livermore Laboratory is briefly described, and the objectives and strategies of the program are outlined.

(EDUCATION, INFORMATION, LAWRENCE-LIVERMORE-LABORATORY)

ST78 11047 EARLY IMPACT OF SOLAR ENERGY THROUGH INDUSTRIAL APPLICATIONS

Maninger, R.C., (California Univ., Livermore, CA), June 23, 1977, UCRL-79515, EDB-77:111134

The Energy Research and Development Administration (ERDA) has established a solar technology transfer program (STTP) as an important part of the ERDA mission to promote rapid and widespread commercialization of solar energy. This program is an innovative approach to technology transfer through information dissemination and training in solar energy. This is done by means of an integrated network of regional technology agents who interact directly with multiplier groups in both the public and private sectors. Details of the program and ways of industrial participation in it are described.

(COMMERCIALIZATION, INFORMATION, US ERDA)

ST78 11048 PRESENT STATE AND PERSPECTIVE OF SOLAR ENERGY APPLICATIONS IN MEXICO

Mayer, E.R., (Universidad Nacional Autonoma de Mexico; Consejo Nacional de Ciencia y Tecnologia, Mexico City, Mexico), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 1:37-57, 8 refs, Aug. 15-20, 1976, EDB-77:118173, A77-48911, A77-48910 23-44

Geographical and climatological conditions in relation to the population growth are reported. A forecast of the energy consumption and of the availability of nonrenewable resources shows the necessity of developing alternative energy sources. The potential of solar energy applications is analyzed and the present state of research and development in the different Mexican institutions is reported.

(CLIMATOLOGY, DEVELOPING NATIONS)

ST78 11049 RENEWABLE ENERGY RESOURCES

Meliss, M., (Kernforschungsanlage, Juelich, Germany), Brennst.-Waerme-Kraft, V 29:136-142, 63 refs, N4, April 1977, In German, EDB-77:140028

An outline of the solar and geothermal resources, utilization, and prospects for larger exploitation is given. Trends in design and construction of wind-driven power plants are also presented.

(GEOTHERMAL, REVIEWS, WIND TURBINES)

ST78 11050 SYNCHRONOUS INVERSION: CONCEPT AND APPLICATION

Meyer, H., (Windworks, Mukwonago, WI), Sharing the Sun: Solar Technology in the Seventies, V 7, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:111408

Synchronous inversion is a process whereby intermittent and/or variable power sources can be used to supplement a primary power source. The alternate power source could be wind, solar electric, solar thermal, hydro, tidal, wave, ocean thermal, geothermal, waste heat from an industrial process, or any other power source capable of being converted to electricity. The primary power source can be any power source of greater capacity and lower impedance than the supplementary power source so that the primary source has the ability to dictate voltage and frequency and is present anytime the alternate power source is in use. Synchronous inversion utilizes an AC power network as a "storage" medium for any form of energy that can be converted to DC power. If more power is available from the alternate source than is needed by the load, the excess flows into the AC power distribution network, thereby reducing the amount of generation required by the primary source. If less power is available from the alternate source than the load requires, the difference is provided by the primary source in the normal fashion. The advantages of synchronous inversion, mainly low cost, are examined from a total systems viewpoint. The theory of operation, design considerations, safety, and ease of interfacing intermittent sources of synchronous inversion are discussed.

(AC SYSTEMS, ECONOMICS, ELECTRIC, POWER GENERATION, STORAGE)

ST78 11051 AN ACADEMIC PROGRAM IN SOLAR ENERGY SCIENCE EDUCATION

Meyers, A.C.III, Boer, K.W., (Univ. of Northern Iowa, Cedar Falls, IA), Sharing the Sun: Solar Technology in the Seventies, V 8:273-278, Aug. 15-20, 1976, International Solar Energy Soc., Solar Energy Soc. of Canada, Winnipeg, Canada, Pergamon, Oxford, England

This report describes a program which deals with the problem of scientific education in solar energy on two levels. The first is with respect to professional personnel who might apply solar energy to solving scientific and engineering problems. The second is with respect to high school teachers who need information on solar energy and interested individuals in the community who can learn the basics of solar energy. Units on other areas of solar energy have been developed and added to appropriate physics and science courses.

ST78 11052 CANADA'S RENEWABLE ENERGY RESOURCES: AN ASSESSMENT OF POTENTIAL

Middleton, P., Argue, R., Burrell, T., Hathaway, G., (Middleton Associates, Toronto, Ontario, Canada), April 1976, NP-21901, EDB-77:113001
Avail:NTIS US Sales Only

Rising costs of conventionsl, frontier, and nuclear energy production and the prospect of future shortages have prompted a resurgence of interest in alternative, renewable energy technologies. This study constitutes a preliminary step in determining which sources, technologies, and applications may be appropriate in Canada and when and under what conditions they might be technically and economically viable. Principle sources of renewable energy (solar radiation, wind, and biomass), as well as waves, thermal gradients, and sensible heat sources are reviewed to establish, in general terms, their significance in the Canadian context. Next, the technical characteristics, efficiency, costs, impacts, and state of the art of sixteen harnessing or conversion technologies are presented as an information base upon which to build an assessment of potential. A method of comparing the life cost of a renewable energy system to that of the likely conventional alternative is proposed and applied in cases where adequate technical and economic data are available. A variety of different economic assumptions are also outlined under which the renewable systems would be cost competitive, this costing methodology is applied in detail to four case studies: solar space and water heating-residential, photovoltaics-residential, wind generator-200 kw, and anaerobic digestion of livestock wastes. Finally the potential for renewable energy approaches in Canada is explored and evaluated from three perspectives: Technical viability, economic viability, and implementation.

(BIOMASS, COOLING, ECONOMICS, GREENHOUSES, HEAT-PUMPS, MANURES, METHANOL, WAVE-POWER, WIND-POWER)

ST78 11053 POSSIBILITIES AND RESTRAINTS IN THE USE OF SOLAR ENERGY

Moesta, H., (Inst. Fur Phys. Chem. II, Univ. Des Saarlandes, Saarbrucken, Germany), Naturwissenschaften, Germany, V 63:491-498, N11, 19 refs, Nov. 1976

The author considers some simple geographic and economic facts with the basic laws of radiation to single out proposals which seem to have the best change of realization in the near future. Presently, technologies with relatively low temperatures and inexpensive collectors are feasible in residences even in high latitudes. Stress is placed on the use of the night sky as a heat sink for cooling in arid countries.

(ECONOMICS, GEOGRAPHIC, NIGHT-SKY, REVIEWS)

ST78 11054 SOLAR ENERGY PROGRAM OF THE INTERNATIONAL ENERGY AGENCY

Morse, F.H., (ERDA, Washington, D.C.), Sharing the Sun: Solar Technology in the Seventies, V 1, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:118272

The International Energy Agency (IEA) was established in November 1974. One of the purposes of the IEA was to promote long-term cooperative efforts in energy R and D. The objective of the IEA Solar Energy Program is to reduce overall costs of solar-energy systems by the pooling of efforts and experience, and to accelerate the large-scale introduction of this technology in the participating countries. Five cooperative projects have been developed by the IEA subgroup on solar energy: (1)development of solar heating, cooling, and hot-water supplying systems; (2)development of components for the above systems; (3)thermal performance testing of solar collectors; (4)development of an insolation instrumentation package and handbook; and (5)inference of insolation parameters from existing meteorological records. In this paper, the details of these solar energy projects of the IEA are summarized.

(COOLING, ECONOMICS, HEATING, INSOLATION, WATER HEATERS)

ST78 11055 SOLAR ENERGY PROGRAM OF NATO COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY

Morse, F.H., (ERDA, Washington, D.C.), Sharing the Sun: Solar Technology in the Seventies, V 1, 11 refs, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:118271

The objective of the solar energy pilot study of the Committee on the Challenges of Modern Society (CCMS) of the North Atlantic Treaty Organization (NATO) is the exchange of information on the solar heating and cooling systems programs and projects of each participating country so as to encourage the cost-effective and practical application of solar energy to heating and cooling in residential, commercial, industrial, agricultural, and public buildings. The key element in this information exchange are: (1)the preparation and distribution of special reports, prepared in an agreed format, on certain projects in the participating country, (2)the distribution of relevant and publicly available reports concerned with solar heating and cooling systems in buildings, and (3) the participating in meetings for the review of research, development, and demonstration programs, discussions, and exchange of information and ideas. In this paper, the CCMS solar energy pilot study is summarized and recent activities are reviewed.

(BUILDINGS, COOLING, ECONOMICS, INFORMATION, HEATING)

ST78 11056 FUTURE IMPORTANCE OF SOLAR ENERGY FOR ENERGY SUPPLY TO THE FEDERAL REPUBLIC OF GERMANY

Oesterwind, D., Meliss, M., Energiewirtsch., Tagesfragen, Germany, V 26:712-720, N12, 30 refs, Dec. 1976

A comprehensive review paper dealing with solar-electric conversion by solar cells and solar-thermal conversion for various applications in the temperature range of 100 to 800 C. Both the economic and the technical sides are considered. Solar energy could supply from three to four times the household summer requirement but in winter, where the consumption is about 60 percent higher, only some 20-30 percent could be covered by solar energy. Therefore, a storage plant or heat pump is required. The authors consider that the low conversion efficiency and large surface area requirement of solar-electric collector plates will deter significant utilization of solar energy for electrical power production in Germany.

(ECONOMICS, ELECTRICAL-POWER, HEAT-PUMPS, SOLAR-CELLS)

ST78 11057 TECHNICAL AND SOCIO-ECONOMIC ASPECTS OF SOLAR ENERGY AND RURAL DEVELOPMENT IN DEVELOPING COUNTRIES

Ramakumar, R., (Oklahoma State University, Stillwater, OK), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 9:162-176, 21 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:119793, A77-49128, A77-48910 23-44

In developing countries, the losing race between demography and development is resulting in the emergence of the dual economy. Unless checked, this will lead to social and political tensions with global consequences. A healthy and dynamic rural growth is necessary to correct this situation. Energy can play a vital role in this process. A step-by-step approach is presented for the adoption of technologies designed to exploit renewable (solar) energy sources at the rural level. It is centered around the establishment of rural energy centers to improve the basic living environment. In due course, the role of these centers is to be expanded to encompass agricultural and small-scale industrial activities. The technical and socio-economic aspects of the step-by-step introduction of solar energy systems in rural areas in developing countries are discussed.

(AGRICULTURE)

ST78 11058 CONCEPTUAL DESIGN STUDY FOR THE APPLICATION OF A SOLAR TOTAL ENERGY SYSTEM AT THE NORTH LAKE CAMPUS, CALLAS COUNTY COMMUNITY COLLEGE DISTRICT

Randall, D.E., Sandia Labs., Albuquerque, NM, ERDA, 202 pages, Oct. 1976, SAND-76-0512
A proposal for the design and installation of an experimental solar total energy system at the new North Lake Campus of the Dallas County Community College District was submitted to ERDA. The ERDA Solar Energy Division of authorized Sandia Laboratories, with the assistance of the DCCCD, Envirodynamics, Inc., and Stearns-Roger, Inc., to conduct a conceptual design study of a solar system for the North Lake facility. This report presents the results of this design study.

(BUILDINGS, COOLING, HEATING)

ST78 11059 GRUNDLAGEN UND WEGE ZUR SONNENENERGIE-NUTZUNG (PRINCIPLES AND WAYS TO UTILIZE SUN ENERGY)

Reinhard, K., ERNO Raumfahrttech, Bremen, Germany, Klim Kaelte Ing, V 5:147-158, N4, 39 refs, April 1977, In German
After introducing solar energy and insolation, the design, efficiency, and performance layout charts of solar collectors (as well as various opportunities for thermal storage) are shown. Areas of utilization within Northern Europe are examined, which include preparation of domestic hot water, space heating and cooling, the desalination of water, generation of electricity, and production of hydrogen.

(INSOLATION)

ST78 11060 SOLAR ENERGY: A SOURCE OF ENERGY FOR OUR DAYS?

Redstad, J., Parr, H., (Fysisk Inst., Univ. of Oslo, Oslo, Norway), Tek. Ukebl., Norway, V 123:137-138, 141-142, N50, 5 refs, Nov. 29, 1976, In Norwegian
The availability of solar energy is reviewed and some current types of solar cells described. Even in the Northern areas of Norway, the available solar energy amounts to several times the energy requirements for heating.

(HEATING, SOLAR-CELLS)

ST78 11061 EQUIPMENT FOR GENERATING ELECTRIC ENERGY FROM SOLAR ENERGY

Robieux, J., Nov. 18, 1976, Patent no. 2,619,480/A, In German, EDB-77:111194
A plant for the production of electrical energy from solar energy is described. The solar radiation is collected using parabolic mirrors which are arranged on a circular surface. At the focal point of each parabolic mirror there is a light conductor which conducts the concentrated light energy to the center of the circular surface. The actual absorber is situated here, which has a fluid flowing through it. The fluid is heated to temperatures of 500-1500 C, and drives a turbine which in turn drives an electric generator. The individual parabolic mirrors can be set to the position of the sun at any time.

(CONCENTRATORS, ELECTRIC-GENERATORS, PARABOLIC REFLECTORS)

ST78 11062 INDUSTRY ACCEPTANCE OF SOLAR TECHNOLOGIES: INSTITUTIONAL BARRIERS AND APPROPRIATE STRATEGIES

Schoen, R., (Univ. of California, Los Angeles, CA), IF, (Ind. Forum), V 7:35-48, N2-3, 1976, EDB-77:137433
Use of solar energy must be associated with energy conservation is design. However, technical innovation (even if economically competitive) needs to be carefully introduced into the building industry and demonstrated carefully. The industry's characteristics require that existing distribution systems be respected or bettered (from all involved participants' points of view). Demonstration projects fall into various types, corresponding to various stages of the innovation-diffusion process (Operation Breakthrough failed on this score). Solar technology is still at the diffusion-to-commercial-readiness stage, requiring carefully designed industry-viable demonstration projects, at the appropriate scale and accompanied by diffusion mechanisms (the kind of project will depend on certain characterizing criteria). Feedback, particularly from the occupant, is important. The project must fit its local context.

(BUILDINGS, COOLINGS, DEMONSTRATION, HEATING)

ST78 11063 CONSUMER DEMAND ANALYSIS: SOLAR HEATING AND COOLING OF BUILDINGS, Final Report

Scott, J.E., (Delaware Univ., Newark, DE), Sept. 1976, COO-2598-1, EDB-77:124832
Avail:NTIS

This study concerns the acceptability of solar heating and cooling to home buyers for residential applications. The study assesses the extent of homeowner awareness of solar technologies, estimates the acceptability of elevated first costs including willingness to trade higher initial costs for life cycle savings, and investigates the impact of solar aesthetics. Also explored are other areas of potential concern to homeowners in evaluating a solar alternative as well as positive motivations that would encourage purchase. Finally, the socio-economic and attitudinal characteristics of individuals more likely to purchase a solar home rather than a conventional home were studied. The results are based on group depth interviews and personal interviews with active home seekers, top executives of large residential development firms, and architects. The sample was split evenly between Denver, CO, and the Philadelphia, PA-Wilmington, DE areas. Implications of the results for the commercialization of solar energy and possible public policy decisions are also discussed.

(ARCHITECTURE, ECONOMICS)

ST78 11064 ENVIRONMENTAL IMPACT OF MAJOR SOLAR POWER DEVELOPMENT

Sears, D.R., Gandel, M.G., (Lockheed Missiles and Space Co., Huntsville, AL), Hartley, R.P R.P., (US Environmental Protection Agency, Cincinnatti, OH), Bradley, W.G., (Environmental Consultants, Inc., Las Vegas, NV), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1, 614-620, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, US Environmental Protection Agency, A77-48773, A77-48701 23-44

We have examined the environmental effects of terrestrial silicon photovoltaic power generation in utility application, by following the chain of events from raw material extraction to plant operation. CDS and GAAS technology, satellite siting, and solar steam-electric plants are also discussed briefly.

(PHOTOVOLTAIC)

ST78 11065 NSF SOLAR ENERGY PROGRAMS IN TRANSITION

Spuhler, H.A., (NSF, Washington, D.C.), Sharing the Sun: Solar Technology in the Seventies, V 1, 4 refs, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:118175

A brief history of the development of National Science Foundation programs in solar energy research is presented. The rationale of the research applied to national needs program is discussed in the context of solar energy applications. The inter-relationships between the National Science Foundation and the Energy Research and Development Administration are outlined, and the transfer of solar energy research activities is described. The restructuring of foundation energy research activities and the nature of some new program thrusts are presented.

(US ERDA)

ST78 11066 SOLAR ENERGY AND URBAN SETTLEMENTS

Swartman, R.K., (Univ. of Western Ontario, London, England), Sharing the Sun: Solar Technology in the Seventies, V 9, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:119792

The influence of energy on urban settlement patterns in the past is reviewed. Then possible patterns in the future as society turns towards solar energy as a major energy source are suggested.

(PLANNING)

ST78 11067 EXPERIMENTAL AND THEORETICAL STUDIES ON SOLAR ENERGY FOR ENERGY CONVERSION

Thomas, A.P., Thekaekara, M.P., (NASA-Goddard Space Flight Cent., Greenbelt, MD), Sharing the Sun: Sol. Technol. in the Seventies, Jt. Conf. of the Int. Solar Energy Soc., Am. Sect. and Solar Energy Soc. of Canada, Inc., Winnipeg, Manitoba, Canada, V 1:338-355, 12 refs, Aug. 15-20, 1976, Am. Sect. of the Int. Solar Energy Soc., Cape Canaveral, FL

The results of investigations to evaluate parameters that affect insolation received on a collector surface are presented. Various measurements using both pyranometer and pyrheliometer and computation of total and spectral irradiance at ground level are made for many combinations of atmospheric parameters for ozone density, precipitable water vapor, turbidity-coefficients, and air mass. A study of air mass as a function of irradiance measured at GSFC, and comparison of the data with computed values of total direct insolation for various parameters indicates that turbidity changes with time of the day and concludes that atmospheric opacity is greater in the afternoon than morning.

(INSOLATION, PYRHELIOMETERS, PYRANOMETERS)

ST78 11068 SOLENERGIN-UNGEN PARENTES (SOLAR ENERGY)

Wettermark, G., Stymne, H., (R. Inst. of Technol., Stockholm, Sweden), VVS Tidskr Vaerme Vent Sanit. Kyltetek, V 48:49-64, N5, 7 refs, May 1977, In Swedish
The potential utilization of solar energy in Sweden is discussed, and taking into account specific local climatic conditions, the problems involved in economical large-scale and long-term solar energy thermal storage and design of large solar power plants are examined.

(INSOLATION, FLAT-PLATE)

ST78 11069 SURVEY OF POWER SOURCES

Wheeler, N., Advanced Electronics Center, Ithaca, NY, 1961, EDB-77:131860
A survey of available "battery" power sources for selection of optimum power source for sonobuoys, missiles, or other similar devices is presented. Power sources described include wind-driven impellers, wave-boosted battery, weight-driven systems, electrochemical cells, solar cells, thermoelectric power generation, thermionic cells, nuclear cells, primary and secondary cells, reserve or delayed-action batteries, fuel cells, etc.

(FUEL-CELLS, SOLAR-CELLS, THERMIONIC-CONVERTERS, SAVE POWER, WIND POWER)

ST78 11070 ENERGY AND THE RURAL SECTOR IN PAPUA, NEW GUINEA

Woodward, J.L., (Papua, New Guinea Univ. of Tech., Lae., Papua, New Guinea), N.Z. Eng., V 32:62-66, N3, 7 refs, March 15, 1977, EDB-77:113000
Energy in a dispersed form and at a low cost is needed if it is to have a significant effect in Papua, New Guinea. Appropriate application of energy at an intermediate-technology level would involve local residents in the construction and operation of solar and wind systems, inexpensive water systems, and a waste-fueled power system. The region's primary resource, manpower, must be utilized to overcome the disadvantages of poverty and a difficult terrain. Wood is the principal fuel and is burned directly as well as converted to producer gas. A review of the village's resources and potential for development concludes that medium-scale projects are feasible if the people are given guidance to help them develop technical and mechanical competence.

(DEVELOPING COUNTRIES, ECONOMICS)

12000 ECONOMICS AND LAW

ST78 12000 THE MARKETABILITY OF INTEGRATED ENERGY-UTILITY SYSTEMS

(Department of Health, Education, and Welfare, Washington, D.C.), (NBS), 45 pages, PB-266042-1, N77-29626
Avail:NTIS
A marketing guide acquaints the prospective marketplace with the potential and underlying logic of the generic integrated utility system (IUS) concept. A sizeable number of educational and medical facilities may well be compatible with the IUS concept, and appropriate implementation of an IUS would bring about the realization of startlingly substantial annual dollar savings for the institution along with impressive energy savings.

(ECONOMICS)

ST78 12001 EMPIRICAL ANALYSIS OF THE RELATIONSHIP BETWEEN ENERGY AND THE ECONOMY

Askin, A.B., Garman, R.L., Lagace, G.L., Malloy, A.J., (FEA, Washington, D.C.), J. Energy Dev., V 2:252-256, N2, Spring 1977, EDB-77:119667
The relationship between developments in the energy sector and general economic activity must be taken into account in the design of a sound energy policy. Analysis of alternative policies can only be made when consideration is given to the macroeconomic environments that affect and are affected by energy projects. Attempts to model energy sector and economy in a general equilibrium have used the Hudson-Jorgenson, Project Independence Evaluation System (PIES), Wharton, and Data Resources, Inc. (DRI) models. Linked DRI and Wharton models were used to determine the long-run effect on the economy of 14 PIES scenarious. Variables used were world crude oil prices, domestic energy policy, and the potential geologic resource. Although both models show energy prices rising with higher world crude oil prices, the DRI model shows a drop in gross national product in contrast to the Wharton model. Domestic energy policies have greater impact on world crude oil prices in the DRI model, but energy supply assumptions show greater impact in the Wharton model. Both models indicate the gross national product increased with energy conservation programs.

(COMPARATIVE-EVALUATIONS, ECONOMICS, ENERGY-MODELS, FORECASTING, RESEARCH-PROGRAMS)

ST78 12002 SOLAR ECONOMICS IN ILLINOIS

Barfield, E.F., Casella, A.J., (Sangamon State University, Springfield, IL), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 10:165-170, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:118191, A77-49152, A77-48910 23-44

Operating costs for houses utilizing conventional fuels for heating, hot water, and/or cooling are compared with those for identical houses that utilize solar energy for the same purposes. Three different sized houses were considered at six different locations in Illinois. Solar insolation data was gathered or calculated for each location. Heating, hot water, and/or cooling load were calculated for each location. Heating, hot water, and/or cooling load were calculated for each house along with system performance utilizing five different sized solar systems. Yearly operating costs for the solar equipped houses were calculated based upon a 20-year life cycle, 8 percent interest rate, and collector costs of $8, $10, or $12 per ft^2.

(COMPARATIVE-EVALUATIONS, HEATING)

ST78 12003 DEMAND-LIMITING CAN GIVE USERS SIGNIFICANT SAVING

Beachley, R.W., (Engineering Consultants Inc., Charlotte, NC), Energy User News, V 2:22, N16, April 25, 1977, EDB-77:145923

Industries can save money by installing demand limiters without sacrificing production, efficiency, or human comfort, according to this engineering consultant. Pulse-rate limiters can usually be obtained for use with the same type of kilowatt-hour meter the utilities use for billing. Photoelectric counters monitor the rotating disc and correlate pulses with consumption. An adjustable limiter is wired to the counter and cuts off selected loads until the pulse rate meets a pre-set limit. Proper programming for interruptible service is essential for the limiter to be both cost and energy-effective. Peak-load and other demand billing charges by the utilities can be offset by using limiters where they are practical. Interruptible service can be effectively used for water heaters and temperature-control equipment. A qualified electrical contractor and engineer can recommend the most economical equipment needed for a specific installation. Utilities are generally favorable to steps taken that level the demand.

(CONTROL-SYSTEMS, CURRENT-LIMITERS, UTILITIES)

ST78 12004 INCENTIVES AND BARRIERS TO THE DEVELOPMENT OF SOLAR ENERGY

Bezdek, R.H., Maycock, P.D., (ERDA, Washington, D.C.), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 9: 64-73, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:118188, A77-49119, A77-48910 23-44

Incentives and barriers to the widespread utilization of solar water and space heating, solar space cooling, agricultural and industrial process heat from solar energy, photovoltaic systems, and solar space systems are discussed. High capital costs, restrictive zoning ordinances, controlled fossil fuel prices, and legal and regulatory restraints are cited as barriers to the introduction of the various types of solar energy systems. Income tax credits, loan guarantees, interest subsidies, property and sales tax exemptions, investment tax credits, the integration of solar energy systems into utility networks and the dissemination of information are mentioned as factors promoting the use of solar energy.

(LOANS, TAX-CREDITS)

ST78 12005 STATE LEGISLATIVE INITIATIVES FOR SOLAR ENERGY IMPLEMENTATION

Binns, W.P., (National Conference of State Legislatures, Washington, D.C.), IF (Ind. Forum), V 7:3-9, N2-3, 1976, EDB-77:140038

Faced with energy shortages and increased costs, it is necessary to (a) improve efficiency of end use and reduce unnecessary demand, and (b) develop a mix of alternative energy sources. Solar energy is a realistic alternative, particularly for the large volume low-grade energy use for heating and cooling buildings and for water heating. In the adjustment process, as society adopts new energy sources, institutional barriers must be identified. The National Conference of State Legislatures has been studying the problem. Initiatives have been taken in some states concerning life-cycle costs, demonstration projects, tax incentives, research, development and information, and solar access rights.

(ACCESS-RIGHTS, HEATING, LEGISLATION, LIFE-CYCLE-COSTS, WATER-HEATERS)

ST78 12006 SOME INSTITUTIONAL PROBLEMS OF RESIDENTIAL SOLAR HEATING

Blair, J.F.Jr., O'Brien, J., (Franklin Inst. Research Labs., Philadelphia, PA), Sharing the Sun: Solar Technology in the Seventies, V 9, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:118267

Because of the overwhelming influence of financial institutions on the building market, the concept that governmental actions are required if solar-assisted heating systems are to become an acceptable technology in the near future is discussed. Barring radical changes, a large-scale introduction of solar-assisted heating will not come about through economic forces alone. The key lies in subsidies which could be in the form of tax abatements to building owners, subsidies by utilities to building owners, preferential utility rates, and, most importantly, a credible and consistent energy policy on the part of the government.

(ECONOMICS, ENERGY-POLICY, FINANCIAL INCENTIVES, HEATING, SUBSIDIES)

ST78 12007 ENVIRONMENTAL ISSUES ASSOCIATED WITH SOLAR HEATING AND COOLING OF RESIDENTIAL DWELLINGS

Brannon, P.J., Church, H.W., Luna, R.E., Thomas, W.A., (Sandia Labs., Albuquerque, NM), April 1977, SAND-77-0172, EDB-77:124734

The negative issues associated with solar heating and cooling of residential dwellings were surveyed. Effects which were addressed as possibly significant include: (1)heat transfer fluids and storage media hazards, (2)material resources usage, (3) architectural and aesthetic changes, (4)air pollution due to outgassing or evaporation losses, (5)reflected light hazards, and (6)legal questions arising from reflected light nuisances and solar rights. The magnitudes of these environmental effects were compared to similar effects from common sources whenever possible.

(ARCHITECTURE, BUILDINGS, FIRE-HAZARDS, HOUSES, STORAGE, WORKING FLUIDS, SAFETY)

ST78 12008 SOLAR INDUSTRY: STATUS REPORT AND FORECAST

Butt, S.H., (Solar Energy Industries Association, Washington, D.C.), Energy Technology IV: Confronting Reality, 1977, Ed: Hill, R.F., Government Institutes, Inc., Washington, D.C., EDB-77:140031

A solar industry has developed during the past three years and doubled in size every nine months. The flat-plate solar collectors needed for solar heating and cooling require simple technology which needs only refinement. Indications of the industry's growth are reflected in the number of new participants and publications in the field. Photovoltaics are expected to expand from space applications to specialized terrestrial uses as increasing energy costs push them into commercialization as rapidly as the heating and cooling industry have experienced. Neither solar energy nor conservation alone can fill the gap between available energy sources and demand, but solar energy can provide a major share. Because it is inexhaustible, non-polluting, and safe, solar development can proceed immediately toward commercialization while other energy sources need further research and technological breakthroughs. The Incentive Program, which just missed Congressional approval last year, needed to expedite commercialization. Forecasts of solar development based on equivalent barrels of oil saved, the dollar value of equipment installed, and both home and non-residential applications project a visible industry within five years and a pervasive one after fifteen years.

(CONCENTRATORS, COOLING, FINANCIAL-INCENTIVES, FLAT-PLATE, HEATING, PHOTOVOLTAIC)

ST78 12009 STATE LEGISLATURES PASS, DEFEAT, SHELVE ENERGY BILLS

Crawford, E., Energy User News, V 2:13, N25, June 27, 1977, EDB-77:139920

The status of major state legislation pertaining to energy is surveyed for the Midwest, Far West, and Southwest for those states whose legislative sessions are completed and are located in major industrial areas. The Midwest states covered are Indiana, Missouri, Minnesota, and Illinois; Far West are Alaska, Arizona, Oregon, and Washington; and Southwest are Texas, Oklahoma, and New Mexico. Legislation tended to be watered down during the course of negotiation in many cases. A number of bills provided incentives for energy conservation through tax credits and the removal of regulatory barriers. Efforts to create coordinated energy panels and state offices met with mixed results. Among the innovative laws passed was New Mexico's mineral severance tax of six cents per BTU to cover primarily coal and uranium, but which will raise electric power rates. Other legislation provided for natural gas storage in depleted Texas fields, siting of power plants in Washington, and hydroelectric projects in Alaska.

(ALASKA, ARIZONA, ENERGY-POLICY, FACILITIES, GOVERNMENT-POLICIES, ILLINOIS, INDIANA, LAWS, MINNESOTA, MISSOURI, NEW MEXICO, OKLAHOMA, OREGON, TEXAS, WASHINGTON)

ST78 12010 CLIMATE MAINTENANCE CONTRACTING: BRIDGING THE CONFIDENCE GAP IN THE SOLAR MARKET

Dayton, D.S., (Tech. Devel. Corp., Boston, MA), Sharing the Sun: Solar Technology in the Seventies, V 10, 11 refs, 1976, Ed: Boer, K.W., Amer. Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:118190

A novel contracting scheme is described for building customer confidence in solar-energy installations while establishing a dependable distributor network for manufacturers. The economics or technology of solar energy applications are not discussed.

(FINANCING, HEATING)

ST78 12011 STATE LEGISLATURES PASS, DEFEAT, SHELVE ENERGY BILLS

Dell, A., Minarcin, D., Energy User News, V 2:13, N26, July 4, 1977, EDB-77:139918

Part two of a legislative wrap-up covers industrial states in the Northeast, South, and Mid-Atlantic whose legislatures have considered energy proposals. New York bills include a proposal to drill for natural gas in Lake Erie, but no nearer than a half-mile from shore and two miles from a public water intake. A proposal to explore state-owned utilities will be re-introduced next session. New Jersey was unable to resolve political differences in time to pass any significant legislation. Industrial growth in Connecticut will feel the impact of rulings to phase out block rates and make time-of-day rates available. Only five of 130 proposed energy bills were passed by the Florida legislature. Maryland, faced with 174 energy bills, is establishing an energy review committee to examine former proposals and set guidelines. Ohio's general assembly will meet throughout the summer to deal with utility projections on demand and supply and natural gas well drilling in Lake Erie. Other states have passed minor bills and defeated or shelved most proposals.

(CONNECTICUT, ECONOMICS, ENERGY POLICY, FLORIDA, LEGISLATION, MASSACHUSETTS, MARYLAND, NEW JERSEY, NORTH CAROLINA, OHIO, PENNSYLVANIA, RHODE ISLAND, SOUTH CAROLINA, WEST VIRGINIA)

ST78 12012 ENERGY POLICY AND UTILIZATION

Deutch, M.J., Energy and the Environment, 1976, Ed: Theodore, L., Amer. Inst. of Chem. Engin., Dayton, OH, EDB-77:127571

Energy conservation is absolutely essential until such time as we can increase energy production from domestic sources. Some conservation measures are more practical and urgent than others, i.e., those that can achieve larger near-term results than energy substitution and supplies from new energy sources. To achieve a large reduction in our energy gap through conservation, we will have to formulate a comprehensive energy policy that has widespread public acceptance to introduce a true conservation ethic. To gain public acceptance, we will have to base our policy choices and schedules, not on wishful thinking, but to determine the relative effectiveness, timing, and feasibility of each strategy to reduce energy use. Each policy choice (including higher energy prices) will also have to be evaluated in the light of risks, disincentives, and effects on employment and inflation. Since our energy gap comes mainly from the short supply of oil and natural gas, a tangible conservation program should concentrate on these fuels. Thus, the priorities in conservation strategies should obviously be directed at the large end-users of imported oil (i.e., transportation and petrochemicals, and other industrial users where some substitution between fuels is feasible).

(ECONOMICS, USA)

ST78 12013 ENERGY CONSERVATION POLICY PROBLEMS

Deutch, M.J., Energy and the Environment, 1976, Ed: Theodore, L., Amer. Inst. of Chem. Engineers, Dayton, OH, EDB-77:127531

While the conservation ethic strategy can produce immediate and short-term savings, projects such as the redesign of equipment and processes in capital-intensive industries can only be completed in a longer time-frame. Furthermore, it appears that many improvements in plants and processes can be derived from better combinations of existing technologies, rather than breakthroughs. Improvements in consumption patterns will still be necessary in the longer-term to ensure efficient allocation of resources and money.

(ECONOMICS, FINANCIAL-INCENTIVES, INSOLATION)

ST78 12014 DEVELOPMENT AND IMPLEMENTATION OF STANDARDS FOR SOLAR HEATING AND COOLING APPLICATIONS

Dikkers, R.D., (National Bureau of Standards, Center for Building Tech., Washington, D.C.), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 1:83-90, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, A77-48913, A77-48910 23-44

Solar-energy program activities being conducted by the National Bureau of Standards (NBS) are primarily centered around projects related to the development and implementation of standards and performance criteria for solar heating and cooling applications. In support of the Energy Research and Development Administration (ERDA) and the Department of Housing and Urban Developments' (HUD) solar-energy research and demonstration programs, NBS has prepared interim performance criteria for residential solar-energy systems and test procedures for determining the thermal performance of solar collectors and thermal storage devices. Currently, NBS is developing (1)interim performance criteria for commercial solar-energy systems; (2)intermediate standards for solar heating and domestic hot water systems that can be used in conjunction with HUD's minimum property standards; (3)draft standards for materials (i.e., sealants, cover plates, insulation) to be used in solar systems; (4)plans for establishing a solar-collector testing laboratory accreditation program; and (5)plans for identifying and developing other needed standards in cooperation with various standards-writing organizations.

(SOLAR-COLLECTORS, STORAGE)

ST78 12015 UTILITY PRICING AND SOLAR ENERGY DESIGN

Feldman, S.L., Anderson, B., Wessler, E., Wirtshafter, R., Breese, J., (Clark Univ., Worcester, MA), (Grad. School of Geography, Total Environment Action, Inc., Harrisville, NH), (NSF, Washington, D.C.), (RANN), NSF-APR75-18006, 177 pages, Sept. 30, 1976, Total Environmental Action, Inc., Harrisville, NH, Report on Project: "Non-conventional Incentives for the Adoption of Solar Energy Design;" GRA17710

This report addresses the impact of solar space conditioning (SHAC) on electric utilities, and the effect of utility pricing on the cost effectiveness and design of solar buildings. A measure of the impact of SHAC on utilities was made from these perspectives of building owner, electric utility, and national economic efficiency. The model, broken into four sectors, represented a composite evaluation. The first sector simulated the performance of a solar building and a conventional building. The second sector calculated the impact of the electricity demands of the two buildings on the loads and subsequent incremental costs of the electric utility. The third sector examined the cost-effectiveness to the building owner of the solar building in comparison to the conventional building. The final sector considered the total costs to society of one alternative building versus the other.

(BUILDINGS, COOLING, ECONOMIC ANALYSIS, ELECTRIC UTILITIES, HEATING)

ST78 12016 PROJECT SAGE: SOLAR ASSISTED GAS ENERGY PROJECT, Interim Report No. 2

Hirshbert, A., Barbieri, R., Bartera, R., Lingwall, J., Schoen, R., Vault, R., (Jet Propulsion Lab., Pasadena, CA), (S. Calif. Gas Co., Los Angeles, CA), Aug. 1976, DSE-WAPO-4691-1, EDB-77:111242

A preliminary description is given of Project Sage, the solar assisted gas energy (SAGE) water heating system currently being tested and evaluated in Southern California. A statement of the goals and objectives of the Sage Water Heating Program, a general description of the project in addition to system performance data, evaluations, and economic analyses of the various pilot studies, and field test installations are presented.

(ECONOMICS, FINANCIAL-INCENTIVES, PILOT-PLANTS, RETROFITTING, WATER-HEATERS)

ST78 12017 ENERGY TECHNOLOGIES FOR THE WEST: ECONOMIC GROWTH AND ENERGY

Hogan, W., (ERDA, Washington, D.C.), Workshop in San Francisco, 98 pages, Sept. 21, 1976, N77-31648

The implementation and operation of formal models and analyses applied to energy problems were described, demonstrating the relationship between economic growth and energy demand and supply. Questions of energy supply and conservation practices were reviewed. The shortage of natural gas was seen as the most pressing issue in California. Comments were made regarding electric energy growth in the Western states, giving attention to the energy consumption/GNP relationship. A group study was then presented which compares the economics of coal-fired and nuclear power plants.

(CONFERENCES, NATURAL GAS, POLICY)

ST78 12018 LEGAL PROBLEMS AND UTILIZATION OF SOLAR ENERGY

Hueber, A., Dgs-Muenchen, Germany, F.R., Heating With Sun: Practical Building Engineering, V 2, 1977, Ed: Bossel, U., In German, EDB-77:144675

The evolution of solar engineering has shown again that a technical innovation precedes legal matters. Therefore, it is necessary to bring positive influence to bear on the new interpretation of existing regulations as well as on the standardization to be carried out under the aspect of solar energy legislation by means of information and appropriated proposals. In view of the utilization of solar energy, the following problems are discussed: The neighbors' rights, the law concerning the planning of new buildings, building permits and building law, and architects' liability.

(LAWS, REGULATIONS)

ST78 12019 SYMPOSIUM ON PRICE AND PRODUCTION CONTROLS IN ENERGY INDUSTRIES, 1976

Huffman, W.J., Ed., Energy Commun., V 3:1-82, N1, 1977, EDB-77:127567

This issue contains the proceedings of a one-day symposium held Thursday, April 1, 1976, on the campus of Texas Tech. University. The purpose of the symposium was to provide a neutral atmosphere and forum which would permit widely divergent viewpoints (and the reasons for the same) to be seriously discussed with little concern for news value, without one-on-one confrontation, and without adversary relationships. Individual perspectives on such controversial topics as divestiture of oil companies, lifeline pricing, social responsibilities of business, need for federal agencies, current federal price structures of interstate sales, impact of intrastate price controls, energy industry controls versus federal regulation in other industries, as well as industrial, public, and labor lobbying organizations were freely expressed as they are related to human and national needs. Five viewpoints are presented, followed by a question and answer session by panelists.

(ECONOMICS, ENERGY-POLICY, NATURAL GAS, WELL DRILLING)

ST78 12020 IMPLICATIONS OF RESIDENTIAL SOLAR SPACE CONDITIONING ON ELECTRIC UTILITIES

Lorsch, H.G., Franklin Inst. Research Labs., Philadelpnia, PA, Rept. No. FIRL-F-C4209, 204 pages, Final Rept. June 1975-Dec. 1976, NSF-CI033, NSF-AER75-18270, GRAI7710, EDB-77:137483

The electrical energy demands of residences in the Philadelphia Electric Company (summer peaking) and Pennsylvania Power and Light Company (winter peaking). Service areas were compared in electric resistance heating, solar heating with electrical back-up, and solar-assisted heat pumps. Market projections of solar heating were made, and the effects on the generating, transmission, and distribution systems of the two utilities were determined in five-year intervals through the year 2000. Costs-to-serve and revenues were compared, possible rate scenarios were investigated, and the effects of different rate structures on the rate of introduction of solar heating were evaluated.

(ELECTRIC HEATING, COMPUTERIZED SIMULATION, HEAT-PUMPS, ECONOMICS, PENNSYLVANIA, RATES)

ST78 12021 EFFECT OF SOLAR HOME HEATING ON ELECTRIC UTILITIES

Lorsch, H.G., (Franklin Inst. Research Labs., Philadelphia, PA), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 9:97-112, 12 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:118264, A77-49123, A77-48910 23-44

The effect of introducing residential solar heating was modeled for two electric utilities in the Northeastern US, one experiencing a summer peak demand, the other a winter peak. For solar-heated homes with electric resistance back-up heating, the annual load factor is found to be approximately 40 percent lower than that of the conventionally heated residence. However, on the coldest day of the year, both types of heating system will place the same load demand on the utility. This identity of peak demand, together with the costs related to the installation of electrical facilities, may lower actual energy savings for the consumer using a combination of solar energy and conventional heating. Alternative rates that would reimburse the utilities for costs of integrating solar heating systems into power networks are considered.

(ECONOMIC ANALYSIS, RESIDENTIAL, USA)

ST78 12022 GENERAL LAW FOR DIRECT SUNLIGHT PENETRATION

Mann, J.E., Curry, G.L., Hartfiel, D.J., Demichelle, D.W., (Virginia Polytec Inst. and State Univ., Blacksburg, VA), Math Biosci, V 34:63-78, N1-2, 19 refs, 1977

The assumption that foliage area distributions may be approximated by probability distributions is used for a general law to relate insolation penetration with crop canopies. It is shown that the Poisson (Beer's) Law is a special case of this more general law. Area and transect problems are treated, and stochastic variation in leaf sizes is considered. Numerical studies are presented which indicate that the Poisson Law is not adequate in all cases for the prediction of sunlight penetration and that stochastic variation in leaf sizes is of less consequence than average leaf size and/or leaf-area index.

(AGRICULTURAL ENGINEERING, INSOLATION)

ST78 12023 USE OF OFF-PEAK ELECTRICITY FOR SOLAR HEATED HOMES

McConnell, R.D., (Hydro-Quebec, Varennes, Quebec), Beaudet, J.H., Piche, B., Maille, E., Sharing the Sun: Solar Technology in the Seventies, V 9, 1976, Ed: Boer, K.W., Amer. Section of the Internat. Solar Energy Soc., Cape Canaveral, FL, EDB-77:118265

The growing interest in solar-home-heating systems led Hydro-Quebec to undertake studies of the possible impact on its load profile of many solar homes equipped with electric heat backup. They are participating with McGill University in a performance evaluation of a solar-home-heating system having electric backup and, with the help of this evaluation, shall attempt to estimate the effect of many similar homes on their load profile. Preliminary thoughts on this matter are presented. The Hydro-Quebec network, like that of many northern utilities, experiences large demand fluctuations during winter months. The peak power demand often occurs during the coldest winter days (usually from 9H to 11H and from 16H to 20H). These so-called peak periods are costly for all electric utilities, and the energy demand pattern of thousands of solar homes with electric-heating backup could have an important effect on the network load profile. In addition to backup heating for lengthy cloudy periods, most solar-home-heating systems incorporate thermal-energy-storage equipment, allowing for one or two days autonomy. In the case of electric heating backup, it appears that it would be beneficial for utilities if the use of off-peak electricity was incorporated into the heating system design. A simple means of doing this would be to place the electric-heating elements in the duct leading to the energy storage or else directly in the storage. Controls would also be needed so that, if the stored thermal energy is low, the storage can be filled during the off-peak periods. Economic estimates are presented for different types of backup heating systems.

(ECONOMICS, STORAGE, UTILITIES)

ST78 12024 SOLAR SYSTEM MARKET CAPTURE IN THE CLIMATO-ECONOMIC REGIONS OF THE UNITED STATES

McCumber, W.H.Jr., (IBM Corp., Federal Systems Div., Huntsville, AL), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 9:18-31, 6 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:118261, A77-49116, A77-48910 23-44

Penetration of solar energy systems into construction markets is determined by the economic expectations of the consumer. Since individual customization is impractical, regions of similar economic and climatological characteristics may be defined against which to optimize designs. This paper defines 51 climato-economic regions of the US and demonstrates two computerized analytical tools, CERES (Comprehensive Economic Recovery Evaluation System) and CAP (Capture Analysis Program), which extrapolate the technical and economic performance of region-optimal systems into national market capture expectations. Used iteratively, CERES and CAP evaluate the sensitivity of market capture to incremental changes in technical characteristics or economic environment.

(COMPUTER-PROGRAM, ECONOMIC-ANALYSIS, MATH-ANALYSIS, USA)

ST78 12025 WATSUN: A SOLAR HEATING SIMULATION AND ECONOMIC EVALUATION PROGRAM, User's Manual

Orgill, J.F., Hollands, K.G.T., (Waterloo Univ., Ontario, Canada), NTIS-ERDA-ENP-21307, 88 pages, April 1976, GRAI7712, ERA no. 02:017533
Avail:ERDA US Sales Only

WATSUN is a Fortran IV computer program designed to test the economic and technical feasibility of solar space heating. Presently, WATSUN is capable of simulating three types of solar heating systems, (a)a liquid-base system with short-term storage, (b) an air-base system with short-term storage, and (c)a liquid-base system with long-term seasonal storage. The three systems allow flexibility, which designers require when selecting among various solar heating alternatives. As with earlier solar heating simulating programs, WATSUN is modular in nature. However, the WATSUN modules consist of systems rather than component models except for an optional flat-plate collector model. The benefit of using system, rather then component models is in reduced computational effort and associated costs.

(BUILDINGS, CANADA, HEATING, STORAGE)

ST78 12026 COMPARISON OF NATIONAL ENERGY CONSUMPTION DATA: SOME PROBLEMS

Parent, J.D., Linden, H.R., (Inst. of Gas Tech., Chicago, IL), Risky to use Energy/GNP Values for Different Countries, 1977, EDB-77:140020

Two aggregate indices commonly used in national energy conservation studies are the per capita annual energy consumption and the ratio of energy use to either gross national product (GNP) or gross domestic product (GDP). It has been reported that both of these indices are greater for the US than for some other highly industrialized countries of about the same level of per capita GDP and standard of living. Hence, the USA has been indicted as wasteful. An effort is made in this report to point out the problems faced when comparing national per capita energy consumption and energy consumption/GDP (E/G) levels. In both cases, it can be grossly misleading to consider only aggregate values of the indices without due allowance for the considerable differences in economic structure and in the mix of energy sources used. It is especially difficult, if not impossible, to put E/G values for different countries on a strictly comparable basis, free of imprecision and arbitrariness. Additional major problems include the difficulty in converting GDP

data from national currencies to a common unit, the fixed US dollars, in a manner consistent with purchasing-power parities. Further, when national time series of E/G values are compared, differences in inflation rates and changes in exchange rates add to the complications and uncertainties. In this report, data are presented for 14 countries, including the United States, for the period 1971-1975. The data include energy consumption as evaluated by three agencies, per capita energy consumption, and national product values according to the International Monetary Fund, and the World Bank. When GDP values in 1975 US dollars are computed from the various data, quite different values can be obtained, depending on the method used. Hence, considerable doubt is cast upon the whole procedure of computing and comparing national E/G values.

(DATA COMPILATION, NATURAL GAS)

ST78 12027 ENERGY: THE IMPACT OF AVAILABILITY AND PRICES ON FUTURE BUSINESS PROSPECTS

Peelle, D.M., Ed., (Univ. of Mich., Ann Arbor, MI), Collection of 12 Papers, 1975, EDB-77:112900

This collection includes 12 papers, all but one being presented at an August 1974 Seminar. These are entitled: Energy: Policy, Availability, and Prices, Harry R. Hall; Public Policy and the Energy Crisis, Edward J. Mitchell; How Federal Price and Allocation Controls on Oil Have Worsened the Energy Crisis, William A. Johnson; Energy Availability in the Near and Long-Range Future, R.R. Wright; Consideration of Natural Gas Supply for Michigan, Donald L. Katz; The Outlook for Coal, Robert V. Price; Electricity: Future Availability and Cost, G.L. Heins; Solar Energy Research and Development, F. Tom Sparrow; Energy in the Automobile, Doron K. Samples; Energy and Future Business Prospects: Implication for Feedstocks-using Industries, William H. Shaker; Energy Conservation in the Processing Industries, Alfred F. Waterland; and Energy Management: Guidelines and Case Histories, G.N. Tiberio. Letter From OPEC is a dissertation by Joseph Kraft on a visit to OPEC headquarters in Vienna.

(AUTOMOBILES, ECONOMICS, GOVERNMENT POLICIES)

ST78 12028 THE POTENTIAL ECONOMIC IMPACE OF SOLAR-HEATED RESIDENCES IN ILLINOIS, 1976-2000

Pogany, D.Z., Dunwoody, J.E., (Ill. Dept. of Business and Economic Development, Div. of Energy, Springfield, IL), Sept. 1976, PB-265489, EDB-77:124841

This study examines the economic viability of solar heating systems for new residential construction in Illinois and accesses its potential economic and energy conserving impacts over the time frame of 1976-2000. Data on heating requirements. Solar radiation and conventional energy costs for six Illinois cities is integrated into a 15-year life cycle cost analysis to determine the economic competitiveness of solar-assisted systems as compared to conventional heating systems. The study concludes with recommended research and policy action.

ST78 12029 COST-PER-BARREL APPROACH TO THE EVALUATION OF ENERGY CONSERVATION OPTIONS

Power, J.N., Gill, G.S., (Federal Energy Admin., Washington, D.C.), Energy and the Environment, 1976, Ed: Theodore, L., EDB-77:127483

A method for evaluating energy conservation investments is presented which is simple, yet as rigorous as any of the conventional criteria. Indeed, it is a simple variant of those methods. Once you know the stream of energy savings during the life of an investment and the rate of discount you want to apply, the implicit cost per barrel of oil saved can be calculated from the following relation: present value of benefits - present value of costs. The implicit cost per barrel, so computed, is then compared with the market cost per barrel and the project selected if the computed implicit cost is less than the market cost of oil or other forms of energy. The method lends itself to a number of variations. For example, it can be used to calculate the implicit cost per barrel from the point of view of the society, or an individual or a corporation. This fact is significant in ascertaining the baseline response to be expected from the private sector and in helping to illuminate alternative governmental policies.

(ECONOMICS)

ST78 12030 REGULATING FOR NEW TECHNOLOGY

Smith, D.S., (Federal Power Commission, Washington, D.C.), Energy Technology IV: Confronting Reality, 1977, Ed: Hill, R.F., Government Institutes, Inc., Washington, D.C., EDB-77:139934

Commissioner Smith reviews the philosophy and objectives of public utility regulation and the potential of energy regulation to establish a climate conducive to introducing new technology. He stresses the importance of modifying rate regulations so that utilities can use R and D funds for high-risk demonstration facilities. Regulators and utilities are challenged to extend the new investment funds for home conservation to apply to solar and other user equipment as well as insulation. Other developments that are foreseen

include better end-use technology to take advantage of time-of-day rates; low energy minimum rates for power that supplements solar, co-generation, and multi-energy systems; effective comprehensive planning for regional energy systems; and reasonable profits to utilities which function well and provide efficient service to their customers.

(DEMONSTRATION PLANTS, ECONOMIC POLICY, FINANCIAL-INCENTIVES, PUBLIC UTILITIES)

ST78 12031 SOLAR MANUFACTURERS' VIEW OF THE INDUSTRY

Speiser, K., Energy Technology IV: Confronting Reality, 1977, Ed: Hill, R.F., Government Institutes, Inc., Washington, D.C., EDB-77:140033

Widespread public support is developing for expanding the solar energy effort, which is now a very small industry of 142 manufacturers who are mostly new in the rapidly growing field. Solar manufacturers have an esprit de corps that comes from establishing market shares in a new industry that is not taken seriously by many critics. Approval or rejection of administration proposals of tax credits and incentives will affect the future growth rate, as will shortages and higher prices of other energy sources. The industry must combat myths that solar energy is only futuristic, that it only works in warm climates, and that there is no real energy shortage. Changes in buying habits are needed so that consumers will accept the life-cycle concept and pay high first-cost prices to attain future savings. The task of adequately informing builders, architects, and consumers about solar energy will be helped by building standards and certified quality control, but will also introduce the problems of establishing criteria for reliable certification and information and of developing the industry infrastructure capable of providing adequate service. Other crucial unknown factors are utility acceptance of solar energy and possible legal questions of solar rights.

(ECONOMIC POLICY, GOVERNMENT POLICIES, LEGAL ASPECTS, PUBLIC UTILITIES)

ST78 12032 ENERGY CONSERVATION: OPPORTUNITIES AND BARRIERS

Thompson, G.P., Energy Awareness, 1977, CONF-770207, EDB-77:145909

Those seeking lower energy consumption should keep in mind that comfort need not be lost; that conservation can be viewed as a challenge rather than a threat. The difficulty of defining waste complicates this challenge of how to analyze costs and benefits. Many opportunities, such as refrigerator efficiency, are trivial and should be taken at once. Others constitute major investment with longer and less-secure payback. Public optimism as it is translated into legal and institutional barriers to conservation, and the lack of realistic price signals all work to discourage conservation. Federal programs for public education and persuasion and the few mandated actions have all been too timid and have tended to pass the hard problems on to the states. The states have responded with programs that are often innovative and comprehensive. Recommendations are for energy rate structures that focus on price signals to discourage wasteful consumption and on mandatory programs for energy efficiency standards.

(ECONOMIC IMPACT, EDUCATION, FINANCIAL-INCENTIVES, GOVERNMENT POLICIES, LAWS)

ST78 12033 LEGISLATIVE OUTLOOK FOR ELECTRIC COMPANIES IN THE 95th CONGRESS

Toll, D.R., (Nat'l Assoc. of Elec. Co's., Washington, D.C.), Electr. Perspect., V 77:2-10, N2, 1977, EDB-77:140001

Executives of electric companies are urged to make a critical examination of the Carter administration's appointments and policy initiatives in order to have a voice in keeping legislation free of unnecessary hardships. Congress as a whole is expected to work well together under the new Congressional leadership, although the new leaders lack the power enjoyed by their predecessors. Reorganization of committees in both houses has diffused energy policy matters. Carter appointees are reviewed, their strengths and weaknesses pinpointed. Carter's proposed energy reorganization is found to be similar to the recommendations of former President Ford, but with some differences. Congress, in writing the authorizing legislation, must deal with several controversial issues: (1)how to insulate the regulatory sector of a single agency, (2)divesting the successful securities exchange commission of its authority, and (3)diffusion and separation of conservation and environmental policy from the agencies close to the end-users. The breadth and general acceptance of Carter's goals raises the question of how effective his appeal for public input will be. The author believes the country may well help devise a new national ethic, but he foresees little impact on energy demand. Electric companies will continue to be affected by piecemeal legislation on environmental issues, rate and regulatory reforms, and conversion to coal.

(ECONOMIC POLICY, GOVERNMENT POLICIES, PUBLIC UTILITIES)

ST78 12034 ECONOMIC ASPECTS OF UNCONVENTIONAL ENERGY RESOURCES

Tybout, R.A., (Ohio State Univ., Columbus, OH), Nuclear and Solar Power, Am. Chem. Soc., Div. Fuel Chem., V 9:31-60, N2, 66 refs, 7 tables, 1965, EDB-77:119696
No abstract available

13000 THERMAL POWER

ST78 13000 SANDIA'S SOLAR TOTAL ENERGY PROGRAM

Leonard, J.A., (Sandia Labs., Albuquerque, NM), SAND-75-5880, EDB-77:124842
Avail:NTIS $4.00
No abstract available

(DEMONSTRATION-PROGRAMS, PARABOLIC-COLLECTORS, RESEARCH-PROGRAMS, THERMAL-POWER)

ST78 13001 MAJOR ENERGY STORAGE SYSTEM TO USE-OFF-PEAK POWER

Electr. Comf. Cond. News, V 3, N12, Dec. 18-20, 1976
The article describes an electric thermal storage system at the Catholic Medical Center in Manchester, New Hampshire. The hospital system uses off-peak power, resulting in all supplied energy being generated by the most efficient generating stations. The combination of the all-electric concept with a total thermal energy system is expected to bring huge savings in energy costs.

(ECONOMICS, HEATING)

ST78 13002 REPORT ON THE SYMPOSIUM AND WORKSHOP ON 5 MWt SOLAR THERMAL TEST FACILITY, 1976

Anon., (ERDA, Div. of Solar Energy, Washington, D.C.), Report on the Symp. and Workshop on the 5 MWt Solar Thermal Test Facility, Houston Univ., Houston, TX, 302 pages, May 17-19, 1976, ERDA, Div. of Solar Energy, Washington, D.C., ALO-3701-76-1
Avail:NTIS
The proceedings include 40 papers on conversion of solar energy into electric power for utilities and other industries. The papers presented deal with the construction of a 5 MWt solar thermal test facility by ERDA at Albuquerque, NM, to test the 1 MW Martin Marietta bench model receiver and perform subsystem research experiments on three 5 MW receivers. Preliminary designs of systems and components for a 10 MWe tower-mounted central receiver power plant connected into a utility's power grid, and research on advanced energy conversion systems capable of application to solar energy conversion and research dealing with the application of solar energy to thermochemical processes are also discussed. Storage tanks, heat pipes, and the feasibility of storing solar thermal energy through the use of thermal decomposition reactions is addressed.

(ELECTRIC, POWER GENERATION, POWER PLANTS)

ST78 13003 SOLAR THERMAL SYSTEMS REQUIREMENTS

Anderson, D.E., (Sheldahl, Inc., Northfield, MN), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:1-8, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:137597, A77-49017, A77-48910 23-44
The collection and utilization of solar thermal energy for electrical power production, industrial process heat, and total energy systems is examined with regard to collection efficiency and system cost. Depending upon such factors as use temperature, siting requirements, back-up energy sources, and cooling requirements, a variety of collection of systems may have "best effectiveness" for given applications. Systems ranging from low temperature (around 100 C) to high temperature (around 500 C) can be all fabricated, installed, and maintained with state-of-the-art technology. Wide-scale use will depend upon selecting the right system and/or the right application.

(ECONOMIC ANALYSIS, HEATING, INSOLATION)

ST78 13004 NITINOL ENGINE DEVELOPMENT

Banks, R., Wahlig, M., (Univ. of California, Berkeley, CA), Sharing the Sun: Solar Technology in the Seventies, V 7, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:111247

Unusual shape-change properties in a class of metals known as shape memory alloys have been applied to the conversion of low-temperature heat to mechanical work. A program for development of practical heat engines based on this phenomenon is underway at the Lawrence Berkeley Laboratory, using the nickel-titanium alloy "55-Nitinol." Details of the current prototype engine design and results of preliminary testing are discussed in light of special considerations for using Nitinol in heat engines.

(HEAT-ENGINES, NICKEL ALLOYS, TITANIUM ALLOYS)

ST78 13005 STORAGE OF SOLAR ENERGY BY INORGANIC OXIDE-HYDROXIDES

Bauerle, G., Chung, D., Ervin, G., Guon, J., Springer, T., (Rockwell International, Canoga Park, CA), Sharing the Sun: Solar Technology in the Seventies, V 3, 5 refs, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:131162

A novel thermal-energy storage concept involving the use of inorganic oxides-hydroxides such as $MgO,Mg(OH)_2$ and $CaO\ Ca(OH)_2$ is under investigation. Solar energy at high temperatures (approximately 350 to 550 C) is used to drive off, in the form of steam, the chemically bound water from the hydroxide. At a later time, when the sun's energy is not available, water or steam can be injected into the resulting oxide material, thus yielding heat energy from the exothermic reaction of water with the oxide. The physical and chemical properties of the $MgO\ Mg(OH)_2$ systems, particularly the reaction rates, thermal conductivity, vapor pressure, and particle characteristics, have been investigated in detail. A reference design of an $MgO\ Mg(OH)_2$ storage system for heating and cooling of buildings has been prepared and a variety of other applications of these systems have been studied.

(BUILDINGS, COOLING, DEHYDRATION, HEATING, STORAGE)

ST78 13006 INTEGRATION OF HIGH TEMPERATURE THERMAL ENERGY STORAGE INTO A SOLAR THERMAL BRAYTON CYCLE POWER PLANT

Beverly, W.D., Engle, W.W., Mahony, F.O., (Boeing Engineering and Construction, Seattle, WA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1195-1202, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, Electric Power Research Institute, EY-76-C-03-1300, A77-48842, A77-48701 23-44

Analytical methods have been developed to support the design and analysis of thermal energy storage (TES) systems for solar thermal power plants employing high temperature Brayton closed-cycle thermal engines with helium or air as the heat transport fluid. System level studies have been undertaken to assess the impact of storage on plant performance, to establish storage system design and performance requirements, and to evaluate various TES design alternatives. Conceptual designs with cost estimates are presented for sensible heat and phase change TES devices. Solar power plant design sensitivity data showing the trades between collector area, storage time, plant performance, plant costs, and busbar energy costs are also included.

(BRAYTON CYCLE, HEAT-EXCHANGERS, STORAGE)

ST78 13007 A UNIQUE RANKINE-CYCLE HEAT PUMP SYSTEM

Biancardi, F.R., Meader, M.D., (United Technol. Res. Center, East Hartford, CT), 11th Intersociety Energy Conversion Engineering Conference, V 2:1157-1162, 4 refs, Sept. 12-17, 1976, State Line, NV, American Inst. Chem. Engrs., American Nuclear Society, Soc. Automotive Engrs., et.al., New York, NY

Feasibility of operating a rankine cycle turbocompressor air conditioning system at temperature levels consistent with present-day flat-plate solar collectors has been demonstrated. During testing of the demonstration system, more than four tons of cooling and in excess of sixty hours of safe reliable operation was obtained at performance levels consistent with prior predicted levels. In the demonstration system, thermal energy is used to vaporize a refrigerant working fluid which is expanded through a turbine to produce mechanical power. The single-stage turbine is mounted on a common shaft with the centrifugal compressor refrigeration system. In the current program, modifications have been made to the laboratory demonstration system to permit the further characterization of the performance potential of the turbocompressor concept over a wide range of operating conditions. Extensive operation of the system has been achieved at condensor temperatures suitable for both water and air cooling and at equivalent turbine inlet temperatures below 160 F and in excess of 220°F. The results of the recent testing are presented herein. Possible modifications to the turbocompressor unit to permit high solar energy utilization at temperatures consistent with flat-plate and medium concentration collectors are described.

(COOLING, FLAT-PLATE, TURBINE)

ST78 13008 HELIOS: A COMPUTATIONAL MODEL FOR SOLAR CONCENTRATORS

Biggs, F., Vittitoe, C.N., (Sandia Labs., Albuquerque, NM), 1977, SAND-77-0642C, EDB-77:111198
Avail:NTIS
Helios is a computer code for mathematically simulating the behavior of the flux pattern from the concentrator field for a solar central receiver power station. Statistical methods are used to incorporate nondeterministic factors. The code is described, and some examples of its output are given.

(SIMULATION, TOWER FOCUS POWER PLANTS)

ST78 13009 PARAMETER STUDY FOR A CENTRAL-RECEIVER POWER STATION

Biggs, F., Vittitoe, C.N., (Sandia Labs., Albuquerque, NM), 1977, SAND-77-0667C, EDB-77:111199
Avail:NTIS
The interactions between alignment and focusing strategies and heliostat errors are described and illustrated. Some descriptions of astigmatic aberrations are developed and are used to suggest an evaluation criterion for concentrators. Finally, an analysis of measurements for evaluating heliostat reflectors is given.

(FOCUSING, HELIOSTATS, TOWER FOCUS POWER PLANTS)

ST78 13010 STORAGE OF STEAM IN OFF-PEAK PERIODS FOR APPLICATION DURING PEAK DEMANDS

Bitterlich, E., (Dtsch. Babcock, Oberhausen, Germany), Brennst.-Waerme-Kraft, V 29:51-58, N2, Feb. 1977, In German, EDB-77:131275
The article shows that integrating a hot water accumulator into a modern power station provides a solution to the peak-load problem, as well as for district heating, which is sensible both from the national economy as well as from the engineering side. It deals in particular with storage systems for balancing load fluctuations in the electricity demand, the need for peak-load power stations in the Federal Republic of Germany, also showing what limits the specific cost of power production, the specific heat consumption, and the installation cost of the storage system may not exceed.

(ECONOMICS, GERMAN FEDERAL REPUBLIC, POWER PLANTS)

ST78 13011 CENTRAL RECEIVER SOLAR THERMAL POWER

Blake, F.A., (Martin Marietta Aerospace, Denver, CO), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:336-354, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, E(04-3)-1110, EDB-77:137459, A77-49037, A77-48910 23-44
The planning of a 10 MWe solar power plant intended as a pilot plant for a 100 MWe project is discussed. A schematic of the pilot plant is provided, and its baseline configuration with respect to the 100 MWe plant is explained. The planned development of cavity receivers is described with attention to features of a 1 MWth cavity receiver steam generator. Two planned experiments, the thermal storage subsystem research experiment and the concentrating heliostat research experiment, are described. The electric power generation subsystem is examined. A preliminary economic summary and a typical day performance profile are provided.

(BOILERS, ECONOMIC ANALYSIS, HEATING, HELIOSTATS, PILOT PLANT, STORAGE)

ST78 13012 EUROPE'S LARGEST SOLAR THERMAL POWER PLANT

Bossel, U., 200-KW Thermal Output Supplemented by two 10-KW Windmills, Mitteilungsbl. Dtsch. Ges. Sonnenenergie, V 1:12-13, N2, March 1976, In German, EDB-77:111193
An overview is given over the solar heating plant which has recently been commissioned in the Camargue, France. This is the largest plant in Europe, with a mean heat output of about 200 kw, for the production of thermal energy from solar energy. The plant consists of 108 parabolic collectors (200 m^2) and 48 flat collectors (110 m^2). Two windmills with outputs of 10 kw each complete the system. The heat energy produced by the solar collectors is given up to three different stores, which in turn are connected to various consumers.

(CONCENTRATORS, FLAT-PLATE, HEAT-EXCHANGERS, STORAGE)

ST78 13013 INTEGRATION OF SOLAR THERMAL POWER PLANTS INTO ELECTRIC UTILITY SYSTEMS

Braun, G.W., Ballance, J.W., Eds., (Southern California Edison Co., Rosemead, CA), Sept. 1976, TID-27627, EDB-77:111188

The findings of a study designed to fill the need for an electric utility to evaluate solar thermal power plants are summarized. Calculations are described which were used to compute the economic value of solar power plants to an electric utility under assumptions that are valid today. Topics covered are: reliability evaluation, economic evaluation, storage, system operation, and cost and design considerations.

(ECONOMICS)

ST78 13014 METHOD OF HEAT STORAGE

Bruns, P.H., Dec. 30, 1976, Patent no. 2,527,119/A, In German, EDB-77:127387
The patent specification claims a super-regional network of connections of go-and-return pipelines for water, into which energy producing plants can feed waste heat and/or excess heat energy for storage, and from which consumers can take useful heat energy via heat exchangers.

(OFF-PEAK-ENERGY, WASTE-HEAT)

ST78 13015 COMPARATIVE ASSESSMENT OF ORBITAL AND TERRESTRIAL CENTRAL POWER PLANTS

Caputo, R., (Calif. Inst. of Tech., Jet Propulsion Lab., Pasadena, CA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2: 1468-1475, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48878, A77-48701 23-44
Recent studies of the Space Power System (SPS) are integrated into a total social cost framework developed for terrestrial central electric power systems. Total social costs include the projection of commercial economics to the time frame of interest as well as the federal research, development, and demonstration (RD&D) costs, the health impacts, the resources required, the environmental impacts, and other social costs. The SPS system is limited to transporting all materials from the earth's surface to geosynchronous orbit. Only silicon photovoltaic is considered as the SPS energy conversion technique. Costs and impacts of the LWR are considered as a reference for nuclear systems, and the low BTU coal gasification with combined cycle gas and steam turbines is considered as a reference for a fossil central electric plant. The ground solar systems considered are solar thermal using the central receiver approach with thermal storage, and solar photovoltaic using the silicon cell with battery storage.

(ECONOMICS, PHOTOVOLTAICS, POWER SATELLITE)

ST78 13016 AN INITIAL COMPARATIVE ASSESSMENT OF ORBITAL AND TERRESTRIAL CENTRAL POWER SYSTEMS

Caputo, R., (Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena, CA), NASA-CR-155042, NAS7-100-77-03-15, JPL-PUBL-77-44, N77-32594
A silicon photovoltaic orbital power system, which is constructed from an earth source of materials, is compared to likely terrestrial (fossil, nuclear, and solar) approaches to central power generation around the year 2000. A total social framework is used that considers not only the projection of commercial economics (direct or in internal costs), but also considers external impacts such as research and development investment, health impacts, resource requirements, environment effects, and other social costs.

(ENERGY POLICY, PHOTOVOLTAICS, POWER SATELLITE)

ST78 13017 APPLICATION OF CHEMICAL ENGINEERING TO LARGE-SCALE SOLAR ENERGY

Chubb, T.A., Nemecek, J.J., Simmons, D.E., (US Navy, E.O. Hulburt Center for Space Research, Washington, D.C.), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 7:364-374, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:111192, A77-49098, A77-48910 23-44

The paper describes the Solchem concept, according to which sunlight is converted to chemical energy in dispersed solar furnaces. The Solchem Power Station consists of the following components: (1) an energy orchard containing dispersed solar-furnace-heated chemical reactors, (2) an assemblage of demand responsive energy storage-boiler tanks, in which large quantities of energy are stored as latent heat-of-fusion, and (3) a conventional dry steam turboelectric generating facility. The solar orchard is characterized by the use of a dissociative chemical reaction and for delivery of the captured energy to the central station area. A detailed comparison of SO_3 and steam-methane working fluids is presented.

(METHANE, POWER PLANTS, SOLAR-FURNACES, STORAGE)

ST78 13018 EVALUATION OF A CHEMICAL HEAT STORAGE SYSTEM FOR A SOLAR STEAM POWER PLANT

Dayan, J., Foss, A.S., Lynn, S., (Calif. Univ., Berkeley, CA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1181-1188, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, ERDA-supported research, A77-48840, A77-48701 23-44

A heat storage system employing the reversible chemical reaction SO_3 yields $SO_2 + \frac{1}{2}O_2$ is synthesized and integrated with the central receiver and conventional steam power cycle of a solar electric power plant. Heat absorption by the chemical reaction takes place in the receiver during the day. Heat release in a separate reactor produces 36 MWe all night through steam generation at 2400 Psi and 1000 F. For optimum use of heat, the storage system needs to be integrated during the daytime with a steam raising system having a power input about five times the storage charge rate. The overall efficiency of the combined system (net electrical output/thermal input) is about 35 percent.

(BOILERS, ECONOMICS, POWER PLANTS)

ST78 13019 CALCULATION OF THE PARAMETERS OF A RADIANT FLUX RECEIVER, TAKING INTO ACCOUNT ITS EXCHANGE WITH THE ENVIRONMENT

Dikareva, R.P., Samoilova, A.Y., Samoilov, E.M., (Novosibirsk Electrotech Inst., Novosibirsk, USSR), Geliotekhnika, V 6:14-17, 1976, In Russian, EDB-77:124732

For precise calculation of the parameters of semiconductor receivers of radiant thermal fluxes, it is necessary to take into account thermal losses through the lateral surface of a thermoelement. The paper presents calculation of sensitivity and time lag. The results are corroborated by experimental data.

(HEAT-TRANSFER, INSOLATION)

ST78 13020 EQUIPMENT FOR THE GENERATION OF ELECTRIC CURRENTS

Dix, S., Nov. 20, 1975, Patent no. 2,520,639/A, In German, EDB-77:111191

The device consists of a lens acting as solar concentrator which is made of two convex plates. The solar rays bundled by the lens fall on a radiation receiver in which a work medium is heated. The work medium heated transports the heat to another device, e.g., a turbine, to which an electric generator is connected.

(CONCENTRATORS, STORAGE, PATENT, TRACKING, TURBINES)

ST78 13021 AN ASSESSMENT OF MECHANICAL ENERGY STORAGE FOR SOLAR SYSTEMS

Dodd, H.M.Jr., Stewart, R.E.D., Varnado, S.G., Aronson, E.A., (Sandia Laboratories, Albuquerque, NM), Chang, G.C., (ERDA, Washington, D.C.), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1174-1180, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48839, A77-48701 23-44

The primary objective of this study is to assess the relative merits of various mechanical energy storage systems when used in conjunction with solar and wind sources. This initial study considered flywheel, pneumatic (compressed air), and underground pumped hydro-storage concepts. Both thermal and photovoltaic collectors utilizing stationary flat-plates through total tracking-focused systems were included. For wind collection, a horizontal axis wind turbine was modeled. Electrical load demands from single residences through utility grids were included. Alternative systems were ranked according to levelized, busbar energy cost calculations, and the amount of displaced, conventionally generated electricity also served as a benefit measure.

(CONCENTRATING COLLECTORS, FLYWHEELS, TRACKING, WIND)

ST78 13022 SOLAR ABSORPTION PROPERTIES OF A HIGH-TEMPERATURE DIRECT-ABSORBING HEAT TRANSFER FLUID

Drotning, W.D., (Sandia Labs., Albuquerque, NM), 1977, SAND-76-9104C, EDB-77:124809

The optical absorption properties of a high-temperature molten salt heat transfer fluid, a eutectic mixture of KNO_3, $NaNO_2$, and $NaNO_3$, known as HITEC (Dupont trade name), were measured from 0.35 μm to 2.5 μm using hemispherical transmission techniques. To enhance solar absorption, particulate metallic oxides of Co or Cu were introduced into the fluid. Absorption spectra of these oxide particle suspensions in the molten salt were determined as a function of dopant concentration ranging from 0 to 0.1 wt percent metal nitrate added to the HITEC. These measurements were carried out at 473 K under flow conditions to cause a homogeneous suspension of particles. Absorption coefficients at a single wavelength were measured up to dopant concentrations of 0.5 wt percent. The suspended particles cause an additional optical abosrption throughout the visible spectrum, which is characteristic of the particular metallic oxide and closely follows a Beer-Lambert concentration dependence. The solar-averaged absorption in a fixed layer thickness was calculated for various concentrations of the fluid-oxide mixtures. The fluid without oxide particles absorbs approximately eight percent of the solar spectrum

per cm of path length, while addition of 0.1 wt percent of $Co(NO_3)_2 \cdot 6H_2O$ increases this absorption to approximately 93 percent per cm. An equivalent wt percent of $Cu(NO_3)_2$, $3H_2O$ causes a solar-averaged absorption of 84.4 percent per cm. Effects of particulate scattering on the measurements are discussed.

(EUTECTICS, NITRATES, TOWER-FOCUS-POWER-PLANTS)

ST78 13023 OPTIMUM OPERATING CONDITIONS FOR A CYLINDRICAL PARABOLIC FOCUSING COLLECTOR-RANKINE POWER GENERATION CYCLE SYSTEM

Edenburn, M.W., (Sandia Labs., Albuquerque, NM), 1977, 6 pages, SAND-75-6132, EDB-77:111187, A77-48905

System operating temperatures, boiler pressure, and associated parameters which maximize solar to electric conversion efficiency and which minimize collector, storage, and power-cycle-system cost have been determined for an electrical generation system which uses cylindrical parabolic focusing collectors as a source of heat, a stratified liquid unit for storage, and a rankine power generation cycle for electrical generation. To perform a parametric study of the system, the analysis used an experimentally verified solar energy collector model to predict collector energy output as a function of inlet temperature, outlet temperature, and fluid flow rate; a rankine cycle model to predict cycle efficiency and heating fluid outlet temperature as a function of peak superheat temperature and boiler pressure; and a daily cycling storage unit model. The study shows that electrical generation efficiency is maximized by using a peak superheat temperature of 635 K (683°F), but when storage cost is considered, the minimum cost system uses a peak superheat temperature of 686 K (775°F) and a boiler pressure of 2.76 mn/m^2 (400 Psi).

(BOILERS, MATH-MODELS, STORAGE)

ST78 13024 CENTRAL RECEIVER SOLAR THERMAL POWER PLANT SYSTEMS ANALYSIS

Eicker, F.J., Brune, J.M., (Sandia Labs., Livermore, CA), Sharing the Sun: Solar Technology in the Seventies, V 5, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:144714

The article describes a margin analysis for determining additional backup capacity and minimizing operating strategies of a solar thermal power plant. In addition to operating strategy, the sensitivity of backup capacity to solar market penetration and the shape of the load curve are presented. The sensitivity of the economic impact of solar power to operating strategies, and to size of various subsystems are also discussed.

(DEMONSTRATION PROGRAMS, ECONOMICS, INSOLATION, STORAGE, TOWER-FOCUS-POWER-PLANTS)

ST78 13025 INVESTIGATION OF METAL FLUORIDE THERMAL ENERGY STORAGE MATERIALS

Eichelberger, J.L., Gillman, H.D., (Pennwalt Corp., King of Prussia, PA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:567-574, Aug. 28- Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, EY-76-C-02-2990, A77-48767, A77-48701 23-44

Storage of thermal energy in the 400-1000 C range is attracting increasing consideration for use in solar power, central power, vehicular, and commercial process systems. This study investigates the practicality of using metal fluorides as the heat storage media. The projected availability of metal fluorides has been studied and is shown to be adequate for wide-spread thermal storage use. Costs are projected and discussed in relation to thermal energy storage applications. Phase diagrams, heats of fusion, heat capacities, vapor pressures, toxicity, stability, volume changes, thermal conductivities, fusion kinetics, corrosion, and container materials of construction for a wide range of fluorides have been examined. Analyses of these data in consideration of thermal energy storage requirements have resulted in selection of the most cost-effective fluoride or fluoride mixture for each of 23 temperature increments between 400 and 1000 C. Thermophysical properties of these 23 materials are presented.

(HEATING, TOXICITY)

ST78 13026 MATHEMATICAL MODELING OF SOLAR POWER SYSTEMS

Elgabalawi, N., Johnson, G.R., (Colorado State Univ., Fort Collins, CO), Sharing the Sun: Solar Technology in the Seventies, V 5, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:144709

A distributed collector solar energy plant with thermal energy transport is the subject of this model. Each collector is composed of a point focus concentrator and a cylindrical cavity absorber, while the heat-dissipating system consists of a heclical pipe inlet of the absorber. The collected energy is then transported through a network of insulated pipes to a central station which contains the turbine, heat exchangers, and heat storage facilities. The mathematical model of paraboloidal mirrors is described by the statistical distribution of the reflected radiation in the focal plane from a surface with

microinaccuracies. The Fresnel reflector is then modeled as a combination of many concentric paraboloidal mirrors. Heat exchangers, steam accumulators, energy storage systems, and turbine performance models are developed. Some of the simulation and modeling problems and limitations in solar power generation are discussed, such as modeling of single and double axis tracking radiation concentration and two-phase flow heat transfer , and an extended abstract is also presented.

(FRESNEL-LENS, HEAT-EXCHANGERS, PARABOLIC, STORAGE)

ST78 13027 SOLAR HEAT STORAGE BASED ON INORGANIC CHEMICAL REACTIONS

Ervin, G., (Rockwell International, Canoga Park, CA), Solar Energy Storage Subsystems for the Heating and Cooling of Buildings, 1975,Eds: Lilleleht, L.U., Beard, J.T., Iachetta, F.A., ASHRAE, Inc., New York, NY, EDB-77:144803

A concept for solar heat storage at higher energy density then fusion heat methods is proposed. It is based on the heat of hydration of certain inorganic oxides, principally MgO and CaO, which form the hydroxides $Mg(OH)_2$ and $Ca(OH)_2$, respectively, as the result of hydration. The requirements and capabilities of this method of storage are summarized. A comparison of heat storage methods is given. Decomposition data is plotted. Hydration and dehydration data are given.

(HYDROXIDES, OXIDES, THERMOCHEMICAL)

ST78 13028 MOLTEN SALT THERMAL ENERGY STORAGE FOR UTILITY PEAKING LOADS

Ferrara, A., Haslett, R., (Grumman Aerospace Corp., Bethpage, NY), Joyce, J., (NASA, Lewis Research Center, Cleveland, OH), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:547-554, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48765, A77-48701 23-44

This paper considers the use of thermal energy storage (TES) in molten salts to increase the capacity of power plants. Five existing fossil and nuclear electric utility plants were selected as representative of current technology. A review of system load diagrams indicated that TES to meet loads over 95 percent of peak was a reasonable goal. Alternate TES heat exchanger locations were evaluated, showing that the stored energy should be used either for feedwater heating or to generate steam for an auxiliary power cycle. Specific salts for each concept are recommended. Design layouts were prepared for one plant, and it was shown that a TES tube-shell heat exchanger system could provide about 7 percent peaking capability at lower cost than adding steam generation capacity. Promising alternate heat exchanger concepts were also identified.

(ECONOMIC ANALYSIS, HEAT EXCHANGERS, NUCLEAR-POWER-PLANTS, TURBINES)

ST78 13029 HELIOSTAT FIELD DESIGN FOR THE ERDA 5 MEGAWATT SOLAR THERMAL TEST FACILITY

Fourakis, E.M., Curtner, K.L., Mitchell, P.D., (Honeywell Energy Resources Center, Minneapolis, MN), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:385-391, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:137462, A77-49040, A77-48910 23-44

The working heliostat field for the ERDA 5 Megawatt Solar Thermal Test Facility was designed to meet the solar thermal power requirements for testing four different receiver subsystem research experiments. Requirements for the field were specified in terms of yearly solar thermal energy available from the heliostats and instantaneous power levels delivered by the heliostat field to the experiments. A ray-trace simulation model of the subsystem research experiment receivers and heliostat field was the principal tool used in this conceptual design. Field deployment, focusing strategy, number of heliostats, and total mirror area required to accomplish the test objectives of the facility were established.

(INSOLATION, MIRRORS, TRACKING)

ST78 13030 CONCEPTUAL DESIGN OF AN OPEN-CYCLE GAS TURBINE SOLAR CENTRAL RECEIVER SYSTEM

Fourakis, E., Mitchell, P.D., (Energy Resources Center, Minneapolis, MN), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:92-98, 3 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:137457, A77-49022, A77-48910 23-44

In the conceptual design of a high-temperature solar electric plant, two mathematical models and associated computer software have been developed and extensively used. The solar central receiver model analyzes the performance of various combinations of collector field and central receiver geometries in terms of gross power received and power flux maps on the receiver walls. The software is a Monte Carlo ray-trace. The heat exchanger and cavity analysis model evaluates the microscopic performance of the heat transfer surfaces and uses the results to evaluate the macroscopic performance of the receiver cavity as a whole.

(GENERATORS, HEAT-EXCHANGERS, HELIOSTATS, MATH MODELS)

ST78 13031 A CENTRAL RECEIVER SOLAR SYSTEM APPLICABLE TO CENTRAL POWER STATIONS

Gervais, R.L., (McDonnell Douglas Astronautics Co., Huntington Beach, CA), Friefeld, J.M., (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA), McKenzie, A.W., (Stearns-Roger, Inc., Denver, CO), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:325-335, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:137458, A77-49036, A77-48910 23-44

This paper presents an overview of a central receiver solar thermal electric system. The design is distinct in that it utilizes (1) first-surface mirrored heliostats, (2) an external single pass-to-superheat receiver, and (3) a sensible heat, thermocline type thermal storage. A 100-MWe commercial power plant, designed for integration into a utility network, is described. A 10-MWe pilot plant whose purpose is to establish technical feasibility and provide an indication of system economics for the commercial system is then given focus. The solar-indigenous subsystems of the 10-MWe pilot plant, i.e., the collector, receiver, and thermal storage are also addressed in some detail.

(HELIOSTATS, PILOT-PLANTS, SOLAR-COLLECTORS, STORAGE)

ST78 13032 HIGH-TEMPERATURE THERMAL ENERGY STORAGE

Green, R.M., Ottesen, D.K., Bartel, J.J., Bramlette, T.T., (Sandia Labs., Livermore, CA), Sharing the Sun: Solar Technology in the Seventies, V 8, 124 refs, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:131153

The results of a survey of current technology relating to high-temperature thermal energy storage are presented. Included in this study are the generic classes of sensible heat and latent heat storage. A summary is given of thermal storage concepts which have been designed, and in some cases constructed and tested, for high-temperature applications. A review of the materials and heat transfer-fluid mechanics technologies relating to thermal storage is presented. Current technology appears to be adequate to support the development of most sensible heat concepts and simple latent heat concepts, while some degree of technology advancement will be required to develop more sophisticated latent heat concepts.

(ECONOMICS, HEATING, POWER-PLANTS, ROCK-BED, SALTS)

ST78 13033 SOLAR THERMAL CONVERSION TO TLECTRICITY UTILIZING A CENTRAL RECEIVER, OPEN-CYCLE GAS TURBINE DESIGN

Grosskreutz, J.C., McBride, E.J., Gray, D.C., (Black and Veatch, Consulting Engineers, Kansas City, MO), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1209-1217, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, Research supported by the Electric Power Research Institute, A77-48844, A77-48701 23-44

A conceptual design of a 60-MWe gas turbine solar-electric system has been completed. Four cavity-type, ceramic-tube heat exchangers produce the 1800 F air required. The turbine-generator and receiver cavities are located at the top of a 650-foot reinforced twoer, which is surrounded by two-axis tracking heliostats. The capital cost of the plant, in 1976 dollars, is estimated as $1350-$1660 per kilowatt, depending on heliostat costs. Hybrid operation makes this plant eligible for capacity credit in a utility network. The primary hardware development required is the ceramic-tube heat exchanger. Silicon carbide tubes have been thermally cycled, using radiant heat, for over 600 cycles with material temperatures up to 2430 F. No tube failures or material degradation were experienced.

(HEAT-EXCHANGERS, POWER-PLANTS)

ST78 13034 METAL HYDRIDE SYSTEMS FOR SOLAR ENERGY STORAGE AND CONVERSION

Gruen, D.M., Sheft, I., (Argonne National Lab., Argonne, IL), Solar Energy Storage Subsystems for the Heating and Cooling of Buildings, 1975, Eds: Lilleleht, L.U., Beard, J.T., Iachetta, F.A., ASHRAE, Inc., New York, NY, EDB-77:144804

An integrated system for energy storage and conversion using metal hydrides is presented. For solar energy applications, the metal hydride system is coupled to a solar concentrator such as the Argonne Compound Parabolic Concentrator (CPC). Use is made of two metal hydrides (M_1H and M_2H) having heats of formation ΔH_1 and ΔH_2 such that $\Delta H_1 = \Delta H_2$. Thermal energy storage densities of approximately 80,000 BTU ft^3 are realizable with appropriate metal hydride systems. Furthermore, by choosing M_2H appropriately, H_2 decomposition pressures of 50 atm can be reached at temperatures near 300 F which are expected to be achieved with CPC's now under construction. Thermal decomposition expansion engines are proposed to generate electricity (or refrigeration) making use of high-pressure hydrogen gas.

(CONCENTRATORS, HYDRIDES, PYROLYSIS)

ST78 13035 DYNAMIC MODELING AND SENSITIVITY ANALYSIS OF SOLAR THERMAL ENERGY CONVERSION SYSTEMS

Hamilton, C.L., (Calif. Inst. of Tech., Jet Propulsion Lab., Pasadena, CA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1218-1223, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, JPL, Caltech, Pasadena, CA, A77-48845, A77-48701 23-44

Since the energy input to solar thermal conversion systems is both time variant and probabilistic, it is unlikely that simple steady-state methods for estimating lifetime performance will provide satisfactory results. The work described here uses dynamic modeling to begin identifying what must be known about input radiation and system dynamic characteristics to estimate performance reliably. Daily operation of two conceptual solar energy systems was simulated under varying operating strategies with time-dependent radiation intensity ranging from smooth input of several magnitudes to input of constant total energy whose intensity oscillated with periods from ½ hour to six hours. Integrated daily system output and efficiency were functions of both level and dynamic characteristics of insolation. Sensitivity of output to changes in total input was greater than one.

(COMPUTER SIMULATION, COLLECTORS, INSOLATION)

ST78 13036 LARGE-SCALE THERMAL STORAGE IN ROCK: CONSTRUCTION, UTILIZATION, AND ECONOMICS

Hardy, M.P., Albertson, V.D., Bligh, T.P., Riaz, M., Blackshear, P.L., (Minnesota Univ., Minneapolis, MN), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:583-590, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, EY-76-S-02-4002, A77-48769, A77-48701 23-44

The performance, design constraints, construction methods, and economics of a large-scale rock bed heat accumulator capable of providing 300 MWt at high temperatures (250 to 500 C) for up to six months are discussed. Six construction schemes are identified and compared in relation to siting requirements, land use, ground-water interaction, rock quality, and construction cost. Examples are given of the present worth of stored energy. For the assumed operating conditions, this present worth of stored energy is less than 15 mills/KWHT, thus making the concept of a rock bed accumulator economically attractive for long-term storage.

(ECONOMIC ANALYSIS)

ST78 13037 DEVELOPMENT OF A THERMAL STORAGE HEATER FOR A CLOSED BRAYTON CYCLE ENGINE

Harper, A.D., Spragins, W.W., (Airesearch Manufacturing Co., Phoenix, AZ), In Intersocity Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:208-215, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, NOO600-73-C-0112m A77-48720, A77-48701 23-44

A sensible heat storage energy system, consisting of a well-insulated graphite core coupled to a closed-cycle gas turbine, is a competitive alternate for many applications where storage batteries are currently used. The key requirement is the design of the insulation system. Four candidate layered insulations are discussed. Conceptual designs and preliminary performance estimates are presented for several core sizes. These results indicate an energy density four to ten times that of a laboratory scale device are reviewed, and the application of this approach as a heat source for the 30-KW CCPS 40-1 engine is described.

(BATTERIES, GAS-TURBINE, GRAPHITE, HEAT-PUMPS, INSULATION)

ST78 13038 POWER WITH HELIOSTATS

Hildebrandt, A.F., Vant-Hull, L.L., (Houston Univ., Houston, TX), Science, V 197:1139-1146, Sept. 1977, Research supported by the Univ. of Houston, E(04-3)-1108, EG-76-05-5178, NSF GI-39456, NSF AER-73-07950-A03, A77-47174

A proposal for the use of heliostats as a means to produce solar energy in quantities great enough to power the electric and gas utilities, i.e., with high-quality heat of at least 300 C and where individual units produce approximately 100 MW of electricity, is outlined. The plan of the solar thermal power system is discussed in detail, including variations in its construction for specific needs. Specifically, the design of the heliostat field, the receiver, tower, and storage facilities are considered. The environmental concerns of such plants are reviewed, as are questions regarding cost planning and reduction. It is concluded that although the cost of producing solar power plants is simular to that of other means of energy production, solar energy production will become increasingly more important in terms of long-range economic and political plans.

(COLLECTORS, POWER-PLANTS)

ST78 13039 HIGH-TEMPERATURE THERMAL ENERGY STORAGE SYSTEM, $Na_2SO_4 + SO_3$ REVERSIBLY YIELDS $Na_2S_2O_7$

Hockett, R.S., Serth, R.W., (Monsanto Research Corp., Dayton, OH), In Intersociety Energy Conversion Engineering Conf. Proceedings, 12th, Washington, D.C., V 1:540-546, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48764, A77-48701 23-44

A preliminary process design is presented for a thermal energy storage system based on the reversible thermal decomposition of sodium pyrosulfate. A thermodynamic analysis of the system operating in conjunction with a conventional rankine steam power cycle is presented, and the materials and volume requirements of the storage system are determined. A number of fundamental problems, which must be resolved in order to demonstrate the technical feasibility of the concept, are identified and discussed.

(PYROLYSIS, RANKINE-CYCLE, SULFATES, TURBINES)

ST78 13040 STORAGE OF THERMAL ENERGY IN MOLTEN SALTS AND METALS

Horsthemke, A., Marschall, E., Brennst.-Waerme-Kraft, V 28:18-22, Jan. 1976, EDB-77:145766, N77-19574

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, and 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.

(MATH MODELS)

ST78 13041 ENERGY CONVERSION AND STORAGE BY CDE (CONCENTRATION DIFFERENCE ENERGY) ENGINE AND SYSTEM

Isshiki, N., Maekawa, Y., Takeuchi, M., (Tokyo Inst. of Tech., Tokyo, Japan), Nikai, I., (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan), Akuta, T., (Nippon Steel Corp., Tokyo, Japan), Kamoshida, J., (Shibaura Institute of Technology, Omiya, Japan), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1117-1124, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48831, A77-48701 23-44

This paper is concerned with a theoretical and experimental investigation of a completely new engine called the CDE (concentration difference energy) engine. The CDE engine utilizes the absorption heat liberated from the exhaust steam absorbed in a thick aqueous solution of inorganic salts as $CaCl_2$, LiCl, NaOH, etc. in which many kinds of alternative energies are used for the regenerations of used solutions thinned by the CDE engine above, and can be converted into useful power and heat.

(RANKINE-CYCLE, SALTS, TURBINES, WASTE-ENERGY)

ST78 13042 DESIGN OF SODIUM-COOLED, CENTRAL RECEIVER SOLAR POWER PLANT

Johnson, T.L., Thomson, W.B., (Rockwell International Corp., Atomics International Div., Canoga Park, CA), In Intersociety Energy Conversion Engineering Conf. Proceedings, 12th, Washington, D.C., V 2:1203-1208, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, EG-76-G-05-5178, A77-48843, A77-48701 23-44

The design of a 100-MWe sodium-cooled, central receiver solar power plant is presented. A sodium-cooled system has the advantages of good heat transfer, stable coolant flow, and high efficiency. Sodium components either are available now or will soon be available as a result of the sodium-cooled reactor programs. A description of three liquid sodium heat-transport systems is presented. Several alternative storage options are examined. The all-sodium thermal storage concept using a hot storage tank and a cold storage tank is simple, affords operational flexibility, and effectively decouples the receiver system operation from the steam generator, a substantial operational advantage. A sodium quantity of 15.3×10^6 kg is required for 6 H of plant operation on stored energy at 100 percent of rated power. The sodium-cooled plant initial cost is slightly less than an equivalent water-cooled plant. However, levelized energy costs are 18 percent lower for the mid-1980's.

(COOLANTS, POWER-PLANTS, STORAGE, TURBINES)

ST78 13043 HIGH-TEMPERATURE THERMAL ENERGY STORAGE

Joyce, J.P., (Lewis Research Center, Cleveland, OH), Trans. Am. Nucl. Soc., V 26:414-415, June 1977, EDB-77:127384
No abstract available

(ERDA, REVIEWS)

ST78 13044 EQUIPMENT FOR CONVERSION OF SOLAR ENERGY INTO MECHANICAL AND ELECTRIC ENERGY

Krauss, R.H., Dec. 16, 1976, Patent no. 2,525, 337/A, In German, EDB-77:111195
Equipment for the conversion of solar energy into mechanical or electric energy is described. The equipment makes use of a working medium, no water, with a low boiling point. The working medium is preheated either by the warm water of the sea surface or by solar energy. It passes into a preheater, in which it is heated above the boiling point. The working medium is vaporized in a superheater (by means of solar concentrators) and enters pressurized a steam turbine, where it is expanded adiabatically while emitting working capacity. Following the turbine, a condenser cooled by sea water of temperature 4-8 C serves to improve the efficiency, starting from the condenser. The working medium comes back to the storage tank. The turbine can provide energy directly or serves as topping stage for an electric generator.

(COOLING, CONCENTRATORS, HEAT-ENGINES, HEAT-EXCHANGERS, SEAWATER, TURBINES)

ST78 13045 COMPARATIVE THERMODYNAMIC PERFORMANCE OF SOME RANKINE-BRAYTON CYCLE CONFIGURATIONS FOR A LOW-TEMPERATURE ENERGY APPLICATION

Lansing, F.L., (Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena, CA), In Its the Deep Space Network, DSN Engineering Section, p. 156-167, N77-31207, N77-31186 22-12
Various configurations combining solar-rankine and fuel-Brayton cycles were analyzed in order to find the arrangement which has the highest thermal efficiency and the smallest fuel share. A numerical example is given to evaluate both the thermodynamic performance and the economic feasibility of each configuration. The solar-assisted regenerative rankine cycle was found to be leading the candidates from both points of energy utilization and fuel conservation.

(COOLING, ENERGY POLICY, ECONOMIC ANALYSIS)

ST78 13046 INORGANIC PHASE CHANGE MATERIALS FOR ENERGY STORAGE IN SOLAR THERMAL PROGRAM

Lefrois, R.T., (Honeywell Energy Resources Center, Minneapolis, MN), Venkatasetty, H.V., (Honeywell Corporate Research Center, Bloomington, MN), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 8: 107-122, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:131157, A77-49103, A77-48910 23-44
The thermal storage subsystem research experiment is described, and the design of the thermal storage tank is explained. Test features of the thermal storage subsystem include an instrumented forced circulation steam-generating system, an instrumented steam-condensing system, an instrumented storage tank, and an instrumental dual steam-trap station. Vaporizer design parameters and condenser design parameters are presented. Vaporizer tube scrapers are considered. Experimental data concerning the behavior of a eutectic mixture of $NaNO_3$ - NaOH. The thermal energy storage material, are provided. The research experiment is intended to aid the design of a solar pilot plant.

(BOILERS, EUTECTICS, HEATING)

ST78 13047 AN EVALUATION OF THE USE OF METAL HYDRIDES FOR SOLAR THERMAL ENERGY STORAGE

Libowitz, G.G., Blank, Z., (Allied Chem. Corp., Materials Res. Center, Morristown, NJ), 11th Intersociety Energy Conversion Engineering Conference, State Line, NV, V 1:673-680, 26 refs, Sept. 12-17, 1976, American Inst. Chem. Engrs., American Nucl. Soc., Soc. Automotive Engrs., et. al., New York, NY
The article reviews basic properties of metal hydrides relevant to their application for storing solar thermal energy. Several plans are discussed in which the formation enthalpy of a primary hydride is used to provide heat while a second hydride or compressed gas is used for hydrogen storage. The results show that, with present technology, a metal hydride-based system is considerably more expensive than sensible heat or phase change material storage. The advantages of a metal hydride-based system are discussed, and technological advances are suggested which would make such a system economically competitive with other thermal storage systems.

ST78 13048 SOLAR POWERED STEAM GENERATION

Magnoli, D., Saddy, M., De Carvalho, A.V.Jr., Lima Verde Leal, M.R., (Centro de Tecnologia Promon, Rio de Janeiro, Brazil), De Siqueira, J.B., Oniga, T., (Instituto Nacional de Tecnologia Promon, Rio de Janeiro, Brazil), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1127-1133, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48832, A77-48701 23-44

Generation of low-pressure saturated steam was investigated conceptually using conventional types of solar collectors. Performance analyses were carried out for single flat-plate collectors with one and two covers, selective absorbing surfaces, and honeycomb structure, and for parabolic concentrators with focal axis along east-west or polar directions. Selection of the best collectors was carried out for 20 degrees south latitude, and was followed by computation of the steam outputs for the latitudes of 10, 20, and 30 degrees south, for clear days at the equinox, winter, and summer solstices. Setting the steam production at around 10 ton/day, 1000 three-m^2 collectors were required. Economic evaluation showed that although the system does not currently compete with conventional steam generation , it might be feasible in the medium term and for remote locations.

(BOILERS, CONCENTRATORS, ECONOMIC ANALYSIS, FLAT-PLATES, PARABOLIC REFLECTORS, TURBINES)

ST78 13049 ECONOMICS OF INTERNAL AND EXTERNAL ENERGY STORAGE IN SOLAR POWER PLANT OPERATION

Manvi, R., Fujita, T., (Calif. Inst. of Tech., Jet Propulsion Lab., Pasadena, CA), NASA 776-11-61-0, In Intersociety Energy Conversion Engineering Conf. Proceedings, 12th, Washington, D.C., V 2:1167-1173, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, JPL Caltech, Pasadena, CA, A77-48838, A77-48701 23-44

A simple approach is formulated to investigate the effect of energy storage on the busbar electrical energy cost of solar thermal power plants. Economic analysis based on this approach does not require detailed definition of a specific storage system. A wide spectrum of storage system candidates ranging from hot water to superconducting magnets can be studied based on total investment and a rough knowledge of energy in and out efficiencies. Preliminary analysis indicates that internal energy storage (thermal) schemes offer better opportunities for energy cost reduction than external energy storage (nonthermal) schemes for solar applications. Based on data and assumptions used in JPL evaluation studies, differential energy costs due to storage are presented for a 100-MWe solar power plant by varying the energy capacity. The simple approach presented in this paper provides useful insight regarding the operation of energy storage in solar power plant applications, while also indicating a range of design parameters where storage can be cost effective.

ST78 13050 THERMOCHEMICAL ENERGY STORAGE AND TRANSPORT PROGRAM

Mar, R.W., Bramlette, T.T., (Sandia Labs., Albuquerque, NM), Trans. Am. Nucl. Soc., V 26: 415-416, June 1977, EDB-77:127385,

No abstract available

(ERDA, REVIEWS)

ST78 13051 LATENT HEAT THERMAL ENERGY STORAGE SYSTEMS ABOVE 450 C

Marianowski, L.G., Maru, H.C., (Inst. of Gas Tech., Chicago, IL), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:555-566, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, EY-76-C02-2888, A77048766, A77-48701 23-44

The feasibility of storing thermal energy at temperatures in the 455 to 535 C (850 to 1000 F) range in the form of latent heat is examined for a number of inorganic salts. The thermophysical properties, safety hazards, corrosiveness, and cost of over 30 salts and salt mixtures are evaluated and compared. Because alkali carbonate mixtures show high thermal conductivity, low volumetric expansion on melting, low corrosivity, good stability, and acceptable storage capacities, they are attractive as latent-heat storage materials in this temperature range. A 35-weight percent Li_2CO_3 65-weight percent K_2CO_3 mixture was selected as a model system for experimental effort. A mathematical analysis for for the cyclic behavior of a phase-change thermal-energy-storage system is described and compared with experimental results. The magnitude of the heat flux attainable in passive heat-exchange systems is shown and means to improve the heat flux are discussed.

(ALKALI-METAL-COMPOUNDS, CARBONATES, HEAT-EXCHANGERS, MATH MODELS, SALTS)

ST78 13052 ROLE OF THE HEAT STORAGE WELL IN FUTURE US ENERGY SYSTEMS

Meyer, C.F., Hausz, W., Ayres, B.L., Ingram, H.M., (General Electric Co., Santa Barbara, CA, Center for Advanced Studies), Dec. 1976, General Electric Co., Santa Barbara, CA, GE-76TMP-27, EDB-77:139700

The heat-storage well system concept is found to have the potential to decrease US energy consumption 10 to 15 percent while substantially reducing water and air pollution. Energy to be conserved is principally that now wasted in generating electricity and in burning fossil fuels for space heating. Results of a study of technical, economic, institutional, environmental, and legal aspects of implementation are reported. Joint production of power and heat with gas turbines and at large central coal-fired plants is analyzed. Costs of joint production, with heat storage, are compared to separate costs of generating heat on-site and purchasing electricity. Water heated as electricity is generated is injected via heat-storage wells into aquifers where it is stored to be withdrawn as needed to meet seasonal heat loads. About 75 percent heat recovery is expected. Producing heat and power jointly with a gas turbine and heat-recovery system with heat storage is compared to separate-product systems and found to cost 25 percent less and to consume 35 percent less fuel. Electricity and heat can be produced jointly and transmitted as far as 125 miles (200 km) from a central plant at a cost about equal to separate-product costs, with an energy saving of 16 percent. Regulatory institutions governing utilities do not yet regard energy conservation as an important consideration, but practices are changing. Municipal utilities, close to community needs such as converting from oil and gas to coal, and with ability to finance more easily than investor-owned utilities by bonds and taxation, are found to be those most likely to first implement the heat-storage well system concept.

(WASTE-HEAT)

ST78 13053 ROLE OF THE HEAT-STORAGE WELL FUTURE US ENERGY SYSTEMS, Final Technical Completion Report

Meyer, C.F., Hausz, W., Ayres, B.L., Ingram, H.M., (General Electric Co., Santa Barbara, CA, Center for Advanced Studies), Sept. 1976, PB-263480, EDB-77:145764

The heat-storage well system concept is found to have the potential to decrease US energy consumption 10 to 15 percent, while substantially reducing water and air pollution. Energy to be conserved is principally that now wasted in generating electricity and in burning fossil fuels for space heating. Results of a study of technical, economic, institutional, environmental, and legal aspects of implementation are reported.

(ECONOMICS)

ST78 13054 GRAVEL AND LIQUID STORAGE SYSTEM FOR SOLAR THERMAL POWER PLANTS

Mitchell, R.C., Morgan, G.R., (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA), Coleman, G., (McDonnell Douglas Astronautics Co., Huntington Beach, CA), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conf., Winnipeg, Canada, V 8:84-94, 3 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:131155, A77-49101, A77-48910 23-44

A new thermal storage concept is described which uses a low-cost rock bed as the primary storage medium with a suitable liquid to transfer the heat in and out of storage. Key developments are described from a current program funded by the US Energy Research and Development Administration. A preliminary design is described for the thermal storage subsystem in a 10-megawatt (electrical) pilot plant central receiver solar thermal power system. Also described is a four-megawatt/hour capacity thermal storage system which has been designed and constructed, and will be tested during 1976.

(PILOT-PLANTS, ROCKS)

ST78 13055 EXPERIMENTAL STUDY OF THE SUBSURFACE TRANSPORT OF WATER AND HEAT AS RELATED TO THE STORAGE OF SOLAR ENERGY

Molz, F.J., Warman, J.C., Jones, T.E., Cook, G.E., (Water Resources Research Inst., Auburn, AL), Sharing the Sun: Solar Technology in the Seventies, V 8, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:131165

Solar heating systems have been proposed wherein confined ground water aquifers are utilized as temporary storage reservoirs for solar-heated water. Thus, there is a practical motivation for obtaining a better understanding of subsurface water and heat transport. The Water Resources Research Institute of Auburn University is performing an aquifer injection and recovery experiment involving heated water. Hot water will be pumped into a confined aquifer, stored within the aquifer for a period of time, and pumped out of the aquifer. During this time, hydraulic head and water temperatures will be recorded in an array of 14 observation wells. The data should serve as a base for testing the predictive abilities of any numerical models describing simultaneous transport of water and heat in the phreatic zone. In addition, the experiments will provide direct experience with the various technical problems related to the subsurface storage, recovery, and use of water heated by solar energy.

(GROUND-WATER, HEAT-TRANSFER)

ST78 13056 TOWER DESIGN CONSIDERATIONS FOR THE SOLAR THERMAL CENTRAL RECEIVER SYSTEMS

Murphy, L.M., (Sandia Labs., Albuquerque, NM), June 1977, SAND-77-8243, EDB-77:124810
Some basic design considerations for concrete solar thermal power towers are described. Seismic disturbances are of primary concern for the large towers being proposed for some commercial systems. For the larger receiver-tower systems, the tower top accelerations due to seismic disturbances are not significantly amplified. However, the attachment of the more massive receivers may become more difficult for the larger systems.

(HELIOSTATS, TOWER-FOCUS-POWER-PLANTS, WIND)

ST78 13057 STRATEGIES FOR COMMERCIALIZING CUSTOMER THERMAL-ENERGY STORAGE

Nelson, S.H., (Argonne National Lab., Argonne, IL), 80 pages, ANL-ES-55, W-31-109-ENG-38, N77-33649
Strategies for commercializing customer thermal storage are presented. Storage techniques evaluated are space heating, air conditioning, hot water heating, and interruptible hot water heating. Storage systems involved store off-peak electric energy for thermal applications during peak-load hours. Analyses of both storage techniques and principal parties affected by storage indicate four barriers: the absence of commercially available air conditioning storage devices, appropriate rates, information on both rates and devices, and widespread utility support. Development of appropriate rates is the key to commercialization. The criteria used to evaluate rate types are maximum combined utility and customer benefits, ease of commercialization, and practical feasibility. Rate types include demand charges, time of use rates, and two forms of load management rates, plus the possibility of utility ownership are considered.

(COOLING, ECONOMICS, HEATING)

ST78 13058 DEMAND SENSITIVE ENERGY STORAGE IN MOLTEN SALTS

Nemecek, J.J., Simmons, D.E., Chubb, T.A., (Naval Research Lab., Washington, D.C.), Sharing the Sun: Solar Technology in the Seventies, V 8, 1976, Ed: Boer, K.W., EDB-77:131156
Heat-of-fusion energy storage and on-demand steam are obtained using heat pipe techniques to transfer heat to and from stacked salt cans and onto boiler tubes within a sealed "energy storage-boiler" tank for solar thermal power plants.

(BOILERS, EUTECTICS, HEAT-PIPES)

ST78 13059 CHEMICAL METHODS OF STORING THERMAL ENERGY

Offenhartz, P.O., (EIC Corp., Newton, MA), Sharing the Sun: Solar Technology in the Seventies, V 8, 1976, Ed: Boer, K.W., EDB-77:131154
Thermal energy storage through chemical reactions is reviewed including second-law restrictions and opportunities. Second-law opportunities arise when the collection temperature exceeds the utilization temperature. In this case, a thermochemically driven heat pump can be used to deliver considerably more heat than is collected. Chemical reactions can be chosen to fit the source and sink temperatures so as to amplify the input heat. A number of currently proposed methods (H_2 generation and storage, hydration-dehydration equilibria, chemical heat pipes, and ammoniacal salt pairs) are assessed with respect to efficiency, cost, chemical feasibility, and suitability for various collection and utilization temperatures.

(CATALYSIS, HEAT-PIPES, HYDROGEN, REVIEWS)

ST78 13060 SEMIANNUAL REVIEW ERDA THERMAL POWER SYSTEMS, DISPERSED POWER SYSTEMS, DISTRIBUTED COLLECTORS, AND RESEARCH AND DEVELOPMENT, MIRROR MATERIALS AND SELECTIVE COATINGS

Pettit, R.B., Butler, B.L., (Sandia Labs., Albuquerque, NM), Feb. 1977, SAND-77-0111, EDB-77:124865
The solar total energy materials research and development efforts are divided into solar selective coatings, mirror materials, and reflector structures. Recent results in each of these areas are described.

ST78 13061 USE OF OILS FOR THE ENERGY TRANSFER IN THE PRIMARY CIRCUIT OF SOLAR HEATING SYSTEMS AND SOLAR POWER PLANTS

Pieper, W., (Rhone-Paulenc Chemie GMBH, Frankfurt Am. Main, Germany, F.R.), Heating With Sun, Practical Building Engineering, V 2, 1977, Ed: Bossel, U., Dgs.-Muenchen, Germany, F.R., EDB-77:144708

Heat transfer media are used in solar power plants in order to quickly absorb and transfer the thermal energy generated in collectors by means of solar radiation. The most important demands required from a heat transfer medium are discussed. Different heat transfer media are used, depending on the type of the system, being a high-temperature or low-temperature system. Furthermore, a 1-MW solar power plant in Odeillo, France is described.

(GLYCOLS, HEAT-TRANSFER)

ST78 13062 A SOLAR-STIRLING TOTAL ENERGY SYSTEM

Pons, R.L., (Ford Aerospace and Communication Corp., Aeronutronic Div., Newport Beach, CA), Fox, R.J., (Walt Disney Productions, WED Enterprises Div., Glendale, CA), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:77-91, 12 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:137463, A77-49021, A77-48910 23-44

A conceptual design of a solar-powered Stirling engine-driven total energy system (TES) is presented. Analysis results are given for a demonstration system which would supply the total energy needs of an advanced concept multi-unit residential complex. The concept also has application to commercial buildings, schools, hospitals, and shopping centers. The system is designed to make maximum use of Stirling automotive technology under current development. Preliminary economic analysis, based on large-scale production of components, indicates an equivalent electrical cost for the proposed complex on the order of 50 mils/KWH.

(BUILDINGS, ECONOMIC ANALYSIS, HOUSES)

ST78 13063 PROCEDURE FOR CALCULATING THERMOCOMPRESSOR THERMODYNAMICAL PARAMETERS FOR SOLAR CONVERSION

Popov, A.G., Trukhov, V.S., (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR), Geliotekhnika, p. 12-19, N3, 1977, In Russian, A77-48519

A procedure for calculating the thermodynamical performance characteristics of a thermocompressor operating on a modified Stirling cycle is worked out. An ideal thermocompressor mocel is developed, with constant temperatures in hot and cold zones, identical masses of working fluid taken in and exhausted over a cycle at constant pressures, no leaks, no friction, no drag, and with an ideal regenerator. Design with rod diameter taken into account and left out of account are considered. The thermal efficiency of the ideal thermocompressor is found to increase with compression ratio and to decline when monatomic working fluid is replaced by diatomic.

(HEAT-EXCHANGERS, STIRLING-CYCLE)

ST78 13064 METHOD AND EQUIPMENT FOR THE CONVERSION OF SOLAR ENERGY INTO MECHANICAL ENERGY

Posnansky, M., Nov. 20, 1975, Patent no. 2,424,315/A, In German, EDB-77:111246

A method of converting solar energy into mechanical energy is described. The radiation energy is concentrated on one effective zone by means of a reflector. The closed cycle of the work medium of a heat power engine is led through the effect zone. The radiation energy is here absorbed directly from the work medium. The work medium can be a gas mixture as well as a suspension or aerosol.

(CONCENTRATORS, HEAT-ENGINES)

ST78 13065 POSSIBLE CLIMATIC IMPACT OF LARGE-SCALE SOLAR THERMAL ENERGY PRODUCTION

Potter, G.L., MacCracken, M.C., (Calif. Univ., Livermore, Lawrence Livermore Lab., Livermore, CA), Math Model, Jan. 1977, UCRL-78855, EDB-77:124735

The ZAM2 (Zonal Atmospheric Model) was used to estimate the climatic effects of large scale solar thermal power facilities. The results appear to be consistent with other numerical experiments. The model response can be summarized by tracing through a feedback loop: decreased surface albedo yields warmer surface yields increased evaporation and increased convection yields increased precipitation in the subtropics and increased water vapor in high latitudes yields increased surface temperatures at high latitudes yields decreased equator-to-pole temperature gradient yields decreased Hadley cell intensity yields possible northward shift of the ITC2 (Intertropical Convergence Zone). The experiment also resulted in a warmer upper troposphere, particularly over the latitudes of maximum area of albedo change. The response was noted in Ellsaesser et.al. (1976). The increased surface energy subsequently increased surface absolute humidity which in turn displaced the convective parcel ascent curve to the right(indicating more water vapor and latent heat release) making the lapse rate less steep and warmer where the water vapor content was lowest. It should be noted that ZAM2 has previously been shown to duplicate quite well the results of a 3-D GCM for large surface perturbations, which is important because it is questionable whether experiments looking at such small changes in local albedo as reported here would be possible, given the synoptic variability inherent in 3-D models.

(MATH MODELS)

ST78 13066 A BASELINE DESIGN FOR LARGE-SCALE SOLAR THERMAL ELECTRIC CONVERSION

Powell, J.C., Boer, K.W., (Honeywell Inc., St. Paul, MN), Sharing the Sun: Solar Technology in the Seventies, V 5:355, Aug. 15-20, 1976, International Solar Solar Energy Society, Solar Energy Soc. Canada, Winnipeg, Canada, Pergamon, Oxford, England, EDB-77:144715

A survey of the current Honeywell design for a 10-megawatt pilot plant is presented. The fundamentals of four major subsystems, (1)heliostats, (2)thermal storage, (3)tower and receiver, and (4)electric generation subsystem, are provided. Performance of the plant based on annual energy is provided along with estimated capital cost requirements. Estimates of busbar energy cost are provided for both the pilot plant and for large commercial versions to be developed in the late 1980's.

(ECONOMICS, 10-MWE PILOT)

ST78 13067 HIGH-TEMPERATURE ENERGY STORAGE IN NATIVE ROCKS

Riaz, M., Blackshear, P.L.Jr., Pfannkuch, H.O., (Univ. of Minnesota, Minneapolis, MN), Sharing the Sun: Solar Technology in the Seventies, V 8, 7 refs, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:131158

The successful utilization of thermal energy derived from solar collectors, from off-peak excess thermal energy of power plants, and from industrial process or waste heat systems is predicted upon the development of suitable storage systems which provide the necessary buffer and matching function between the time-varying thermal energy inputs and the output thermal and electrical loads. The technical feasibility of large-volume packed beds using native earth or rock materials for long-duration (months) storage of thermal energy at high temperatures (up to 500 C) and power levels (in the tens of MWt range) compatible with electric power generation and community heating in total energy systems context are explored. The advantages of this storage concept derive from the inherent simplicity of the overall system, from its utilization of low-cost, on-site, native materials resulting in potentially minimum environmental impact, and from the increased energy density obtainable with large temperature swings. A generic configuration of heat accumulators involving arrays of pebble-filled trenches (or holes) surrounded by undisturbed earth and fed by hot air from above or below is examined.

(COLLECTORS, MATH MODELS, ROCK-BEDS)

ST78 13068 THERMAL ENERGY STORAGE DEMONSTRATION UNIT FOR VUILLEUMIER CRYOGENIC COOLER, Interim Report, June 2, 1975-Aug. 31, 1976

Richter, R., (Xerox Electro-Optical Systems, Pasadena, CA), REPT-2340-I-1, AFAPL-TR-76-110, F33615-75-C-2045, AD-A040895, N77-33613

This report covers the work performed under the Thermal Energy Storage Demonstration Unit Program. The report presents the analysis, design, fabrication, and testing of a thermal energy storage demonstration unit which was to be mated to an existing Vuilleumier cooler (AFLIR) to demonstrate the concept of powering such a device directly with stored thermal energy. The thermal energy storage demonstration unit was to be sized for delivering 1000 watts thermal power for one hour at a temperature of 1250 + or -25 F. The ternary eutectic 64 MgF_2 - 30 LiF - 6 KF, which has a eutectic temperature of 1310 F, was selected as the thermal energy storage material. The report presents the approach and the assumptions underlying the design of the unit which incorporates a heat pipe for the transfer of energy from the thermal energy storage material to the hot cylinder of the Vuilleumier cooler. Details of the fabrication and the testing of the Thermal Energy Storage Demonstration Unit are presented. The analysis of the test data led to the conclusion that the basic design satisfied all requirements that were established for a TES unit. The thermal energy storage material, however, was found to apparently release its latent heat of fusion over a wider temperature range than had been anticipated. This fact can be attributed to nonisothermal phase transformation or a bulk thermal conductivity that is lower than had been assumed for the salt.

(HEAT PIPES, POWER PLANTS)

ST78 13069 DEVELOPMENT STATUS OF THE FIXED MIRROR SOLAR CONCENTRATOR

Russel, J.L.Jr., Schuster, J.R., Eggers, G.H., (General Atomic Co., San Diego, CA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1141-1146, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48834, A77-48701 23-44

The general atomic company fixed mirror solar concentrator (FMSC) employs a fixed mirror trough that produces a sharp line focus regardless of sun position. The heat receiver is moved in a circular arc to track the focal line. FMSC modules of precast concrete and glass mirrors are being fabricated to supply a 260 m^2 mirror field to Sandia Laboratories for their Solar Total Energy Demonstration Facility.

(FOCUSING)

ST78 13070 PRELIMINARY SYSTEM ANALYSIS OF A FIXED-MIRROR SOLAR POWER CENTRAL STATION, Final Report

Russell, J.L.Jr., Eggers, G., Emrich, W., Openshaw, F., Walker, W., (General Atomic Co., San Diego, CA), June 1977, EPRI-ER-434(6-77), EDB-77:131104, EDB-77:124813

As part of the Electric Power Research Institute (EPRI) Solar Thermal Program objectives to evaluate alternative distributed receiver systems, EPRI has contracted with General Atomic Company (GA) to perform a preliminary systems design and evaluation of their fixed-mirror solar concentrator (FMSC). In order to assist in this evaluation, a computer program was written to model a preliminary system definition of a power plant design for an FMSC. Analytical models were developed to simulate the performance and to model the cost of subsystems using both heat transfer salt (marketed as "HITEC") and carbon dioxide gas(CO_2) as the primary heat transfer fluids. It was found that the cost of the HITEC system was about half that of the CO_2 system. The computer code was exercised to obtain preliminary plant cost estimates and data on the sensitivity of the plant cost to changes in design parameters. Because of limited funding, the results derived in this study are limited and preliminary and were used to indicate trends in cost sensitivity.

(CONCENTRATORS, HEAT-TRANSFER, MATH MODELS, SALTS, STORAGE)

ST78 13071 STEAM-TIGHT AND HEAT-INSULATING FLOATING COVER FOR THE WATER SURFACE OF LARGE THERMAL ENERGY ACCUMULATORS

Schoell, G., Nov. 11, 1976, Patent no. 2,518,925/A, In German, EDB-77:112737

A steam-tight and heat-insulating floating cover for the water surface of large thermal energy accumulators is made of a carpet-like tissue woven of thin foil strips (warp) and air-filled foil tubes (weft).

(PATENT)

ST78 13072 SMITH MULTIMODULE SOLAR-ELECTRIC PLANT

Smith, O.J.M., (Calif. Univ., Berkeley, CA), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:99-116, 1 ref, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:144716, A77-49023, A77-48910 23-44

A practical solar-thermal-electric power plant can be built at a reasonable cost with available materials and conventional engineering design techniques. Fields of steerable mirrors concentrate the reflected sunlight on hot receptors behind heat-conserving windows on short towers. The absorbed heat from the hot receptors is carried by heat exchange fluids through pipes to a central station power plant containing heat exchangers to preheat and boil water and to superheat steam, and a conventional turbine and electrical generator. A 100-megawatt power plant would be supplied from 1100 towers of 35-meters height, each tower receptor illuminated by a hexagonal field of 50 m x 48 m. Each field has 312 mirrors of 2 m^2 surface each. The capital cost in dollars per megawatt-hour of annual production has been reduced by unique heliostat field geometry, mirror construction, high transmission window, high absorption cavity, and optimum utilization of available heat at different temperatures in the thermodynamic cycle.

(HEAT-EXCHANGERS, HEATING, HEAT-STORAGE, MIRRORS)

ST78 13073 FERMI FUNCTION MODEL ABSORPTION PROFILE FOR SOLAR-THERMAL CONVERSION

Soule, D.E., Schnitzmeyer, J.H., McKie, W.R., (Western Illinois Univ., Macomb, IL), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:310-322, 10 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, Research supported by the Western Illinois University and Argonne National Laboratory, EDB-77:137604, A77-49035, A77-48910 23-44

A parametrized Fermi Function Model is introduced to fit the spectral absorptance profiles of typical spectrally selective absorbing layers over the wavelength range from 0.3 to 40 microns. The resulting temperature dependence of spectral and thermodynamic solar-thermal conversion efficiencies for a focused concentrator system are calculated. Comparisons made between spectrally selective and blackbody absorbers over the concentration ratio range from 1x to 10,000x showed spectrally selective absorbers to be advantageous usually up to at least 100x (about 500-800 C), with the assumption that the absorbing surface is thermally durable over the required temperature range. With existing optical data, the effect of high-temperature spectral absorptance is also taken into account. The relative merits of the parametrized model versus the usual spectral absorptance/emittance ratio are discussed in the light of potential solid-state spectral absorptance profile tailoring.

(COLLECTORS, CONCENTRATORS, HEATING, MATH MODELS, PARABOLIC REFLECTORS)

ST78 13074 TURNTABLE SOLAR ARRAYS

Swet, C.J., (ERDA, Washington, D.C.), Sharing the Sun: Solar Technology in the Seventies, V 5, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:137603

A method of assembling and orienting extremely compact arrays of linear concentrators is described, in which the entire array is rotated as a unit in turntable fashion to follow the sun. The performance of such arrays is examined parametrically in terms of direct energy interception per unit area, as a function of geometry, geographic latitude, time of day, and season of year, and is shown to exceed that of arrays of individually oriented linear collectors that rotate about north-south polar axes. An adaption based on the use of tilted Fresnel refractors is described, which enables the collection of diffuse sunlight while concentrating the direct component. The feasibility and utility of this adaptation are preliminarily assessed. Applications of turntable arrays to irrigation pumping, electric power generation, and total energy systems are depicted.

(CONCENTRATORS, TRACKING)

ST78 13075 ENERGY STORAGE ACTIVITIES AT ERDA

Swet, C.J., (ERDA, Washington, D.C.), Solar Energy Storage Subsystems for the Heating and Cooling of Buildings, 1975, Eds: Lilleleht ,L.U., Beard, J.T., Iachetta, F.A., American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., New York, NY, EDB-77:144807

The thermal energy storage activities at ERDA which come under the Division of Conservation Research and Technology are discussed. The areas of electric power generation and industrial, commercial, and residential applications are mentioned briefly. Some mention is made of other energy storage means; mechanical, electrical, chemical, and magnetic.

ST78 13076 1 MWTH SOLAR CAVITY STEAM GENERATOR SOLAR TEST PROGRAM

Tracey, T.R., Blake, F.A., (Martin Marietta Aerospace, Denver, CO), Royere, C., (CNRS, Odeillo, Pyrenees-Orientales, France), Brown, C.T., (Georgia Inst. of Tech., Atlanta, GA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1224-1230, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, E(40-1)-4921, EY-76-C-03-1068, A77-48846, A77-48701 23-44

The primary objective of this program was to demonstrate the efficient conversion of solar energy to thermal energy in the form of steam as soon as possible. The largest solar test facility available was the facility located in Odeillo, France. There Therefore, the test article was designed for testing at the 1-MW level. The test article is a cavity-type receiver with an aperture of 1.03 meters. The inner walls consist of blackened steel tubes designed to deliver steam at 8619 KPA and 510 C. The solar testing consisted of a total of 161 hours of which 71.5 hours were at rated operating conditions 8619 KPA, 510 C, and 105 hours were at full boiler pressure. The maximum power input was 738 KW. The measured thermal efficiency of the cavity was 92 percent. During the program the receiver was cycled to rated conditions 26 times and the boiler was cycled to rated conditions 30 times. In addition, many other transients were encountered, including cloud interruptions.

(FURNACES)

ST78 13077 THERMAL ENERGY STORAGE USING LARGE HOLLOW STEEL INGOTS

Turner, R.H., (Jet Propulsion Lab., Pasadena, CA), Sharing the Sun: Solar Technology in the Seventies, V 8, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:131160

High-temperature thermal energy storage (to 500 C, 930 F) using hollow steel ingots is investigated. Preliminary studies indicate that the system should be reliable, characterized by low operation and maintenance costs and associated with low development risk. The estimated installed system energy unit storage cost $13.50/KWH-T.

ST78 13078 EQUIPMENT FOR CONVERSION OF RADIATION ENERGY, PARTICULARLY OF SOLAR RADIATION, INTO ELECTRIC POWER

Von Hacht. G., Dec. 30, 1976, Patent no. 2,525, 630/A, In German, EDB-77:134876

An equipment for converting solar radiation into electric power is described. The solar radiation is concentrated by lenses, and is radiated in conically widening light conducting fibers on the inside of which, or in whose surrounding there are light-sensitive surfaces. Further it is possible to arrange the length of the fibers and to provide the ends of the fibers with reflecting mirror surfaces so that a laser effect occurs inside the fibers. This could lead to amplification of the light in the fibers.

(LENSES, PATENT, SOLAR-CELLS)

ST78 13079 HTS THERMAL STORAGE PEAKING PLANT

Vrable, D.L., Quade, R.N., (General Atomic Co., San Diego, CA), April 1977, ORNL-SUB-4188-2
A study was conducted to evaluate the use of the General Atomic Company (GA) high-temperature gas-cooled reactor (HTGR) to generate intermediate load and peak power by using heat-transfer salt (HTS) thermal storage. The study investigated the technical and economic aspects of the conceptual design to confirm the system's viability for this application. Using a reference thermal power level of 2000 MW(T), preliminary system analysis was performed and a selection of the system configuration was completed. The approach to the study consisted of establishing a reference point by selecting a peaking capacity, duty cycle, and the thermal power split between the base load and peaking plant. The reference point design served as a basis for evaluating the technical and economic aspects of the system. Using the same salt storage loop and conversion system, the evaluation was extended to larger and smaller reactor sizes to assess economic attractiveness. Conceptual design data are provided for the major plant components. Preliminary cost estimates for the plant design and power costs were performed for the selected reference design.

(EUTECTICS, MOLTEN, SALTS)

ST78 13080 GEORGIA TECH HIGH TEMPERATURE SOLAR TEST FACILITY

Walton, J.D.Jr., (Georgia Inst. of Tech., Atlanta, GA), In Symposium on Electromagnetic Windows Proceedings, 13th, Atlanta, GA, p. 133-138, Sept. 21-23, 1977, Georgia Inst. of Tech., ERDA-sponsored research, A77-49745, A77-49726 23-32
The Georgia Institute of Technology Solar Thermal Test Facility, which involves a 400-KW solar furnace suitable for simulating aerodynamic heating of radomes, is described. Plans for the facility, scheduled to begin preliminary operation in 1977, call for an initial array of 550 circular mirrors made of low-iron window glass. Mechanical drive mounts for directing the concentrated solar energy to various test areas are also included in the planning. Calculations indicate that with maximum heat flux and concentration ratios, the solar furnace could provide a test area in which at least 175 KW of radiant thermal energy is available. Additional documentation of the facility is also mentioned.

(COLLECTORS, FURNACES, HEATING, MIRRORS)

ST78 13081 REPORT ON SOLAR THERMAL POWER SYSTEMS AND THEIR POTENTIAL FOR UTILITY APPLI APPLICATIONS

Watson, M., Katz, E.L., Bruce, R.W., (Aerospace Corp., Los Angeles, CA), Trans. Am. Nucl. Soc., V 26:1, June 1977, EDB-77:124804
No abstract available

(ECONOMICS, GOVERNMENT POLICIES, OFF-PEAK-ENERGY-STORAGE)

ST78 13082 AMMONIUM HYDROGEN SULFATE DECOMPOSITION FOR STORAGE OF ENERGY FOR ELECTRICAL POWER GENERATION

Wentworth, W.E., Chen, E., Boer, K.W., (Chem. Dept., Univ of Houston, Houston, TX), Sharing the Sun: Solar Technology in the Seventies, Winnipeg, Canada, V 8, Aug. 15-20, 1976, International Solar Energy Soc., Solar Energy Soc. of Canada, Pergamon, Oxford, England
The decomposition of ammonium hydrogen sulfate (NH_4HSO_4) into NH_3, H_2O, and SO_3 looks very promising for storage of (power generation grade) energy. The change in enthalpy, ΔH, is very high (≈80 Kcal/mole), and this heat content combined with the fact that products can be stored as liquids leads to a high capacity for energy storage (≈740 Kcal/l). This reaction occurs without a catalyst and the product SO_3 must be stored separately from NH_3 and H_2O. The details of the separation are discussed along with the thermodynamics and kinetics of the reactions involved.

ST78 13083 LARGE-SCALE ELECTRICAL POWER GENERATION AND STORAGE

Wright, J.K., (Central Electricity Generating Board, London, England), Aspects of Energy Conversion, 17 refs, Eds: Blair, I.M., Jones, B.D., Van Horn, A.M., 1976, Pergamon Press Inc., Elmsford, NY, EDB-77:112987
The discussion on large central power stations for electricity generation describes the present methods and possible improvements. Subjects covered briefly include plant mix, the steam cycle, dual cycles, gas turbine combined cycle, MHD generation, thermionic generation, freon and potassium vapor turbines, nuclear gas turbines, fuel cells, reject heat, reject to sea or rivers, cooling towers, and district heating. The second part of the discussion is concerned with possible ways of storing electrical energy on a large scale. Subjects covered in this area include economics of storage, pumped-water storage, compressed-air storage, superconducting storage, flywheel storage, battery storage, electrolysis storage systems, and heat storage. It is concluded that during the next 20 years there could be a case for installing substantially more storage capacity on the CEGB system. Schemes that present the most interesting technical challenges, such as flywheels

or superconducting electromagnetic stores, seem to be the least attractive economically. More attractive are the electrochemical methods and the storage of compressed air. Cheapest and simplest of all could well be the storage of additional hot water in the boiler circuit of a thermal power station.

(ECONOMICS, UNITED KINGDOM)

ST78 13084 RADIATIVE HEAT TRANSFER IN CAVITY-TYPE AXISYMMETRIC COLLECTORS FOR HIGH-TEMPERATURE SOLAR ENERGY PLANTS

Zakhidov, R.A., Klychev, S.I., (Akademiia Nauk Uzbekskoi SSr, Tsentral'Noe Proektno-Konstruktorskoe I Tekhnologicheskoe Biuro Nauchnogo Priborostroeniia, Uzbek, SSR), Geliotekhnika, p. 39-44, N3, 1977, In Russian, A77-48523

Radiative heat transfer in cavity-type solar collectors was investigated with the object of arriving at useful simplifications in early-design selection of cavity parameters. A computer program is developed and the effect of optical-geometrical cavity parameters on heat flux is investigated, with attention given to the concentration field. Relationships between influx distribution and redistributions of outward-going flux are explored.

ST78 13085 THERMAL SCALE MODELING OF THE CENTRAL RECEIVER OF A HELIUM BRAYTON CYCLE SOLAR POWERPLANT

Zentner, R.C., Shannon, R.L., (Boeing Co., Engineering and Construction Div., Seattle, WA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:179-186, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, Research supported by the Electric Power Research Institute and Boeing Co., A77-48717, A77-48701 23-44

The paper describes a commercial central-receiver solar power plant concept which utilizes Brayton cycle turbomachinery in an intermediate load power plant role. A one-megawatt solar receiver, the bench model solar receiver, will be used to evaluate the central receiver design. Characteristics of this test model which are similar to those of the commercial unit include its heat exchanger operating temperatures, up to 870 C, insulation wall temperatures of about 1090 C, and thermal performance. Several aspects of the engineering and design of the receiver model are discussed, and theoretical design requirements for thermal similitude are considered.

(HEAT-EXCHANGERS, HEATING, INSULATION, TURBINE)

14000 THERMIONIC/THERMOELECTRIC

ST78 14000 TRIANGULAR-ELECTRODE HIGH POWER-DENSITY THERMOPILES

Brandstetter, A., Yekutieli, G., (Dept. of Nuclear Phys., Weizmann Inst. of Sci., Rehovath, Israel), Proc. of the International Conf. on Thermoelectric Energy Conversion, Arlington, TX, p.156-159, 23 refs, Sept. 1-3, 1976, IEEE, New York, NY

The feasibility of high power-density thermoelectric generators has been studied in the past by several researchers, both from a physical and a technological point of view, but no devices of practical interest have been proposed so far. This paper describes some recent efforts to test a certain concept involving thin thermoelements sandwiched between metal electrodes of triangular cross-section and its applicability to direct conversion of concentrated solar energy.

(THERMOELECTRIC CONVERSION)

ST78 14001 OVERALL EFFICIENCY OF A SOLAR COLLECTOR USING A FRESNEL LENS AND THERMOELECTRIC MODULE TO GENERATE ELECTRICAL POWER

Cobble, M.H., Smith, P.R., (New Mexico State Univ., Las Cruces, NM), Proc. of the International Conf. on Thermoelectric Energy Conversion, Arlington, TX, p. 162-167, 5 refs, Sept. 1-3, 1976, IEEE, New York, NY

In this report, a type of Fresnel lens is analyzed to determine its efficiency and concentration, with allowance for reflection at the two surfaces and absorption within the lens. A plot of concentration as a function of lens angle is given and the efficiency of the thermoelectric module is determined when there are convection and radiation losses at the hot surface (junction). The efficiency of the thermoelectric generator is shown graphically for various hot surface temperatures, and for several loss parameter values. An expression for the optimum efficiency based on the ratio of resistances is developed, and an expression for the overall efficiency is developed for a solar collector which utilizes a Fresnel lens and a thermoelectric module for the purpose of generating electrical power.

(CONCENTRATION, CONCENTRATORS, EFFICIENCY)

ST78 14002 CONVERSION OF SOLAR ENERGY INTO ELECTRICAL POWER BY MEANS OF THE THERMOELECTRIC EFFECT

Landecker, K., (Univ. of New England, Armidale, NSW, Australia), Proc. of the International Conf. on Thermoelectric Energy Conversion, V 1-6, 7 refs, Sept. 1-3, 1976, Arlington, TX, IEEE, New York, NY

This paper is intended to be a survey of the present state of the development of thermoelectric devices insofar as they are capable of serving as converters for insolation into electrical energy. Thermoelectric cells may be constructed using inexpensive and common raw materials and that the necessity to grow single crystals can be avoided without essentially impairing the efficiency of the thermoelements. The principles for a successful design are outlined.

ST78 14003 ON POWER-GENERATING THERMOJUNCTIONS WITH RADIAL FLOW OF CURRENT FOR SOLAR ENERGY CONVERSION

Landecker, K., (New England Univ., Armidale, New South Wales, Australia), Solar Energy, V 19:439-443, N5, 1977, Research supported by the Australian Research Grants Committee, A77-50202

It was shown in a previous publication that in refrigerating thermocouples whose arms are in the form of coaxially arranged thermoelectric disks in which the current flow is radial, the effect of joule heating on the performance is considerably reduced if the outer and inner radii of the disks are in the ratio of 4.5. It is now shown that if the same couples are used for the generation of power, the performance is enhanced in such a way that the internal resistance appears to be greatly reduced in magnitude. It is again found that disks with lateral boundaries in the form of hyperboloids have the most favourable shape. The thermojunctions described have been used mainly for research into utilization of solar energy.

(CONVERSION, THERMOCOUPLES, THERMOELECTRIC POWER)

ST78 14004 INTERNATIONAL CONFERENCE ON THERMOELECTRIC ENERGY CONVERSION, UNIVERSITY OF TEXAS, ARLINGTON, TEXAS, SEPTEMBER 1-3, 1976, PROCEEDINGS

Rao, K.R., (Texas Univ., Arlington, TX), Conf. Sponsored by the Inst. of Electrical and Electronics Engineers, New York, NY, Inst. of Electrical and Electronics Engineers, Inc., 192 pages, 1976, A77-49753

The papers deal with radioisotope thermoelectric generators (RTG's), thermoelectric (TE) materials and their properties, TE coolers, TE generators, novel TE devices, and TE heat-pump systems. Topics include recent terrestrial and undersea applications of RTG's, thermal optimization of small PU-238-fuelled RTG's, thermoelectric properties of Group I chalcogenides, quenching of thermoelectric Ge-Si alloys, a computer-aided design for a TE heat exchanger, and a numerical analysis of the transient behavior of TE coolers. Optimization of a TE generator design for fixed heat-input operation is also examined along with power-generating thermojunctions with radial current flow in coaxial disks, performance characteristics of a sodium heat engine, the overall efficiency of a solar collector that uses a Fresnel lens and a TE module to generate electrical power, an application of TE coolers as blackbody reference sources, and techniques for estimating heat loads on TE coolers.

(HEAT-PUMPS)

ST78 14005 SOLAR THERMIONIC POWER SYSTEMS FOR TERRESTRIAL APPLICATIONS

Shimada, K., Swerdling, M., (Calif. Inst. of Tech., Jet Propulsion Laboratory, Pasadena, CA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1590-1601, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48893, A77-48701 23-44

The results of a feasibility study which showed that a low-temperature, high high-efficient thermionic power system can efficiently convert solar energy to electrical energy without heat transport, as required by most solar thermal systems described. A three-dimensional (two-axis tracking) 93 m^2 parabolic solar concentrator, consisting of mirrors on a foam glass substrate and designed to a concentration ratio (mirror area/ aperture area) of 2000, is considered for producing a design temperature of 1100 C at an efficiency of 75 percent. A tracking subsystem must track the sun at an accuracy of a nominal plus or minus 1.0 degree for maximum use of the sun's energy. Each complete solar thermionic power system unit rated at about 20 KWE peak can generate approximately 48,000 KWH/year. In addition, a thermal energy conversion system can be cascaded within the thermionic power system so that the high-quality waste heat can be further utilized to increase the net electrical output. Potential applications of a solar thermionic power generation system are remote sites, apartment house complexes, heating and cooling, hydrogen production, and large power stations.

(COLLECTORS, PARABOLIC)

15000 OCEAN THERMAL DIFFERENTIAL

ST78 15000 TO DESIGN, CONSTRUCT, AND TEST A MODEL SEA SOLAR POWER PLANT

Anderson, H.H., (Sea Solar Power, Inc., York, PA), (NSF, Washington, D.C.), NSF-RANN-SE-GI-44213-PR-75-4, NSF-GI-44213, NSF-RA-N-75-306, Annual Progress Rept. June 1-Dec. 12, 1974, 22 pages, Jan. 24, 1975, PB-263-949-OST, EDB-77:144722

A small model sea solar power plant was designed to demonstrate and test a vapor turbine, driven by a halocarbon vapor, boiled by heat from tap water at 70 to 90 F, and exhausted into a condenser cooled by ice water. The purpose was to demonstrate whether a turbine could actually be made to run under these conditions of very small temperature difference. The turbine was built and run at vapor temperature difference heads as low as 3 F.

(DEMONSTRATION MODEL, OCEAN-ΔT, TURBINE TEST)

ST78 15001 ENHANCED SINGLE-PHASE HEAT TRANSFER FOR OCEAN THERMAL ENERGY CONVERSION SYSTEMS, Final Report

Bergles, A.E., Jensen, M.K., (Iowa State Univ. of Science and Technology, Ames, IA), April 1977, ORNL-SUB-77-14216-1, EDB-77:111211

Preliminary studies have shown that the heat exchanger costs for an ocean thermal energy conversion (OTEC) system represent approximately half of the total capital cost. Much of the OTEC research is now directed at development of lower cost heat exchangers which are not unduly affected by biofouling. It appears that reduced size (and cost) will require utilization of enhanced heat transfer surfaces for both the boiler and the condenser. An ititial study directed toward assessing the potential for heat transfer enhancement of the sea water, or single-phase side, of these heat exchangers is described. Single-phase forced-convection heat transfer can be enhanced by a wide variety of techniques. Of primary interest in large-scale heat exchange equipment are a number of "passive" techniques which do not require external power to generate and sustain the improvement. These techniques are: rough surfaces, extended surfaces, displaced enhancement devices, and swirl flow devices. As part of this study the world literature was surveyed to locate representative data for these techniques. A computer search of an extensive collection of general literature on heat transfer enhancement was utilized. Heat transfer and friction factor data are presented for various techniques and subgroups of techniques, particularly those data which demonstrate the maximum reported improvements in heat transfer coefficients.

(BIBLIOGRAPHIES, BIOFOULING, HEAT-EXCHANGERS, HEAT-TRANSFER-ENHANCEMENT, OCEAN-ΔT)

ST78 15002 OCEAN THERMAL POWER PLANT HEAT EXCHANGERS

Czikk, A.M., Fenner, G.W., Notaro, F., Zawierucha, R., (Union Carbide Corp., Tonawanda, NY), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:461-484, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:137472, EDB-77:144721, A77-49045, A77-48910 23-44

The cost-performance characteristics of heat exchangers for the ocean thermal power cycle were studied. The preferred heat exchangers are shell-and-tube exchangers with the seawater tube side to minimize corrosion and fouling. The use of heat transfer enhancements was considered. Corrosion and biofouling by seawater were studied in connection with choice of materials of construction. Control of biofouling will be necessary for operation. Preferred methods of control are chlorination and continuous mechanical cleaning. The hydraulic problems involved in the evaporator design were studied, and a system optimization program for studying heat exchanger designs was developed. Exchangers using enhanced tubes were found to cost $942/KW for a 100-MW plant, or 33 percent less than with plain tubes. The cost penalty for substituting multiple flooded bundles for sprayed evaporator bundles was $325/KW.

(BIOFOULING, CORROSION, ECONOMICS, MATERIALS)

ST78 15003 TECHNICAL AND ECONOMIC FEASIBILITY OF OCEAN THERMAL ENERGY CONVERSION

Dugger, G.L., Francis, E.J., Avery, W.H., (John Hopkins University, Laurel, MO), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:9-45, 46 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, Research supported by the US Maritime Administration and ERDA, EDB-77:137467, A77-49018, A77-48910 23-44

Ocean Thermal Energy Conversion (OTEC) plants will employ the temperature difference between the solar-heated surface layer of a tropical ocean (24 to 28 C) and the water at 500 to 1200 m depth (4 to 7 C) as the source and sink for a rankine cycle system to generate electrical power. The first commercial plants could be deployed in the mid-1980's, and we believe they will be competitive then with fossil fuel and nuclear energy sources for selected applications. Ammonia (for fertilizers) is a particularly attractive

product, because 95 percent of the ammonia produced in the US is now made from natural gas, our scarcest resource. Direct delivery of electric power to short may also be competitive for, e.g., the southeastern United States. In the 1990's delivery of liquid hydrogen and many other products should become attractive. Various OTEC plant-ship concepts, their economics, onboard production plants, and some of the environmental considerations are discussed.

(FEASIBILITY-ANALYSIS, OCEAN-ΔT)

ST78 15004 STUDIES OF BIOFOULING IN OCEAN THERMAL ENERGY CONVERSION PLANTS

Fetkovich, J.G., Grannemann, G.N., Meier, D.L., Munchmeyer, F.C., (Carnegie-Mellon Univ., Pittsburgh, PA), Sharing the Sun: Solar Technology in the Seventies, V 5, 1976, 15 pages, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, COO-4041-4, EDB-77:137471, EDB-77:111205, A77-49044

Efforts to extract energy from the ocean's thermal gradients by means of closed-cycle ocean thermal energy conversion (OTEC) plants require very large heat exchangers. The seawater passing through these will be heated (or cooled) by only a few degrees. Under these conditions it is feared that biological fouling (biofouling) may seriously impede heat transfer unless appropriate measures are taken. There exists surprisingly little data on biofouling under conditions approximating those expected to exist in an OTEC heat exchanger. For these reasons, we have undertaken a study of biofouling in simulated OTEC heat exchangers. Currently, the effect of fouling on the heat transfer coefficient is being investigated as a function of the material used and water velocity. Next, the effectiveness of several means of biofouling prevention will be determined. Later stages of the study will include investigation of variation with a number of other phenomena important to OTEC design and operation.

(HEAT-EXCHANGERS, OCEAN-ΔT, TEST)

ST78 15005 GULF STREAM OTEC RESOURCE POTENTIAL AND ENVIRONMENTAL IMPACT ASSESSMENT OVERVIEW; OCEAN THERMAL ENERGY CONVERSION

Harrenstien, H.P., McCluney, W.R., (Florida Solar Energy Center, Cape Canaveral, FL), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:522-534, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:137475, Also See ST77 19073, A77-49048, A77-48910 23-44

The basic features of the ocean thermal energy conversion (OTEC) project are described with regard to environmental impact and the potential of gulf stream resources for the construction of an OTEC plant. Categories of environmental considerations are outlined for both the plant itself and the related land-based construction and support facilities with the alteration of the near-surface portion of the thermocline identified as the most significant problem. Climatological effects of a depressed sea surface temperature is discussed in terms of both regional and global effects. The gulf stream resources are presented along with a basic analytical model and related calculations.

(ENVIRONMENT-EFFECTS, MATH MODEL, OCEAN-ΔT, THERMOCLINES)

ST78 15006 STEADY-STATE EVAPORATOR MODELS OF SOLAR SEA POWER PLANTS, Part I

Hetyei, S.A., Neuman, C.P., (Carnegie-Mellon Univ., Pittsburgh, PA), Aug. 1976, COO-2895-5, EDB-77:111207

Previously, a methodology was developed for modeling the dynamic and steady-state behavior of solar sea power plants (SSPP). Here, the pertinent physical alws of heat transfer and mass balance are applied to develop a lumped parameter, steady-state model for tube-and-shell evaporators incorporating falling films. This model is analyzed to investigate the assumption of constant heat transfer coefficients in modeling the steady-state behavior of smooth-tube evaporators operated in the turbulent flow regime. It is concluded that, for all practical purposes, the local heat transfer coefficient on the working fluid side of the evaporator tube is constant for both fixed and ± 10 percent changes in the inlet working fluid flow rate. The overall objective is to develop simulation models of a complete SSPP as tools of design and optimization.

(OCEAN-ΔT, MATH MODELS, WORKING-FLUIDS)

ST78 15007 OCEAN THERMAL ENERGY CONVERSION, RESOURCE, ECOLOGICAL, AND ENVIRONMENTAL STUDIES; THERMAL PROFILE ENVELOPES AND CROSS-SECTIONS FOR POTENTIAL OTEC PLANT SITES, Interim Quarterly Report no. 3

Hubert, W.E., Greenfeldt, N.L., (Ocean Data Systems, Inc., Monterey, CA), NSF-RA-760095, NSF C-1020, 37 pages, PB-266704-6, N77-31659
Avail:NTIS

The most promising sites for ocean thermal energy conversion (OTEC) plants are examined. The three US-controlled regions that show promise as sites for prototype OTEC installations are the Gulf Stream, Hawaiian Islands, and Puerto Rico. The environmental considerations of these sites are ocean temperature differences, current structure, and storm damage potential.

(ENVIRONMENTAL SURVEYS, OCEAN-ΔT, SITE EVALUATION)

ST78 15008 OCEAN FOOD AND ENERGY FARM PROJECT, SUBTASK 4, PRELIMINARY DESIGN STUDIES OF SUBSTRATE AND UPWELLING SYSTEMS, Volume 1, KELP SUPPORT SUBSTRATE STRUCTURES FOR USE IN THE OFEF PROJECT, Progress Report

James, A.L., Murphy, D.W., (Naval Undersea Center, Kailua, HI), Sept. 1976, ERDA-USN-1027-3/1, EDB-77:144699

Preliminary design investigations of artificial substrate structures to support kelp plants in the open ocean are reported. The substrate structure is defined, and a set of operational requirements is established. A number of structural concepts were generated in "brainstorm" sessions and were grouped into four generic classifications: tension grid, rigid member, membrane, and inflatable structures. This study focused on tensioned grid structures because they appear to be simple, cost effective, and consist of cables which are also integral to many of the other structural concepts. A series of model inves investigations was utilized to select a tension grid configuration for the preliminary design. Computer structural analysis techniques were used in developing the tension grid design. The result appears to be flexible and to offer considerable promise. The cable system analysis techniques developed in this effort will be required in the design of future cable structures. A brief summary is given of the uses and analytic capabilities of the programs.

(BIOMASS PLANTATIONS, MATH MODELS, OFFSHORE PLATFORMS, STRUCTURAL MODELS)

ST78 15009 EXPERIMENTAL AND ANALYTICAL RESEARCH ON THE EXTERNAL FLUID MECHANICS OF OCEAN THERMAL ENERGY CONVERSION PLANTS, Progress Report, April 1-Sept. 30, 1976

Jirka, G.H., Harlemen, D.R.F., Fry, D.J., Johnson, R.P., (Massachusetts Inst. of Tech., Cambridge, MA), Nov. 12, 1976, COO-2909-1, EDB-77:111208

The experimental set-up has been completed and two series of experiments have been conducted, both simulating OTEC operation in a stagnant ocean but with different design conditions (radial jet versus separate jet discharge). Two separate data reports have been transmitted to NRL (appendices A and B). The preliminary experimental results demonstrate, amongst others, that: (a) the mixing of the discharge flow in the vicinity of OTEC is primarily dependent on discharge momentum and only secondarily dependent on discharge design details. Higher discharge momentum results in larger mixing ratios. Discharge momentum, in turn, is proportional to the power required for the discharge pumps. (b) Under standard oceanographic conditions, an OTEC plant in the order of 100 to 200 MWE should not experience significant recirculation effects. A radial jet model based on the integral technique has been developed which predicts the mixing and geometric chara characteristics of the discharge jets. Preliminary results indicate that the model is correctly predicting the observed data trends.

(FLOW MODELS, MIXING-LAYERS, OCEAN-ΔT)

ST78 15010 ALTERNATIVE FORMS OF ENERGY TRANSMISSION FROM OTEC PLANTS

Konopka, A., Biederman, N., Talib, A., Yudow, B., (Institute of Gas Technology, Chicago, IL), 1977, CONF-770331-5, EDB-77:124816

The transmission of OTEC-derived chemical and electrical energy is compared. The chemical energy-carriers considered are the following: gaseous and liquid hydrogen, liquid ammonia, methanol, gasoline, hudrazine hydrate, anhydrous hydrazine, unsymmetrical dimethylhydrazine (UDMH), 1.7-octadiyne, and tetrahydrodicyclopentadiene. The assessment assumes that each of the above energy carriers were transported by barge and/or pipeline. The delivered costs were then compared with transmission of electricity by submarine cables. Because chemical and electrical energy are not equivalent, however, their comparison can only be done after the outputs are converted to a common form. Thus, in addition to presenting the delivered cost and overall energy efficiency of the chemical energy-carriers, we have provided a discussion of the equipment, costs, and efficiencies of converting the hydrogen and ammonia delivered into electricity, and the electricity delivered into hydrogen and ammonia. A concise technical assessment and economic analysis of components associated with the conversion, storage, transportation, and shore-based receiving facilities for the conversion of OTEC mechanical energy to chemical energy is provided and compared to the conversion and transmission of electrical power. Results concerning the hydrogen and ammonia analysis were determined as part of the OTEC program at IGT from May 1975 through May 1976 under contract no. NSF-C1008 (AER-75-00033) with the National Science Foundation and ERDA. Information concerning carbonaceous fuels and high-energy fuels production was developed as part of the current IGT OTEC program under contract no. E(49-18)-2426 with ERDA.

(COMPARATIVE-EVALUATIONS, ECONOMICS, OCEAN-ΔT)

ST78 15011 OPTIMIZATION STUDY OF OTEC DELIVERY SYSTEMS BASED ON CHEMICAL-ENERGY CARRIERS, Final Report

Konopka, A.J., Talib, A., Yudow, B., Biederman, N., (Institute of Gas Technology, Chicago, IL), Dec. 1976, ERDA-NSF-00033-76-T1, EDB-77:144720
Avail:NTIS $10.00

The techno-economic feasibility of chemical energy carriers was studied. Specifically, the chemical energy carriers analyzed were hydrogen, as a gas and as a liquid, and liquid ammonia. Designs of systems for producing and transporting chemical energy to shore were completed. Estimates of the cost at which chemical energy would be available from an onshore terminal have been prepared. These estimates are expressed as a function of two major variables: the shaft-power cost on board the OTEC plant and the distance of the OTEC plant from shore. The size and weight characteristics of chemical energy plants that could be placed on board an OTEC plant were estimated. A techno-economic evaluation of the marine riser connecting the OTEC platform with an ocean-bed platform was provided. A technical and economic evaluation of conversion of delivered ammonia to ammonium nitrate and urea was completed and a general analysis of chemical energy reconverted into electricity onshore was also made. The information for the major project tasks, production, transmission, terminalling, and conversion back to electricity, is given.

(ECONOMICS, ENERGY-TRANSMISSION, HYDROGEN, OCEAN-ΔT, STORAGE)

ST78 15012 ELECTRIC POWER FROM THE OCEAN THERMAL GRADIENT

Lavi, A., (Carnegie-Mellon Univ., Pittsburgh, PA), (IEEE), Proceedings of the IEEE International Conference on Cybernetics and Society, Washington, D.C., p. 699-703, 5 refs, Nov. 1-3, 1976

This paper surveys the development of the ocean thermal energy conversion concept in the US. It is shown that with the implementation of current laboratory heat transfer concepts into working heat exchangers, the cost of busbar electricity becomes competitive with that from nuclear reactors. Power can be utilized to reduce metals and produce chemicals, notably ammonia, and synthetic fuels. The benefits from large-scale implementation are: creation of a new export industry, stimulation of economy through the production of energy, and reduced reliance on foreign oil and on nuclear energy.

(ECONOMICS, HEAT-EXCHANGERS, OCEAN-ΔT)

ST78 15013 OCEAN THERMAL ENERGY CONVERSION (OTEC)

Lavi, A., (ERDA, Washington, D.C.), In NASA, Marshall Space Flight Center Proc. of the ASPE/MSFC Symp. on Eng. and Productivity gains from Space Technol., p. 87-94, Also see ST77 15070, N77-30278, N77-30273 21-31
Avail:NTIS

Energy Research and Development Administration research progress in ocean thermal energy conversion (OTEC) is outlined. The development program is being focused on cost-effective heat exchangers; ammonia is generally used as the heat exchange fluid. Projected costs for energy production by OTEC vary between $1000 to $1700 per KW.

(DEVELOPMENT-PROGRAM, ENERGY POLICY, HEAT-EXCHANGERS)

ST78 15014 HEAT EXCHANGER DESIGN USING EXPERIMENTAL DATA ON FLUTED VERTICAL TUBES, Part I

Lavi, A., Rothfus, R.R., (Carnegie-Mellon Univ., Pittsburgh, PA), Oct. 31, 1976, COO-2895-8, EDB-77:124825

Recently, experimental data on the heat transfer characteristics of fluted surfaces have been acquired. As a result, new models must be developed for incorporation in the design process. The new models and a simplified design procedure for OTEC-exchangers are presented without any claim of optimality. The design will be used subsequently to develop cost and layouts for a realizable self-sufficient and a 1-MWE OTEC plant. The same design will be used to investigate the sizing of tributaries and mains in a heat exchanger for a 25-MWE module. The model for the evaporator relates the tube diameter, ammonia feed rate, recycle ratio, and tube length. A similar model for the condenser is obtained, without the recycle ratio. The models derived are shown to be readily usable in an OTEC system optimization.

(AMMONIA, EVAPORATORS, HEAT-EXCHANGERS, OCEAN-ΔT, SIMULATION MODEL, WORKING-FLUIDS)

ST78 15015 SENSITIVITY ANALYSIS FOR OTEC PROPANE AND MIXTURE CYCLES, OCEAN THERMAL ENERGY CONVERSION

Lawson, C.A., Iqbal, K.Z., Fish, L.W., Starling, K.E., (Oklahoma University, Norman, OK), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:507-521, 3 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:137474, A77-49047, A77-48910 23-44

The results of sensitivity analysis calculations are presented for OTEC (ocean thermal energy conversion) cycles using propane and propane-and-butane mixtures as working fluids. Parameter studies in the sensitivity analysis include heat exchanger LMTD's (log mean temperature differences), sea water velocities in heat exchanger tubes, warm sea water temperature rise and cold sea water temperature drop in the heat exchangers, and the cold sea water pipe length. In addition, mixture composition (mole fraction N-butane) for the

propane-n-butane system was treated as a parameter. These calculations show that with present state-of-the-art heat exchanger technology, there are virtually no economic trade-offs because of the dominant costs of the heat exchangers. It was observed that because mixtures offer an increased economic advantage over pure working fluids as the temperature rise of the cold sea water is increased, mixtures as working fluids should become more attractive as heat exchanger costs are reduced.

(HEAT-EXCHANGERS, PROPANE-N-BUTANE MIXTURES, WORKING-FLUIDS)

ST78 15016 SIMPLIFIED ALGORITHM TO SOLVE GEOMETRIC PROGRAMMING PROBLEMS USING FORTRAN

Lepley, M., (Carnegie-Mellon Univ., Pittsburgh, PA), Oct. 1, 1976, COO-2895-6, EDB-77 EDB-77:124824

Geometric programming has proven to be a useful tool for the optimum design of solar sea power plants. The Carnegie-Mellon University team working on the OTEC concept has found it profitable to develop a Fortran-based computer code to solve simple geometric programs which arise often in OTEC work. This report describes such a program and gives an outline of how the computer program can be used in general.

(COMPUTER CALCULATIONS, FORTRAN, MATH MODELS, OCEAN-ΔT)

ST78 15017 OUTLINE FOR OPTIMIZING AND EVALUATING PROPOSED OTEC SYSTEMS

Lyon, R.N., (Oak Ridge National Lab., Oak Ridge, TN), 1977, CONF-770331-2, EDB-77:111204

The need to begin the development of a general modeling and optimization method for ocean thermal energy conversion systems for assistance in making a wide variety of administrative and design decisions is emphasized. Concepts that should be included in the model are outlined.

(ECONOMICS, MATH MODELS, OCEAN-ΔT, OPTIMIZATION)

ST78 15018 ANALYTICAL AND EXPERIMENTAL STUDIES OF OTEC HEAT TRANSFER PROBLEMS AT OAK RIDGE NATIONAL LABORATORY

Michel, J.W., (Oak Ridge National Lab., Oak Ridge, TN), 1977, CONF-770331-1, EDB-77:111203

During the past year, Oak Ridge National Laboratory has been involved in assisting ERDA in analysis, planning, and implementing a program to develop advanced heat exchangers for ocean thermal energy conversion (OTEC) application. An analysis of the NH_3 binary cycle and the current state of commercial heat exchanger technology indicated that the goals of this program should be to improve the seawater heat transfer coefficients by a factor of 2, the ammonia heat transfer coefficients by a factor of 2 to 4, and to be able to control fouling factors at a value of 0.0003 or below. These improvements, coupled with qualifying aluminum for this seawater-ammonia service, would go far toward assuring the economic viability of the OTEC concept. A single-tube ammonia heat transfer loop has been built and operated to evaluate the heat transfer characteristics of fluted tubes. Preliminary ammonia condensation results are presented.

(AMMONIA, BIOFOULING, FLUTED-TUBES, HEAT-EXCHANGERS, OCEAN-ΔT, WORKING-FLUIDS)

ST78 15019 ECONOMIC ASPECTS OF OCEAN THERMAL ENERGY CONVERSION

Naef, F.E., (Lockheed Missiles and Space Co., Inc., Washington, D.C.), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:392-411, 7 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:137468, A77-49041, A77-48910 23-44

The results of several studies indicate that solar energy collected by the surface layers of the ocean can be converted to electricity using contemporary technology, and with design and fabrication improvements, can be made economically competitive with fossil and nuclear fuelled plants. OTEC technology is reviewed and economic issues are identified and discussed. Because the plant is modular and operates in the marine environment, major components can be manufactured in existing shipyards and can be operated by established marine contractors and maritime labor. The process of large-scale implementation is investigated by conceptualizing a technology delivery system (TDS) and examining the impact of various design features and government incentives.

(FORECASTING, ENERGY-POLICY, INCENTIVES, OCEAN-ΔT)

ST78 15020 DESIGN OF LOW-COST ALUMINUM HEAT EXCHANGERS FOR OTEC PLANT-SHIPS, OCEAN THERMAL ENERGY CONVERSION

Olson, H.L., Pandolfini, P.P., Blevins, R.W., Dugger, G.L., Avery, W.H., (John Hopkins University, Laurel, MD), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:485-506, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, ERDA-supported research, EDB-77:137473, A77-49046, A77-48910 23-44

Successful commercial implementation of ocean thermal energy conversion (OTEC) plant-ships will require a capital cost competitive with land-based plants. The most expensive components of an OTEC system are the evaporators (heated by warm surface water), the condensers (cooled by water from 700 to 1000 m depth), and the floating ocean platform. To minimize these costs, simple two-phase-flow heat exchangers made of large-diameter aluminum tubes (ammonia inside, sea water outside) have been designed for integration in a simple barge-type reinforced concrete hull. Each 2.5-MWE (net) evaporator or condenser module has 132 tubes approximately 700 ft long, folded to 27 horizontal passes each; six of these tubes are "nested" in a vertical plane in each of 22 "elements." The estimated costs for the heat exchangers are reported.

(ECONOMICS, OCEAN-ΔT)

ST78 15021 INTERNAL HEAT TRANSFER EXPERIMENTS IN A SIMULATED OTEC EVAPORATOR TUBE

Olsen, H.L., Pandolfini, P.P., Rice, J.L., (John Hopkins Univ., Laurel, MD), 68 pages, APL-JHU-AEO-76-066, N00017-72-C-4401, N77-29611
Avail:NTIS

Internal heat transfer tests have been conducted for ammonia in two phase flow inside a nearly horizontal aluminum tube. This tube simulates one pass of a multipass evaporator tube for use in a low cost ocean thermal energy conversion plant-ship concept. The tests covered mass flows, heat fluxes, qualities up to 20 percent vapor by mass, and tube angles. Stratified, wavy or intermittent flow occurred in all tests. The results indicate that overall internal heat transfer coefficients essentially equivalent to the prior predictions for this heat exchanger concept are obtained in evaporators using horizontal tubes.

(HEAT-EXCHANGERS, AMMONIA, OCEAN-ΔT, PLANT-SHIP, TESTS, TRANSFER-COEFFICIENTS)

ST78 15022 ABATEMENT OF BIOFOULING AND CORROSION IN OTEC HEAT EXCHANGERS USING LOW ENERGY SURFACES, OCEAN THERMAL ENERGY CONVERSION

Ostrozynski, R.L., Jones, P.E., (Allied Chemical Buffalo Research Laboratory, Buffalo, NY), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 5:436-445, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:137470, A77-49043, A77-48910 23-44

The control of marine fouling and corrosion on heat exchanger surfaces is discussed with regard to the development of appropriate chemical processes in heat-exchanger manufacture, and the evaluation of various surface treatments as antibiofoulants and corrosion protectants. A three-stage treating procedure for aluminum, titanium, and a copper-nickel alloy is described, and the effects of dual-reactive silanes for the improvement of monolayer-metal adhesion are investigated. Ocean testing of a series of treated panels is presented along with an assessment of the results, obtained by visual observation, electron spectroscopy for chemical analysis, and scanning electron microscopy. The biofouling resistance of ionic copper is evaluated, and plans for future work are outlined.

(ALUMINUM-ALLOYS, COPPER-ALLOYS, OCEAN-ΔT, PROTECTIVE COATINGS, TESTING)

ST78 15023 OTEC BIOFOULING AND CORROSION PROGRAM

Perrigo, L.D., Jensen, G.A., (Battelle Pacific Northwest Labs., Richland, WA), Research Program, March 1977, BNWL-SA-6208, EDB-77:144718

One of the major technical hurdles that must be crossed to bring OTEC into commercial use is the solution to biofouling, corrosion, and deposition reactions that are expected to reduce heat transfer efficiency. In January 1976, ERDA established a project activity office at Battelle-Northwest whose mission it is to develop, procure, monitor, and evaluate projects to define, prevent, and/or alleviate biofouling and corrosion problems expected in OTEC power plants. Since start-up, this project activity office has developed a methodology to guide work, assumed responsibility or contracted for 10 projects, and expects to have several more contractors work on various aspects of biofouling and corrosion problems in the near future. The priorities for near and intermediate term work are identified and the operation of the project activity office is described.

(OCEAN-ΔT, RESEARCH-PROGRAM)

ST78 15024 OCEAN THERMAL ENERGY CONVERSION SYSTEM BIOFOULING AND CORROSION PROBLEMS

Perrigo, L.D., Jensen, G.A., (Battelle Pacific Northwest Labs., Richland, WA), Sept. 1976, BNWL-SA-5970, EDB-77:111202

The Energy Research and Development Administration (ERDA) is sponsoring a program to explore the possibilities for beneficially using the temperature difference between warm surface water of the tropical oceans and the deeper colder water to operate a heat engine. Because as much as 4 to 6 percent of the expected demand for power in the United States by 2020 could be supplied by this source which is known as ocean thermal energy conversion,

this is one of the potential alternatives being explored by the federal government to lessen our dependence upon conventional energy sources. One of the major technical hurdles that must be overcome to bring this alternative energy source into beneficial use is the solution to biofouling problems that are expected to impede efficient heat transfer in the power plant evaporator and condenser systems. There are allied problems in the corrosion of materials that must also be solved. In January 1976, ERDA established a project office at Battelle-Northwest whose mission it is to develop, procure, and monitor projects to define, control, and alleviate biofouling and corrosion problems expected in OTEC power plants. Since start-up, this project office has developed a methodology to guide work in this area, assumed control of on-going projects, and initiated others. The results of work to develop a biofouling device and the corrosion behavior of aluminum in ammonia-sea water mixtures are reported.

(COATINGS, HEAT-EXCHANGERS, OCEAN-ΔT, RESEARCH-PROGRAM)

ST78 15025 NET ENERGY ANALYSIS OF AN OCEAN THERMAL ENERGY CONVERSION (OTEC) SYSTEM

Perry, A.M., Marland, G., Zelby, L.W., (Institute for Energy Analysis, Oak Ridge, TN), Feb. 1977, ORAU-IEA(M)-77-1, EDB-77:124826

The energy requirements for construction and operation of an OTEC system are estimated. The conceptual system selected for analysis was one developed by Lockheed Missiles and Space Company. It uses a rankine power cycle with ammonia as the working fluid, and is based on essentially available technology. The plant would be located about 20 miles offshore and would produce 160 MWE of net electricity that would be carried ashore by underwater cable for transmission and distribution by conventional means. Evaporators and condensers for the ammonia power cycle were assumed to be made of titanium (for resistance to corrosion) although it is recognized that aluminum alloys, preferable from a cost standpoint, may prove to have acceptable corrosion resistance. Net electrical output of the plant at an assumed 90 percent plant factor is 1.26×10^9 KWH(E) per year. Annualized energy inputs for construction and operation (including periodic repair and replacement of major plant components) are estimated to be 15×10^5 KWH of electricity and 37×10^{10} BTU of direct or indirect fuel consumption not associated with the electricity inputs. Thus the electrical energy "subsidy" represents about one percent of net station output, while non-electric energy subsidies add up to approximately 300 BTU per KWH(E). If the electrical energy inputs are assumed to come from fossil-fuelled plants with an overall energy requirement of 13,850 BTU per net KWH(E), then the overall energy subsidy is about 58×10^{10} BTU per year. The delivered energy from the OTEC plant is thus nearly 7 to 10 times the direct and indirect primary energy inputs. Therefore, this OTEC system would return useful energy far in excess of the energy inputs required for its construction and operation.

(OCEAN-ΔT, SYSTEMS-ANALYSIS)

ST78 15026 TWO-DIMENSIONAL NUMERICAL MODEL OF THE NEAR-FIELD FLOW FOR AN OCEAN THERMAL POWER PLANT, PART I, THE THEORETICAL APPROACH AND A LABORATORY SIMULATION

Roberts, G.O., Piacsek, S.A., Toomre, J., (Science Applications, Inc., McLean, VA), (Naval Research Lab., Washington, D.C.), Turbulent Water Motions, 1976, DSE-1005-5, EDB-77:137464

This report describes the computer model NRFLO2, which has been developed to calculate the near-field stratified turbulent flow driven by the intakes and outflows of an ocean thermal power plant. A two-dimensional geometry is assumed, with the power plant intakes and jet outflows modelled by boundary conditions on the left boundary of a rectangular domain. Horizontal flow through the right boundary, to or from the far-field, is allowed by assuming a pressure in hydrostatic equilibrium with the ambient density distribution. The code uses a first-order closure model to treat the stratfield turbulence. Advanced numerical methods enable convergent and accurate solutions to be obtained rapidly and economically. A simple laboratory simulation of two-dimensional stratified turbulence driven by intakes and jet outflows is proposed in order to address the general question of near-flow recirculation. Such an experiment would also provide vital data for verifying the code NRFLO2 and its successors, and for tuning the turbulence parameters to give the best agreement. Numerical results from NRFLO2 are presented for the proposed experimental simulation. They confirm the analysis predicting a stability limit on the far-field horizontal flow, and demonstrate the occurrence of recirculation for fast-flow cases.

(COMPUTER-CALCULATIONS, ENVIRONMENTAL-IMPACTS, MATH MODELS, OCEAN-ΔT, TURBULENT-WATER-MOTIONS)

ST78 15027 CONCURRENT STUDIES OF ENHANCED HEAT TRANSFER AND MATERIALS FOR OCEAN THERMAL EXCHANGERS, Progress Report, July 1, 1975-July 31, 1976

Rothfus, R.R., (Carnegie-Mellon Univ., Pittsburgh, PA), July 31, 1976, COO-2641-1, EDB-77:144719

To demonstrate the enhancement of heat transfer in OTEC exchangers by means of fine axial-flutes on the heat transfer surfaces, experiments have been performed on single internally or externally fluted tubes of 1-inch diameter. Internal flutes provide water-side enhancement of both heat transfer and friction to about the same extent. At moderate

water velocities, heat transfer coefficients and friction factors are greater than those of the comparable smooth tube by a multiplying factor about equal to the fluted-to-smooth surface area ratio. Area ratios from 1.0 to 1.5 have been tested using two styles of flutes. Flute heights have ranged from 3 to 35 mils, tube lengths from 2 to 8 ft. Heat transfer experiments have been performed on freon-11 moving in a thin layer under gravity down the outer surface of a smooth tube and of a tube having 26-mil external axial flutes. Test lengths have averaged 4.5 ft. Enhancements of the local coefficient by 3 to 5 times has been observed during both evaporation and condensation. The effectiveness of the flutes is greatest in the range of laminar-turbulent transition.

(AXIAL-FLUTES, EVAPORATORS, HEAT-EXCHANGERS, OCEAN-ΔT, SURFACE-ENHANCEMENT, WORKING-FLUIDS)

ST78 15028 HAZARDS AND MATERIALS COMPATIBILITY OF AMMONIA FOR POWER PLANT APPLICATIONS

Rubin, A.M., Lyon, R.N., (Oak Ridge National Lab., Oak Ridge, TN), (Franklin Inst. Research Labs., Philadelphia, PA), 1977, CONF-770515-1, EDB-77:111381

Results and a discussion of a comprehensive literature review on the materials compatibility, thermal stability, safety and handling, storage, and shipping of ammonia are presented. The potential use of ammonia as a power plant working fluid and a heat transport medium is discussed. The thermodynamic properties of ammonia make it attractive for use in a variety of systems, including the following: (1)geothermal binary cycle power plant, (2)bottoming cycle of a gas-turbine high-temperature gas-cooled nuclear reactor (GT-HTGR), (3)ocean thermal-energy conversion plant, and (4)steam power plant heat rejection using an air-cooled condensing, vapor-condensing heat transport system, or an unusually cold heat sink. In some cases, the use of ammonia allows practical power production from an otherwise marginal heat-supply/heat-sink combination.

(GEOTHERMAL, OCEAN-ΔT, SAFETY, THERMAL-POWER-PLANTS, THERMAL-STABILITY, WORKING-FLUIDS)

ST78 15029 WATER FLOW HEAT TRANSFER CONDUCTANCE ENHANCEMENT IN ROUND TUBES BY MEANS OF FLOW-MODIFYING INSERTS

Sabin, C.M., Poppendiek, H.F., Connelly, D.J., Dunbar, J.G., (Geoscience Ltd., Solana Beach, CA), March 1977, SAN-1094-1, EDB-77:137466

Geoscience Ltd. is under contract to ERDA to investigate means for improving water-side and ammonia boiling heat transfer conductances in OTEC power plant heat exchangers, in order that the cost of these massive and expensive components might be decreased. Water heat transfer results with inserts which generate fairly large-scale motions in the flow, i.e., motions which are not restricted to the so-called laminar sub-layer and buffer layer in the tube, are presented. The work on enhancement of conductances for water flowi flowing within round tubes is directed toward the search for surfaces which exhibit for a particular heat transfer conductance, the minimum friction factor. The work is exploratory, so that testing of any one configuration has been limited. Since large-scale motions were of interest in these particular tests, the inserts chosen were those which would, in concept, generate strong radial components in the flow without recourse to eddy shedding or random turbulence. A variety of candidate configurations were tested in an open-water channel, using dye to follow fluid motions, and on this basis choices were made for use in heat transfer tests. The chosen configurations have been tested for performance in a round tube installed in water heat transfer apparatus. Results are reported for several spacings of each insert, and a wide range of Reynolds moduli.

(AMMONIA, CONFIGURATION, HEAT-EXCHANGERS, OCEAN-ΔT)

ST78 15030 ALTERNATIVE ENERGY TRANSMISSION SYSTEMS FROM OTEC PLANTS, PROJECT 8980 Second Quarter Progress Report, October-December 1976

Talib, A., Yudow, B., Blazek, C., Foh, S., Konopka, A., Biederman, N., (Institute of Gas Technology, Chicago, IL), Feb. 1977, DSE-2426-8, EDB-77:111209

Ocean thermal energy conversion (OTEC) plants are likely to be located some distance offshore, and several different approaches have been suggested for carrying the energy these plants produce to the energy user. Energy carriers evaluated include both chemical and electrical energy. The Institute of Gas Technology (IGT) is conducting a study to provide a technical and economic evaluation of two previously unexamined concepts for converting OTEC energy to a storable transportable form, and shipping it to a shore-based receiving terminal. One concept deals with an onboard electrical system that is used to produce high-temperature heat and shipping this thermal energy to shore in some form of thermal storage system, such as a molten salt. The other concept is to use OTEC energy to produce carbonaceous fuels using electrolytic hydrogen produced onboard and carbon dioxide extracted from sea water or delivered from a shore-based facility. Methane, methanol, and conventional light fuels of the gasoline family will be considered for synthesis at the OTEC plant. The possibility of producing high-energy fuels, such as hydrazine, UDMH, 1-7 octadiyne, and tetrahydrodicyclopentadiene is also being analyzed. During the second quarter we concentrated our efforts on the following areas: (1)analyzing the techno-economic characteristics of producing gasoline from methanol on an OTEC platform, (2) determining carbon dioxide levels in sea water, (3)evaluating various processes for the extraction of CO_2 from sea water, (4)collecting information concerning OTEC energy barge

and pipeline transportation systems, and (5) developing a method for analyzing thermal energy transport systems. Research progress is summarized.

(ELECTROLYSIS, FEASIBILITY-STUDIES, HYDROGEN, METHANE, METHANOL, OCEAN-ΔT, STORAGE)

ST78 15031 ALTERNATIVE ENERGY TRANSMISSION SYSTEMS FROM OTEC PLANTS, PROJECT 8980 Third Quarter Progress Report, January 1-March 31, 1977

Yudow, B., Konopka, A., Biederman, N., (Institute of Gas Technology, Chicago, IL), May 1977, DSE-2426-12, EDB-77:131111

Three types of thermal energy storage media were considered for transport of OTEC energy. They were the following: (1) sensible heat media, which depends upon the heat capacity of the material for energy storage, (2) latent heat of fusion material, and (3) reversible chemical reactions, which depend upon the change in energy content of certain compounds as chemical bonds are broken and other bonds are made. Only those systems operating in the nominal temperature range of 400 to 1000 F were considered. The lower limit of the temperature swing of sensible heat thermal energy systems was approximately 400 F. A literature search was undertaken and completed. As a result of the literature search, four thermal energy transport system concepts were selected and synthesized into conceptual systems that use OTEC energy to charge the thermal storage medium installed in a ship hull, then transport the heat storage system to shore for use, or convert the thermal energy to electricity using a heat engine. The four conceptual designs, of which two used sensible heat storage, one used the latent heat of fusion, and one used a reversible chemical reaction, were derived from thermal energy storage conceptual designs for solar thermal-electric power plants or solar total energy systems. The four thermal energy transport systems were: (1) rock-oil hybrid, a sensible heat storage system using crushed gravel rock and a heat transfer fluid, Caloria HT-43; (2) HITEC, a sensible heat storage system using a molten salt; (3) sodium hydroxide, a latent heat of fusion system also using sensible heats of liquid and solid phases; and (4) sulfur trioxide-sulfur dioxide, a reversible chemical reaction system using the following reaction: SO_3 + heat reversible $SO_2 + \frac{1}{2}O_2$. Results of a cost-efficiency analysis of the four systems are tabulated and discussed.

(ECONOMICS, FEASIBILITY-STUDIES, LATENT-HEAT, SENSIBLE-HEAT, STORAGE, THERMOCHEMICAL)

ST78 15032 COMPARISON OF THE ECONOMICS OF NUCLEAR AND SOLAR POWER

Zener, C., (Carnegie-Mellon Univ., Pittsburgh, PA), Sharing the Sun: Solar Technology in the Seventies, V 5, 5 refs, 1976, Ed: Boer, K.W., EDB-77:137476

This paper compares the estimated capital costs per net power capacity for nuclear and for ocean thermal energy conversion plants ordered today for delivery in the mid-1980's. The estimate for nuclear plants takes into consideration the 24 percent annual increase in estimated costs since 1967, the historical factor of two of the actual cost over the estimated cost, and finally the low 56 percent average capacity factor for large nuclear plants, versus the planned-for capacity factor of 80 percent. The estimate for OTEC plants starts from estimates made by industry using only state-of-the-art components, and introducing anticipated improvements in the performance of heat exchangers. The estimates obtained in this manner give approximately $3,000 for nuclear, approximately $1,000/KW for OTEC generating capacity with 80 percent capacity factor.

(COMMERCIALIZATION, COMPARATIVE-EVALUATIONS, OCEAN-ΔT, NUCLEAR-POWER)

16000 WIND POWER CONVERSION

ST78 16000 WIND DRIVEN ELECTRIC POWER GENERATOR

Agsten, C.F., July 19, 1977, US Patent no. 4,036,916, EDB-77:137751

A wind-driven electric power generator is described which has a shroud arranged in a path of fluid flow. Within the shroud is disposed a stationary shaft supporting a wind generator assembly. The shroud can be the veil of a conventional cooling tower, with the wind generator assembly including a rotor connected to an electric generator arranged for converting rotary motion of the rotor to electrical energy, thus saving some of the energy created by the natural draft passing up the veil of the cooling tower. Space frame box trusses provided with airfoils provide lightweight arms for the rotor, with the rotor being arranged anywhere in the shroud. When a hyperbolic cooling tower veil is used as the shroud, the rotor will usually be positioned in the throat of the veils.

(CONFIGURATION)

ST78 16001 SOME CONTRIBUTIONS TO AERODYNAMIC THEORY FOR VERTICAL AXIS WIND TURBINES

Ashley, H., (Stanford University, Stanford, CA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1624-1632, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, AF-AFOSR-74-2712, A77-48897, A77-48701 23-44

A review and modest extensions of quasi-steady aerodynamic theory for performance prediction on Darrieus-type turbines are presented. Results are given for both parallel-axis and curved-blade configurations. Blade stall and variable inflow are neglected; it is hypothesized that unsteady effects support the former approximation down to lower values of tip-speed ratio than hitherto believed. Both profile and induced drag are included, and their influences on power and downwind force are expressed in terms of elliptic integrals. Comparisons are presented with power data from the Sandia two-meter turbine. Three values of profile drag coefficient are employed, and it is argued that numbers in the range drag coefficient range of 0.015-0.017 are most appropriate to the example chosen. A linearized analysis of unsteady-flow effects on performance is summarized. Calculations suggest that they may be larger than might be expected in view of the low operating reduced frequencies of these machines.

(BLADES, COMPARATIVE-EVALUATIONS)

ST78 16002 ESTIMATING WIND POWER POTENTIAL

Baker, R.W., Hennessey, J.P., (Oregon State Univ., Corvallis, OR), Power Eng., V 81:56-57, N3, March 1977, EDB-77:125014

Tests of the Widger method at four Pacific-Northwest locations show that accurately estimating the shape of wind speed distribution is critical, and that an empirical method of wind speed measurement may not be usable at good wind power sites.

(DISTRIBUTION-MEASURING, PACIFIC-NORTHWEST, SITE-SELECTION, WIND)

ST78 16003 WIND ENERGY: A REVITALIZED PURSUIT

Blackwell, B.F., Feltz, L.V., (Sandia Labs., Albuquerque, NM), (American Society of Mechanical Engineers, Albuquerque, NM), 1975, EDB-77:118386

An estimate of the wind energy available in the Great Plains area has been determined, and it was concluded that this energy is large in comparison to the 1973 US electrical energy consumption. The status of the Darrieus-type vertical-axis wind turbine being investigated by Sandia Laboratories is reviewed.

(AERODYNAMICS, ECONOMICS, GREAT PLAINS, VERTICAL-AXIS)

ST78 16004 STATUS OF THE ERDA-SANDIA 17-METRE DARRIEUS TURBINE DESIGN

Blackwell, B.F., (Sandia Lab., Albuquerque, NM), Energy Dig., London, England, V5:6, N6, Dec. 1976, EDB-77:118292

The article is an excerpted paper from an International Symposium, "Wind Energy Systems," held at St. John's College, Cambridge, England. Under sponsorship of the Energy Research and Development Administration (ERDA) wind energy program, Sandia Laboratories has been investigating the Darrieus wind turbine as an alternative to the conventional horizontal-axis wind turbine. The current effort at Sandia Laboratories has been directed toward the design and fabrication of a 17-meter diameter Darrieus turbine. The basic rotor configuration consists of three NaCa 0012 blades, each blade being supported by two struts that extend from the vertical rotating shaft to the blades. The rotating shaft, which will be fabricated from steel, has an outer diameter of 0.508 m (20 in) with 2.54 cm (1 in) wall thickness. The blades are required to operate up to 75 rpm in a 26.8 m/s (60 mph) wind without permanent deformation and to withstand 53.6 m/s (120 mph) wind at zero rpm. The turbine base contains the means of axial support of the turbine, the power train (consisting of a speed increaser, synchronous generator, and an inductive starter), and a braking system. The desing rotational speed is 45.4 rpm and maximum power is 70 KW. Due to turbine component inefficiencies, the electrical generator will see approximately 60 KW, which is its rated capacity.

(BLADES, FABRICATION, RESEARCH-PROGRAMS, VERTICAL-AXIS, WIND)

ST78 16005 APPLICATION OF LAMINATED WOODEN BLADES TO A TWO-METER DARRIEUS TYPE VERTICAL-AXIS WIND TURBINE

Butler, B.L., Blackwell, B.F., (Sandia Labs., Albuquerque, NM), SAND-76-0284, N77-29612 Avail:NTIS

The use of laminated Lauan plywood in a two-meter-diameter, three-bladed Darrieus wind turbine is described. The manufacture, testing, and tensile stress analysis of laminated wooden blades are described. The thin NaCa 0012 blade was excited into resonance well below the peak power rpm and constrained the turbine to low power output. The two-meter wind turbine model tests indicated that, with appropriate blade design, wood has potential for small vertical axis wind turbines.

(MANUFACTURE, TEST)

ST78 16006 WIND ENERGY RESOURCE SURVEY OF NEW ZEALAND: PRELIMINARY ANALYSIS OF METEOROLOGICAL DATA, Report no. 8

Cherry, N.J., (Lincoln Coll., Canterbury, New Zealand), April 1976, NP-21761, EDB-77:118384
Initial results are presented of an analysis of wind data from the New Zealand Meteorological Service for the wind energy resource survey of New Zealand. The analysis is confined in general to data supplied in the form of wind speed frequency distributions and tables of average wind speeds. The analysis of wind data from the New Zealand Network indicates by comparison with other surveys that most areas of New Zealand have moderate to very high mean wind energy fluxes, even though the anemometers are not necessarily located in the windiest places. There is a large proportion of New Zealand where the mean wind energy flux is greater than 200 w/m^2.

ST78 16007 THE USE OF BUILT FORM TO ENHANCE THE OUTPUT OF WIND COLLECTORS, BUILDING DESIGN FOR WIND CONCENTRATION

Coonley, D.R., (Design-Research-Consulting, Harrisville, NH), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 7: 253-267, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:111359, A77-49090, A77-48910 23-44
Buildings often give rise to extreme wind velocities at ground level, especially when there is an open area for the wind to pass through. This paper considers the possibility of utilizing the wind ducting capabilities of built structures in an attempt to gain better use of and increased energy output from wind energy conversion systems. Attention is given to the integration of wind collector systems with buildings. The variation of fixed wind collector output with variation in wind direction is studied and methods for reducing wind problems around buildings are examined.

(ARCHITECTURE, BUILDING-ENHANCEMENT)

ST78 16008 STOCHASTIC MODELING OF SITE WIND CHARACTERISTICS, Progress Report, September 15-December 14, 1976

Corotis, R.B., (Northwestern Univ., Evanston, IL), Jan. 1977, RLO-2342-1, EDB-77:118397
Work was started relative to changing the esisting computer programs to accomplish the goals of the present contract. Preliminary work was also done on site selection, and five regional sites were identified for closer study. From these five sites the final selection of locations for study will be made. Letters were sent to a number of fellow researchers inquiring into the availability of appropriate wind records.

(COMPUTER-CODES, SITE-SELECTION)

ST78 16009 WIND ENERGY MISSION ANALYSIS, Executive Summary

Coty, U., (Lockheed-California Co., Burbank, CA), Oct. 1976, TID-27698, EDB-77:137744
The Wind Energy Conversion Branch of the Energy Research and Development Administration undertook the task of determining the economic viability of wind energy conversion systems (WECS). A contract, AT(04-3)-1075 "wind energy mission analysis," was awarded to Lockheed early in 1975 and completed early in 1976. The results of this study are severely condensed and summarized in this executive summary to provide an overview of over 850 pages of report and appendices and over 1,000 pages of processed wind data.

(ECONOMICS, FEASIBILITY STUDIES, MARKET)

ST78 16010 WIND ENERGY MISSION ANALYSIS, Final Report

Coty, U.A., (Lockheed-California Co., Burbank, CA), Sept. 1976, SAN-1075-1, EDB-77:137742
Maps of wind power densities are presented covering the United States and territories. Each region is assessed in terms of available wind power, its distribution over the land, and its frequency, deviation, and strength. A matrix of energy users and their applications of wind energy conversion systems is assembled and evaluated to select those combinations which have the highest potential in terms of nationwide impact. The high potential applications are analyzed in depth to determine degree of market penetration, performance and cost goals, marketing channels, incentives to implementation, and institutional constraints. An initial assessment of public acceptance was performed durin during the course of the study which is analyzed and reported. Widely varying scenarios are postulated to develop extreme, yet possible, limits of implementation rates. The effects of these implementation rates are determined as they pertain to production rates, supply of critical materials, land usage, capital requirements, environmental pollution, electrical energy generated, fossil fuel saved, balance of trade, net flow of free energy, and energy payback time.

(ECONOMICS, ENERGY-PAYBACK, ENVIRONMENTAL, FEASIBILITY-STUDIES, PUBLIC-RELATIONS, UNITED-STATES, WIND-MAPS)

ST78 16011 HIGH POTENTIAL OF WIND AS AN ENERGY SOURCE

Coty, U., Dubey, M., (Lockheed-California Co., Burbank, CA), Energy LA: Tackling the Crisis, 1976, Ed: Robinson, J.W., Western Periodicals Co., North Hollywood, CA, EDB-77:137745

Wind energy is an abundant resource in the United States. It can be captured economically by large wind-turbine generators and used to supplement electric energy provided from fossil-fuel and hydroelectric resources. Today's technology is more than adequate for wind energy to make an immediate contribution to alleviating the energy crunch. A recently completed study sponsored by the Energy Research and Development Administration shows that the full potential of the wind is far greater than previously estimated. Full implementation would produce clean energy without pollution, and would make a significant contribution to the conservation of our fossil-fuel reserves.

(ECONOMICS, OVERVIEW)

ST78 16012 EFFECTS OF INITIAL PRODUCTION QUANTITY AND INCENTIVES ON THE COST OF WIND ENERGY

Coty, U., Vaughn, L., (Lockheed-California Co., Burbank, CA), Jan. 3, 1977, CONF-770210-9, EDB-77:137740

The effect of initial production quantity on the selling price of a two-MW wind turbine generator is determined. To this is added the effect of loan interest rates, taxes, and other annual operating expenses. The cost of electrical energy generated is determined and compared to the cost of fuel for private utilities and to the cost of buying energy wholesale for public utilities. From this comparison, the initial production quantities of wind turbine generators is determined, which would bring cost of wind energy down to a competitive level. The data presented also shows the effect on initial production quantity required of introducing incentives such as guaranteed loans. The effect of annual average wind speed at the site is assessed in terms of initial production quantity required. It is concluded that without incentives, and with wind sites having seven m/s annual average windspeed, the initial production quantity is 260 units to bring the cost of wind energy down to the present price of oil (2.6 cents/KWH) for private utilities and down to 1.5 cents/KWH for public utilities. With guaranteed loans provided as an incentive, the initial production quantity required drops to 95 units. Federal power agencies could meet the present cost of oil with energy from wind turbine generators with an initial production order of 40 units.

(ECONOMICS, FINANCIAL INCENTIVES)

ST78 16013 WIND SHEAR EXTREMES

Court, A., (National Climatic Center, Ashville, NC), Initial Wind Energy Data Assessment Study, ED: Changery, M.J., May 1975, PB-244132, EDB-77:137736

Extremes of wind speeds, and of their differences in space (shears) and time (gusts) are studied according to extreme value theory. A central concept in this theory is that of the "characteristic extreme" or "expected extreme." Equations that express independent bivariate normal and related x_2 wind distributions are presented.

(MATH MODELS, VARIATIONS)

ST78 16014 DESIGN AND OPERATIONAL EVALUATION OF A 25-KW WIND TURBINE GENERATOR FOR RESIDENTIAL HEATING APPLICATIONS

Cromack, D.E., Heronemus, W.E., McGowan, J.G., (Massachusetts University, Amherst, MA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1668-1675, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, E(49-18)-2365, A77-48901, A77-48701 23-44

No abstract available

(BLADES, DESIGN-ANALYSIS)

ST78 16015 A NON-AEROSPACE APPLICATION OF PLANS: PRELIMINARY STRUCTURAL DESIGN OF WIND TURBINE DIFFUSER

Crouzet-Pascal, J., (Grumman Aerospace Corp., Bethpage, NY), 88 pages, RM-629, E(11)-2615, N77-31604

A baseline design for a lightweight diffuser, its calculated weight, and the method employed to calculate the specific sizes in the design are described. Formulas are presented that permit the straightforward assessment of the effect on the diffuser weight, and the related cost of power generation, of changes in dimensions, material, or allowable deflections. It was established that for a scale variation in the over-all size of the diffuser, the cost of power generation attributable to the diffuser varies linearly with the diffuser front radius. It was also established that as compared to using aluminum, the cost would actually go up with standard strength steel but down with higher strength steel. Allowing the structure to be more flexible cannot yield a reduction in cost unless a change in material properties is allowed.

(WEIGHT-REDUCTION)

ST78 16016 ENERGY ANALYSIS OF A WIND ENERGY CONVERSION SYSTEM FOR FUEL DISPLACEMENT

Devine, W.D.Jr., (Institute for Energy Analysis, Oak Ridge, TN), Feb. 1977, ORAU-IEA(M)-77-2, EDB-77:137741

Energy conversion machines which utilize renewable supplies of energy as fuel may deliver considerably more energy to ultimate users than is consumed during manufacture, deployment, and operation of the machine. An input-output approach is employed to estimate the energy embodied in a 1,500 KW(E) horizontal-axis wind electric generating station used to displace fossil fuel in an electric utility system. Five ratios comparing delivered electrical energy to the energy requirement of the wind machine are displayed. The results indicate that the system considered could be a large net producer of energy and should displace a quantity of fossil energy equivalent to that embodied in the machine in considerably less than one year.

(ECONOMICS, NET-ENERGY)

ST78 16017 HIGH-POWER WIND TURBINE WITH KINETIC ACCUMULATOR

Diggs, R.E., July 12, 1977, US Patent no. 4,035,658, EDB-77:137752

A high-power wind turbine with kinetic accumulator is disclosed. The invention includes a circular wall, a wall turbine movably mounted to the circular wall so that it can be moved to face the wind, a non-linear generator connected to the wind turbine to generate electrical power, a fly wheel, and a drive wheel disposed in contact with the fly wheel to drive the fly wheel. A reversible non-linear motor is connected to the drive wheel to drive the drive wheel or to be driven by the fly wheel. The non-linear generator is connected to the reversible motor to rotate the drive wheel to rotate the fly wheel when the non-linear generator generates excess electrical power. The fly wheel rotates the drive wheel to drive the reversible motor to generate electrical power when the non-linear generator does not generate sufficient electrical power.

(CONFIGURATION, FLY WHEELS)

ST78 16018 CONVERSION AND STORAGE OF WIND ENERGY AS NITROGENOUS FERTILIZER

Dubey, M., (Lockheed-California Co., Burbank, CA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:525-532, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, NSF-C-75-22186, A77-48762, A77-48701 23-44

The use of wind energy, air, and water to produce ammonia for use as a nitrogenous fertilizer is discussed. A study shows that it is technologically feasible to reduce the scale of an ammonia processing plant to produce a tiny fraction of the output rates of full-scale commercial plants. Such a system can be adequately powered by a wind turbine driving an electrolysis cell to produce the required hydrogen feedstock. The process is described, and several factors, such as energy storage, product storage, and energy balance and component matching, are considered. The economics of the system are analyzed, and it is thought that the cost of the produced fertilizer will be competitive if natural gas prices continue to rise.

(ECONOMICS, ELECTROLYSIS, FEASIBILITY-ANALYSIS, FERTILIZERS-PRODUCTION, ON-SITE)

ST78 16019 WIND POWER PROJECT DEVELOPMENT BY ELECTRICITE DE FRANCE

Fille, R.B., Houille Blanche, V 30:45-66, N1, 1975, In French, EDB-77:137757

The results of EDF's wind power development programme from 1947 to 1966 are reviewed. The engineering development of the larger French wind power generators is described in detail: these are the 800-KW Nogent-le-Roi, the 132-KW, and 1000-KW machines at Saint Remy-des-Landes. Brief details are also given of British, Danish, and German generators. A table lists main parameters of 15 large wind generators developed by eight different countries.

(DENMARK, GERMANY, UNITED KINGDOM)

ST78 16020 DEVELOPMENT OF A WIND ENERGY SITE SELECTION METHODOLOGY, Progress Report, May 3-Dec. 3, 1976

Freeman, B.E., Patnaik, P.C., Phillips, G.T., (Science Applications, Inc., La Jolla, CA), 1976, RLO-2440-76-4, EDB-77:137758

The components of the site selection methodology, and the method of empirical orthogonal eigenfunctions for the identification of recurrent meteorological patterns in the climatological data are described. Several faster meteorological computer codes are compared. The further development and testing of the primitive equation models (the Sigmet family of codes) are described. This consists of developments which will permit calculations to be performed more rapidly (through partial implicitization) and more accurately (through improved physical models).

(COMPARATIVE-EVALUATIONS, COMPUTER-CODES, MATH MODELS)

ST78 16021 HARNESSING THE WIND: A WAY OF LIFE

Galazen, T., Org. Gard. Farming, V 24:36-40, 42, N10, Oct. 1977, EDB-77:144890

The successful experiences of Martin Jopp in Minnesota when in 1917 he first lit a three-volt flashlight bulb with a wind generator are followed. He has perfected the technology and provides repair service for wind generators. His shop equipment to construct and repair generator parts is powered by wind. Excess electricity generated by the wind machines at his home is stored in 60 storage batteries, hooked up to provide a 120-volt DC supply which, in addition to the workshop, also powers ordinary light bulbs and many appliances generally served by household AC current. Aluminum he needs for making new replacement wind-machine parts is supplied by beer cans, sardine containers, and other scrap aluminum.

(HISTORY, ON-SITE, RESIDENTIAL)

ST78 16022 INVESTIGATION OF EXCITATION CONTROL FOR WIND-TURBINE GENERATOR STABILITY

Gebben, V.D., (NASA, Lewis, Cleveland, OH), NASA-TM-73745 E-9313, ERDA-NASA-1028-77-3, N77-31614
Avail:NTIS

High-speed horizontal-axis wind turbine generators with blades on the downwind side of the support tower require special design considerations to handle disturbances introduced by the flow wake behind the tower. Experiments and analytical analyses were made to determine benefits that might be obtained by using the generator-exciter to provide system damping for reducing power fluctuations.

(GENERATOR-EXCITER, HORIZONTAL-AXIS, POWER-FLUCTUATIONS, TOWER-INTERACTION)

ST78 16023 FLUID DYNAMICS OF DIFFUSER AUGMENTED WIND TURBINES

Gilbert, B.L., Oman, R.A., Foreman, K.M., (Grumman Aerospace Fluid Dynamics Laboratory, Bethpage, NY), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1651-1659, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, E(11-1)-2616, A77-48899, A77-48701 23-44

The diffuser augmented wind turbine (DAWT) is one of the advanced concepts being investigated to improve the economics of wind energy conversion systems (WECS). Application of modern boundary layer control techniques has reduced the surface area requirements of an efficient diffuser by an order of magnitude. Many parameters that effect the performance of the diffuser system have been examined in small-scale wind-tunnel tests with a family of compact diffusers, using screens and centerbodies to simulate the presence of a turbine. Flow field surveys, overall performance, the effect of ground proximity, and the prospects for further improvement are described. The baseline configuration is a conical, 60-degree included angle diffuser with an area ratio of 2.78 controlled by two tangential injection slots. This first generation DAWT can provide about twice the power of a conventional WECS with the same turbine diameter and wind. Economic estimates show that this DAWT can be as much as 50 percent cheaper than conventional WECS for the same rated power.

(CONFIGURATION, WIND-TUNNEL TESTS)

ST78 16024 SANDIA VERTICAL-AXIS WIND TURBINE PROGRAM, Technical Quarterly Report, July-Sept. 1976

Grover, R.D., Veneruso, A.F., Eds, (Sandia Labs., Albuquerque, NM), June 1977, SAND-77-0711, EDB-77:111358

This quarterly report describes the activities of the Sandia Laboratories' Vertical-Axis Wind Turbine (VAWT) Project during the period July to September 1976, transitional quarter of Fiscal Year 1976. Included are the highlights of the quarter-review of the status of general design efforts in the areas of aerodynamics, structures, and testing.

(AERODYNAMICS, DARRIEUS, TEST)

ST78 16025 EXAMINATION OF SMALL WIND-ELECTRIC SYSTEMS IN MICHIGAN

Haack, B.N., (Univ. of Michigan, Ann Arbor, MI), 1977, University Microfilms Order no. 77-18,014, EDB-77:144889

This study examines the use of small wind-powered generators for supplying electricity to individual households in Michigan. The primary interests in this study were to: (1) gain a better understanding of the performance of a small wind system under typical conditions, (2) determine how that performance is influenced by component variations in the technological, consumptive, and meteorological subsystems, and (3) explore several methods for evaluating these systems including an economic evaluation, an energy analysis, and an assessment of relative environmental impacts. A computer-operated simulation model of a small wind electric system was constructed for use as the basic methodological tool in this study. Components included in this model were wind speed observations collected at

Michigan first-order meteorological stations, residential electrical consumption data from sampled Michigan households, and characteristics of commercially available and develop developmental equipment, including aerogenerators, storage devices, and electrical inverters.

(COMPUTER-SIMULATION, ECONOMICS, ENVIRONMENTAL-IMPACTS, NET-ENERGY, ON-SITE RESIDENTIAL)

ST78 16026 NUMERICAL AND MEASUREMENT METHODS OF WIND ENERGY ASSESSMENT

Hardy, D.M., (California Univ., Livermore, CA), Aug. 1977, UCRL-79896(Rev. 1), EDB-77:144888

The Lawrence Livermore Laboratory (LLL) is engaged in a quantitative study of wind energy, its magnitude and its variations, as a part of the Federal Wind Energy Program. Attention is given to hilly or mountainous regions, where terrain strongly effects the near-surface air-flow. Many parts of the nation can be classed as mountainous, including the Pacific Coast, Rocky Mountain, and New England regions. Complex terrain results in dramatic increases or decreases in wind speed that make wind energy assessment in these areas especially difficult. The complete methodology is systematic and should prove useful in all mountainous regions in providing a cost-effective documentation of the wind resource.

(MATH MODELS, MONITORING, MOUNTAINOUS-REGIONS)

ST78 16027 WIND STUDIES IN COMPLEX TERRAIN

Hardy, D.M., (California Univ., Livermore, CA), May 1977, UCRL-79430, EDB-77:111368

The development and application of general methods of wind energy assessment for hilly or mountainous areas is described. The island of Oahu, Hawaii is being used as an initial study area to develop procedures useful there and in other mountainous regions. Numerical model calculations and field measurements are employed in studying the spatial and temporal variations of wind energy. Field measurement and model results show very significant wind energy spatial variations occur as a result of complex terrain. Applications of the methodology in identifying locations of wind enhancement with multi-megawatt power collection potential are described.

(MONITORING, MOUNTAINOUS-AREAS, NUMERICAL MODEL, TOPOGRAPHY)

ST78 16028 AN ASSESSMENT OF WIND-POWERED GENERATORS FOR NAVIGATIONAL AIDS

Herrera, G., Weiner, H., (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), Nelson, D., (US Coast Guard, Washington, D.C.), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1660-1667, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, MIPR-Z-70099-5-50352, A77-48900, A77-48701 23-44

No abstract available

(BATTERIES, ECONOMICS, SOLAR CELLS)

ST78 16029 PRELIMINARY ASSESSMENT OF THE POTENTIAL FOR MEDIUM AND LARGE CAPACITY WIND GENERATORS USED AS FUEL SAVERS FOR AC DIESEL-BASED POWER SYSTEMS IN ONTARIO

Higgin, R.M.R., Brown, C.K., (Ontario Ministry of Energy, Toronto, Canada), Sharing the Sun: Solar Technology in the Seventies, V 7:15 pages, 1976, Ed: Boer, K.W., American Section of the International Solar Energy Society, Cape Canaveral, FL, EDB-77:111346, A77-49085

preliminary analyses have been made of the potential of wind generators as fuel savers for diesel-based power systems in Northern Ontario, In both the low-power case (less than 10 KW) and high-power case (greater than 100 KW) the criteria for competitive operation of a wind-diesel hybrid power system appears to be greater than 12.5 mph mean annual wind speeds and diesel fuel costs of greater than $1.00 per gallon. A number of telecommunications and community power sites in Northern Ontario meet these criteria so that a "proof of concept" experiment is planned to validate the assumptions used in the analyses, and to develop the coupling and control systems for wind-diesel systems.

(CANADA, CONTROL-SYSTEMS, ECONOMICS, WIND-DIESEL)

ST78 16030 WIND POWER: PIPE DREAM OR REALITY

Hirschfeld, F., Mechanical Engineering, V 99:20-28, Sept. 1977, A77-48503

It has been estimated that the power which is potentially attainable from the surface winds over the US is more than 30 times the probably total power consumption of the US by 1980. However, attempts to utilize this resource for power-generation applications in the past have generally not been economically successful. In connection with the energy

crisis, the federal government has undertaken a program for the development of economical wind systems capable of providing up to 30 years of reliable, automatic, relatively maintenance-free service. The program includes plans for the development of a 1.5-MW horizontal-axis propeller-type experimental wind turbine generator with a composite rotor 61 m in diameter. Attention is given to an experimental 100-KW unit, a review of prominent wind-power projects in the first half of the 20th century, the development and promotion of wind systems for farm and rural use, and questions of economic viability.

(BLADES, ECONOMIC, FEASIBILITY-ANALYSIS, HORIZONTAL-AXIS, RURAL-USE)

ST78 16031 REGULATION, STORAGE, AND CONVERSION OF WIND-PRODUCED ELECTRICAL ENERGY AT THE LEVEL OF A FEW HUNDRED WATTS

Hirst, P., Rees, D.H., (Marinair Radar Ltd.), Energy Dig., London, England, V 5:7-9, N6, Dec. 1976, EDB-77:118395

The article is an excerpted paper from an international symposium, "Wind Energy Systems," held at St. John's College, Cambridge, England. The wind turbine assumed is one of the vertical-axis type coupled through a gearbox to a permanent magnet alternator. By reducing magnetic "cogging" in the alternator and mechanical friction as much as possible, the system will rotate at very low wind speeds with the alternator unloaded. The battery charger will accept, over a 10:1 range, whatever voltage the alternator produces, and will load the alternator with a current determined to be a pre-programmed function of alternator voltage. In this way the wind turbine may be operated near optimum efficiency over a considerable range of wind speed. On rising wind speed the alternator voltage rises until a selected level is reached. A simple voltage-sensing arrangement provides a signal and power to a linear force motor to release the friction brake on the epicyclic gearbox. This permits the annulus to rotate and limits the speed and torque of the alternator rotor. For powering many commercial pieces of equipment, an AC supply is required. Producing a true sine wave is inefficient and expensive. A simple square-wave inverter may be adequate.

(CONTROL-SYSTEMS, STORAGE, SQUARE-WAVE INVERTER, VERTICAL-AXIS)

ST78 16032 OPTIMUM WIND-ENERGY CONVERSION SYSTEMS

Huetter, U., (University of Stuttgart), Annual Review of Fluid Mechanics, V 9, 1977, Ed: Van Dyke, M., Annual Reviews, Inc., Palo Alto, CA, EDB-77:125013

Information on optimum characteristics of wind turbines is presented concerning the advantages of high specific speed. Limitations for specific speed, rotor characteristics at stall state, the rotor's disc-velocity coefficient, vortex-state problems, the near-critical operating rotor (NCR), refinements simplifications, and optimum rated power.

(AERODYNAMICS, CONFIGURATION-DESIGN, MATH MODELS, BLADES)

ST78 16033 VORTEX KINETIC ENERGY CONCENTRATOR

Huq, R., Loth, J.L., (Dept. of Aerospace Eng., West Virginia Univ., Morgantown, WV), 11th Intersociety Energy Conversion Engineering Conference, State Line, NV, V 2:1773-1778, 12 refs, Sept. 12-17, 1976, American Inst. Chem. Engrs., New York, NY, American Nucl. Soc., Soc. Automotive Engrs., et.al.

The paper describes the aerodynamic performance of a non-rotating vortex kinetic energy concentrator and a vertical high-lift finite wing which is oriented into the wind. As the wing develops lift, the trailing vortex sheet rolls up to form a single vortex of significant strength. The azimuthal motion in this vortex provides the core with concentrated rotational kinetic energy which can be harnessed by an appropriate rotor placed coaxially with the vortex core. The power harnessed per unit rotor area can be increased up to five fold, with a reduction in rotor size. The theoretical aspects of the concentrating kinetic energy in the trailing wing-tip vortex behind a high-lift wing are reported with specific design criteria. The energy concentration rate for various rotor sizes and wing-loading characteristics has been computed.

(BLADES, AERODYNAMICS, DIFFUSER-DESIGN)

ST78 16034 STATUS OF WIND-ENERGY CONVERSION SYSTEMS (WECS) FOR ELECTRIC UTILITY POWER GENERATION

Johanson, E.E., (JBF Scientific Corp., Wilmington, MA), Trans. Am. Nucl. Soc., V 26:2, June 1977, EDB-77:125006

No abstract available

(ECONOMICS, RESEARCH-PROGRAMS)

ST78 16035 WIND-ENERGY STATISTICS FOR LARGE ARRAYS OF WIND TURBINES, Annual Progress Report, May 1-Dec. 31, 1976

Justus, C.G., Hargraves, W.R., (Georgia Inst. of Tech., Atlanta, GA), Jan. 1977, RLO-2439-77-1, EDB-77:118385

In a manner similar to the analysis of arrays of wind turbines in New England and the central US (ERDA-NSF-00547-76-1), array analyses are being done for the Great Lakes area, and for the Pacific Coast. In addition to the types of data computed for the New England and central US arrays (time autocorrelations, spatial cross-correlations, mean wind turbine power by season, output power probability distributions, and speed and power-run time probabilities), additional analyses of wind speed and power by time of day and wind speed versus heating or cooling degree days are also being done. Also power output corrections for density mean wind speed gusts, RMS direction fluctuations and for vertical shear are being incorporated, as described in subsequent sections of this report. As examples of the array analysis, results from the Great Lakes array for 1971 are presented.

(GREAT LAKES, GUSTS, MATH MODELS, MONITORING, STATISTICS, TIME-OF-DAY)

ST78 16036 WIND DATA COLLECTION AND ASSESSMENT

Justus, C.G., (National Climatic Center, Ashville, NC), Initial Wind Energy Data Assess Assessment Study, May 1975, Ed: Changery, M.J., PB-244132, EDB-77:137738

The wind data collection and assessment portion has as its objective to determine from the surface wind power the statistics necessary for system evaluation studies, and also to determine the height variation of these statistics since the typical wind generator system will not be located at the level of surface anemometers. The necessary wind data statistics can be characterized in terms of a two-parameter distribution function. Two choices that seemed to be doing a good job are the log-normal distribution and the Weibull distribution. Another assumption is that these statistics are sufficiently continuous so that a national map can be drawn of these wind-power statistics. The goal of this project is to come out with a map of the necessary two parameters that describe the distribution functions.

(DATA-COMPILATION, MAP, MONITORING, SITE-EVALUATION, STATISTICS)

ST78 16037 CONTROL SYSTEM FOR WIND-POWERED GENERATORS

Kroth, G.J., (Sandia Labs., Albuquerque, NM), May 1977, SAND-77-0287, EDB-77:118394

In a system of wind-powered generators, a reliable, yet inexpensive control system is desirable. Such a system would be completely automatic so it could be left unattended for long periods. It would respond to electrical representations of data such as bearing temperature, vibration, wind velocity, turbine velocity, torque, or any other pertinent data. It would respond by starting or stopping the turbine, controlling the loading, or sounding an alarm. A microprocessor-based controller capable of these functions is described.

(COMPUTERS, CONTROL-SYSTEM, MICROPROCESSOR)

ST78 16038 EXPERIMENTAL DATA AND THEORETICAL ANALYSIS OF AN OPERATING 100-KW WIND TURBINE

Linscott, B.S., Glasgow, J., (NASA, Lewis, Cleveland, OH), Anderson, W.D., Donham, R.E., (Lockheed California Co., Burbank, CA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1633-1650, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, NAS3-20036, A77-48898, A77-48701 23-44

Part of the cooperative effort between NASA and ERDA has been the design and the erection of an experimental wind turbine by the NASA-Lewis Research Center. This 100-KW turbine, designated the MOD-O, is located at the NASA Plum Brook Site near Sandusky, Ohio. Experimental test data have been correlated with analyses of turbine loads and complete system behavior of the 100-KW MOD-O wind turbine generator over a broad range of steady state conditions, as well as during transient conditions. The deficit in the ambient wind field due to the upwind tower turbine support structure was found to be very significant in exciting higher harmonic loads associated with the flapping response of the blade in bending.

(AERODYNAMIC-LOADS, BLADES, DYNAMIC-STRESS, HORIZONTAL-AXIS)

ST78 16039 THE APPLICATION OF WIND POWER SYSTEMS TO THE MINNESOTA POWER AND LIGHT COMPANY

Malver, F.S., (Honeywell, Inc., Minneapolis, MN), Overom, L.D., (Minnesota Power and Light Co., Duluth, MN), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 7:289-303, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, E(11-1)-2619, EDB-77:111350, A77-49092, A77-48910 23-44

A Honeywell study was conducted to assess current wind energy conversion system (WECS) viability for a utility application and to define the attributes and performance requirements of a system capable of yielding a satisfactory return on investment to a utility company. Minnesota Power and Light Company has served as the case study subject utility. An initial system definition based on available wind information and near-term wind turbine generator technology is given. A WECS simulation to convert wind data to wind energy available to the utility's grid was developed along with simulations for evaluating baseline wind turbine generators and an advanced technology wind turbine.

(COMPUTERIZED SIMULATION, ECONOMICS, FEASIBILITY-ANALYSIS, UTILITIES)

ST78 16040 OPTIMIZATION AND CHARACTERISTICS OF A SAILWING WINDMILL ROTOR, Final Report, Feb. 1, 1975-Jan. 31, 1976

Maughmer, M.D., (Princeton University, Princeton, NJ), (ERDA, Washington, D.C.), 86 pages, NSF-RANN-GI-41891-FR-75-4, NSF-GI-41891, N77-33652

A detailed accounting of the development and operational techniques of the Princeton Moving Vehicle Windmill Testing Facility is presented. Also presented is a complete documentation of the performance build-up of a 12-foot diameter, two-bladed sailwing rotor. An examination of an exploratory research effort directed toward using a small, first-stage, co-axial rotor to augment windmill performance is included. Finally considered are 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.

(AERODYNAMICS, OPTIMIZATION, WIND-TUNNEL TESTS)

ST78 16041 SOME LEGAL-INSTITUTIONAL IMPLICATIONS OF OFFSHORE WIND ENERGY CONVERSION SYSTEMS

Mayo, L.H., (George Washington University, Washington, D.C.), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 7: 195-214, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:111349, A77-49086, A77-48910 23-44

Wind energy conversion systems (WECS) are being given systematic attention in the US, although the effort to date is still in a relatively preliminary stage. Studies underway or proposed are expected to provide needed data concerning technological practicability, economic competitiveness, and socio-political acceptability of wind WECS configurations. Offshore WECS present unique problems, particularly of a legal-institutional nature, including potentially conflicting national-international and federal-state jurisdictional claims, competing sea area uses, land use management, utility policy and regulation, and incentives to utilize innovational energy technologies. The existing array of federal energy statutes appears to provide an adequate legal framework for vigorous research, development, and demonstration programs. But it may become advisable to enact specific legislation to eliminate or ameliorate certain constraints on the implementation of offshore WECS if significant private sector participation is to be encouraged.

(ECONOMIC, ENERGY-POLICY, INTERNATIONAL LAW, LEGISLATION, SOCIO-POLITICAL)

ST78 16042 WIND ENERGY: LARGE AND SMALL SYSTEMS COMPETING

Metz, W.D., Science, V 197:971-973, Sept. 2, 1977, A77-48267

Windpower, which is available on an annual basis in amounts comparable to the average energy flux of sunlight in many areas, offers one of the most inexpensive means of producing energy. The possibilities are investigated for utilizing features available in many windy regions, such as hydroelectric systems, capable of producing energy storage by holding back water while the wind is blowing, and underground gas formations, suitable for compressed air storage. Possible interference with television reception constitutes one of the major objections to wind installations, as television's synchronization speed, 30 cycles per second, is near the rotation speed of large wind systems. The use of fiberglass glades is suggested as a partial remedy for the problem. Several existing wind machine programs are discussed with regard to construction, cost evaluation, effectiveness, and storage capacities. It is concluded that both large and small wind systems have the potential to compete with conventional electric systems.

(ECONOMIC, FIBERGLASS BLADES, STORAGE)

ST78 16043 ROTOR FOR WIND-DRIVEN MACHINE

Moran, K.E., May 24, 1977, US Patent no. 4,025,233, EDB-77:125009

In the rotor of a windmill electric generator, blades are secured to a hub by means of individual tab-receiving slots and a common "knock-off" hubcap, this mounting means providing for rapid assembly and disassembly. The mounting structure itself establishes a predetermined pitch at the blade root, thus permitting the advantages of an optimum twisted blade to be obtained without the need for an excessively complex blade configuration. The result is a compace generator unit that can be used easily in remote areas and stowed with camping equipment.

(BLADES, CONFIGURATION, ON-SITE, PATENT)

ST78 16044 EXACT 60-CYCLE POWER GENERATION AT ANY SPEED, FOR WINDMILL APPLICATIONS

Morash, R.T., (Precise Power Corp., Bradenton, FL), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:498-504, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48759, A77-48701 23-44

A new electrical power generator produces any exact frequency, at any shaft rpm. The speed can vary over a wide range without affecting the output frequency or voltage. This capability has been developed on operating units for precise frequency converters and flywheel energy storage units in uninterruptable power systems. Other useful applications are 60-cycle power directly from a varying speed windmill shaft; auxiliary power take-off from a mobile unit variable speed prime mover; up-rating diesel-generator sets by allowing the diesel to run at optimum design speeds; energy conservation in on-site or small power systems by using variable speed to match load requirement; precise power for portable or remote locations such as geodetic survey work or video applications; unusual frequency requirements; and simple parallel operation of numerous generators producing identical frequency. A typical unit is described. Units from kilowatt to megawatt sizes can be built.

(FLYWHEEL, FREQUENCY-STABILITY, AC-GENERATORS, STORAGE, VOLTAGE-REGULATORS)

ST78 16045 VARIABLE GEOMETRY VERTICAL AXIS WINDMILL

Musgrove, P.J., (Reading Univ., London, England), Energy Dig., London, England, V 5:10-11, N6, Dec. 1976, EDB-77:131214

The article is an excerpted paper from an international symposium, "Wind Energy Systems," held at St. John's College, Cambridge, England. The VGVAW operates aerodynamically in exactly the same way as the Darrieus windmill, but has straight blades attached to a horizontal cross-arm. If the blades are rigidly attached to the cross-arm, bending stresses in high wind speeds become excessive, and cross-bracing between the blades, though possible, is impractical. In the VGVAW excessive blade stresses are avoided by attaching the blades to the cross-arm via a hinge. At low rotational speeds, corresponding to low wind speeds, the blades are kept in the upright position, against hinge stops, by tension in the tie-wires. These tie-wires, attached to the upper part of each blade, are connected to a single vertical extension spring housed within the inner, tubular, windmill drive shaft. Typically the springrate and pre-tension are adjusted so that when the wind speed is less than about five m/s the moment about the hinge, due to the tie-wire tension, exceeds the moment about the hinge due to blade centrifugal forces. Up to this speed, which is approximately the annual average wind speed over the ulk., the blades therefore remain upright and give maximum aerodynamic efficiency. When the wind speed increases, the rotational speed of the windmill also increases, and the resulting increased centrifugal forces make the blades incline outwards. The prototype VGVAW, has a diameter of three m and two blades, each two m long, and is supported on a five m high, 10 cm diameter guyed steel tower.

(BLADES, DARRIEUS, TEST)

ST78 16046 ANALYSIS OF THE WIND-DRIVEN RECIPROCATOR

Nassar, E.M., (Illinois Inst. of Tech., Chicago, IL), Energy LA: Tackling the Crisis, 1976, Ed: Robinson, J.W., Western Periodicals Company, North Hollywood, CA, EDB-77:137756

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.

(AERODYNAMICS, AIRFOILS, CONFIGURATION)

ST78 16047 SURVEY OF WIND MEASUREMENT FIELD PROGRAMS

Orgill, M.M., (Battelle Pacific Northwest Labs., Richland, WA), 162 refs, May 1977, BNWL-WIND-3, EDB-77:144894

One of the objectives of the Wind Characteristics Program Element (WCPE) is to identify and catalog existing meteorological data sets which might be used for model validation and for other wind energy conversion systems (WECS) studies. A subtask of this program of identifying meteorological data sets is the identification and cataloging of field programs that have used extensive wind measuring metworks. Field programs with mesoscale wind networks are identified with data sets that might be suitable for site localization techniques.

(COMPUTER-PROGRAMS, DATA-ANALYSIS, SITE-SELECTION, STATISTICAL MODELS)

ST78 16048 AEOLIAN WINDMILL

Payne, P.R., May 17, 1977, US Patent no. 4,024,409, EDB-77:125010
A system is disclosed which utilizes a member which oscillates in response to movement of a fluid past it and a means for utilizing the energy generated by the oscillation. In one embodiment the oscillating member is a cable utilizing wind or water as generator or pump. In a second embodiment the oscillating member is an airfoil having either pitch control or active circulation control.

(CONFIGURATION, OSCILLATING AIRFOIL, PATENT, WIND)

ST78 16049 WIND-ELECTRIC CONVERSION UTILIZING FIELD-MODULATED GENERATOR SYSTEMS

Ramakumar, R., (Oklahoma State University, Stillwater, OK), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 7:215-225, 23 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, ERDA-supported research, EDB-77:111365, A77-49087, A77-48910 23-44
Variable-speed constant-frequency wind-electric systems operate at a constant tip speed ratio with varying wind speeds and enable the extraction of a part of the energy spilled by constant-speed constant-frequency systems. This paper describes the variable-speed constant-frequency wind-driven field modulated generator system under development at Oklahoma State University, sponsored by ERDA-NSF. Proposed control schemes and the experimental research program underway are briefly discussed. These systems appear to be most attractive in the "small" (10 to 50 KW) and "100-KW scale" (50 to 250 KW) sizes and for use in large-capacity "multirotor on one tower" concepts.

(CONSTANT-FREQUENCY, VARIABLE-SPEED, 10 TO 50 KW)

ST78 16050 SEMI-ANNUAL REPORT OF THE WIND CHARACTERISTICS PROGRAM ELEMENT, April-December 1976

Ramsdell, J.V., (Battelle Pacific Northwest Labs., Richland, WA), Jan. 1977, BNWL-WIND-2, EDB-77:144393
The Wind Characteristics Program Element (WCPE) provides wind information, through the Wind Energy Conversion Program (WECP), for those involved in energy program planning, design and evaluation of performance of wind energy conversion systems (WECS), selection of sites for WECS installation, and WECS operations. Currently the technical work within the WCPE is divided among four program areas. These areas are to provide wind characteristics for design and performance evaluation, site selection, resource assessment, and operations. Work is being undertaken in the first three areas.

(DATA-COMPILATION, SITE-SELECTION, STATISTICAL-MODELS)

ST78 16051 RECENT CANADIAN ACTIVITIES IN WIND POWER

Rangi, R.S., (National Research Council, Ottawa, Canada), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 1:110-118, 10 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:118389, A77-48916, A77-48910 23-44
Canadian research and industrial projects involving vertical-axis wind turbines (VAWT) are reviewed. The design of the Magdalen Islands 200-KW VAWT intended to commence operation in October 1976 is examined with attention to test models, planned uses, and expected annual output. The uses of wind power for water supply and as a power source for agricultural equipment in developing countries is considered briefly. The VAWT installed on permanent pack ice in the Beaufort Sea is described, and two sizes of commercially available VAWT are indicated.

(CANADA, TEST MODELS, UTILITIES, VERTICAL-AXIS)

ST78 16052 NEW DETAILS ON WIND POWER CLIMATOLOGY

Reed, J.W., (Sandia Labs., Albuquerque, NM), 1977, SAND-77-0696C, EDB-77:125001
The National Isodyn Map of average available wind power was used to help select fifteen stations, representative of interesting wind power climatic regimes, for detailed analyses of ten-year records of hourly wind speed observations. These long time series have been corrected for observer bias, homogenized to constant anemometer exposures, and extrapolated to select heights 10 m, 20 m, and 50 m above flat terrain. Various analyses have shown that correction generally gave results in excellent agreement with the National Isodyn contours, turbine cut-in and cut-off speed selections were not critical to power recovery efficiency, turbine rated speed needs to be tailored to the regional wind climate, stand-alone systems require huge storage filters to smooth annual and inter-annual variations in supply, and modest storage will effectively filter periodicities of a few days in both supply and demand.

(ANNUAL-VARIATIONS, FLAT-TERRAIN, SITE-SELECTION, STORAGE)

ST78 16053 METEOROLOGICAL STUDIES FOR WIND POWER: A Progress Report

Reed, J.W., (Sandia Labs., Albuquerque, NM), Aug. 5, 1977, SAND-77-1255C, EDB-77:137739
Ten-year time series of hourly wind speed observations at fifteen selected stations have been used to generate time series of available wind power. These have been run through computer-simulated turbine systems to study long-term, particularly annual and longer, variations in potential supply. These variations were so large that stand-alone generating systems would require huge, uneconomical storage capacities to provide reliable service. There appeared to be a minimum in wind power cost as a function of storage capacity with a few KWHR/m_2 capacity, and this value was applicable at almost every location studied.

(COMPUTER-SIMULATED, ECONOMICS, METEOROLOGY, MONITORING, SITE-SELECTION, STORAGE)

ST78 16054 ENERGY STORAGE NEEDS FOR WIND POWER SYSTEMS

Reed, J.W., (Sandia Labs., Albuquerque, NM), 1977, SAND-76-9058, EDB-77:118393
Wind varies on all time scales, but hourly and longer term oscillations are most important to economical wind energy extraction schemes. Periodic variations in available wind energy, of diurnal, synoptic, annual, and larger scales, are not often correlated with demand so that some form of energy storage is needed. Most current ERDA-sponsored research in wind energy assumes connection to an existing power network and resource storage in the form of saved fossil fuels. Long-term hourly wind observations at several representative US locations have been used to show that a totally independent and perfectly reliable wind energy system would require an impractically large storage capacity, primarily to cover year-to-year and annual cycles of available wind energy. As reliability is allowed to decrease, a considerable reduction in storage capacity is possible. This is demonstrated by statistical results for several climatic regimes.

(ANNUAL, DIURNAL, ECONOMICS, OPTIMIZATION, STORAGE, SYNOPTIC)

ST78 16055 ESTIMATION OF WINDS OVER THE GREAT LAKES

Resio, D.T., Vincent, C.L., (Army Engineer Waterways Experiment Station, Vicksburg, MS), Journal of the Waterway, Port, Coastal, and Ocean Division, Proceedings Paper 12951, V 103:265-283, NWW2, 30 refs, Fig. 13, Append. 1, May 1977, W77-09022
Past efforts to estimate wind speeds over a large lake have met with very limited success. The purpose of this study was to demonstrate that, with a combined theoretical-empirical approach, winds over a lake can be obtained from transformed wind speeds at nearby land stations. The theoretical results provided a basis for comparison of many empirical data sets and established a rational means of analyzing the expected differences between winds over land and winds over a marine surface, which, in turn, afforded a means of examining systematic variations in the ratio of wind speeds over a lake to wind speeds over land. The good agreement between theory and observation indicated that wind estimates over the lake could be made for a wide range of synoptic conditions with an rms error of five knots. The theoretical curve for the lake wind-land wind ratio provided an estimat of lake winds well beyond wind speeds for which there were good empirical data.

(GEOSTROPHIC WIND, MATH MODELS, NUMERICAL-ANALYSIS)

ST78 16056 SANDIA VERTICAL-AXIS WIND TURBINE PROJECT, Technical Quarterly Report, April 1-June 30, 1976

Reuter, R.C.Jr., Sheldahl, R.E., (Sandia Labs., Albuquerque, NM), SAND-76-0581, E(29-1)-789, N77-29613
Avail:NTIS
Highlights for the quarter and status reports on activities in areas of systems studies aerodynamics, electrical systems, structures, and mechanical design are presented. Subheadings in each section cover general development activities and activities related to the 17-meter turbine and the 5-meter turbine.

(AERODYNAMICS, STRUCTURAL-DESIGN)

ST78 16057 VORTEX AUGMENTOR CONCEPTS FOR WIND ENERGY CONVERSION

Sforza, P.M., (Polytechnic Inst. of New York, Brooklyn, NY), (NSF, Washington, D.C.), (RANN), 65 pages, Jan. 1976, Progress rept. May-Nov. 1975, NSF-AER75-00850, NSF-RA-760423, PB-263 749-4ST
A progress report on research, design, and development of aerodynamic devices which can concentrate and augment natural winds is presented. The keystone element here is the generation and control of discrete vortices of high kinetic energy density by the appropriate interaction of suitably designed aerodynamic surfaces with natural winds of low kinetic energy density. Properly designed turbines would be utilized to transform the energy in this compacted field to useful shaft work. This idea is termed the Vortex Augmentor Concept (VAC). Two major goals are described: (1)Evaluation and assessment of

the VAC for wind energy conversion applications; and (2)Construction and operation of a small-scale outdoor test model. Each task objective is reviewed so that a description of progress to date as well as anticipated activities for the remainder of the program is presented.

(AERODYNAMIC, MODEL TESTS)

ST78 16058 ENERGY CONTENT OF WINDS IN THE HIGH PLAINS REGION OF SOUTHWESTERN US

Sittler, O.D., (Eastern New Mexico University, Portales, NM), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 7:243-252, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:111347, A77-49089, A77-48910 23-44

Winds at Portales, New Mexico are being studied to assess the amount of wind energy available and its distribution in time. The analysis includes the effect of short-term variations in wind speed, or gusts, in the calculation of total energy content. Data collected between November, 1975, and April, 1976, indicate that average wind speed exceeds 4.5 m/s for 9.6 hrs/day on the average. During these hours, the average energy flux per day is about 2.2 kwhr per m^2. Sequences of four or five days having energy flux less than 1.0 KWHR per m^2 seldom occur; thus, wind could supply energy in this region on a regular basis with the help of energy storage or through procedures which match energy demand to times when wind energy is available.

(NEW-MEXICO, SITE-EVALUATION)

ST78 16059 LARGE WINDPOWER SYSTEMS INTEGRATED WITH EXISTING ELECTRIC UTILITIES

Smith, R.T., Swanson, R.K., Johnson, C.C., (Southwest Research Institute, San Antonio, TX), Ligon, C., (Southwestern Public Service Co., Amarillo, TX), Lawrence, J., Jordan, D., (Texas Tech University, Lubbock, TX), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 7:317-327, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:111351, A77-49094, A77-48910 23-44

This paper reports a study of the feasibility of the use of wind turbine generators as supplemental energy sources on an existing electric utility network. The time frame is the period of the next two decades. Specifically, the study is centered upon the geographical region served by Southwestern Public Service Company, an investor-owned utility with present capacity of approximately 2200 Mw. It includes the panhandles of Texas and Oklahoma, parts of Eastern New Mexico, and some communities in Southwestern Kansas. Of prime importance, this region exhibits the highest wind energy potential of any area of comparable size in the continental United States.

(KANSAS, NOMOGRAPHS, OKLAHOMA, NEW-MEXICO, STORAGE, TEXAS)

ST78 16060 DYNAMIC BLADE-LOADING IN THE ERDA-NASA 100-KW AND 200-KW WIND TURBINES

Spera, D.A., Janetzke, D.C., Richards, T.R., (NASA, Lewis, Cleveland, OH), NASA-TM-73711, Presented at the Nat'l Conf. of the Am. Wind Energy Assoc., Boulder, CO, May 11-14, 1977, ERDA-NASA-1004-77-2 E-9242, E(49-26)-1004, N77-30599
Avail:NTIS

Dynamic blade loads, including aerodynamic, gravitational, and inertial effects, are presented for two large horizontal-axis wind turbines: the ERDA-NASA 100-KW MOD-O and 200-KW MOD-OA wind power systems. Calculated and measured loads are compared for an experimental MOD-O machine in operation. Predicted blade loads are also given for the higher power MOD-OA wind turbine now being assembled for operation as part of a municipal power plant. Two major structural modifications have been made to the MOD-O wind turbine for the purpose of reducing blade loads. A stairway within the truss tower was removed to reduce the impulsive aerodynamic loading caused by the tower wake on the downwind rotor blades. Also, the torsional stiffness of the yaw drive mechanism connecting the turbine nacelle to the tower was doubled to reduce rotor-tower interaction loads. Measured reductions in load obtained by means of these two modifications equalled or exceeded predictions.

(AERODYNAMIC-LOADS, GRAVITATIONAL-EFFECTS, VIBRATIONAL-STRESS)

ST78 16061 WINDMILL OPTIMIZATION

Stickney, G.H., (Univ. of Missouri, Columbia, MO), Energy LA: Tackling the Crisis, 17 refs, 1976, Ed: Robinson, J.W., Western Periodicals Company, North Hollywood, CA, EDB-77:137754

This paper treats the development and statement of the windmill law. It also shows the derivation of the equation for the power surface relating the wind velocity, power, and angular velocity of the rotor. It is an application of basic fundamentals and yields several insights regarding the phenomena encountered in wind power applications.

(BASIC-FUNDAMENTALS, BLADES, MATH MODELS, OPTIMIZATION)

ST78 16062 SELECTION OF TOWER HEIGHT FOR A WIND-DRIVEN PLANT

Stodhart, A.H., (National Climatic Center, Ashville, NC), Initial Wind Energy Data Assessment Study, May 1975, ED: Changery, M.J., PB-244132, EDB-77:137750

Many statements have been made from time to time concerning the value of increasing tower height above that required to give adequate ground clearance to the rotor of an aerogenerator. This minimum ground clearance is usually reckoned to be around 10 meters, because of the increased relative effect of ground-induced turbulence below this level, the undoubted reduction in mean wind speed, even on the most favorable sites, near to ground level, and, in the extreme case, the safety element. It is not merely a question of improvement in wind regimes that is to be sought but also an improvement in the operating conditions for the wind rotor itself. The problem of optimum tower height is discussed.

(GROUND-INDUCED TURBULENCE, MECHANICAL STRUCTURES, OPTIMUM TOWER-HEIGHT)

ST78 16063 DRIVE TRAIN NORMAL MODES ANALYSIS FOR THE ERDA-NASA 100-KILOWATT WIND TURBINE GENERATOR

Sullivan, T.L., Miller, D.R., Spera, D.A., NASA, Lewis, Cleveland, OH), NASA-TM-73718 E-9266, ERDA-NASA-1028-77-1, E(49-26)-1028, N77-30611

Natural frequencies, as a function of power, were determined using a finite element model. Operating conditions investigated were operation with a resistive electrical load and operation synchronized to an electrical utility grid. The influence of certain drive train components on frequencies and mode shapes is shown. An approximate method for obtaining drive train natural frequencies is presented.

(FINITE-ELEMENT-METHOD, MATH MODEL, RESONANT-FREQUENCIES)

ST78 16064 SAILWING WINDMILL CHARACTERISTICS AND RELATED TOPICS, Quarterly Progress Report, 4th, Oct. 1-Dec. 31, 1974

Sweeney, T.E., Nixon, W.B., Maughmer, M.D., Blaha, R., (Princeton Univ., Princeton, NJ), March 1975, PB-265828, EDB-77:118390

The method of experimentally determining the performance of large-scale windmill models mounted on a moving vehicle is discussed. As a result of the wind tunnel experiments, analysis, and the large-scale vehicle work, an optimization of a particular rotor is described, as are the results of blade twist experiments as a method of rpm control. Because the wind tunnel models were necessarily small-scale, rigid rotor blades were used. However, the large-scale rotors tested and reported upon were of the Princeton sailwing type. By means of dimensional analysis and by experiments, the significant tension coefficient for the trailing edge cable of the sailwing rotor was determined and evaluated. This tension coefficient enables the design of such a rotor to be such that the luffing threshold can be avoided for any given set of conditions.

(SAILWING-ROTOR, TEST, WIND-TUNNEL)

ST78 16065 TEMPERATURE CONTROL SYSTEM UTILIZING NATURALLY OCCURRING ENERGY SOURCES

Tompkins, L.L., April 5, 1977, US Patent no. 4,015,962, EDB-77:125007

A temperature control system for an enclosed structure is disclosed which utilizes two circuits, one for heating and one for cooling the structure. The system makes maximum use of naturally occurring sources of energy, such as wind and solar heat, to provide the requisite heating or cooling. Wind-driven compressors, one in each circuit, provide the motive force for the heating and cooling fluid in the closed-loop circuits. The cooling circuit transfers heat to the heating circuit to minimize unutilized energy. A storage unit is provided to store heat or low-temperature fluid when heating or cooling of the structure is not immediately required.

(COOLING, HEATING)

ST78 16066 MODERN RESEARCH IN THE FIELD OF WIND ENERGY

Van Holten, T., (Dept. of Aerospace Eng., Delft Tech. Univ., Delft, Netherlands), Ingenieur, Netherlands, V 89:129-136, N7, 8 refs, Feb. 17, 1977, In Dutch

Problems for study include windmill technology, meteorological questions, and the coupling to the electricity network of a fluctuating energy source. An historical survey from CIRCA 1900 is followed by a discussion of the potential contribution of wind energy in the light of recent investigations.

(NETHERLANDS, RESEARCH-PROGRAMS)

ST78 16067 WIND ENERGY POTENTIAL IN THE COASTAL AREAS OF LOUISIANA

Whitehurst, C.A., Sarco, B., Blanchard, W.A., (Louisiana State Univ., Baton Rouge, LA), LA Eng., p. 6-9, Dec. 1976, EDB-77:111348

Wind-power data for various sites along the Louisiana Gulf Coast are presented. The feasibility of using current design wind turbines for electric power generation at these sites is discussed.

(ECONOMICS, FEASIBILITY-STUDIES, GULF-OF-MEXICO, SITE-SELECTION, WIND-POWER-DATA)

ST78 16068 WIND POWER PLANT

Wieduwilt, G., Aug. 26, 1976, Patent no. 2,505,954/A, In German, EDB-77:111363

The wind power plant described in this invention consists of a vertical rotor with a horizontal and traversa to wind direction running shaft, with circular impeller shovels. Extra guide shovels provide that wind cannot have a hindering affect on the impeller shovels at any position. In addition, a wind detour canal is provided. This has the task of capturing a greater amount of wind and that of distributing the wind to the wheels so that the back side of the wheels are activated also. Through channeled wind gutters the wind is eventually led to the center of the wind power plant. Additionally, the complete installation has a vertical-axis turbine. It is similarly constructed as the above described horizontal-axis turbine, but displays a substantially smaller moment of inertia, so that it is also capable of responding to smaller wind velocities.

(BLADES, CONSTRUCTION, HORIZONTAL-AXIS, VERTICAL-AXIS)

ST78 16069 AN INVESTIGATION OF PERISTALTIC PUMPING PHENOMENA WITH WIND ENERGY APPLICATIONS Ph.D. Thesis

Wilson, D.E., (Texas Univ., Austin, TX), 201 pages, N77-32586
Avail:Univ. Microfilms Order no. 77-11608

An analytical investigation of peristaltic transport by means of a transverse travelling, or bending wave imposed on the boundary of a circular cylinder is conducted to determine the efficiency of this mode of mass transport. An analytical study is made to determine what aerodynamic-force and system parameters are responsible for an unstable bending wave (galloping) in a flexible hollow circular cylinder supported at both ends and filled with a fluid.

(AERODYNAMIC-FORCE, CIRCULAR-CYLINDERS, PUMPS)

ST78 16070 EXPERIMENTAL EVALUATION OF A SOLAR/WIND-POWERED SPACE HEATING AND HOT WATER-HEATING SYSTEM IN THE PACIFIC NORTHWEST

Yamagiwa, A., (Seattle City Light, Seattle, WA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 2:1243-1249, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48849, A77-48701 23-44

No abstract available

(ECONOMIC, HEAT-PUMPS, STORAGE)

ST78 16071 VIBRATION CHARACTERISTICS OF A LARGE WIND TURBINE TOWER ON NON-RIGID FOUNDATIONS

Yee, S.T., Chang, T.Y.P., Scavuzzo, R.J., Timmerman, D.H., Fenton, J.W., (NASA, Lewis, Cleveland, OH), May 1977, EDB-77:111355, ERDA-NASA-1004-77-1

Vibration characteristics of the MOD-OA wind turbine wupported by non-rigid foundations were investigated for a range of soil rigidities. The study shows that the influence of foundation rotation on the fundamental frequency of the wind turbine is quite significant for cohesive soils or loose sand. The reduction in natural frequency can be greater than 20 percent. However, for a foundation resting on well-graded, dense granular materials or bedrock, such effect is small and the foundation can be treated as a fixed base.

(SOIL-RIGIDITIES, STRUCTURES)

ST78 16072 WIND ENERGY: A RENEWABLE ENERGY OPTION

Zimmerman, J.S., (General Electric Co., Philadelphia, PA), In NASA Marshall Space Flight Center, Proc. of the ASPE-MSFC Symp. on Eng. and Productivity gains from Space Technol., p. 33-68, N77-30276, N77030273 21-31
Avail:NTIS

Wind turbine generator research programs administered by the Energy Research and Development Administration are examined. The design and operation of turbine demonstration models are described. Wind assessments were made to determine the feasibility of using wind-generated power for various parts of the country.

(RESEARCH-PROGRAMS)

17000 BIOMASS

ST78 17000 BIOLOGICAL PRODUCTIVITY OF RENEWABLE RESOURCES USED AS INDUSTRIAL MATERIALS

Bethel, J.S., National Research Council, Washington, D.C., Committee on Renewable Resources for Industrial Materials, NSF, Washington, D.C. Div. of Policy Research and Analysis, 112 pages, 1976, GRAI7712, EDB-77:127501

The report evaluates the biological productivity of industrially owned renewable resources in terms of current yields, existing land bases, and increments to these bases that may be reasonably forecast by 1985 and 2000. The forecast divides naturally into two parts: the silvicultural product of wood; and products for industry from agriculture consisting chiefly of vegetable fibers, oil seeds, wool, animal fats, tallows, and hides. Wood is not only by far the most important renewable resource used for industrial materials, but also one whose production can be greatly increased if needed. Agricultural products include cotton and other vegetable fibers. Furthermore, there is little reason to believe that market demand will strain biological potential by 1985 or 2000. Under these conditions, long-term estimates of productivity become a mere exercise in imagination. Consideration is made of the energy requirements and environmental impacts associated with the implementation of the recommendations on these renewable resources.

(BIOMASS, ECONOMICS)

ST78 17001 REFERENCE MATERIALS SYSTEM: A SOURCE FOR RENEWABLE MATERIALS ASSESSMENT

Bethel, J.S., National Research Council, Washington, D.C., Committee on Renewable Resources for Industrial Materials, NSF, Washington, D.C. Div. of Policy Research and Analysis, 36 pages, 1976, GRAI7712, EDB-77:127502

The potential problems from changes in patterns of materials supply or use are causing concerns as the current emphasis is on mineral or nonrenewable resources. The Science and Technology Policy Office (STPO) reexamined the role of renewable resources, as the other major component of natural resources, in helping to better meet needs for materials in the future. Important factors to be taken into account in assessing the desirable balance between these different classes of resources for materials are (1) the increasing variety of technological options available for choice of material for a required performance in a given application, and (2) the increasing concern to minimize both consumption of energy and environmental impact. Strong specialization exists in forest sciences and wood products on the one hand, and agricultural sciences and associated natural materials (such as fibers and leathers) on the other. A broader view is required of the science and technology of natural products and, correspondingly, more integrated statistical information on resources, and on materials flows and use (including aspects associated with energy and the environment). The above considerations led to this analysis of renewable materials in the United States economy as a basis for identifying both the optimum use of such resources and the role of science and technology in helping overcome barriers to their use.

(BIOMASS, ECONOMIC ANALYSIS, GOVERNMENT POLICIES)

ST78 17002 SOLAR SEWAGE PLANT 75 PERCENT ENERGY SELF-SUFFICIENT

Engineering News-Record, V 197:20, N12, Sept. 1976, W77-02354

The design of a 450,000-gal/day primary and secondary waste water treatment plant that will treat waste water from 4200 residents of rural Wilton, Maine, using solar energy as an integral part of the biological treatment process is described. The sun's radiance will heat the process via solar collectors from the time waste water enters the plant through economical screw pumps until the treated effluent is passed through energy recycling heat pumps and out into a small stream. The plant's components are to be stacked and compacted to conserve heat and to allow waste water to flow in short runs, for the most part by gravity. The building is shaped to hold snow on the roof and sides for natural insulation and is located in a man-made dish so that sunlight reflecting off snow-covered hills can be used for heating. Methane gas, which is generated by the sludge digestion process will be stored in tanks for heating the building on rainy days, running an electric generator, and for use as a back-up heat source for the digesters. The projected result is a treatment plant that will supply more than 75 percent of its own energy requirements, saving roughly $4450/year in fuel and electricity costs.

(INSOLATION)

ST78 17003 AGRICULTURAL AND FORESTRY WASTES AS AN ENERGY RESOURCE

Alich, J.A.Jr., Witwer, J.G., (Stanford Research Institute, Menlo Park, CA), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 7:146-156, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, A77-49083, A77-48910 23-44

The feasibility of converting agricultural and forestry residues to energy is evaluated based on a country-by-country inventory for the counterminous United States. The impact of this energy resource on the US energy system is forecast using the SRI energy model.

(BIOMASS, ECONOMICS)

ST78 17004 ENERGY CONSERVATION AND FUEL PRODUCTION BY PROCESSING SOLID WASTES

Alter, H., (National Center for Resource Recovery, Inc., Washington, D.C.), Environ. Conserv., V4:11-19, N1, Spring 1977, EDB-77:118107

Disposal of municipal solid wastes may result in needless environmental damage and loss or degradation of land. In addition, the material and fuel resources contained in the wastes remain unused. The extents of these latter in the entire United States are estimated in the paper. New terms are introduced to aid more precise estimation than hitherto of the amount of energy which can be conserved through processing and recovering the resources in minicipal solid waste. Further, the likely rate of implementation of resource recovery in the US is predicted on the basis of a simple model which relies on the assumption that the rate of implementation is proportional to the number of plants that are or will be actually on-line. There is a great temptation to combine the rate of implementation with the sum of the energy potentially recoverable from the various sources of wastes, and to convert the answer to, for example, so many barrels of oil per day. This exercise is not technically justified. Nonetheless, the energy that is potentially recoverable from solid wastes has an arithmetic equivalence of the order of magnitude of one million barrels of oil per day (1.6×10^{9} m^3, or 158×10^{9} l) in the United States alone, and even more if a generous fraction of agricultural and crop residues could be garnered for processing. This order of magnitude, perhaps as much as substitution equivalence, should be compared with the stated US goal of conservation of two million barrels of oil per day (presumably also an arithmetic equivalence) from all sources by the end of 1977, not just from solid wastes.

(MATH MODELS)

ST78 17005 OCEAN FOOD AND ENERGY FARM PROJECT, SUBTASK NO. 6: SYSTEMS ANALYSIS, Volume 6, MARICULTURE SUBSYSTEM, Final Report

Anderson, B.N., Integrated Sciences Corp., Santa Monica, CA, July 1976, ERDA-USN-1027076-1, EDB-77:144701

A systems analysis for an ocean kelp farm and the subsequent conversion of the kelp crop to methane gas was undertaken. Possible mariculture systems which could be operated in conjunction with the kelp farm were examined. Systems for kelp bass, oysters, and salmon are defined. The analysis includes estimation of the investment and operating costs, the revenues derived, and the biological productivity of each system. Depending upon the mariculture system selected and certain economic assumptions which are described, gas costs can be reduced by 25 to 50 percent. Research required for the implementation of the mariculture is described.

(BIOMASS, ECONOMICS)

ST78 17006 CELLULOSE: FROM SOLID WASTE TO CHEMICAL RESOURCE

Andren, R.K., Nystrom, J.M., (US Army, Natick Laboratories, Natick, MA), In Energy from Solid Waste Utilization; Proceedings of the Sixth Annual NE Regional Antipollution Conf. on a New Source of Materials, Energy, and Jobs: Solid Wastes Processing, Kingston, RI, p. 333-348, July 8-9, 1975, Technomic Pub. Co., Inc., Westport, CT, 1976, A77-47219, A77-47210 22-85

The potential for using cellulosic materials as a major source of food, fuel, and chemicals is discussed. The annual 600 million tons of collectable waste biomass with cellulose as a primary chemical component may be classified into industrial wastes, agricultural wastes, and municipal refuse. Present research for the utilization of waste cellulosic materials includes fuel production, food or protein production, and cellulosic saccharification for the production of solvents, antibiotics, and enzymes. Enzymatic saccharification (which takes place at 50 to 55 C at a ph of 4.8) is suggested as a feasible method for converting a renewable organic chemical resource into products such as ethanol and chemical feed stocks. This process is described with regard to the production of cellulase enzymes, the hydrolysis of cellulose, and the treatment of recoverable resources such as lignin.

(BIOMASS)

ST78 17007 FUELS AND CHEMICALS FROM THE SUN THROUGH BIOCONVERSION

Bogan, R.H., (Washington Univ., Seattle, WA), In Sharing the Sun: Solar Technology in the Seventies; Proc. of the Joint Conf., Winnipeg, Canada, V 7:2-6, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:111237, A77-49076, A77048910 23-44

Bioconversion solar energy technology promises to provide the basis for major renewable fuel supplies in the future. Utilizing plant biomass materials as an energy feedstock, this technology is expected to supply the US with up to 15 quads of energy in the form of fuels and industrial chemicals by the year 2020. Comparable global supplies appear feasible. Agricultural and forest residues are the most promising near-term energy resources. Terrestrial and marine energy farming systems are expected to become the dominant sources of biomass energy feedstocks after the year 2000.

(BIOMASS)

ST78 17008 INDIRECT ENERGY SAVINGS GENERATED BY URBAN REFUSE RECOVERY

Broussaud, A., (Bureau de Recherches Geologiques et Minieres, France), Proc. of the Fifth Mineral Utilization Symposium, IIT Research Inst., Chicago, IL, 1976, Ed: Alesnin, E., EDB-77:113161

Recovery of values from municipal waste has made rapid progress in the past few years. It is not only a way to save raw materials, it also provides means for conserving energy. A method is described for calculating the amount of energy in all forms saved in the application of the incinerated municipal waste recovery process developed by the Bureau de Recherches Geologiques et Minieres. It is shown that more than 1.5 million BTU can be saved per ton of incinerated residue and that those energy savings concern primarily fossil fuels but do not imply a reduction in electrical energy consumption.

(FRANCE)

ST78 17009 PHOTO-OXIDATION OF N-HEXADECANE SENSITIZED BY XANTHONE

Gesser, H.D., Wildman, T.A., Tewari, Y.B., (Univ. of Manitoba, Winnipeg, Canada), Environ. Sci. Technol., V 11:605-608, N6, 15 refs, June 1977

The photosensitized oxidation of hexadecane on water is studied as a model system for the solar dissipation of oil spills. Xanthone acts as a sensitizer forming hexadecanol with a quantum yield, at 313-335 nm, of 0.60-0.16, depending on intensity. Yields of peroxides are about one percent of the alcohol produced. A mechanism is proposed consistent with the alkylperoxy radical detected by ESR.

(INSOLATION)

ST78 17010 BIOMASS ENERGY FOR HAWAII: Volume 1, SUMMARY AND BACKGROUND; Volume 2, SUGAR OPERATIONS; Volume 3, MIXED MUNICIPAL REFUSE; Volume 4, TERRESTRIAL AND MARINE PLANTATIONS, Book

Gill, A., Ed., Beck, C., Salvesen, K., Chun, L., Yang, C., Murata, D., Keller, M., Stanford Univ., Stanford, CA, V 1:175 pages, V 2:159 pages, V 3:212 pages, V 4:243 pages, 1977, A77-48250

The conversion of biomass resources into energy, fuels, and by-products is discussed, with attention given to programs in Hawaii involving terrestrial and marine biomass plantations, energy recovery from municipal refuse treatment plants, and uses for sugar cane harvesting wastes. Biomass conversion processes to increase the available energy supply in Hawaii, such as direct combustion, pyrolysis anaerobic digestion, or fermentation, are described. In particular, the generation of electrical power from bagasse (sugar cane waste) and the production of ethanol fuel as a by-product of sugar refining are considered. Schemes for exploiting municipal refuse resources, including use of pyrolytic gases in power plants, are also treated. The reports emphasize an interdisciplinary approach to the energy problem, relying on legal and economic analyses, as well as technical studies.

(ECONOMIC ANALYSIS, ELECTRIC POWER PLANTS, INDUSTRIAL WASTES, PYROLYSIS)

ST78 17011 SILVICULTURE ENERGY PLANTATIONS

Inman, R.E., (Mitre Corp., McLean, VA), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, A77-48910 23-44, V 7:100-103, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:111176, A77-49079

A systems study of silviculture plantations to produce energy-chemical feedstock is underway. An analysis of biomass production costs is being performed for ten sites in the United States. Production scenarios will be combined with various biomass conversion scenarios to estimate final product costs. Final results will be reported in February, 1977.

(BIOMASS, ECONOMICS)

ST78 17012 ENERGY AND PROTEIN PRODUCTION FROM PULP MILL WASTES, Progress Report, December 15, 1976-March 15, 1977

Jurgensen, M.F., Patton, J.T., (Michigan Tech. Univ., Houghton, MI), March 1977, COO-2983-3 EDB-77:113136

During the past quarter, dignificant progress was made toward demonstrating the feasibility of producing protein and methane from pulp mill waste materials. The most significant result obtained in the project to date occurred when ozonated spent sulfite liquor, SSL, was demonstrated to be a suitable substrate for biosynthesis. Sustained production of methane was obtained by biological conversion of ozonated SSL. Total methane production approximated two volumes of gas per volume of ozonated SSL after approximately three days' reaction time. A detailed study of the effect of ph on ozonation indicates that low ph's favor the breakdown of SSL into organic fragments that are more easily assimilated by microorganisms. In addition, approximately one-half as much ozone is required to effect maximum degradation at ph 4 as compared to ph 8. Even with this lower dosage of ozone the resulting product is more amenable to bioconversion. The results were confirmed by BOD measurements on ozonated products and the biosynthesis of methane. There is even a preliminary indication that ozonation upgrades the substrate to a level suitable for the biosynthesis of protein with torula yeast.

(BIOSYNTHESIS, METHANE, WASTES)

ST78 17013 FUELS VIA BIOCONVERSION

Keenan, J.D., (Dept. of Civil and Urban Eng., Univ. of Pennsylvania, Philadelphia, PA), Energy Convers., V 16:95-103, N3, 39 refs, 1977

In this report, the potential mechanisms for fuel production by biochemical means are reviewed within the context of principal metabolic pathways. Engineering options for bioconversion of fuels include the direct use of photosynthesis materials, the photosynthetic production of hydrogen, and the fermentation of organic matter. The conclusion is that, although biological processing is a feasible renewable energy source, process economics prevent the current use of such systems. This problem will be overcome by improving conversion efficiencies and by reducing the costs of harvesting. The application of biochemical engineering techniques to these problems is discussed.

(ECONOMICS)

ST78 17014 METHANE PRODUCTION FROM SOLID WASTE

Kispert, R.G., Sadek, S.E., Wise, D.L., (Dynatech R/D Co., Cambridge, MA), In Energy From Solid Waste Utilization; Proceedings of the Sixth Annual Northeastern Regional Antipollution Conference on a New Source of Materials, Energy and Jobs: Solid Wastes Processing, Kingston, RI, A77-47210 22-85, p. 315-332, July 8-9, 1975, Technomic Publishing Co., Inc., Westport, CT, 1976, A77-47218

The process description for the anaerobic production of methane from solid waste consists of (1)feed preparation, (2)digestion, (3)gas treatment and handling, and (4) effluent disposal. An economic analysis of the procedure develops a computer model, reviews the system advantages and disadvantages, and calculates the cost of gas and of methane at baseline conditions. A sensitivity study and a forecast of the potential impact of the system are reviewed along with an evaluation of the process design, economics, and future plans. It is concluded that waste-produced methane may have a significant impact as a supplemental source of pipeline-quality gas and that anaerobic digestion of the organic portion of municipal refuse is currently the only known process for energy recovery in this form.

(ANAEROBES, BIOMASS, ECONOMIC ANALYSIS)

ST78 17015 ENERGY CAN BE GREEN

Lewin, R., New Sci., V 74:474-475, N1053, May 26, 1977, EDB-77:111182

A brief review is given of the research in developing new plants and biomass systems for energy conversion. Attempts to improve photosynthesis and engineering nitrogen-fixing genes into plants are also considered.

(ALGAE, BIOMASS, PHOTOSYNTHESIS)

ST78 17016 THE PROSPECTS FOR FUELS FROM BIOMASS

Lipinsky, E.S., (Battelle Columbus Labs., Columbus, OH), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., A77-48701 23-44, V 1:94-99, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, ERDA-supported research, A77-48713

The prospects for making fuels from biomass are investigated by considering the process of converting sugar cane to ethanol and studying the economics of ethanol as a motor fuel. A cost analysis is made for a large ethanol distilling plant, and it is

found that the cost of anhydrous ethanol would be about 31 cents per liter. Adding anhydrous ethanol in a suitable gasoline blend would increase the selling price of gasoline .015 cents to .021 cents per liter.

(ETHYL ALCOHOL)

ST78 17017 FIELD CROPS AS A FUTURE SOURCE OF FUELS AND CHEMICAL FEEDSTOCKS

Lipinsky, E.S., (Battelle Columbus Labs., Columbus, OH), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, A77-48910 23-44, V 7:104-117, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, ERDA-supported research, A77-49080

Such field crops as sugar cane, sorghums, sugar beets, wheat, and corn are under investigation as sources of fuels and commodity chemicals. Ethanol and methanol appear more attractive for industrial use than for fuel usage. Thermochemical production of fertilizer ammonia appears especially attractive. Genetic optimization, agronomic improvements, whole-plant harvesting, and hauling cost reductions may all be needed to fulfill the economic promise of this approach to ameliorating the hydrocarbon crisis.

(ALCOHOLS, AMMONIA, BIOMASS)

ST78 17018 FEASIBILITY OF USING POWER PLANT REJECT HEAT FOR URBAN FOOD AND METHANE PRODUCTION

Olszewski, M., Diaz, L.F., (Oak Ridge Nat'l Lab., Oak Ridge, TN), 11th Intersociety Energy Conversion Engineering Conference, State Line, NV, V 2:1664-1668, 6 refs, Sept. 12-17, 1976, American Inst. Chem. Engrs., New York, NY, American Nucl. Soc., Soc. Automotive Engrs., et.al.

This report examines the technical feasibility of using low-temperature power plant waste heat in evaporative pad greenhouses and with sewage sludge digesters. The simulated results for Phoenix, Arizona indicate that the electrical production of the power system using this combined agro-methane-cooling tower heat rejection system is superior to that of a power plant using only cooling towers. In addition to satisfying the total urban power demand, the agro-methane complex produces all the fresh vegetables required by the city and enough methane to meet the yearly gas needs for five percent of the population. This results in substantial energy savings that are associated with winter heating of the greenhouse and use of methane to replace natural gas for home use.

(GREENHOUSES)

ST78 17019 A FEASIBILITY STUDY OF BIO-GAS PRODUCTION IN INDIVIDUAL FARMS IN SOUTHWESTERN ONTARIO

Ostrovski, C.M., Peters, N., Sullivan, J.L., (Western Ontario Univ., London, Canada), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, A77-48910 23-44, V 7:129-145, 12 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, A77-49082

A mathematical model has been developed to examine the economic feasibility of building small digesters for single-farm utilization (on a scale of about 200 acres) to produce energy (methane gas) and fertilizer from renewable resources (crop residue and animal waste). The model considers (1)the volume of the gas needed, (2)the quantity of heat needed to operate the digester, (3)the volume and cost of a digester to produce enough heat for purposes 1 and 2, (4)the amounts of residue required and fertilizer produced, and (5)a comparison of the cost of building and operating the digester and the benefits achieved. The Moses Computer Program for solving the model is presented. Some case studies relating to farms in Southwestern Ontario are discussed.

(BIOMASS, COMPUTER PROGRAMS, MATH MODELS)

ST78 17020 BIOLOGICAL CONVERSION OF BIOMASS TO METHANE, Quarterly Progress Report, Sept. 1-Nov. 30, 1976

Pfeffer, J.T., (Illinois Univ., Urbana, IL, Dept. of Civil Engineering), 14 pages, N77-33627
Avail:NTIS

Manure fermentation processes are described to produce methane from biomass. The study relating to the effect of reactor design is underway, but the results are too preliminary to evaluate.

ST78 17021 PERPETUALLY RENEWABLE BIOMASS PROSPECTS: A COMPARISON OF US AND CANADIAN ECOSYSTEM CARRYING CAPACITIES VS NEEDS

Robertson, E.E., (Biomass Energy Inst., Inc., Winnipeg, Canada), In Sharing the Sun: Solar Energy in the Seventies; Proceedings of the Joint Conf., Winnipeg, Canada, A77-48910 23-44, V 7:157-179, 10 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:111181, A77-49084

This paper will delineate the solar, climatic, and other perpetually renewable ecosystem prerequisites for biomass formation. It will then attempt to quantify the geographical areas in both countries which already satisfy the foregoing prerequisites. It will focus attention upon awesome programs which may become necessary to preserve and expand North America's ecosystem's capacity to perpetually provide our essential biomass, not only for energy but for food, fiber, chemical feedstocks, fertilizers, and pharmaceuticals.

(INSOLATION)

ST78 17022 ENERGY FROM WASTES

Sabel, W., (Oxford polytechnic, Oxford, England), Aspects of Energy Conversion, 1976, Eds: Blair, I.M., Jones, B.D., Van Horn, A.J., Pergamon Press, Inc., Elmsford, NY, EPA-03:003901 EDB-77:113142

The technological, economic, environmental, and societal aspects of energy conversion and energy recovery from industrial and domestic wastes are briefly discussed.

ST78 17023 METHANE PRODUCTION THROUGH BIOCONVERSION OF AGRICULTURE RESIDUES

Schulte, D.D., Kroeker, E.J., Sparling, A.B., Lapp, H.M., (Manitoba Univ., Winnipeg, Canada), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, A77-48910 23-44, V 7:119-128, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, Research supported by the Biomass Energy Inst. Univ. of Manitoba, Agricultural Inst. of Canada, and Shell Canada, A77-49081

Bioconversion of agricultural residues to methane gas has been restricted in the past by lack of understanding of process performance at the high organic loading rates and high organic solids concentrations normally associated with animal manures and crop residues. Experiments at the University of Manitoba carried out at organic loading rates several times that normally associated with sewage sludge digestion and at ammonia concentrations far above that formerly thought to be toxic to methane-producing bacteria have shown extreme process stability. These and other results indicate that there may be a useful role for anaerobic digestion in the formulation of practical and economic farm-scale bioconversion units.

(BIODEGRADATION, ECONOMIC ANALYSIS)

ST78 17024 OCEAN FOOD AND ENERGY FARM PROJECT, Subtask 5, Site Survey Studies, Progress Report

Seligman, P.F., (Naval Undersea Center, San Diego, CA, Undersea Sciences Dept.), Dec. 15, 1976, ERDA-USN-1027-5, EDB-77:144700

Studies on the establishment of criteria for selection of sites for the ocean-farming of kelp are reported. Biological and engineering limitations and requirements, economic and geo-political considerations are included. Currents, temperature, and nutrients of various areas in the Pacific Ocean were surveyed. Information is also included on tropical and extratropical cyclones, winds, and wind-generated ocean waves in the areas under consideration. Recommendations are made for specific sites off the coast of Southern California.

(AQUACULTURE, BIOMASS, CALIFORNIA, ECONOMICS)

ST78 17025 WASTE-TREATMENT PLANT POWERED BY ON-SITE ENERGY

Smay, V.E., Popular Science, V 209:97-164, N3, Sept. 1976, W77-00594

A waste-treatment plant design for reducing off-site energy requirements is described. Except for a period from mid-December through February, solar energy and methane are expected to produce more than 90 percent of the heat required for the plant. A 1500-ft^2 flat-plate, glass-covered, hydronic solar collector will be the primary source of solar heat. This heat will go mainly to the anaerobic sludge digesters which operate most efficiently at 95 F. Excess solar heat will be used for space heating and domestic hot water. Methane which will be obtained from the sludge digesters as a by-product will serve as a long-term storage medium for the solar energy. The plant will also recover 75 percent of the heat from the exhaust air in the vent system and all the heat from the electric (methane-fuelled) generator. The building structure will be constructed of concrete blocks and bricks with insulation between. The roof is designed to retain snow for insulation value. Snow will also be used as a solar reflector. The project is due for completion by late 1977.

(HEAT-TRANSFER, INSOLATION, METHANE)

ST78 17026 MUNICIPAL WASTE MANAGEMENT ALTERNATIVES

St. Clair, C.W., Energy Awareness, 1977, CONF-770207, EPA-03:003608, EDB-77:113135

Resource recovery, by which materials and energy are extracted from solid wastes, is a new direction from the traditional handling of wastes that solves waste disposal problems and is responsive to the need for conservation. Collections of trash now represent a $2.5 billion expense just to move it from one place to another. Another half billion is spent on open dumping, which will be prohibited when the resource conservation and recovery act takes effect in 1983.

Source separating, allowing recycling of paper, glass, aluminum, etc., can be handled by separate containers and pick-up trucks. Pilot facilities are now in operation to demonstrate equipment able to take compacted mixed trash and, through shredding, save sifting, sorting, and separation, recover specific materials. New devices, such as a trommel at a New Orleans plant, saves energy by separating the inorganic material prior to shredding. The organic fraction can be used for energy recovery because its low sulfur quality offsets its lower heating value. Other uses include pyrolysis, composting, sanitary landfill, animal feed, and methane gas. Demonstration projects in several cities are described. Specifications from these projects will be used to develop markets and appropriate private and public participation. Resource recovery, unlike national energy policy, remains a local option and involves a capital-intensive effort and community support.

(METHANE, PYROLYSIS)

ST78 17027 THE PHOTOSYNTHESIS ENERGY FACTORY: ANALYSIS, SYNTHESIS, AND DEMONSTRATION

Szego, G.C., Fraser, M.D., Harmer, C.H., Henry, J.F., Scholten, W.B., Vail, C.W., (Intertechnology-Solar Corp., Warrenton, VA), Oswald, W.J., Benemann, J.R., (California Univ., Berkeley, CA), In Intersociety Energy Conversion Engineering Conf. Proceedings, 12th, Washington, D.C., A77-48701 23-44, V 1:461-468, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48753

The photosynthesis energy factory is a synergistic combination of the dry land energy plantation and an algae production system which can produce, on a perpetually renewable basis, unpolluting and totally domestic fuels from solar energy and various residues. From the energy plantation, woody plant matter is produced which is chipped and used as a solid fuel in a power plant to produce electricity. The algae production system uses the nutrients in wastewater and the CO_2 in power plant flue gas to produce algae, which are harvested and ultimately digested anaerobically to produce methane. Digester sludge is disposed of in a beneficial way by being put onto the energy plantation. A comprehensive techno-economic model is being developed for a systems analysis. Potential sites for a demonstration project are being analyzed and selected. The final task in this project is to develop a preliminary design and associated cost estimates for a proposed demonstration.

(ALGAE, BIOMASS)

ST78 17028 RECENT CANADIAN ACTIVITIES IN BIOMASS

Timbers, G.E., Downing, C.G.E., (Agriculture Canada, Engineering Research Service, Ottawa, Canada), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, A77-48910 23-44, V 1:119-125, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, A77-48917

Total Canadian biomass production as food, feed, and lumber is an appreciable 145 million tonnes with an estimated additional 43 million tonnes of pasture. Additional biomass production as agriculture and forestry residues adds another 90 million tonnes. The latter materials, with a crude energy content of about 1650 million GJ, can be considered as a possible source of energy, or, through processing, as a source of feed. Conversion of waste biomass to feed would increase the efficiency of land use and could allow some conversion of forage land to cereal production to help meet the future world demands. Canadian studies include methane from animal wastes, fuel from forestry and agricultural residues, and residue modification for feeds, including chemical and physical procedures. The contributions of biomass to energy need to be assessed for both direct and indirect effects and studies underway in various areas should aid in the assessment, both in terms of conventional and energy economics.

(AGRICULTURE)

ST78 17029 SOLID FUELS FROM BIOMASS: SOME ENVIRONMENTAL AND ECONOMIC CONSIDERATIONS

Vail, C.W., Henry, J.F., (Intertechnology-Solar Corp., Warrenton, VA), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., A77-48701 23-44, V 1:90-93, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48712

A hypothetical woody biomass plantation with a given operating schedule was analyzed in terms of the universal soil loss equation in order to estimate the average amount of soil lost to erosion over an extended period of plantation operation. It is shown that such an energy plantation culture is less intense than traditional agriculture. Thus,

lands classified as marginally fit for agriculture can be used to produce biomass crops on a renewable basis. The cost of producing fuel with the required conservation measures is estimated to be slightly more than $1.20 per million BTU.

(ARKANSAS, LOUISIANA)

ST78 17030 STATE AND DEVELOPMENT OF WASTE MANAGEMENT

Van Wickeren, P., (Siedlungsverband Ruhrkohlenbezirk, Essen, Germany, F.R.), Tech. Mitt., V 70:26-35, N1, Jan. 1977, In German, EDB-77:113180

Controlled disposal of municipal and industrial waste in central collecting stations, processing plants, and depots is discussed. Refuse disposal plants are competition for densely populated areas and their surroundings. The importance of environmental protection on account of federal and laender law on refuse and clean air standards is described and technical-economic optimization of central plants and their chances in practice of being realized are considered. The significance of recycling for refuse management is discussed.

(GERMANY, REVIEWS)

ST78 17031 HIGHLY ENERGY-EFFICIENT WILTON WASTEWATER-TREATMENT PLANT

Wilke, D.A., Fuller, D.R., Civil Engineering-ASCE, V 46:70-72, N5, May 1976, W77-00579

A highly efficient waste water treatment plant design that minimizes the need for off-site energy requirements is described. The design takes advantage of gravity flow to reduce pumping needs, solar energy to provide heat for the anaerobic digesters, and concrete construction to retain heat for the building itself. Waste water is lifted into the plant by screw pumps, which use less energy than conventional pumps, and flows through the rest of the plant by gravity. Pretreatment is provided by comminution and grit removal. Gross solids are removed by rotary screens. Secondary biological treatment is accomplished via a rotating biological contactor. Final solids separation is accomplished in clarifiers from which the solids are combined with the primary screenings and pumped to anaerobic digesters for stabilization before dewatering and disposal. Disinfectant for the effluent is generated on-site electrochemically from salt and water. First-year energy cost savings are estimated to be $4,700.

(CONCRETE, ECONOMICS, INSOLATION)

ST78 17032 DON'T WASTE WATERWEEDS

Wolverton, B., McDonald, R.C., (National Space Tech. Labs., Bay St. Louis, MS), Use of Water Hyacinths as Fertilizer, Biogas Generator, and Animal Feed, New Sci., p. 318-320, Aug. 12, 1976, EDB-77:124692

The water hyacinth, which has clogged rivers and streams in the Southeastern United States and many tropical countries, can be used to treat liquid effluents and is a potential source of fertilizer, bio-gas from anaerobic digestion, and livestock feed. Research being sponsored by NASA to investigate these uses of water hyacinths is briefly described.

(BIOMASS, METHANE)

ST78 17033 CASSAVA FUEL ALCOHOL IN BRAZIL

Yang, V., Milfont, W.N.Jr., Scigliano, A., Massa, C.O., Sresnewsky, S., Trindade, S.C., (Centre de Tecnologia Promon, Rio de Janeiro, Brazil), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., A77-48701 23-44, V 1:44-53, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48707

Energetics and economics of ethanol production from cassava under Brazilian conditions were analyzed. A 150-m^3/day alcohol distillery based on batch conversion and fermentation steps and employing a totally enzymatic process was the base distillery chosen. Comparison with alcohol production from sugar cane juice was made. Prospects for process energy improvements and effects on alcohol production costs are discussed and compared to base-distillery results. Net energy-ratio concept was used as basis for process energetics analysis. Sharp increase in cassave agriculture productivity is expected to considerably improve cassava fuel alcohol economics.

(BIOMASS, METHANE)

ST78 18000 MINIATURE SOLAR-ELECTRIC POWER SYSTEM

Drummond, J.E., (Maxwell Labs., Inc., San Diego, CA), In Intersociety Energy Conversion Engineering Conf. Proceedings, 12th, Washington, D.C., A77-48701 23-44, V 2:1238-1242, Aug. 28-Sept. 2, 1977, American Nuclear Society, Inc., La Grange Park, IL, A77-48848

The paper describes a small solar power system designed for a single-family dwelling. The total system consists of five subsystems: optical thermal input, thermal-to-electrical conversion, waste heat deployment, and control. A typical system would consist of 22 stages of ferroelectric heat engines each using nearly-carnot cycles and 23 intervening, electrically actuated, heat pipes. Each stage is 30 micrometers thick and each heat pipe 1.7 cm long. A KW converter would fit inside a box 20 cm^2 x 45 cm. The converter would weigh 3 KG and would pay back the energy required for mining, refining, and combining the materials of which it is constructed in 22 days at a quarter of its peak power output.

(AUTOMATIC CONTROL, CARNOT-CYCLE, HEAT-PIPES)

ST78 18001 RESIDENTIAL APPLICATION OF PHOTOVOLTAIC ENERGY SYSTEMS

Federmann, E.F., Pittman, P.F., Nearhoof, S., Rittelmann, P.R., (Westinghouse Electric Corp., Pittsburgh, PA), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conf., Winnipeg, Canada, A77-48910 23-44, V 10:206-211, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, EDB-77:118199, A77-49155

The prospect of reduced cost photovoltaic material creates a potential for on-site systems that can provide the bulk of residential electrical and thermal requirements. The likelihood of increased energy costs combined with increased system use with time should assure economic viability in virtually all regions of the United States in about 20 years. The sizing, economic viability, and performance of various photovoltaic systems were determined for seven geographical regions on a study just completed for ERDA. Of these, one of the Atlanta, GA type residences was chosen for this discussion. A specific system and function is specified, as well as all necessary subsystems.

(ATLANTA, GA, SOLAR-CELLS, SOLAR COLLECTORS)

ST78 18002 EXTENSION OF THE HOTTEL-WHILLIER-BLISS MODEL TO THE ANALYSIS OF COMBINED PHOTOVOLTAIC-THERMAL FLAT-PLATE COLLECTORS

Florschuetz, L.W., (Arizona State Univ., Tempe, AZ), Sharing the Sun: Solar Technology in the Seventies, V 6, 1976, Ed: Böer, K.W., EDB-77:124729

The well-known Hottel-Whillier-Bliss model for thermal analysis of flat-plate collectors is extended to the analysis of combined photovoltaic-thermal collectors in a manner, such that, with simple modification of the conventional parameters of the HWB model, all of the existing relations and supporting information available in the literature still apply. Beyond the basic assumptions of the original HWB model, it is only necessary to assume that the local photovoltaic cell conversion efficiency is a linear-decreasing function of the local cell temperature over the operating temperature range of the combined collector. Based on the extended model, examples of both thermal and electrical performance of the combined collector as a function of collector design parameters are presented and discussed.

(MATH MODELS)

ST78 18003 SOLAR CELL SHINGLE

Forestieri, A.F., Ratajczak, A.F., Sidorak, L.G., (NASA, Lewis, Cleveland, OH), Aug. 24, 1976, EDB-77:131089, N77-10645

A solar cell shingle may be made of an array of solar cells on a lower portion of a substantially rectangular shingle substrate made of fiberglass cloth or the like. The solar cells may be encapsulated in fluorinated ethylene propylene or some other weatherproof translucent or transparent encapsulant to form a combined electrical module and a roof shingle. The interconnected solar cells are connected to connectors at the edge of the substrate through a connection to a common electrical bus or busses. An overlap area is arranged to receive the overlap area of the roof shingle. Accordingly, the same whingle serves the double function of an ordinary roof shingle, which may be applied in the usual way, and an array of cooperating solar cells from which electrical energy may be collected.

ST78 18004 A COMBINED SOLAR-ELECTRIC AND THERMAL SYSTEM FOR USE IN INDIVIDUAL FAMILY HOUSING

Shewchun, J., Thompson, D.A., St. Pierre, J.A., Liikala, R., Haber, C.J., Carter, R., (McMaster Univ., Hamilton, Ontario, Canada), Sharing the Sun: Solar Technology in the Seventies, Winnipeg, Canada, V 6:106-107, Aug. 15-20, 1976, Internat. Solar Energy Soc., Solar Energy Soc. Canada, Pergamon, Oxford, England, EDB-77:124783

The abstract describes how electricity is generated through photovoltaic process and heat collected in absorbine panels and stored using air as the transport medium. A prototype home has been designed in which the solar roof consists of combined modular drop-in panels approximately 16 in x 30 in, which generate electricity (100 amps at about 0.5 volts per panel) and collect thermal energy. The design is based on using 3 in-diameter single-crystal silicon solar cells, while storage of this electricity is in conventional lead acid batteries of 1-KWH capacity. The main characteristics of the thermal system are its compactness and high efficiency. The design has been for a system compatible with existing home construction techniques, and the estimated cost figures for a combined electric-thermal system with a 10-KW electric generator and a 10^6 BTU thermal storage capacity are given. The perspective for reaching a cost figure in the $10,000 range is examined. Experiments conducted on components of the proposed combined solar electric-thermal home are presented.

(SOLAR-CELLS)

19000 LARGE-SCALE PHOTOVOLTAIC, HYDROGEN PRODUCTION, AND OTHER

ST78 19000 ELECTROCHEMICAL SOCIETY, INCORPORATED MEETING, 151st, EXTENDED ABSTRACTS, 1977

(Electrochem. Soc. Inc., Princeton, NJ), Electrochem. Soc., Inc., Meet, 151st, Extended Abstr., Philadelphia, PA, V 77-1:1027 pages, May 8-13, 1977, Publ. by Electrochem. Soc., Inc., Princeton, NJ

Four hundred and two papers by various authors were given at the conference. The articles were grouped under fifteen headings indluding materials and processes for solar heating and cooling and selective surfaces, and electrode materials and processes for energy conversion and storage.

ST78 19001 ESTIMATING WAVE ENERGY FROM A WAVE RECORD

Aranuvachapun, S., Johnson, J.A., (East Anglia University, Norwich England), Deutsche Hydrographische Zeitschrift, V 30:26-30, N1, 1977, A77-48327

This note is concerned with the calculation of wave energy from a time series record of wave heights. Various methods are used to estimate the wave energy. For wave records that contain a number of different frequencies, it is shown that the most accurate method for calculating the wave energy is by the use of Fourier analysis.

(FOURIER-ANALYSIS, TIME-SERIES-ANALYSIS, WAVE-POWER)

ST78 19002 ENERGY FROM SEA WAVES: A CONTRIBUTION TO THE ENERGY SUPPLY

Behrendt, V., Meerestechnik, V 8:37-42, N2, April 1977, In German, EDB-77:144887

Technical systems for the utilization of wave energy must always be developed with a view to one single, or a few possible applications for the generated secondary energy. This approach will permit a system to be found which can be matched in optimum degree to the primary energy source, the wave, and also promises maximum utilization of the generated secondary energy. Because of the technical problems still to be solved, it is assumed that wave energy converters will in the first instance attain only regional significance as energy suppliers. The fact that precisely the highly developed countries should apply their technical knowledge to the development of such wave energy converters, including storage and energy transmission systems, holds true for the Federal Republic of Germany in particular. Even though such appliances could hardly be employed in countries such as Germany, they would nevertheless be extremely suitable for use in many countries of the third world.

(ECONOMICS, DEVELOPING-NATIONS, FORECASTING, WAVE-POWER)

ST78 19003 THEORETICAL TREATMENT OF THE PHOTOELECTRO-CHEMICAL PRODUCTION OF HYDROGEN

Bockris, J.O'M., Uosaki, K., (Flinders Univ. of South Australia, Bedford Park, Australia), Int. J. Hydrogen Energy, V 2:123-138, N2, 26 refs, 1977, EDB-77:137382

Theoretical expressions for photocurrents at p-type and n-type semiconductors have been set up under the initial assumption that the rate-determining step is the discharge process for H_3O^+ at p-type electrode and OH^{-2} of semiconductor electrodes, e.g., energy gap, etc. The calculated results for the quantum efficiencies are from 10^{-2} to 10 percent depending on the properties of the semiconductors (CFA maximum of 0.1 percent in the metal case). The theoretical results for TiO_2 are inconsistent with observations. Consequently, the presence of surface states and the supply of holes as the rate-determining step are introduced into the model's formalism and yield results consistent with observation. The photocurrents or whole cells are calculated, and finally, the hydrogen production rate under solar irradiation is evaluated for a typical cell.

(ELECTROLYSIS, HYDROGEN-PRODUCTION, PHOTOLYSIS, TITANIUM-OXIDES)

ST78 19004 TRENDS IN ELECTROCHEMISTRY

Bockris, J.O'M., Ed., Rand, D.A.J., Ed., Welch, B.J., Ed., (Flinders Univ. of South Aust., School of Phys. Sci., Bedford Park, Australia), Trends in Electrochem: Aust. Electrochem. Conf., 4th, Flinders Univ., Bedford Park, S. Australia, 408 pages, Feb. 16-20, 1976, Publ. by Plenum Press, New York, NY

This volume contains 23 lectures and papers which outline the aspects of electrochemistry which are in the future energy technologies. Topics in energy developments include: fuel cell applications, solar energy, hydrogen production, and sodium-sulfur batteries. A section covering mineral sulfide electrochemistry is included as well as a section on advances in electrochemical techniques.

ST78 19005 TUNGSTEN TRIOXIDE AS AN ELECTRODE FOR PHOTOELECTROLYSIS OF WATER

Butler, M.A., Nasby, R.D., Quinn, R.K., (Sandia Lab., Albuquerque, NM), Solid State Commun., V 19:1011-1014, N10, 20 refs, Aug. 1976

The n-type tungsten trioxide is shown to be a stable semi-conducting anode for the photoelectrolysis of water. A band-gap of 2.7 EV provides a factor of three increase in the utilizable solar spectrum as compared to TiO_2.

(COMPARATIVE-EVALUATIONS, BAND-GAP)

ST78 19006 FORECAST COMPUTATION OF MAXIMUM WAVE AT VENICE LAGOON INLET ENTRANCES

Cavaleri, L., (CNR, Venezia, Italy), Energ. Elettr., V 53:533-544, N10, 17 refs, Oct. 1976, In Italian, EDB-77:131212

A forecast of wave motion under extreme conditions within lagoon inlets is presented. Given sea conditions off the coast according to Glenn, the wave energy spectrum deformations are studied during their approach to the coast as a result of refraction and shoaling phenomena. After having ascertained sea conditions at the inlets, propagation and deformation of individual frequencies are studied inside each one, up to a given cross-section. Energy spectrum, maximum and significant wave, and components of these magnitudes which are perpendicular to the section are presented for each given cross-section at 50 m intervals (70 m for the Lido).

(HARBORS, ITALY, WAVE-POWER)

ST78 19007 PROGRESS OF FEASIBILITY REASSESSMENT OF EXPLOITING FUNDY TIDAL ENERGY

Clark, R.H., Walker, R.L., Engineering Institute of Canada, Annual Congress, 90th, Halifax, Nova Scotia, Canada, 43 pages, Oct. 5-8, 1976, A77-47971

A joint Canadian and Provincial Government Program to assess the technical, environmental, and economic feasibility of electrical power generation from tidal energy at the Bay of Fundy (Nova Scotia-New Brunswick) is reviewed. Aspects of the design process, including the choice between single and hydraulically linked basin schemes, the integration of power plants into existing transmission systems, the development of a finite difference model for more accurate simulation of tidal flow, the estimation of capital costs for plants having capacities from 50 to 10,000 MW and the location and capacity of energy storage facilities, are considered. In addition, utility loads in the Canadian Maritime Provinces and Quebec through the 1990's are projected, and the relative cost of tidal energy from the proposed Bay of Fundy generating plants is estimated.

(BAY-OF-FUNDY, CANADA, ECONOMIC, FINITE-DIFFERENCE MODEL, FEASIBILITY-ANALYSIS, TIDE-POWER)

ST78 19008 HARNESSING THE OCEAN WAVES, SWELLS, AND TIDES

Dervy, A.J., Energy LA: Tackling the Crisis, 1976, Ed: Robinson, J.W., Western Periodicals Co., North Hollywood, CA, EDB-77:137730

In general, the ocean surface is disturbed for various reasons and consequently, waves, swells, and tides result. This mass of rising and falling waters has potential and kinetic energies. Basic mechanical systems for harnessing these energies are presented. The system consists of transforming the energy imparted by the swells to a floating member to a rotary motion, which then can drive electric generators or other useful mechanisms. A mathematical treatment of the motions, design, and cost estimates are given. The studies indicate definite feasibility of this concept for developing power from the ocean, and warrant the R and D necessary to further its development.

(CONFIGURATION, MATH MODELS, TIDAL-POWER, WAVE-POWER)

ST78 19009 TIDEWATER POWER PLANT

Diggs, R.E., Aug. 2, 1977, US Patent no. 4,039,847, EDB-77:144885
A device and method of converting tidal currents into power is described. The device comprises a plurality of modules and is mounted in tidal water so that one face is presented inland and the opposite face is presented seaward. Each module comprises a turbine mounted on an elevator means which moves the turbine vertically in response to water level changes during a tide. The modules are alternately presented toward the inland and seaward directions, thereby permitting tidal water movement associated with both flood and ebb tides to be converted into power. Apparatus for sensing the amount of water flowing over the turbine for controlling the movement of the elevator device and apparatus for withdrawing power from the device are also disclosed.

(CONTROL-SYSTEM, PATENT, TIDAL-POWER)

ST78 19010 MODERNIZATION OF A SMALL HYDRO PLANT

Eberhardt, A., (Harza Engineering Co., Chicago, WI), Civ. Eng., New York, NY, V 47:60-61, N9, Sept. 1977, EDB-77:144654
Old, unprofitable hydroelectric plants were usually abandoned until a project to rebuild the Cornell Hydro Plant in Wisconsin demonstrated how money, time, and energy can be saved. The powerhouse was demolished and rebuilt with single modifications that maintain a constant minimum river flow, increase the flood passage capacity, save energy with single small transformers for each generator, and use heat recovered from the generators for space heating. Stripped-down turbines maintain a constant flow, speed, and smooth start-up. Crane rental cost was eliminated by using a small mobile crane that can be shared by other installations. The project took less than two years to complete and cost $520 per KW of installed capacity.

(CONSTRUCTION, ECONOMICS, HYDROELECTRIC-POWER, RETROFITTING)

ST78 19011 ENERGY RECOVERY FROM SEA WAVES WITH THE AID OF OSCILLATING FLOATING BODIES

Ferdinande, V., (Rijks Univ. Gent, Belgium), Ingenieursblad, V 46:42-49, N2, 13 refs, Feb. 1977, In Dutch, EDB-77:124998
The theoretical mechanical energy of gravity waves and that of sea waves off the Belgian Coast is discussed. The hydrodynamic theory of energy recovery from sea waves by means of floating bodies is considered and several projects of converting wave theory into usable energy are described. The conditions and possibilities of utilizing sea wave energy along the Belgian Coast are examined.

(BELGIUM, WAVE-POWER)

ST78 19012 HYDROGEN AND OXYGEN FROM WATER

Fletcher, E.A., (Minnesota University, Minneapolis, MN), Moen, R.L., Science, V 197:1050-1056, Sept. 9, 1977, A77-46573
A preliminary proposal for an idealized model of a one-step, high-temperature, thermochemical, effusional process for producing hydrogen and oxygen from water using solar energy is described. A schematic diagram of the apparatus and its system efficiency are defined along with a simple situation to show the effect of high-temperature operation on the system efficiency. Membrane materials, and the design and production are discussed. A series of user-interactive computer experiments is developed to determine the optimum operation variables. It is concluded that the effusional-separation of hydrogen and oxygen from water at high temperatures using solar power is possible.

(EFFUSIONAL-SEPARATION, HIGH-TEMPERATURE, HYDROGEN-PRODUCTION, THERMOCHEMICAL)

ST78 19013 WAVE POWER

Glendenning, I., Count, B.M., (Central Electricity Generating Board, Southampton, England), Chem. Eng., London, England, V 313:595-600,604, Sept. 1976, EDB-77:118381

Characteristics of the power available from ocean waves are reviewed. Various wave energy converter devices are also described. The feasibility of a wave power system in the United Kingdom is discussed.

(UNITED KINGDOM)

ST78 19014 OCEAN WAVE POWER

Glendenning, I., (Central Electricity Generating Board, Marchwood Engineering Laboratories, Southampton, England), Applied Energy, V 3:197-222, July 1977, A77-49349

The potential of wave power and some of the more promising methods of harnessing it are discussed with attention to the wave energy arriving on the west coast of the United Kingdom. Unresolved technical and engineering problems are examined, and the impact of wave power on the environment is considered. Data on wave power and its variability are supplied. It is suggested that wave power could be exploited to conserve fossil fuels but is unlikely to be competitive with nuclear power.

(ECONOMIC, ENVIRONMENTAL-EFFECTS, UNITED KINGDOM)

ST78 19015 HYDROGEN-A FUEL FOR THE FUTURE

Gregory, D.P., (Energy System. Res. Inst. of Gas Technol., Chicago, IL), Gas Waerme Int., V 26:124-134, N3, 35 refs, March 1977, In German

The concept of using hydrogen as a gaseous carrier of energy is outlined. The existing gas pipelines could be used for distribution of hydrogen. This paper reviews the status of the research on the electrochemical and thermochemical production, pipeline transmission, and cryogenic, hydride, and pressure storage of hydrogen.

(ELECTROCHEMICAL, PIPELINE-TRANSMISSION, THERMOCHEMICAL)

ST78 19016 PROSPECTS FOR PIPELINE DELIVERY OF HYDROGEN AS A FUEL AND AS A CHEMICAL FEEDSTOCK

Gregory, D.P., Biederman, N.P., Darrow, K.G.Jr., Konopka, A.J., Wurm, J., (Inst. of Gas Technol., Chicago, IL), Am. Gas Assoc., Oper. Sect., Proc., V 76, N39, 20 refs, 1976, EDB-77:124649

Industrial uses of new hydrogen sources pipelined to points of utilization by the natural gas industry are analyzed. Hydrogen fuel manufacture using nuclear and solar energy is considered. Costs and environmental impact of transmission of electricity and hydrogen are compared.

(ENVIRONMENTAL IMPACTS, HYDROGEN-PRODUCTION, PIPELINES)

ST78 19017 METHOD AND EQUIPMENT OF THE GENERATION OF ELECTRICAL ENERGY FROM SOLAR ENERGY

Gubo, E., Jan. 20, 1977, Patent no. 2,510,226/C, In German, EDB-77:111186

A method for the conversion of solar energy into electrical energy is described. Firstly, electrical energy generated by means of solar cells is used for the electrolysis of water. Sea water is preferably used. The electrolysis products can be stored or immediately led to a burner. The heated steam produced in the burner drives a steam turbine which is connected to an electric generator. The whole plant may be installed floating on the sea. The steam occurring at the outlet of the turbine may be used as sweet water after condensation.

(ELECTROLYSIS, HYDROGEN-PRODUCTION, PATENT, SOLAR-CELLS)

ST78 19018 STATE OF THE ART

Gwynn, J.D., (Eng. and Power Dev. Consult Ltd.), Consult. Eng., London, England, V 41:23, N4, April 1977, EDB-77:131211

The means for investigation, design, execution, and operation of tidal energy utilization projects are reviewed.

(CONSTRUCTION, ECONOMICS, ENVIRONMENTAL-EFFECTS, TIDAL-POWER)

ST78 19019 HYDROGEN: AN ENERGY CARRIER OF THE FUTURE

Hamerak, K., Chem.-Anlagen Verfahren, V 2:68-73, Feb. 1977, In German, EDB-77:144524

Some advantages and fields of application of hydrogen are outlined in the introduction. Hydrogen production by conventional water electrolysis, by the thermochemical iron-chlorine cycle process, and by a new water electrolysis method still in the laboratory stage are dealt with in which the electrolysis voltage is considerably reduced by the action of solar UC light on an anode consisting of p-conducting material.

(ELECTROLYSIS, HYDROGEN-PRODUCTION, THERMOCHEMICAL)

ST78 19020 SEMICONDUCTOR ELECTRODES: PHOTOELECTROCHEMICAL BEHAVIOR OF SEVERAL POLYCRYSTALLINE METAL OXIDE ELECTRODES IN AQUEOUS SOLUTIONS

Hardee, K.L., Bard., A.J., (Univ. of Texas, Austin, TX), J. Electrochem. Soc., V 124: 215-224, N2, Feb. 1977, EDB-118192

An investigation was made of the photoelectrochemical properties of several polycrystalline metal oxide electrodes prepared by chemical vapor deposition, direct oxidation of the metal, or heating of suitable metal salt solutions. Further data are given on the behavior of the previously discussed TiO_2 and Fe_2O_3 electrodes, including tunneling effects and the operation of the Fe_2O_3 in a solar cell. Other n-type materials studied were V_2O_5, WO_3, and PbO. WO_3 and PbO showed good anodic photocurrents but only WO_3 appeared stable. Bi_2O_3 showed both n and p-type photocurrents, but had a poor stability. CuO produced a good cathodic photocurrent (indicating p-type behavior) with a photoresponse at wavelengths of 700 nm and below. Two other oxides, Cr_2O_3 and CoO, exhibited small p-type photoeffects.

(ELECTRODES, ELECTROLYSIS, HYDROGEN-PRODUCTION, PHOTOGALVANIC-CELLS, PHOTOLYSIS, REDOX FUEL-CELLS)

ST78 19021 THE USE OF FUNCTIONALIZED POLYMERS AS PHOTOSENSITIZERS IN AN ENERGY STORAGE REACTION

Hautala, R.R., Little, J., Sweet, E., (Georgia University, Athens, GA), Solar Energy, V 19:503-508, N5, 1977, E(38-1)-893 NSF, CHE-75-13752, A77-50208

Insoluble polymer-bound photosensitizers, useful for the conversion of norbornadiene (1) to quadricyclene (2), have been synthesized. An acetophenone analog was produced by Friedel-Crafts acylation of polystyrene resin, while treatment of chloromethylated resin with salicyladehyde and triethylamine produced an analog of benzyloxybenzaldehyde. Reaction of lithio-polystyrene resin with methyl 4-(n,n-dimethylamino) benzoate gave a ketone equivalent to 4-(n,n-dimethylamino) benzophenone (3). Quantum yields for the conversion of 1 and 2 using the polymer-bound sensitizers were generally comparable to, but slightly lower than, the analogous compound in homogeneous solution. The quantum yield of polymer-bound 3 was less solvent dependent than that of the homogeneous counterpart. The advantages of isolating the photosensitizer to the photochemical reactor stage of a photochemical solar energy storage device are discussed. Efficient sensitization by polymer-bound photosensitizers demonstrates the feasibility of this approach.

(ISOMERIZATION, PHOTOCHEMICAL STORAGE, PHOTOSENSITIVITY)

ST78 19022 EFFECTS OF NONLINEARITIES ON WAVE POWER ESTIMATES

Hudspeth, R.T., (Oregon State Univ., Corvallis, OR), J. Power Div., Am. Soc. Civ. Eng., V 103:51-64, N1, 11 refs, July 1977, COO-2946-1, EDB-77:137732, EDB-77:124994

Contours of relative errors between deterministic wave power estimates computed by the nonlinear numerical Dean Stream function and by linear wave theory are graphically presented on the dimensionless relative wave steepness-relative water depth dissection plane. A contour of zero relative error is found to intersect the breaking and to establish a lower bound for which the effect of nonlinearities on wave power estimates may be neglected for engineering purposes. Deterministic wave power estimates that are determined by linear wave theory should specifically identify the parameters of wave height, wave period, and water depth in order that the effect of nonlinearities on the magnitude of the wave power estimates may be evaluated.

(DEAN-STREAM-FUNCTION, MATH MODELS, TABLES)

ST78 19023 UTILIZATION OF THE ENERGY FROM OCEAN WAVES

Isaacs, J.D., Wick, G.L., Schmitt, W.R., (Delaware Univ., Newark, DE), (Univ. of California, San Diego, La Jolla, CA), 1976, COO-2946-1, EDB-77:124993, Also see ST77 19077

An assessment of the extent and distribution of wind-wave energy in the oceans is presented. This is followed by a review of some conventional and unconventional mechanisms for the harnessing of the power of waves. The design and performance of a wave-powered pump developed at Scripps is described.

(PUMPS, WAVE-POWER)

ST78 19024 PHOTON ENERGY STORAGE IN ORGANIC MATERIALS: THE CASE OF LINKED ANTHRACENES, Technical Report, Nov. 1, 1975-Dec. 31, 1976

Jones, G., II, Bergmark, W.R., Reinhardt, T.E., (Boston Univ., Boston, MA), AD-A039702 TR-6, N00014-76-C-0442, 32 pages, N77-31615
Avail:NTIS

Criteria for the photochemical storage of solar energy as latent heat are outlined. Energy storing valence isomerizations which may be driven by irradiation and which may be reversed by heating with or without a catalyst are described. Data for photoisomerizations which utilize 300 to 500 nm radiation with storage capacities of 50 to 250 cal/g and with storage efficiencies of five to ten percent are summarized. New data concerning linked anthracenes which photoisomerize with Phi = 0.20.4 are provided. A photocalorimeter for the measurement of storage enthalpies is described. New systems for the practical conversion of solar energy are suggested.

(LATENT-HEAT, ORGANIC-COMPOUNDS, PHOTOCHEMICAL STORAGE)

ST78 19025 MOTION ANALYSIS OF INTERLINKED ARTICULATED BODIES FLOATING AMONG SEA WAVES

Katory, M., (Br. Ship. Res. Assoc.), Nav. Archit., V 1:28-29, 3 refs, Jan. 1977, EDB-77:137734

An analytical procedure for the prediction of motion responses of multiply-connected bodies freely floating among sea waves is introduced below. This new theory is of interest to the offshore industry in general and to the design of wave power generators in particular. The analysis method can be used to deal with tow-out arrangements of offshore structures and with wave-contouring rafts intended as electrical power generators. The wave-contouring raft arrangement comprises a number of shallow-draughted constant cross-section barges connected to each other along their edges through straight hinges. The arrangement is then moored in a direction perpendicular to the predominant direction of progressing sea waves. The relative rotational displacement between the adjacent barges is converted into electrical potential through hydraulic pump circuits.

(BARGES-DESIGN, OFFSHORE-PLATFORMS, WAVE-POWER)

ST78 19026 TAPPING OCEAN WAVE ENERGY FOR POWERING GAS TURBINE PLANTS

Lastella, J., Gas Turbine World, V 5:38-40, May 1975, EDB-77:125000

A new device invented by M. Tornabene of the Amanda Machinery Co. converts random wave action into mechanical or electrical power. In combination with gas turbine-generators, it makes for an extremely efficient peaking plant and, with provision for energy storage during off-hours (possibly through water electrolysis for hydrogen production), for a baseload power plant. The device offers low cost, long service life, and low maintenance needs.

(CONVERTERS, WAVE-POWER)

ST73 19027 METHOD FOR INCREASING THE EFFICIENCY OF THE ELECTRIC GENERATING PROCESS

Levine, S.K., (Wind Harness Co., New York, NY), Energy LA: Tackling the Crisis, 1976, Ed: Robinson, J.W., Western Periodicals Company, North Hollywood, CA, EDB-77:137755

A heat source heats air which rises in a duct having at least a 100-m 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.

(COOLING-TOWERS, CONFIGURATION, HEAT-EXCHANGER, NATURAL-CONVECTION, WIND)

ST78 19028 SPACE POWER TECHNOLOGY APPLIED TO THE ENERGY PROBLEM

Miller, J.L., Morgan, J.R., (NASA, Marshall, Huntsville, AL), In Its Proc. of the ASPE-MSFC Symp. on Eng. and Productivity Gains from Space Technol., p. 257-269, N77-30273 21-31 N77-30294

A solution to the energy problem is suggested through the technology of photovoltaic electrolysis of water to generate hydrogen. Efficient solar devices are discussed in relation to available solar energy, and photovoltaic energy cost. It is concluded that photovoltaic electrolytic generation of hydrogen will be economically feasible in 1985.

(HYDROGEN-PRODUCTIVITY, PHOTOVOLTAIC ELECTROLYSIS, SOLAR-CELLS)

ST78 19029 ARRANGEMENT FOR THE CONVERSION OF NATURAL KINETIC ENERGY INTO USABLE POWER

Mossinsohn, Y., June 26, 1976, Patent no. 2,555,120/A, In German, EDB-77:111344

The arrangement according to invention consists of a series of so-called energy collector bodies, which are chained onto an endless ribbon. This is hung between two pulleys, that are arranged behind each other in the current direction and a convex surface in the opposite direction. One section of the ribbon is above and therefore outside the current source, the other inside. At least one of the pulleys is connected to a

conventional power producer, for example, an electric generator. The arrangement according to invention is to be used particularly in the wave breakers of the ocean coast.

(KINETIC-ENERGY, PATENT, POWER GENERATION, WAVE-POWER)

ST78 19030 HYDROGEN PRODUCTION FROM WATER UTILIZING SOLAR HEAT AT HIGH TEMPERATURES

Nakamura, T., (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tanashi, Tokyo, Japan), Solar Energy, V 19:467-475, N5, 14 refs, 1977, A77-50205

Possibilities of producing hydrogen and oxygen from water utilizing solar heat at high temperatures are investigated. The process of direct thermal decomposition of water is studied using a conceptual model. It is shown that the thermodynamic requirements for the direct thermal decomposer are difficult to realize from the structural viewpoint and that existing separation methods are not applicable for such a decomposition process if it is to attain sufficiently high thermal efficiencies. Feasibilities of realizing simple two-step thermochemical decomposition processes are investigated based on existing thermochemical data. It is predicted, as the results of thermochemical decomposition process, using iron oxide operates efficiently at relatively low temperatures attainable with solar heat and compatible with structural materials.

(FEASIBILITY-ANALYSIS, HYDROGEN-PRODUCTION, HIGH-TEMPERATURE, THERMOCHEMICAL-DECOMPOSITION)

ST78 19031 PRELIMINARY FEASIBILITY STUDY FOR UTILIZATION OF WATER WAVE ENERGY

Nath, J.H., Williams, R.M., (Delaware Univ., Newark, DE), (Oregon State Univ., Corvallis, OR), 1976, COO-2946-1, EDB-77:124996

The purpose of this study was to make a preliminary assessment of the latent wave energy in areas of the United States coastlines where wave energy plants may be located, and to examine the economics of construction and operation. This report presents the results of: an estimate for the total yearly energy content in ocean waves; an extimate for the annual cost of energy conversion, including construction and operating costs; an estimate of the cost-benefit ratio based on the sale price for electrical energy; and a very preliminary assessment of environmental impact from wave energy conversion devices.

(CONSTRUCTION, ECONOMICS, FEASIBILITY-STUDIES, UNITED-STATES, WAVE-POWER)

ST78 19032 PHOTOELECTROLYSIS

Nobe, K., Bauerle, G.L., Braun, M., (Univ. of California, Los Angeles, CA), J. Appl. Electrochem., V 7:379-382, N5, Sept. 1977, EDB-77:137381

The photoelectrochemical behavior of n-type TiO_2 in aqueous solutions was investigate investigated. Current-potential characteristics of polycrystalline TiO_2 and single crystals of TiO_2 of two different surface orientations (perpendicular and parallel to the "C" axis) were measured in the dark and under irradiation of a 150 W xenon lamp with an intensity of 20 percent of one sun. The rate of photo-induced oxygen evolution on TiO_2 anodes increased in the following order: polycrystal TiO_2, single crystal TiO_2 (perpendicular), single crystal TiO_2 (parallel). Photo-induced hydrogen evolution on p-type single crystal gaas was obtained with photocurrents associated with hydrogen evolution over an order of magnitude larger than those obtained for oxygen evolution on illuminated TiO_2. The wavelengths at the maxima in the spectral photoresponse of TiO_2 were as follows: polycrystal TiO_2, 3100 A; single crystal TiO_2 (perpendicular), 3250 A; single crystal TiO_2 (parallel), 3450 A. The maximum in the spectral photoresponse of gaas was at 6650 A. A photoelectrolysis cell, which consisted of an illuminated polycrystal TiO_2 anode and a pt cathode, developed photocurrents equivalent to about 0.1 MA CM^{-2} for an incident radiant power of one sun.

(ELECTROLYSIS, HYDROGEN-PRODUCTION)

ST78 19033 HYDROGEN AND ELECTRICITY FROM WATER AND LIGHT

Ohashi, K., McCann, J., Bockris, J.O'M., (South Australia, Flinders University, Adelaide, Australia), International Journal of Energy Research, V 1:259-277, July-Sept. 1977, A77-46609

Four self-driven photoelectrochemical hydrogen producers, n-TiO_2/p-CDTE, n-TiO_2/p-GAP, n-$SrTiO_3$/p-CDTE, and n-$SrTiO_3$/p-GAP, were constructed and examined in one-m NaOH. The current-potential curves of the individual electrodes and the current-cell voltage relationships were measured. Cell current-density measurements versus time demonstrated that the output of each cell is stable for at least 12H. The n-$SrTiO_3$/p-GAP cell under xenon light irradiation was the most efficient at 0.7 percent. The n-TiO_2/p-GAP cell was estimated as the most efficient under solar light at 0.1 percent. The stability of p-CDTE and its energy gap of 1.5ev make it a prospect for use as a photocathode in future photoelectrochemical hydrogen process.

(ELECTROCHEMICAL-CELLS, HYDROGEN-PRODUCTION, PHOTOELECTROCHEMICAL)

ST78 19034 CATHODES FOR PHOTODRIVEN HYDROGEN GENERATORS: ZNTE AND CDTE

Ohashi, K., Uosaki, K., Bockris, J.O'M., (Flinders Univ., Adelaide, Australia), Int. J. Energy Res., V 1:25-30, N1, 1977, EDB-77:144525

ZNTE (E_G 2.26EV) and CDTE (E_G 1.5ev) were studied as possible candidates ofr a photocathode in the photoelectrochemical production of hydrogen. Current-potential relationships with and without light, photocurrent-wavelength relationships at various potentials, and the flatband potential, were measured for both electrodes in 1 N NaOH solution. The stabilities of both electrodes in NaOH solution were also examined. CDTE is a possible photocathode, but ZNTE is unacceptable, because the photocurrent appears at a too-negative potential in relation to its negative flatband potential, and because of its low stability.

(ELECTROCHEMICAL-CELLS, ELECTROLYSIS, HYDROGEN-PRODUCTION, PHOTOCATHODES)

ST78 19035 POWER RESOURCE ESTIMATE OF OCEAN SURFACE WAVES

Panicker, N.N., (Woods Hole Oceanographic Institution, Woods Hole, MA), Ocean Eng., V 3: 429-439, N6, Dec. 1976, COO-2946-1, EDB-77:124999, Also EDB-77:124997

The distribution of wave energy and power as functions of longitude and latitude are presented for the Northern Hemisphere at 12Z, October 2, 1975. Both the large peak of the distribution in the Atlantic Ocean and the smaller peak in the Pacific Ocean are found to be at longitudes towards the eastern end of the ocean basins. This "Eastern Accumulation" of wave energy and power offers interesting contrast to the western intensification of currents. Distribution of wave power with latitude shows peaks of wave power in the mid-latitudes. The total surface wave energy in the seas of the world for the same time is estimated to be 1600 x 10^{15} J. The corresponding total wave power estimate is 90 x 10^{15} W. The rate of renewal of wave power is estimated to be 10^{12} - 10^{13} W, about the present level of world power consumption.

(ATLANTIC, MATH MODELS, MID-LATITUDES, PACIFIC, WAVE-POWER)

ST78 19036 TEMPORAL AND SPATIAL VARIABILITY OF POWER FROM OCEAN WAVES ALONG THE WEST COAST OF NORTH AMERICA

Pierson, W.J.Jr., Salfi, R.F., (Delaware Univ., Newark, DE), (CUNY Inst. of Marine and Atmospheric Sciences, New York, NY), 1976, COO-2946-1, EDB-77:124992

The applicability of computer-based numerical wave hindcasts to the calculation of the day to day variations of available wave power off the West Coast of North America is illustrated. The limited data base will be greatly improved in a few more years if present plans mature. The techniques can eventually be extended to the world ocean. The results show that available wave power is highly variable on a day to day basis and from winter to summer for the grid points that were studied. Other locations would be much less variable. Various trade-off and design considerations have been mentioned that may serve as a guide in pursuing these matters further.

(COMPUTER-CALCULATIONS, PACIFIC, POWER-POTENTIAL, WAVE-POWER)

ST78 19037 AN ASSESSMENT OF HYDROGEN AS A MEANS TO STORE SOLAR ENERGY

Ramakumar, R., (Oklahoma State University, Stillwater, OK), In Sharing the Sun: Solar Technology in the Seventies; Proceedings of the Joint Conference, Winnipeg, Canada, V 8:163-175, 28 refs, Aug. 15-20, 1976, International Solar Energy Society, Cape Canaveral, FL, ERDA-supported research, EDB-77:131084, A77-49107

A brief review and assessment of the use of hydrogen as a means to store solar energy is presented. Electrolytic and non-electrolytic methods proposed for hydrogen production from solar energy, hydrogen storage methods, and utilization techniques are surveyed. Overall system concepts with several manifestations of solar energy as inputs are discussed along with their efviciencies and economic aspects.

(ECONOMICS, ELECTROLYTIC, HYDROGEN PRODUCTION, NON-ELECTROLYTIC, STORAGE)

ST78 19038 OBSERVATIONS OF THE POWER AND DIRECTIONAL SPECTRUM OF OCEAN SURFACE WAVES

Regier, L.A., (MIT, Cambridge, MA), Davis, R.E., (California University, La Jolla, CA), Journal of Marine Research, V 35:433-451, Aug. 1977, A77-47272

No abstract available

(WATER-CURRENTS, WAVE-POWER, WIND-EFFECTS)

ST78 19039 HYDROGEN QUANTUM YIELDS IN THE 360 NM PHOTOLYSIS OF EU/2+ SOLUTIONS AND THEIR RELATIONSHIP TO PHOTOCHEMICAL FUEL FORMATION

Ryason, P.R., (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), Solar Energy, V 19:445-448, N5, 1977, NAS7-100, A77-50203

Water decomposition by a cyclic photoredox process is discussed in general terms. Thermodynamics determines the wavelength of the charge-transfer band corresponding to electron transfer to or from water of hydration of a cation. These relationships indicate that it is unlikely that a photoreduction reaction resulting in water decomposition will occur in the sea-level solar range of wavelengths. Such is not the case for photo-oxidation, and an example is known: the photolysis of EU (2+) in aqueous solution. Hydrogen quantum yields have been determined for this reaction. They are sufficiently high (about 0.3) as to offer encouragement for the further exploration of photoredox reactions as a means of solar energy conversion.

(CYCLIC PHOTOREDOX, HYDROGEN-PRODUCTION, PHOTO-OXIDATION)

ST78 19040 HYDROGEN ENERGY-ITS POTENTIAL PROMISES AND PROMISES

Sauter, G.D., (Univ. of California, Lawrence Livermore Lab., Lawrence, CA), World Hydrogen Energy Conf. Proceedings, 1st, Miami Beach, FL, V 3:5-12, March 1-3, 1976, Sess. 1C, Pub. by Univ. of Miami, Coral Gables, FL

Hydrogen represents a means for facilitating the transmission, storage, and utilization of energy which potentially can be coupled to a variety of primary sources. This paper presents the author's opinions regarding the potential promises and problems of hydrogen energy.

(FEASIBILITY-STUDY, HYDROGEN FUELS)

ST78 19041 AFTER GAS, AUSTRALIAN NORTHWEST OFFERS TIDAL WAVE ENERGY

Scott, W.E., Energy Int., V 14:22-24, N6, June 1977, EDB-77:119787

Tidal power and ocean currents in Australia are estimated to have the potential for a series of integrated northwestern coastal plants to produce 400 TWH, enough for domestic use and a significant quantity for export. The concept has the advantages of environmental acceptability, the opportunity to free conventional energy resources for export, employment opportunities, a capacity to produce hydrogen and oxygen, anticipated revenues in excess of capital costs, and an inexhaustible energy source. The ebb and flow of tides can be used in inlet and bay areas by installing turbines with reversible propellers. Where this is not feasible, a tidal paddle wheel on a floating platform offers a low capital cost. Anchored semi-submersible large-diameter turbines are under study for generating electricity form slow-moving ocean streams. An integrated system, dependent on the timing of tidal movements, could offer continuous production. Power transmission to the integration unit and then to centers of use will result in as much as 35 percent loss. Schemes to ship hydrogen and water for recombination and conversion to electrical energy or to convert to methanol introduce costs and environmental problems, while microwave transmission has technical requirements to be met. Submarine cable appears to be the most logical method for short distances.

(AUSTRALIA, ECONOMICS, ENVIRONMENTAL, POWER-TRANSMISSION, SITE-SELECTION, SOCIAL-IMPACT, TIDAL-POWER, WAVE-POWER)

ST78 19042 TIDAL POWER

Shaw, T.L., (Univ. of Bristol, Bristol, England), Chem. Eng., London, England, V 313: 592-594,611, Sept. 1976, EDB-77:118380

Prospects for the utilization of tidal power in the United Kingdom are examined from the standpoint of basic resources, economics, state of the technology, and environmental considerations.

(ECONOMICS, ENVIRONMENTAL-IMPACT, UNITED KINGDOM)

ST78 19043 DESIGN OF PENSTOCK WYES FOR THE BASI HYDRO STATION

Singhota, J.S., Goyal, M.R., (Bhakra Beas. Management Board, Chandigarh, India), Int. Water Power Dam Constr., V 29:42-46, N6, June 1977, EDB-77:137423

The tailrace waters from the Shannan Powerhouse, near Jogindernagar in Himachal Pradesh, India, are being used for further power generation in another cascade power-house at Basi. The tailrace waters at Shannan are taken by a power flume tailing into a diurnal balancing reservoir. A 1753 mm-diameter penstock designed for a discharge of 11.33 m^3/s carries flow from the reservoir to the Basi Powerhouse about 1100 m away. The penstock is of welded steel pipe construction, supported at bends by concrete anchor blocks, and at intermediate points by concrete saddle supports. An expansion joint has been provided between every two consecutive anchor blocks. At lower levels, the penstock diameter is reduced to 1524 mm, to use the available plate thickness. Near the power-house this 1524

mm-diameter penstock bifurcates into two 1219 mm-diameter ranches, which feed the two units in the power-house. A 1219 mm-diameter branch pipe has also been taken from the main penstock to feed the stand-by unit. In view of the facilities available, it was decided to manufacture the WYES from plate steel. The plate thickness used for the penstock varied from 9 mm to 41 mm. The foreign exchange component for the project being limited, most of the steel was obtained from indigenous sources. Some 41 mm-thick plates became available as spare from Bhakra penstocks which had just been completed. This was the maximum thickness of the plate available for the Basi penstock. The WYE's made of plate steel require either internal or external reinforcement at the junctions. Internal reinforcement is in the shape of a web, and for external reinforcement, curved girders are provided at the junction.

(FLOW-REGULATORS, HYDROELECTRIC-POWER, INDIA, SITE-SELECTION, WAVE-POWER)

ST78 19044 RECOVERABLE WAVE POWER CONCEPTS

Slotta, L.S., (Delaware Univ., Newark, DE), (Slotta Engineering Associates, Inc., Corvallis, OR), 1976, COO-2946-1, EDB-77:124995

A presentation is made of a number of available wave energy conversion devices, oceanic water wave power locations of associated high power density areas, and some concepts for amplifying ocean waves for increased power.

(FEASIBILITY-STUDIES, SITE-SELECTION)

ST78 19045 PROSPECTS FOR HYDROGEN PRODUCTION BY WATER ELECTROLYSIS TO BE COMPETITIVE WITH CONVENTIONAL METHODS

Srinivasan, S., Salzano, F.J., (Brookhaven Nat'l Lab., Upton, NY), World Hydrogen Energy Conf. Proc., 1st, Miami Beach, FL, V 2:23-27, 14 refs, March 1-3, 1976, Sess. 6B, Pub. by Univ. of Miami, Coral Gables, FL

With the impending unavailability of oil and natural gas, hydrogen will be produced on a large scale in the United States (1) from coal. or (2) by water electrolysis using electricity derived from nuclear or solar energy. The cost of purification of hydrogen produced from fossil fuels will increase its costs to about the same level as that of electrolytic hydrogen. Areas of research, which will be necessary to achieve the goals, are reviewed. The General Electric Solid Polymer Water Electrolyzer and Teledyne Alkaline Water Electrolysis Cells, both operating at about 120 to 150 C, look most promising in achieving the goals of low capital cost and high energy efficiency.

(FUEL-CELL, HYDROGEN-PRODUCTION)

ST78 19046 PUMPING POWER GENERATION USING SOLAR ENERGY, HOT SPRING WATER, FACTORY WASTE WATER, AND POWER STATION THERMAL EFFLUENT

Tanaka, T., July 10, 1975, Patent no. 1952-85,742, In Japanese, EDB-77:127380

Using hot spring water, factory waste water, solar energy, and atomic power plant thermal effluent, heat-exchangeable organic media or liquefied gases are heated and vaporized. The vapor is then sent ot a pressure tank filled with river water or sea water. The pressurized water is forced through conduit to a tank located in a high place and flows down again to drive a turbine for power generation. The water can be reused after providing motive force for the turbine.

(PATENT, PUMPED STORAGE, THERMAL-EFFLUENTS)

ST78 19047 METHOD OF WATER PUMPING AND PUMPING POWER GENERATION USING THERMAL FACTORY EFFLUENT, HOT SPRING WATER, AND SOLAR ENERGY

Tanaka, T., Dec. 19, 1975, Patent no. 1950-157,743, In Japanese, EDB-77:127379

Through the combined utilization of hot spring water, factory thermal effluent, and solar energy, a low-temperature vaporizing medium provides the force to raise water to elevated storage. The water is used to drive a turbine which provides electrical energy for the desalination of sea water by electrolytic ionic exchange of dolomite or by other methods. The waste water can be recycled.

(DESALINATION, ELECTROLYTIC IONIC-EXCHANGE, PATENT, PUMPED STORAGE, THERMAL-EFFLUENTS)

ST78 19048 FLUID CURRENT TURBINE WITH FLEXIBLE COLLECTORS

Thompson, D.F., Mouton, W.J.Jr., May 24, 1977, US Patent no. 4,025,220, EDB-77:111130

The invention relates to a fluid-current energy-conversion plant, especially useful for electricity generation, utilizing an axial-flow turbine as the energy conversion element, having self-inflated flexible collector elements for capturing a portion of the fluid current, increasing its velocity, guiding at least some of each portion into the turbine's mouth, then returning the captured flow into the stream.

(PATENT, TURBINE-DESIGN, WATER-CURRENT POWER)

ST78 19049 WAVE MOTOR COMPRISED OF A SUBMERGED FLOATING NETWORK OF CHAMBERS FORMED BY WALLS PERMITTING VARIABLE GEOMETRY

Tornkvist, R.E.A., July 19, 1977, US Patent no. 4,036,563, EDB-77:144886
A wave-energy transformer for transformation of wave-energy into pressure energy of water in a pipe system is described. The transformer consists of a submerged space network of chambers at least partially closed by walls pivoted to adjacent walls. The walls are deformable due to the action of the waves. At least two of said deformable walls in each chamber are connected to at least one pumping means for pumping water into said pipe system owing to the deformation of said walls.

(PATENT, PUMPS, WAVE-POWER)

ST78 19050 ENERGY SAVINGS THROUGH ON-SITE FUEL CELLS IN INDUSTRIAL APPLICATIONS

Voelker, G.E., (ERDA, Fuel Cell Branch, Washington, D.C.), Bolan, P., (United Technologies Corp., Power Systems Div., Farmington, CT), In Intersociety Energy Conversion Engineering Conference Proceedings, 12th, Washington, D.C., V 1:456-460, Aug. 28Sept. 2, 1977, A77-48701 23-44, American Nuclear Society, Inc., La Grange Park, IL, A77-48752
Cogeneration with electric generating equipment located or near the load rather then centrally sited can provide important means of conserving energy resources. The energy savings which could be achieved in certian industrial applications by use of on-site fuel cell power plants have been examined. Twelve industrial processes were selected for study. A fuel cell system was specified for each of the 12 selected industrial processes and energy resource consumption was determined in each case. Eleven of the 12 applications used recovered heat as well as the electricity produced by the fuel cell. In six cases, process by-product fuel was used and in four processes, direct current electricity was provided. When compared with traditional energy resource consumption in each process, significant potential savings were found in all cases. In five of the processes studied, savings exceeded 20 percent. Overall, for the 12 processes investigated, extensive use of on-site fuel cell systems could result in resource of 190,000 barrels of oil (equivalent) per day.

(COGENERATION, HYDROGEN-FUELS)

ST78 19051 TIDAL ENERGY AND SYSTEM PLANNING

Wilson, E.M., (Univ. of Salford, Salford, England), Consult. Eng., London, England, V 41: 25, N4, Aptil 1977, EDB-77:131210
A different approach to look to the system to do the necessary regulation of the tidal scheme's energy production is discussed. Variation in cost/KWH of energy sent out from various sources at varying load factors is presented graphically.

(LOAD-FACTORS, PUMPED-STORAGE, TIDAL-POWER)

ST78 19052 CONFERENCE ON INORGANIC PHOTOCHEMISTRY RELATED TO TRANSFER, STORAGE, CONSERVATION, AND CONVERSION OF ENERGY, HELD AT DULLES MARRIOTT HOTEL, Washington, D.C., June 5, 6, 1975

Wrighton,, M.S., (Massachusetts Inst. of Tech., Cambridge, MA), (NSF, Washington, D.C.) 33 pages, 1975, NSF-MPS75-15668, NSF-ERG-75-24, PB-263 923-5ST
Key objectives of this conference were to identify areas of fundamental research in inorganic and organometallic photochemistry related to energy conversion problems and to frame a set of recommendations in order to stimulate activity in the most promising areas. Additionally, emphasis was placed on identifying research activities in this growing field that would lead to significant advances in the areas of chemical synthesis and catalysis. As a result of the discussions at the conference, eight research areas were agreed upon as inorganic photochemistry: (1)photoreactions leading to the production of high-energy materials, (2)new stiochiometric photoreactions, (3)photoelectrochemistry, (4)electronic structure of organometallics, (5)kinetics and mechanisms associated with excited states and reactive intermediates, (6)properties and structure of excited states, (7)theory for qualitative understanding of excited state processes, and (8)photocatalysis and photo-assistance.

(ENERGY STORAGE, INORGANIC, PHOTOCHEMICAL)

ST78 19053 IRON OXIDE SEMICONDUCTOR ELECTRODES IN PHOTOASSISTED ELECTROLYSIS OF WATER

Yeh, L.S.R., Hackerman, N., (Rice Univ., Houston, TX), J. Electrochem. Soc., V 124:833-836, N6, June 1977, EDB-77:118038
The preparation of polycrystalline n-type iron oxide electrodes by heating of iron samples in air is reported. The behavior of these electrodes in aqueous solutions of different ph values in the presence and absence of illumination is shown. The photocurrent response of these electrodes to all wavelengths in the visible region is seen. Photo-assisted electrolysis of water occurs at these wavelengths resulting in the evolution of

oxygen bubbles at the iron oxide electrodes with no niticeable corrosion problems in ph 40 acetate buffer to 5.5 m KOH solutions.

(HYDROGEN-PRODUCTION, PHOTOCURRENT-RESPONSE, PHOTOLYSIS)

ST78 19054 ENVIRONMENTAL EFFECTS ARISING FROM SALINITY GRADIENT AND OCEAN WAVE POWER GENERATING PLANTS

Zeigler, J.M., Hyer, P.V., Wass, M.L., (Delaware Univ., Newark, DE), (Virginia Inst. of Marine Science, Gloucester Point, VA), 1976, COO-2946-1, EDB-77:124991

The environmental effects of salinity gradient and wave power generating plants are discussed in the following areas: temperature impacts, salinity impacts, additives, fresh water needs, direct impacts, site specific impacts, and air quality and aesthetics.

(SITE-SELECTION)

AUTHOR INDEX

AGSTEN, C.F.	016000
AHMED, S.	010015
AITKEN, D.W.	011006
AITKEN, D.W.	011005
ALBERTSON, V.D.	013036
ALICH, J.A., JR.	017003
ALTER, H.	017004
ANDERSON, B.	012015
ANDERSON, B.N.	017005
ANDERSON, D.E.	013003
ANDERSON, H.H.	015000
ANDERSON, W.D.	016038
ANDREN, R.K.	017006
ARANUVACHAPUN, S.	019001
ARGUE, R.	011032
ARMSTRONG, J.E.	010016
ARMSTRONG, W.C.	010017
ARONSON, E.A.	013021
ASHLEY, H.	016001
ASKIN, A.B.	012001
AUER, W.W.	011021
AVERY, W.H.	015003
AVERY, W.H.	015020
AYRES, E.L.	013053
AYRES, B.L.	013052
BAKER, R.W.	016002
BANKS, R.	013004
BARBIERI, R.	012016
BARD, A.J.	019020
BARFIELD, E.F.	012002
BARTEL, J.J.	013032
BARTERA, R.	012016
BAUERLE, G.	013005
BAUERLE, G.L.	019032
BAUERMEISTER, K.	010018
BEACHLEY, R.W.	012003
BEATTIE, D A*	010019
BEAUDET, J.H.	012023
BECK, C.	017010
BEECHER, M.E.	011007
BEHRENDT, V.	019002
BENEMANN, J.R.	017027
BENNINGTON, G.	011008
BERDAHL, P.	011009
BERGLES, A.E.	015001
BERGMARK, W.R.	019024
BETHEL, J.S.	017001
BETHEL, J.S.	017000
BEVERLY, W.D.	013006
BEZDEK, R.H.	012004
BIANCARDI, F.R.	013007
BIEDERMAN, N.	015011
BIEDERMAN, N.	015010

BIEDERMAN, N.	015031
BIEDERMAN, N.	015030
BIEDERMAN, N.P.	019016
BIGGS, F.	013009
BIGGS, F.	013008
BINNS, W.P.	012005
BITTERLICH, E.	013010
BLACKSHEAR, P.L.	013056
BLACKSHEAR, P.L., JR.	013067
BLACKWELL, B.F.	016003
BLACKWELL, B.F.	016005
BLACKWELL, B.F.	016004
BLAHA, R.	016064
BLAIR, J.F., JR.	012006
BLAKE, F.A.	013011
BLAKE, F.A.	013076
BLANCHARD, W.A.	016067
BLANK, Z.	013047
BLASY, J.A.	011039
BLAZEK, C.	015030
BLEVINS, R.W.	015020
BLIGH, T.P.	013036
BOCKRIS, J.O.M.	019003
BOCKRIS, J.O.M.	019033
BOCKRIS, J.O.M.	019034
BOER, K.W.	013066
BOER, K.W.	013082
BOER, K.W.	011051
BOER, K.W.	011005
BOGAN, F.H..	017007
BOLAN, P.	019050
BOOBAR, M.G.	011010
BORCVANSKY, V.T.	011011
BOSSEL, U.	011012
BOSSEL, U.	013012
BOSTIAN, H.E.	010020
BOSTIC, C.E., JR.	011013
BOURGEOIS, S.V.	010044
BOWEN, J.C.	011014
BOWONDER, B.	010021
BRAMLETTE, T.T.	013050
BRAMLETTER, T.T.	013032
BRANDSTETTER, A.	014000
BRANNON, P.J.	012007
BRAUN, M.	019032
BREESE, J.	012015
BROUSSAUD, A.	017008
BROWN, C.K.	016029
BRUCE, R.W.	013031
BRUNE, J.M.	013024
BRUNS, F.H.	013014
BUDENHOLZER, R.A.	010022
BUECHE, A.M.	010023

BURRELL, T.	011052
BUTLER, E.L.	013060
BUTLER, E.L.	016005
BUTLER, M.A.	019005
BUTT, S.H.	012008
CALVIN, M.	011015
CAPUTO, R.	013016
CAPUTO, R.	013015
CARTER, R.	018004
CASELLA, A.J.	012002
CATANIA, P.J.	011016
CAVALERI, L.	019006
CENTRELL, J.S.	011017
CHANG, T.Y.P.	016071
CHARD, R.A.	011018
CHATEL, E.	011019
CHATTERJEE, K.S.	010024
CHEN, E.	013082
CHERRY, N.J.	016006
CHERRY, W.R.	011020
CHERRY, W.R.	011021
CHUBB, T.A.	013017
CHUBB, T.A.	013058
CHUN, L.	017010
CHUNG, D.	013005
CHURCH, R.W.	012007
CLARK, R.H.	019007
COBBLE, M.H.	014001
COCKSHUTT, E.P.	010025
CONNELLY, C.J.	015029
COOK, G.E.	013055
COOK, J.	011022
COONLEY, D.R.	016007
CORCTIS, R.B.	016008
COSTOGUE, E.N.	011023
COTY, U.	016009
COTY, U.	016012
COTY, U.	016011
COTY, U.A.	016010
COUNT, B.M.	019013
COURT, A.	016013
CRAWFORD, E.	012009
CROMACK, D.E.	016014
CROUZET-PASCAL, J.	016015
CURRY, G.L.	012022
CURTNER, K.L.	013029
CZIKK, A.M.	015002
DARROW, K.G., JR.	019016
DAVIS, J.M.	011024
DAVIS, R.E.	019038
DAYAN, J.	013018
DAYTON, D.S.	012010
DE CARVALHO, A.V., JR	013048

DE WINTER, F. 011026
DELL, A. 012011
DEMICHELLE, D.W. 012022
DENTON, F. 011025
DERVY, A.J. 019008
DEUTCH, M.J. 012012
DEUTCH, M.J. 012013
DEVINE, W.D., JR. 016016
DIAZ, L.F. 017016
DIGGS, R.E. 019009
DIGGS, R.E. 016017
DIKAREVA, R.P. 013019
DIKKERS, R.D. 012014
DIX, S. 013020
DODD, H.M., JR. 013021
DONHAM, F.E. 016038
DOWNING, C.G.E. 017028
DROTNING, W.D. 013022
DRUMMOND, J.E. 018000
DUBEY, M. 016011
DUBEY, M. 016018
DUGGER, G.L. 015003
DUGGER, G.L. 015020
DUNBAR, J.G. 015029
DUNWOODY, J.E. 012028
EBERHARDT, A. 019010
EDENBURN, M.W. 013023
EGGERS, A.J., JR. 011027
EGGERS, G. 013070
EGGERS, G.H. 013069
EICHELBERGER, J.L. 013025
EICKER, F.J. 013024
ELGABALAWI, N. 013026
EMRICH, W. 013070
ENGLE, W.W. 013006
ERVIN, G. 013005
ERVIN, G. 013027
FEDERMANN, E.F. 018001
FELDMAN, S.L. 012015
FELTZ, L.V. 016003
FENNER, G.W. 015002
FENTON, J.W. 016071
FERDINANDE, V. 019011
FERRARA, A. 013028
FETKOVICH, J.G. 015004
FILLE, R.B. 016019
FINE, R. 011029
FISH, L.W. 015015
FLACK, P. 011030
FLETCHER, E.A. 019012
FLORSCHUETZ, L.W. 013002
FOH, S. 015030
FOREMAN, K.M. 016023

FORESTIERI, A.F.	018003
FOSS, A.S.	013018
FOSTER, H.D.	011031
FOURAKIS, E.	013030
FOURAKIS, E.M.	013029
FRANCIS, E.J.	015003
FRASER, M.C.	017027
FREEMAN, B.E.	016020
FRENCH, E.P.	011032
FRIEDLANDER, G.D.	010027
FRIEDLANDER, G.D.	010026
FRIEFELD, J.M.	013031
FRY, D.J.	015009
FUJITA, T.	013049
FULLER, D.R.	017031
FULLER, F.B.	010028
FURUKAWA, T.	010029
GAGE, S.J.	010030
GALAZEN, T.	016021
GANDEL, M.G.	011064
GARDNER, J.L.	010031
GARMAN, F.L.	012001
GEBBEN, V.D.	016022
GERVAIS, R.L.	013031
GESSER, H.D.	017009
GILBERT, B.L.	016023
GILL, G.S.	012029
GILLMAN, H.D.	013025
GLASGOW, J.	016038
GLENDENNING, I.	019014
GLENDENNING, I.	019013
GORE, E.	010045
GORHAM, F.S., JR.	011033
GOYAL, M.R.	019043
GRANNEMANN, G.N.	015004
GRAY, D.C.	013033
GREEN, R.M.	013032
GREENFELDT, N.L.	015007
GREGORY, D.P.	019016
GREGORY, D.P.	019015
GRETHER, D.	011009
GROSSKREUTZ, J.C.	013033
GRUEN, D.M.	013034
GUBO, E.	019017
GUON, J.	013005
GWYNN, J.D.	019018
HAACK, B.N.	016025
HABER, C.J.	018004
HACKERMAN, N.	019053
HAGEL, J., III	010032
HAGGERTY, J.J.	010033
HAMERAK, K.	019019
HAMILTON, C.L.	013035

HARDEE, K.L. 019020
HARDY, C.M. 016027
HARDY, C.M. 016026
HARDY, M.P. 013036
HARGRAVES, W.R. 016035
HARLEMEN, D.R.F. 015009
HARMER, C.H. 017027
HARPER, A.D. 013037
HARRENSTIEN, H.P. 015005
HARTFIEL, D.J. 012022
HASLETT, R. 013028
HATHAWAY, G. 011052
HAUSER, L.G. 010034
HAUSZ, W. 013052
HAUSZ, W. 013053
HAUTALA, R.R. 019021
HEATH, S.D. 011035
HENRY, J.F. 017027
HENRY, J.F. 017029
HERCNEMUS, W.E. 016014
HERRERA, G. 016028
HERWIG, L.C. 011037
HERWIG, L.C. 011036
HERWIG, L.C. 011038
HETYEI, S.A. 015006
HIGGIN, R.M. 016029
HILDEBRANDT, A.F. 013038
HILL, R.F. 010035
HIROTA, H. 010036
HIRSCH, R.L. 011039
HIRSCHFELD, F. 016030
HIRSHBERT, A. 012016
HIRST, P. 016031
HOCKETT, R.S. 013039
HOFFMAN, H.L. 010041
HOGAN, W. 012017
HOLLANDS, K.G.T. 012025
HORIZONTAL-AXIS, VERTICAL-AXIS 016068
HORSTHEMKE, A. 013040
HUBERT, W.E. 015007
HUDSPETH, R.T. 019022
HUEBER, A. 012018
HUETTER, U. 016032
HUG, R. 016033
HYER, P.V. 019054
INGRAM, H.M. 013053
INGRAM, H.M. 013052
INMAN, R.E. 017011
IQBAL, K.Z. 015015
ISAACS, J.C. 019023
ISSHIKI, N. 013041
JAMES, A.L. 015008
JANETZKE, D.C. 016060

JAUMOTTE, A.L.	011041
JENSEN, G.A.	015024
JENSEN, G.A.	015023
JENSEN, M.K.	015001
JIRKA, G.H.	015009
JIRSAK, T.	011042
JOHANSON, E.E.	016034
JOHNSON, C.C.	016059
JOHNSON, G.R.	013026
JOHNSON, J.A.	019001
JOHNSON, R.P.	015009
JOHNSON, T.L.	013042
JONES, G., II.	019024
JONES, F.E.	015022
JONES, R.A.	010037
JONES, T.E.	013055
JORDAN, D.	016059
JOYCE, J.P.	013043
JURGENSEN, M.F.	017012
JUSTUS, C.G.	016035
JUSTUS, C.G.	016036
KATORY, M.	019025
KATZ, E.L.	013081
KEELER, J.S.	010037
KEENAN, J.D.	017013
KELLER, M.	017010
KISPERT, R.G.	017014
KITAMURA, N.	011043
KLEINKAUF, W.	011044
KLYCHEV, S.I.	013084
KNIGHT, D.C.	011045
KONOPKA, A.	015010
KONOPKA, A.	015030
KONOPKA, A.	015031
KONOPKA, A.J.	015011
KONOPKA, A.J.	019016
KRATNER, K.L.	010038
KRAUSS, R.H.	013044
KROEKER, E.J.	017023
KROTH, G.J.	016037
KYLE, M.L.	010039
LAGACE, G.L.	012001
LAMBERT, D.F.	010041
LANDECKER, K.	014003
LANDECKER, K.	014002
LANSING, F.L.	013045
LAPP, H.M.	017023
LASTELLA, J.	019026
LAVAN, Z.	010022
LAVI, A.	015012
LAVI, A.	015014
LAVI, A.	015013
LAWRENCE, J.	016059

LAWSON, C.A.	015015
LEFROIS, R.T.	013046
LEONARD, J.A.	013000
LEPLEY, M.	015016
LEVINE, S.K.	019027
LEWIN, F.	017015
LIBOWITZ, G.G.	013047
LIGON, C.	016059
LIIKALA, R.	018004
LIMA VERDE LEAL, M.R.	013048
LINDEN, F.R.	012026
LINDENA, S.	011023
LINGWALL, J.	012016
LINSCOTT, B.S.	016038
LIPINSKY, E.S.	017017
LIPINSKY, E.S.	017016
LITTLE, J.	019021
LORSCH, F.G.	012020
LORSCH, F.G.	012021
LOTH, J.L.	016033
LUNA, R.E.	012007
LYNN, S.	013018
LYON, R.N.	015017
LYON, R.N.	015028
MACCRACKEN, M.C.	013065
MAEKAWA, Y.	013041
MAGNOLI, D.	013048
MAHONY, F.O.	013006
MAILLE, E.	012023
MALLOY, A.J.	012001
MALVER, F.S.	016039
MANINGER, R.C.	011047
MANINGER, R.C.	011046
MANN, J.E.	012022
MANVI, R.	013049
MAR, R.W.	013050
MARIANOWSKI, L.G.	013051
MARLAND, G.	015025
MARSCHALL, E.	013040
MARTIN, M.	011009
MARU, H.C.	013051
MARVIN, F.H.	011039
MASSA, C.G.	017033
MAUGHMER, M.D.	016064
MAUGHMER, M.D.	016040
MAYCOCK, P.D.	012004
MAYER, E.R.	011048
MAYO, L.H.	016041
MCBRIDE, E.J.	013033
MCCANN, J.	019033
MCCLONEY, W.R.	015005
MCCONNELL, R.D.	012023
MCCUMBER, W.H., JR.	012024

MCDONALD, R.C.	017032
MCFARLAND, B.L.	011010
MCGOWAN, J.G.	016014
MCKENZIE, A.W.	013031
MCKETTA, J.J.	010041
MCKIE, W.R.	013073
MEADER, M.D.	013007
MEIER, D.L.	015004
MELISS, M.	011049
MELISS, M.	011056
METZ, W.D.	016042
MEYER, C.E.	013052
MEYER, C.F.	013053
MEYER, H.	011050
MEYERS, A.C., III	011051
MICCOLIS, J.M.F.	010042
MICHEL, J.W.	015018
MIDDLETON, P.	011052
MILFONT, W.N., JR.	017033
MILLER, C.R.	016063
MILLER, J.L.	019023
MINARCIN, D.	012011
MITCHELL, P.D.	013030
MITCHELL, P.D.	013029
MITCHELL, R.C.	013054
MOELLER, G.L.	010045
MOESTA, H.	011053
MOLZ, F.J.	013055
MORAN, K.E.	016043
MOPASH, R.T.	016044
MORGAN, G.R.	013054
MORGAN, J.R.	019028
MORSE, F.H.	011055
MORSE, F.H.	011054
MOSSINSOHN, Y.	019029
MOURNIGHAN, R.E.	010020
MOUTON, W.J., JR.	019048
MUNCHMEYER, F.C.	015004
MURATA, D.	017010
MURPHY, D.W.	015008
MURPHY, L.M.	013056
MUSGROVE, P.J.	016045
NAEF, F.E.	015019
NAKAMURA, T.	019030
NALBANDIAN, S.J.	011010
NASBY, R.D.	019005
NASSAR, E.M.	016046
NATH, J.H.	019031
NAY, M.W., JR.	011024
NEARHOOF, S.	018001
NELSON, D.	016023
NELSON, S.H.	013057
NEMECEK, J.J.	013058

NEMECEK, J.J.	013017
NEUMAN, C.F.	015006
NILAND, F.	011006
NIXON, W.B.	016064
NOBE, K.	019032
NOTARO, F.	015002
NYSTROM, J.M.	017006
O'BRIEN, J.	012006
OESTERWIND, D.	011056
OFFENHARTZ, P.O.	013059
OHASHI, K.	019033
OHASHI, K.	019034
OLSEN, H.L.	015021
OLSON, H.L.	015020
OLSZEWSKI, M.	017013
OMAN, R.A.	016023
OPENSHAW, F.	013070
ORGILL, J.F.	012025
ORGILL, M.M.	016047
OSTROVSKI, C.M.	017019
OSTROZYNSKI, R.L.	015022
OSWALD, W.J.	017027
OTTESEN, D.K.	013032
OVEROM, L.C.	016039
PALMEDO, P.F.	010043
PANDOLFINI, P.P.	015021
PANDOLFINI, P.P.	015020
PANICKER, N.N.	019035
PARENT, J.C.	012026
PARR, H.	011060
PATNAIK, P.C.	016020
PATTON, J.T.	017012
PAYNE, P.R.	016048
PENNY, M.M.	010044
PERRIGO, L.D.	015024
PERRIGO, L.D.	015023
PERRY, A.M.	015025
PETERS, N.	017019
PETTIT, F.B.	013060
PFANNKUCH, H.O.	013067
PFEFFER, J.T.	017020
PHILLIPS, G.T.	016020
PIACSEK, S.A.	015026
PICHE, B.	012023
PIEPER, W.	013061
PIERSON, W.J., JR.	019036
PITTMAN, P.F.	013001
POGANY, C.Z.	012028
PONDER, T.C.	010041
PONS, R.L.	013062
POPOV, A.G.	013063
POPPENDIEK, H.F.	015029
POSNANSKY, M.	013064

POTTER, G.L. 013065
POWELL, J.C. 013066
POWER, J.N. 012029
QUADE, R.N. 013079
QUINN, R.K. 019005
QURESHI, A.S. 010045
RAMACHANDRAN, A. 010046
RAMAKUMAR, R. 011057
RAMAKUMAR, R. 013037
RAMAKUMAR, R. 016049
RAMSDELL, J.V. 016050
RANDALL, D.E. 011058
RANGI, R.S. 016051
RAO, K.R. 014004
RATAJCZAK, A.F. 018003
REDSTAD, J. 011060
REED, J.W. 016054
REED, J.W. 016053
REED, J.W. 016052
REES, D.F. 016031
REGIER, L.A. 019038
REINHARD, K. 011059
REINHARDT, T.E. 019024
RESIO, D.T. 016055
REUTER, R.C., JRR. 016056
REYNOLDS, G.F. 010047
RIAZ, M. 013067
RIAZ, M. 013036
RICE, J.L. 015021
RICHARDS, T.R. 016060
RICHTER, R. 013068
RITTELMANN, P.R. 018001
ROBERTS, G.C. 015026
ROBERTSON, S.E. 017021
ROBIEUX, J. 011061
ROHATGI, P.K. 010021
ROTHFUS, R.R. 015027
ROTHFUS, R.R. 015014
ROZELL, D.K. 011006
RUBIN, A.M. 015028
RUSSEL, J.L., JR. 013069
RUSSELL, J.L., JR. 013070
RYASON, P.R. 019039
SABEL, W. 017022
SABIN, C.M. 015029
SADDY, M. 013048
SADEK, S.E. 017014
SAILWING, WINDMILL, ROTOR 016040
SALFI, R.F. 019036
SALVESEN, K. 017010
SALZANO, F.J. 019045
SAMOILOV, E.M. 013019
SAMOILOVA, A.Y. 013019

SANDERS, J.P.	010048
SARCO, E.	016067
SAUTER, G.C.	019040
SCAVUZZO, R.J.	016071
SCHMIESING, R.L.	011024
SCHMITT, W.R.	019023
SCHNITZMEYER, J.H.	013073
SCHOELL, G.	013071
SCHOEN, R.	011062
SCHOEN, R.	012016
SCHOLER, N.E.	010049
SCHOLL, M.	011008
SCHOLTEN, W.B.	017027
SCHULTE, D.D.	017023
SCHUSTER, J.R.	013069
SCIGLIANO, A.	017033
SCOTT, J.E.	011063
SCOTT, R.W.	010041
SCOTT, W.E.	019041
SEARS, D.R.	011064
SELIGMAN, P.F.	017024
SERTH, R.W.	013039
SEWELL, W.R.D.	011031
SFORZA, P.M.	016057
SHANNON, R.L.	013035
SHAW, T.L.	019042
SHEFT, I.	013034
SHELDAHL, R.E.	016056
SHELLEY, E.F.	010050
SHEWCHUN, J.	018004
SHIMADA, K.	014005
SIDORAK, L.G.	018003
SIMMONS, D.E.	013058
SIMMONS, D.E.	013017
SINGHOTA, J.S.	019043
SITTLER, D.D.	016058
SKOVRONEK, H.S.	010020
SLOTTA, L.S.	019044
SMAY, V.E.	017025
SMITH, D.S.	012030
SMITH, C.J.M.	013072
SMITH, F.R.	014001
SMITH, R.T.	016059
SONNINO, T.	010051
SOULE, D.E.	013073
SPARLING, A.B.	017023
SPEIGER, K.	012031
SPERA, D.A.	016060
SPERA, D.A.	016063
SPRAGINS, W.W.	013037
SPRINGER, T.	013005
SPUHLER, H.A.	011065
SPESNEWSKY, S.	017033

SRINIVASAN, S.	019045
ST. CLAIR, C.W.	017026
ST. PIERRE, J.A.	018004
STARLING, K.E.	015015
STEWART, R.E.D.	013021
STICKNEY, G.H.	016061
STODHART, A.H.	016062
STYMNE, H.	011068
SUDARSKIS, M.	010052
SULLIVAN, J.L.	017019
SULLIVAN, T.L.	016063
SUSSMAN, S.S.	010053
SWANSON, R.K.	016059
SWARTMAN, R.K.	011066
SWEENEY, T.E.	016064
SWEET, E.	019021
SWERDLING, M.	014005
SWET, C.J.	013075
SWET, C.J.	013074
SZEGO, G.C.	017027
TAKEUCHI, M.	013041
TALIB, A.	015011
TALIB, A.	015010
TALIB, A.	015030
TANAKA, T.	019047
TANAKA, T.	019046
TEWARI, Y.B.	017009
THEKAEKARA, M.P.	011067
THOMAS, A.P.	011067
THOMAS, W.A.	012007
THOMPSON, C.A.	018004
THOMPSON, C.F.	019048
THOMPSON, G.P.	012032
THOMSON, W.B.	013042
TIMBERS, G.E.	017028
TIMMERMAN, D.H.	016071
TOLBERT, W.A.	011024
TOLL, D.F.	012033
TOMPKINS, L.L.	016065
TOOMRE, J.	015026
TORNKVIST, R.E.A.	019049
TRACEY, T.R.	013076
TRINDADE, S.C.	017033
TRUKHOV, V.S.	013063
TURNER, R.H.	013077
TYBOUT, R.A.	012034
UOSAKI, K.	019003
UOSAKI, K.	019034
VAIL, C.W.	017027
VAIL, C.W.	017029
VAN HOLTEN, T.	016066
VAN WICKEREN, P.	017030
VANT-HULL, L.L.	013038
VARNADO, S.G.	013021
VAULT, R.	012016
VENERUSO, A.F.	016024
VETTER, E.C.	010055
VINCENT, C.L.	016055
VITTITOE, C.N.	013008

VITTITOE, C.N.	013009
VOELKER, G.E.	019030
VON HACHT, G.	013078
VRABLE, C.L.	013079
VUAGHN, L.	016012
WADE, H.	011022
WAHLIG, M.	011009
WAHLIG, M.	013004
WALKER, R.L.	019007
WALKER, W.	013070
WALL, J.C.	010041
WALTON, J.D., JR.	013080
WARMAN, J.C.	013055
WASS, M.L.	019054
WATSON, M.	013081
WEHRLE, V.A.	010015
WEINER, F.	016028
WENTWORTH, W.E.	013082
WESSLER, E.	012015
WETTERMARK, G.	011068
WHEELER, N.	011069
WHITEHURST, C.A.	016067
WICK, G.L.	019023
WIEDUWILT, G.	016068
WILDMAN, T.A.	017009
WILKE, D.A.	017031
WILLIAMS, R.M.	019031
WILSON, D.E.	016069
WILSON, E.M.	019051
WIRTSHAFTER, R.	012015
WISE, D.L.	017014
WITWER, J.G.	017003
WOLF, P.C.	010056
WOLVERTON, B.	017032
WOODWARD, J.L.	011070
WRIGHT, J.K.	013083
WRIGHTON, M.S.	019052
WURM, J.	019016
YAMAGIWA, A.	016070
YANG, C.	017010
YANG, V.	017033
YASHAROFF, N.	010057
YEE, S.T.	015071
YEH, L.S.R.	019053
YEKUTIELI, G.	014000
YIM, H.C.	011037
YUDOW, B.	015030
YUDOW, B.	015031
YUDOW, B.	015010
YUDOW, B.	015011
ZAKHIDOV, R.A.	013084
ZAWIERUCHA, R.	015002
ZEIGLER, J.M.	019054
ZELBY, L.W.	015025
ZENER, C.	015032
ZENTNER, R.C.	013085
ZIMMWEMAN, J.S.	016072

SUBJECT TERM INDEX

C, POWER-GENERATION, STORAGE/ 011050
CE, EDUCATION# AC-SYSTEMS, ECONOMICS, ELECTRI 011061
FE-CYCLE-COSTS# INITIATIVES, ACADEMIC-PROGRAM, ENERGY-SCIEN 012005
CNSERV/ PROCEEDINGS, MEETING, ACCESS-RIGHTS, LEGISLATION, LI 010001
, HEATING, INSULATION, STORA/ ADHESIVE, SEALANT, INDUSTRY, C 011014
ADHESIVES, COOLING, FLAT-PLATE 016048
AGRICULTURE, TRANSPORTATION, AEOLIAN-WINDMILL, PATENT, WIND 010033
LATION# PROBABILITY, AEROSPACE-TECHNOLOGY, NASA-PRO 012022
AGRICULTURAL-ENGINEERING, INSO 017003
CUSES, SOLAR-DRYING# AGRICULTURAL, WASTES, BIOMASS# 011021
PROCESS-HEAT# AGRICULTURE, BUILDINGS, GREENH 011008
CUSES, HEATING, ERDA# AGRICULTURE, COOLING, HEATING, 011020
EROSPACE-TECHNOLOGY, NASA-PR/ AGRICULTURE, ECONOMICS, GREENH 010033
BIOMASS, CANADA, AGRICULTURE, TRANSPORTATION, A 017028
ONOMIC, DEVELOPING-COUNTRIES, AGRICULTURE# 011057
-P/ GUIDELINES, CONSERVATION, AGRICULTURE# RURAL, SOCIO-EC 010014
HEAT-STORAGE-WELL, AIR-FORCE-FACILITIES, COMPUTER 013053
WIND, RECIPROCATOR, AIR-POLLUTION, SPACE-HEATING# 016046
ANE# AIRFOILS# 017033
ALCOHOL, BRAZIL, BIOMASS, METH 017017
ALCOHOLS, AMMONIA, BIOMASS# 017015
REVIEW, ALGAE, BIOMASS, PHOTOSYNTHESIS 017027
HOTOSYNTHESIS, DEMONSTRATION, ALGAE, BIOMASS# P 013004
NITINOL-ENGINE, HEAT-ENGINES, ALLOYS# 016021
WIND, ALUMINUM, RESIDENTIAL# 017017
ALCOHOLS, AMMONIA, BIOMASS# 015029
N-THERMAL-POWER# AMMONIA, HEAT-EXCHANGERS, OCEA 017014
METHANE, SOLID-WASTE, ANAEROBES, BIOMASS# 016052
WIND, ANNUAL-VARIATIONS, STORAGE# 011048
OGY# APPLICATIONS, MEXICO, CLIMATOL 011012
ATE, STORAGE# CANADA, ARCHITECTURE, BIOMASS, FLAT-PL 012007
HAZARDS, STORAGE, WORKING-FL/ ARCHITECTURE, BUILDINGS, FIRE- 016007
MENT# WIND, ARCHITECTURE, BUILDING-ENHANCE 011063
RESIDENTIAL-APPLICATIONS, ARCHITECTURE, ECONOMICS# 011007
ARIES# ARIZONA-STATE-UNIVERSITY, LIBR 011022
ARIZONA, PRIVATE-SECTOR# 011011
INFORMATION-SERVICE, ARIZONA# 017029
FUELS, BIOMASS, ARKANSAS, LOUISIANA# 013074
, TRACKING# ARRAYS, FRESNEL, CONCENTRATORS 011023
ECONOMICS, SOLAR-CELL ARRAYS, TRACKING# 019035
, WAVE-POWER# ATLANTIC, MATH-MODELS, PACIFIC 013065
S, CLIMATIC-IMPACT# ATMOSPHERIC-MODEL, MATH-MODEL 019041
OWER# AUSTRALIA, TIDAL-POWER, WAVE-P 012027
MENT-POLICIES# BUSINESS, AUTOMOBILES, ECONOMICS, GOVERN 012004
INCENTIVES, BARRIERS, LOANS, TAX-CREDITS# 010027
FUEL-CELLS, LITHIUM-SULFUR, BATTERIES, SOLAR-CELLS# 016028
GENERATORS# BATTERIES, SOLAR-CELLS, WIND, 019004
ELECTROCHEMISTRY, BATTERIES# 019011
BELGIUM, WAVE-POWER# 010021
CASTI/ ENERGY-SYSTEMS, INDIA, BIBLIOGRAPHIES, ECONOMIC, FORE 010031
EOTHERMAL, RESEARCH-PROGRAMS/ BIBLIOGRAPHIES, ENVIRONMENT, G 015001
AN-THERMAL-ENERGY-CONVERSION, BIBLIOGRAPHIES# /TRANSFER, OCE 010000
, NASA# ENERGY, BIBLIOGRAPHY, UPDATED, INDEXES 017019
H-MODELS# BIO-GAS, ONTARIO, BIOMASS, MAT

MICS# BIOCONVERSION, BIOCHEMICAL-ENGINEERING, ECONO 017013
INEERING, ECONOMICS# BIOCONVERSION, BIOCHEMICAL-ENG 017013
FUELS, BIOCONVERSION, BIOMASS# 017007
AN-THERMAL-ENERGY-CONVERSION, BIOFOULING, CORROSION# OCE 015024
TEC# BIOFOULING, HEAT-EXCHANGERS, O 015018
CEAN-THERMAL-ENERGY-CONVERSI/ BIOFOULING, HEAT-EXCHANGERS, O 015022
GY-CONVERSION# BIOFOULING, OCEAN-THERMAL-ENER 015004
OTEC, BIOFOULING# 015023
FUELS, BIOMASS, ARKANSAS, LOUISIANA# 017029
FOOD, BIOMASS, CALIFORNIA# 017024
BIOMASS, CANADA, AGRICULTURE# 017028
EAT-PUMPS, OCEAN T/ HANDBOOK, BIOMASS, CANADA, GEOTHERMAL, H 011029
N-PRODUCTION, PHOTOCHEMISTRY/ BIOMASS, CHLOROPLASTS, HYDROGE 011015
NERGY-POLICY, FRANCE, JAPAN,/ BIOMASS, DEVELOPING-NATIONS, E 011037
VERNMEN/ REFERENCE-MATERIALS, BIOMASS, ECONOMIC-ANALYSIS, CO 017001
E# BIOMASS, ECONOMICS, MARICULTUR 017005
ION# BIOMASS, ECONOMICS, DEMONSTRAT 017011
RESOURCES, BIOMASS, ECONOMICS# 017000
FRANCE, BIOMASS, ECONOMICS# 017008
, FUEL-PRODUCTION# BIOMASS, ELECTRICAL-GENERATION 017010
L# FUELS, BIOMASS, ETHANOL, ETHYL-ALCOHO 017016
ED-ECONOMY, SOCIO-EC/ BRAZIL, BIOMASS, ETHANOL, HYDROGEN-BAS 010042
CANADA, ARCHITECTURE, BIOMASS, FLAT-PLATE, STORAGE# 011012
R, WIND-POWER# CANADA, BIOMASS, HEAT-PUMPS, WAVE-POWE 011052
BIO-GAS, ONTARIO, BIOMASS, MATH-MODELS# 017019
FOOD, BIOMASS, MATH-MODELS# 015008
MANURE, BIOMASS, METHANE# 017020
ALCOHOL, BRAZIL, BIOMASS, METHANE# 017033
TION# BIOMASS, NORTH-AMERICA, INSOLA 017021
OLTAIC, WIND, NSF# BIOMASS, OCEAN-THERMAL, PHOTOV 011027
REVIEW, ALGAE, BIOMASS, PHOTOSYNTHESIS# 017015
CELLULOSE, BIOMASS, SACCHARIFICATION# 017006
THESIS, DEMONSTRATION, ALGAE, BIOMASS# PHOTOSYN 017027
FUELS, BIOCONVERSION, BIOMASS# 017007
ENERGY-CONVERSION, BIOMASS# 017022
ALCOHOLS, AMMONIA, BIOMASS# 017017
METHANE, BIOMASS# 017023
AGRICULTURAL, WASTES, BIOMASS# 017003
MATH-MODELS, BIOMASS# 017004
HANE, SOLID-WASTE, ANAEROBES, BIOMASS# MET 017014
INDIA, GEOTHERMAL, BIOMASS# 010046
BIOSYNTHESIS, METHANE, WASTES# 017012
S, WIND, TURBINE# BLADES, CARRIEUS, VERTICAL-AXI 016005
WIND, BLADES, HORIZONTAL-AXIS, RURAL 016030
WINDMILL, BLADES, MATH-MODELS# 016061
WIND, STORAGE, BLADES# 016042
WIND, MATH-MODELS, BLADES# 016032
, PILOT-PLANT, STORAGE# BOILERS, ECONOMICS, HELIOSTATS 013011
BOILERS, MATH-MODELS, STORAGE# 013023
ER, WIND# BOOK, ENERGY-POLICY, TIDAL-POW 011040
AT-PUMPS# STORAGE, BRAYTON-CYCLE, GAS-TURBINE, HE 013037
, STORAGE# BRAYTON-CYCLE, HEAT-EXCHANGERS 013006
OGEN-BASED-ECONOMY, SOCIO-EC/ BRAZIL, BIOMASS, ETHANOL, HYDR 010042

ALCOHOL,
, TURBINES, STEAM-GENERATION,
WIND, ARCHITECTURE,
LEGAL-PROBLEMS, LIABILITY,
NTY, EDUCATION#
N, HEATING# NATO,
ERDA, DESIGN,
NALYSIS, HEATING, UTILITY-PR/
N, STORAGE, INORGANIC#
INDUSTRY-ACCEPTANCE,
CMICSS, FLAT-PLATE, HEAT-PUM/
GE, WORKING-FL/ ARCHITECTURE,
DRYING# AGRICULTURE,
ERGY-SYSTEM, STIRLING-ENGINE,
CS, GOVERNMENT-POLICIES#
ATA#
FOOD, BIOMASS,
BIOMASS,
FLAT-PLATE, STORAGE#
AVE-POWER, WIND-POWER#
ATING#
OIL, GAS, COAL, CONSERVATION,
, OCEAN T/ HANDBOOK, BIOMASS,
ATING, COOLING, GRAIN-DRYING,
TIDAL-ENERGY,
ICAL-AXIS# WIND,
WATSON, SIMULATION,
GENERATORS, WIND,
ENERGY-RESOURCES,
LATENT-HEAT, STORAGE,
CONTROL,
CHEMICAL, STORAGE,
ERATORS, HYDROGEN-PRODUCTION,
CATION#
HEAT-PIPES, REVIEWS#
OMICS, POWER-PLANTS#
ION, PHOTOCHEMISTRY/ BIOMASS,
OSPHEREIC-MODEL, MATH-MODELS,
APPLICATIONS, MEXICO,
WIND, ELEC/ POWER-GENERATION,
FORECASTING, GEOTHERMAL#
ERGY-POLICY# OIL, GAS,
ATE'#
H-MODELS,# MODEL,
LLS# EPA-VAN, HEAT-PUMPS,
THERMIONIC,
HELIOSTATS,
ALINATION, INSOLATI/ GERMANY,
HUD, NBS, STORAGE,
MS, ECONOMICS, RANKINE-CYCLE/
COOLING#
ENERGY-POLICY, FORECASTING, /

BRAZIL, BIOMASS, METHANE# 017033
BRAZIL# CONCENTRATORS 013048
BUILDING-ENHANCEMENT# 016007
BUILDING-PERMITS, REGULATIONS# 012018
BUILDING-TRADES, SAN-DIEGO-COU 011035
BUILDINGS, COOLING, INFORMATIO 011055
BUILDINGS, COOLING, HEATING# 011058
BUILDINGS, COOLING, ECONOMIC-A 012015
BUILDINGS, COOLING, DEHYDRATIO 013005
BUILDINGS, DEMONSTRATION# 011062
BUILDINGS, DEMONSTRATION, ECON 011030
BUILDINGS, FIRE-HAZARDS, STORA 012007
BUILDINGS, GREENHOUSES, SOLAR- 011021
BUILDINGS# TOTAL-EN 013062
BUSINESS, AUTOMOBILES, ECONOMI 012027
CALIFORNIA, RESOURCES, SOLAR-D 011009
CALIFORNIA# 017024
CANADA, AGRICULTURE# 017028
CANADA, ARCHITECTURE, BIOMASS, 011012
CANADA, BIOMASS, HEAT-PUMPS, W 011052
CANADA, COOLING, ECONOMICS, HE 011031
CANADA, ENERGY-POLICY# 010025
CANADA, GEOTHERMAL, HEAT-PUMPS 011029
CANADA, INSOLATION# HE 011016
CANADA, MATH-MODEL# 019007
CANADA, MODEL, UTILITIES, VERT 016051
CANADA, PHOTO-OXIDATION# 017009
CANADA, SPACE-HEATING# 012025
CANADA# 016029
CARBOHYDRATE, FORECASTING# 010047
CARBONATES, MATH-MODELS, SALTS 013051
CARNOT-CYCLE, HEAT-PIPES# 018000
CATALYSTS, HEAT-PIPES, REVIEWS 013059
CATHODES# HYDROGEN-GEN 019034
CELLULOSE, BIOMASS, SACCHARIFI 017006
CHEMICAL, STORAGE, CATALYSTS, 013059
CHEMICAL, STORAGE, STEAM, ECON 013018
CHLOROPLASTS, HYDROGEN-PRODUCT 011015
CLIMATIC-IMPACT# ATM 013065
CLIMATOLOGY# 011048
COAL-GASIFICATION, ECONOMICS, 010034
COAL, COMPARATIVE-EVALUATIONS, 010039
COAL, CONSERVATION, CANADA, EN 010025
COLLECTORS---SEE-ALSO-'FLAT-PL
COLLECTORS, CONCENTRATORS, MAT 013073
COLLECTORS, EDUCATION, FUEL-CE 010049
COLLECTORS, PARABOLIC# 014005
COLLECTORS, POWER-PLANTS# 013038
COLLECTORS, SPACE-HEATING, DES 011039
COLLECTORS# 012014
COMMERCIAL-APPLICATIONS, SYSTE 011010
COMMERCIAL, STORAGE, HEATING, 013057
COMMERCIALIZATION, ECONOMICS, 010035

, ERDA#
IONAL-CONSTRAINTS, LAND-USE#
ASTING, GEOTHERMAL# COAL,
GIS, ECONOMICS#
R#
VATION, AIR-FORCE-FACILITIES,
HEELS, WIND# STORAGE,
DEMONSTRATION,
VORTEX,
-PLATE, REVIEWS, EUROPE#
TORS# PATENT, GERMANY,
TING, UNITED-KINGDOM#
RAGE/ UNITED-STATES, GERMANY,
MATH-MODEL, SALTS, STORAGE#
ECHANICAL-ENERGY# PATENT,
, SEAWATER, TURBINES/ PATENT,
ION, POWER-PLANTS, MATH-MODE/
MODEL, COLLECTORS,
INANCIAL/ INDUSTRY, FORECAST,
STORAGE,
NG, TURBINES# PATENT,
ARRAYS, FRESNEL,
-GENERATION, BRAZIL#
CZECHOSLOVAKIA, REPORT,
FRESNEL, THERMOELECTRIC,
ERGY-CONVERSION, ENGINEERING,
OELECTRIC# INTERNATIONAL,
NVERSION/ SELECTIVE-SURFACES,
AT-PUMPS# PROCEEDINGS,
SOLAR-TECHNOLOGY,
MODELS,
-POLICIES, PUBL/ LEGISLATION,
TIES, COMPUTER-P/ GUIDELINES,
OLICY# OIL, GAS, COAL,
FORECASTING#
ION-CENTR/ ENERGY-CONVERSION,
EDUCATION, LAWS, FINANCIAL-/
CIAL-INCENTIVES, INSOLATION#
EGRATED-UTILITY-S/ ECONOMICS,
NERGY-TECHNOLO/ RAIL-TRAFFIC,
IL-SHALE#
ERNMENT-POL/ COST-PER-BARREL,
RGY-POLICY,#
ADHESIVE, SEALANT, INDUSTRY,
S, MATH-ANALYS/ SOLAR-SYSTEM,
S# STORAGE, ROCK,
ESEARCH-PROGRAMS, / HANDBOOK,
TILITIES# HANDBOOK,
POLICY, SOCIAL-FACTORS#
TING, GEOTHERMAL, POPULATION/
POLICY, FORECASTING#
ACILITIES, COMPUTER-PROGRAMS,
NG#

COMMERCIALIZATION, INFORMATION 011047
COMMUNICATION, STUDY, INSTITUT 010007
COMPARATIVE-EVALUATIONS, FOREC 010039
COMPARATIVE-EVALUATIONS, ILLIN 012002
COMPUTER-PROGRAM, HEAT-TRANSFE 013084
COMPUTER-PROGRAMS, CONSUMPTION 010014
CONCENTRATING-COLLECTORS, FLY# 013021
CONCENTRATOR# 013069
CONCENTRATOR# 016033
CONCENTRATORS, ECONOMICS, FLAT 011044
CONCENTRATORS, ELECTRIC-GENERA 011061
CONCENTRATORS, FLAT-PLATE, HEA 011018
CONCENTRATORS, FLAT-PLATE, STO 011025
CONCENTRATORS, HEAT-TRANSFER, 013070
CONCENTRATORS, HEAT-ENGINES, M 013064
CONCENTRATORS, HEAT-EXCHANGERS 013044
CONCENTRATORS, HELIOS, SIMULAT 013008
CONCENTRATORS, MATH-MODELS,# 013073
CONCENTRATORS, PHOTOVOLTAIC, F 012008
CONCENTRATORS, PYROLYSIS# 013034
CONCENTRATORS, STORAGE, TRACKI 013020
CONCENTRATORS, TRACKING# 013074
CONCENTRATORS, TURBINES, STEAM 013043
CONCENTRATORS# 011042
CONCENTRATORS# 014001
CONFERENCE, GEOTHERMAL, WIND# 010008
CONFERENCE, SOLAR-CELLS, THERM 011000
CONFERENCE, STORAGE, ENERGY-CO 019000
CONFERENCE, THERMOELECTRIC, HE 014004
CONFERENCE# 011002
CONFERENCES, NATURAL-GAS# 012017
CONGRESS, ECONOMIC, GOVERNMENT 012033
CONSERVATION, AIR-FORCE-FACILI 010014
CONSERVATION, CANADA, ENERGY-P 010025
CONSERVATION, DEMAND-FACTORS, 010023
CONSERVATION, ECONOMIC, POLLUT 010020
CONSERVATION, ECONOMIC-IMPACT, 012032
CONSERVATION, ECONOMICS, FINAN 012013
CONSERVATION, EDUCATIONAL, INT 012000
CONSERVATION, ENERGY-POLICY, S 010018
CONSERVATION, ENERGY-POLICY, O 010016
CONSERVATION, INVESTMENTS, GOV 012029
CONSERVATION, LEGISLATION, ENE 010050
CONSERVATION# /DINGS, MEETING, 010001
CONSTRUCTION, ECONOMIC-ANALYSI 012024
CONSTRUCTION, ECONOMIC-ANALYSI 013036
CONSUMPTION, DEMAND-FACTORS, R 010013
CONSUMPTION, DEMAND-FACTORS, U 010012
CONSUMPTION, ECONOMIC, ENERGY- 010010
CONSUMPTION, ECONOMIC, FORECAS 010048
CONSUMPTION, ECONOMIC, ENERGY- 010022
CONSUMPTION# /ION, AIR-FORCE-F 010014
CONTROL-SYSTEM, COOLING, HEATI 016065

WIND, GENERATORS,
ERS, UTILITIES#
PES#
 POWER-PLANTS, HELIOSTATS#
OWER-PLANTS, TURBINE#
GY, FERTILIZER#
S# REGULATION, STORAGE,
SURVEY,
TURBINE,
E, TUREINES#
 INORGANIC# BUILDINGS,
ATING, UTILITY-PR/ BUILDINGS,
CANADA,
INSULATION, STORA/ ADHESIVES,
 INSOLATION# HEATING,
AGRICULTURE,
R# PROGRAM-PLAN,
ERDA, DESIGN, BUILDINGS,
CONTROL-SYSTEM,
NATO, BUILDINGS,
OMICS, GEOGRAPHIC, NIGHT-SKY,
ELIOSTATS, IRRIGATION, PUMPS,
COMMERCIAL, STORAGE, HEATING,
NERGY-CONVERSION, BIOFOULING,
 INVESTMENTS, GOVERNMENT-POL/
ERGY-POLICY, NATURAL-GAS, WE/
CONTROL-SYSTEMS,
TRATORS#
IS, WIND#
 TURBINE# BLADES,
VERTICAL-AXIS, WIND, TURBINE,
VERTICAL-AXIS, WINDMILL,
Y# PROJECT-INDEPENDENCE,
 MODELS# WIND,
N-PROGRAMS, EDUCATION, MIUS#
WIND,
ELS# WAVE-POWER,
C# BUILDINGS, COOLING,
CONSERVATION,
OPULATION-DYNAMICS# ISRAEL,
AMS, / HANDBOOK, CONSUMPTION,
HANDBOOK, CONSUMPTION,
ION, MIUS# DATA-COMPILATION,
ICS, GOVERNMENT-POLICIES, ER/
PHOTOSYNTHESIS,
T-PLATE, HEAT-FLW/ BUILDINGS,
STEAM,
ER-PLANTS# STORAGE,
CTORS, RESEARCH-PROGRAMS, TH/
ER-PLANT#
CONTROL-SYSTEM, MICROPROCESSOR 016037
CONTROL-SYSTEMS, CURRENT-LIMIT 012003
CONTROL, CARNOT-CYCLE, HEAT-PI 018000
CONVERSION, ELECTRIC-INDUSTRY, 010026
CONVERSION, HEAT-EXCHANGERS, P 013033
CONVERSION, STORAGE, WIND-ENER 016018
CONVERSION, WIND, VERTICAL-AXI 016031
CONVERTERS, THERMOELECTRIC# 014002
CONVERTERS, WAVE-POWER# 019026
COOLANTS, POWER-PLANTS, STORAG 013042
COOLING, DEHYDRATION, STORAGE, 013005
COOLING, ECONOMIC-ANALYSIS, PE 012015
COOLING, ECONOMICS, HEATING# 011031
COOLING, FLAT-PLATE, HEATING, 011014
COOLING, GRAIN-DRYING, CANADA, 011016
COOLING, HEATING, PROCESS-HEAT 011008
COOLING, HEATING, THERMAL-POWE 011003
COOLING, HEATING# 011058
COOLING, HEATING# 016065
COOLING, INFORMATION, HEATING# 011055
COOLING, REVIEWS# ECON 011053
COOLING# HEATING, H 011041
COOLING# 013057
CORROSION# OCEAN-THERMAL-E 015024
COST-PER-BARREL, CONSERVATION, 012029
COST, SYMPOSIUM, ECONOMICS, EN 012019
COVER, PATENT, INSULATION# 013071
CURRENT-LIMITERS, UTILITIES# 012003
CURRICULUM, EDUCATION# 011017
CZECHOSLOVAKIA, REPORT, CONCEN 011042
DARRIEUS, TURBINE, VERTICAL-AX 016004
DARRIEUS, VERTICAL-AXIS, WIND, 016005
DARRIEUS# 016024
DARRIEUS# 016045
DATA-ACQUISITION, ENERGY-POLIC 010011
DATA-ANALYSIS, SITE-SELECTION, 016047
DATA-COMPILATION, DEMONSTRATIO 010017
DATA-COMPILATION# 016036
DEAN-STREAM-FUNCTION, MATH-MOD 019022
DEHYDRATION, STORAGE, INORGANI 013005
DEMAND-FACTORS, FORECASTING# 010023
DEMAND-FACTORS, FORECASTING, P 010051
DEMAND-FACTORS, RESEARCH-PROGR 010013
DEMAND-FACTORS, UTILITIES# 010012
DEMONSTRATION-PROGRAMS, EDUCAT 010017
DEMONSTRATION-PROGRAMS, ECONOM 011038
DEMONSTRATION, ALGAE, BIOMASS# 017027
DEMONSTRATION, CONCENTRATOR# 013059
DEMONSTRATION, ECONOMICSS, FLA 011030
DEMONSTRATION, FURNACES# 013076
DEMONSTRATION, HEAT-PIPES, POW 013068
DEMONSTRATION, PARABOLIC-COLLE 013000
DEMONSTRATION, TOWER-FOCUS-POW 013024

DUSTRY-ACCEPTANCE, BUILDINGS, DEMONSTRATION# IN 011062
BIOMASS, ECONOMICS, DEMONSTRATION# 017011
OM# WIND, DENMARK, GERMANY, UNITED-KINGD 016019
Y, COLLECTORS, SPACE-HEATING, DESALINATION, INSOLATION# /MAN 011059
DESALINATION, PATENT, STORAGE# 019047
'DESIGN ' NOT INDEXED
URE# RURAL, SOCIO-ECONOMIC, DEVELOPING-COUNTRIES, AGRICULT 011057
S# NEW-GUINEA, DEVELOPING-COUNTRIES, ECONOMIC 011070
,# UNITED-NATIONS, WIND, DEVELOPING-COUNTRIES, ECONOMIC 011019
ECHNOLOGY, RESOURCES-MANAGEM/ DEVELOPING-COUNTRIES, ENERGY-T 010043
ICY, FRANCE, JAPAN,/ BIOMASS, DEVELOPING-NATIONS, ENERGY-POL 011037
G, WAVE-POWER# SEA-WAVES, DEVELOPING-NATIONS, FORECASTIN 019002
RESEARCH, EPCA, DEVELOPMENT, PROGRAM# 011039
INTERNATIONAL, RESEARCH, DEVELOPMENT# 011026
CNAL-ENERGY-AGENCY, RESEARCH, DEVELOPMENT# INTERNATI 011054
WAVE-POWER, WIND-EFFECTS, DIRECTIONAL-SPECTRUM# 019038
STORAGE, WIND, DIURNAL# 016054
BAL-ASPECTS, SOCIAL-IMPACT, / EARTH-RESOURCES, ECONOMIC, GLO 010028
-CONTROL# EARTH-RESOURCES, ENVIRONMENTAL 010009
PETROLEUM-INDUSTRY, ECONOMETRICS, GEOTHERMAL# 010041
REFERENCE-MATERIALS, BIOMASS, ECONOMIC-ANALYSIS, GOVERNMENT- 017001
ILITY-PR/ BUILDINGS, COOLING, ECONOMIC-ANALYSIS, HEATING, UT 012015
SOLAR-SYSTEM, CONSTRUCTION, ECONOMIC-ANALYSIS, MATH-ANALYS 012024
STORAGE, ROCK, CONSTRUCTION, ECONOMIC-ANALYSIS# 013036
ELECTRICAL-POWER, INSOLATION, ECONOMIC-ANALYSIS# /ESS-HEAT, 013003
WS, FINANCIAL-/ CONSERVATION, ECONOMIC-IMPACT, EDUCATION, LA 012032
RESIDENCES, ILLINOIS# ECONOMIC-IMPACT, SOLAR-HEATED, 012028
LICIES, LEGAL-ASPE/ INDUSTRY, ECONOMIC-POLICY, GOVERNMENT-PO 012031
UBLIC-UTILITIES# REGULATING, ECONOMIC-POLICY, INCENTIVES, P 012030
L-FACTORS# CONSUMPTION, ECONOMIC, ENERGY-POLICY, SOCIA 010010
ASTING# CONSUMPTION, ECONOMIC, ENERGY-POLICY, FOREC 010022
UTILITY-SYSTEMS, FLORIDA, ECONOMIC, ENVIRONMENTAL,# 010006
UTILITY-SYSTEMS, MICHIGAN, ECONOMIC, ENVIRONMENTAL# 010005
STEMS, INDIA, BIBLIOGRAPHIES, ECONOMIC, FORECASTING# /RGY-SY 010021
MAL, POPULATION/ CONSUMPTION, ECONOMIC, FORECASTING, GEOTHER 010048
AL-IMPACT, / EARTH-RESOURCES, ECONOMIC, GLOBAL-ASPECTS, SOCI 010028
PUBL/ LEGISLATION, CONGRESS, ECONOMIC, GOVERNMENT-POLICIES, 012033
SALT, STORAGE, ECONOMIC, HEAT-EXCHANGERS# 013028
RGY-CONVERSION, CONSERVATION, ECONOMIC, POLLUTION-CONTROL# / 010020
, WIND, DEVELOPING-COUNTRIES, ECONOMIC,# UNITED-NATIONS 011019
RESOURCES, ECONOMIC# 012034
TIONAL, INTEGRATED-UTILITY-S/ ECONOMICS, CONSERVATION, EDUCA 012000
BIOMASS, ECONOMICS, DEMONSTRATION# 017011
ERATION, STORAGE/ AC-SYSTEMS, ECONOMICS, ELECTRIC, POWER-GEN 011050
EAT-PUMPS, SOLAR-CE/ GERMANY, ECONOMICS, ELECTRICAL-POWER, H 011056
CASTING, TIDAL-/ SOUTH-KOREA, ECONOMICS, ENERGY-DEMAND, FORE 010029
CASTING, RESEARCH-PROGRAMS# ECONOMICS, ENERGY-MODELS, FORE 010053
CASTING, RESEARCH-PROGRAMS# ECONOMICS, ENERGY-MODELS, FORE 012001
INDUSTRIAL, ENERGY-PLANNING, ECONOMICS, ENERGY-POLICY# 010055
CASTING, / COMMERCIALIZATION, ECONOMICS, ENERGY-POLICY, FORE 010035
RAL-GAS, WE/ COST, SYMPOSIUM, ECONOMICS, ENERGY-POLICY, NATU 012019
NTIVES, SUBSIDIES# ECONOMICS, ENERGY-POLICY, INCE 012006
TS, TIDAL-POWER# ECONOMICS, ENVIRONMENTAL-EFFEC 019018

S# PROJECT-SAGE, ECONOMICS, FINANCIAL-INCENTIVE 012016
S, INSOLATION# CONSERVATION, ECONOMICS, FINANCIAL-INCENTIVE 012013
, EUROPE# CONCENTRATORS, ECONOMICS, FLAT-PLATE, REVIEWS 011044
EXCHANGERS# TEST-FACILITY, ECONOMICS, FRESNEL-LENS, HEAT- 011034
KY, COOLING, REVIEWS# ECONOMICS, GEOGRAPHIC, NIGHT-S 011053
, ER/ DEMONSTRATION-PROGRAMS, ECONOMICS, GOVERNMENT-POLICIES 011038
BUSINESS, AUTOMOBILES, ECONOMICS, GOVERNMENT-POLICIES 012027
, OFF-PEAK-ENERGY-STORAGE# ECONOMICS, GOVERNMENT-POLICIES 013081
G, ERDA# AGRICULTURE, ECONOMICS, GREENHOUSES, HEATIN 011020
CANADA, COOLING, ECONOMICS, HEATING# 011031
LANT, STORAGE# BOILERS, ECONOMICS, HELIOSTATS, PILOT-P 013011
BIOMASS, ECONOMICS, MARICULTURE# 017005
ENGINEERING, ECONOMICS, PLANNING# 011036
CHEMICAL, STORAGE, STEAM, ECONOMICS, POWER-PLANTS# 013018
ECONOMICS, RANKINE-BRAYTON# 013045
ERCIAL-APPLICATIONS, SYSTEMS, ECONOMICS, RANKINE-CYCLE# /OMM 011010
UTILITIES, MODEL, ECONOMICS, RESIDENTIAL-HEATING 012021
TRACKING# ECONOMICS, SOLAR-CELL ARRAYS, 011023
TIDAL-POWER, ECONOMICS, UNITED-KINGDOM# 019042
ENERGY-POLICY, ECONOMICS, USA# 012012
ENERATION, COAL-GASIFICATION, ECONOMICS, WIND, ELECTRIC-POWE 010034
WIND, GENERATORS, ECONOMICS,# 016011
WIND, MICHIGAN, SIMULATION, ECONOMICS# 016025
GUINEA, DEVELOPING-COUNTRIES, ECONOMICS# NEW- 011070
PATIVE-EVALUATIONS, ILLINOIS, ECONOMICS# COMPA 012002
L-APPLICATIONS, ARCHITECTURE, ECONOMICS# RESIDENTIA 011063
WER-PLANTS, ELECTRIC-UTILITY, ECONOMICS# PO 013013
STORAGE, POWER-PLANT, ECONOMICS# 013049
FRANCE, BIOMASS, ECONOMICS# 017008
ION, BIOCHEMICAL-ENGINEERING, ECONOMICS# BIOCONVERS 017013
HYDROGEN, FUELS, ECONOMICS# 019050
RESOURCES, BIOMASS, ECONOMICS# 017000
SEWAGE-PLANT, METHANE, ECONOMICS# 017002
POWER-PLANT, HEAT-EXCHANGERS, ECONOMICS# OCEAN-THERMAL- 015002
UM/ BUILDINGS, DEMONSTRATION, ECONOMICSS, FLAT-PLATE, HEAT-P 011030
-VAN, HEAT-PUMPS, COLLECTORS, EDUCATION, FUEL-CELLS# EPA 010049
L# UNDERGRADUATE, EDUCATION, HEATING, RESIDENTIA 011005
CE-LIVERMORE-LABORATORY,# EDUCATION, INFORMATION, LAWREN 011046
CNSERVATION, ECONOMIC-IMPACT, EDUCATION, LAWS, FINANCIAL-INC 012032
TION, DEMONSTRATION-PROGRAMS, EDUCATION, MIUS# DATA-COMPILA 010017
INFORMATION-DISSEMINATION, EDUCATION, PUBLIC# 011006
EMIC-PROGRAM, ENERGY-SCIENCE, EDUCATION# ACAD 011051
ING-TRADES, SAN-DIEGO-COUNTY, EDUCATION# BUILD 011035
CURRICULUM, EDUCATION# 011017
Y-S/ ECONOMICS, CONSERVATION, EDUCATIONAL, INTEGRATED-UTILIT 012000
HYDROGEN, OXYGEN, EFFUSIONAL-SEPARATION# 019012
WIND, ELECTRIC-CONVERSION# 016049
S, PILOT-PLANTS, STORAGE# ELECTRIC-GENERATION, HELIOSTAT 013066
TENT, GERMANY, CONCENTRATORS, ELECTRIC-GENERATORS# PA 011061
S, HELIOSTATS# CONVERSION, ELECTRIC-INDUSTRY, POWER-PLANT 010026
WIND, ELECTRIC-POWER-GENERATOR# 016000
ASIFICATION, ECONOMICS, WIND, ELECTRIC-POWER# /ATION, COAL-G 010034
STORAGE, MIDWEST, WIND, ELECTRIC-UTILITIES# 016059

FCWER-PLANTS,	ELECTRIC-UTILITY, ECONOMICS#	013013
R-CELLS#	ELECTRIC, PATENT, LENSES, SOLA	013078
CRAGE/ AC-SYSTEMS, ECONOMICS,	ELECTRIC, POWCR-GENERATICN, ST	011050
CDUCTICN# BICMASS,	ELECTRICAL-GENERATION, FUEL-PR	017010
TORAGE, UNITED-KINGDOM#	ELECTRICAL-POWER-GENERATION, S	013083
SOLAR-CE/ GERMANY, ECCNCMICS,	ELECTRICAL-POWER, HEAT-PUMPS,	011056
ECONOMIC-ANALY/ PRCCESS-HEAT,	ELECTRICAL-POWER, INSOLATION,	013003
	ELECTRCCHEMISTRY, BATTERIES#	019004
TUNGSTEN,	ELECTRCDE, PHCTCELECTRCLYSIS#	019005
GEN-PRCDUCTIO/ SEMICONDUCTCR,	ELECTRODES, ELECTRCLYSIS HYDRO	019053
ELLS# SEMICONDUCTOR,	ELECTRODES, PHOTCLYSIS, FUEL-C	019020
C/ SEMICONDUCTCR, ELECTRODES,	ELECTRCLYSIS HYDROGEN-PRCDUCTI	019053
GEN-PRCDUCTION#	ELECTRCLYSIS, FUEL-CELL, HYDRC	019045
ICN, THERMCCHEMICAL#	ELECTRCLYSIS, HYCROGEN-PRCDUCT	019019
	'ENERGY ' NOT INDEXED	
IMPACTS, INTERNATIONAL-CCCPE/	ENERGY-EALANCE, ENVIRONMENTAL-	010040
STATE-LEGISLATURES,	ENERGY-EILLS, PART-ONE#	012009
ES# PART-TWO,	ENERGY-EILLS, STATE-LEGISLATUR	012011
TEMS-ENGINEERING/ GUIDELINES,	ENERGY-CCNSERVING-SYSTEMS, SYS	010045
CNAL-PRCDUCT, INTERNATIONAL#	ENERGY-CCNSUMPTICN, GRCSS-NATI	012026
	ENERGY-CCNVERSION, BIOMASS#	017022
N, ECCNCMIC, PCLLUTICN-CCNTR/	ENERGY-CCNVERSION, CONSERVATIC	010020
, CCNFERENCE, GECTHERMAL, WI/	ENERGY-CCNVERSION, ENGINEERING	010008
SOLAR-CELLS#	ENERGY-CCNVERSION, FUEL-CELLS,	010037
PYRHELICMETERS, PYRANCMETER/	ENERGY-CCNVERSICN, INSOLATICN,	011067
WIND,	ENERGY-CCNVERSION, NET-ENERGY#	016016
RIC-POWER# THERMCJUNCTIONS,	ENERGY-CCNVERSION, THERMCELECT	014003
VCRTEX, WIND,	ENERGY-CCNVERSION#	016057
URFACES, CCNFERENCE, STORAGE,	ENERGY-CCNVERSION# /ELECTIVE-S	019000
DAL-/ SOUTH-KCREA, ECONOMICS,	ENERGY-DEMAND, FCRECASTING, TI	010029
SEARCH-PROGRAMS# ECCNCMICS,	ENERGY-MCDELS, FCRECASTING, RE	010053
SEARCH-PROGRAMS# ECCNCMICS,	ENERGY-MCDELS, FCRECASTING, RE	012001
ERGY-PCLICY# INDUSTRIAL,	ENERGY-PLANNING, ECONOMICS, EN	010055
	ENERGY-PCLICY, ECONOMICS, USA#	012012
RAIL-TRAFFIC, CCNSERVATICN,	ENERGY-PCLICY, ENERGY-TECHNCLC	010018
MPACTS, MEETINGS#	ENERGY-PCLICY, ENVIRONMENTAL-I	010054
CONSUMPTICN, ECONOMIC,	ENERGY-PCLICY, FCRECASTING#	010022
COMMERCIALIZATICN, ECONCMICS,	ENERGY-PCLICY, FCRECASTING, RE	010035
BIOMASS, DEVELCPING-NATIONS,	ENERGY-PCLICY, FRANCE, JAPAN,	011037
THERMAL, HYDROGEN, JAPAN, EU/	ENERGY-PCLICY, FUEL-CELLS, GEO	010032
TECHNCLOGY-TRANSFER# NATC,	ENERGY-PCLICY, GLCBAL-ASPECTS,	010052
SIDIES# ECONCMICS,	ENERGY-PCLICY, INCENTIVES, SUB	012006
AN-THERMAL-ENERGY-CCNVERSION,	ENERGY-PCLICY, INCENTIVES# /CE	015019
CFFSHCRE, WINC,	ENERGY-PCLICY, LEGISLATICN#	016041
COST, SYMPOSIUM, ECONCMICS,	ENERGY-PCLICY, NATURAL-GAS, WE	012019
CCNSERVATICN,	ENERGY-PCLICY, OIL-SHALE#	010016
POWER-SATELLITE#	ENERGY-PCLICY, PHOTCVOLTAICS,	013016
CONSUMPTICN, ECONCMIC,	ENERGY-PCLICY, SCCIAL-FACTORS#	010010
HERMAL-PCWER, WINC#	ENERGY-PCLICY, SCUTH-AFRICA, T	010057
ND# BOCK,	ENERGY-PCLICY, TIDAL-POWER, WI	011040
CCNSERVATICN, LEGISLATICN,	ENERGY-PCLICY,#	010050
, ENERGY-PLANNING, ECONCMICS,	ENERGY-PCLICY# INDUSTRIAL	010055
DEPENDENCE, DATA-ACQUISITICN,	ENERGY-PCLICY# PROJECT-IN	010011

AN-THERMAL-ENERGY-CONVERSION, ENERGY-POLICY# OCE 015013
, COAL, CONSERVATION, CANADA, ENERGY-POLICY# OIL, GAS 010025
PENNSYLVANIA, ENERGY-POLICY# 011013
AL-EFFECTS, GEOTHERMAL, POLL/ ENERGY-PRODUCTION, ENVIRONMENT 010030
, FORECASTING# ENERGY-RESOURCES, CARBOHYDRATE 010047
ACADEMIC-PROGRAM, ENERGY-SCIENCE, EDUCATION# 011051
RAPHIES, ECONOMIC, FORECASTI/ ENERGY-SYSTEMS, INDIA, BIBLIOG 010021
HAZARDS, OCEAN-OT, WIND# ENERGY-TECHNOLOGY, FUEL-CELLS, 010044
POLICIES, JAPAN# ENERGY-TECHNOLOGY, GOVERNMENT- 011043
RESEARCH-PROGRA/ MANAGEMENT, ENERGY-TECHNOLOGY, INSULATION, 010015
ANAGEM/ DEVELOPING-COUNTRIES, ENERGY-TECHNOLOGY, RESOURCES-M 010043
CONSERVATION, ENERGY-POLICY, ENERGY-TECHNOLOGY# /L-TRAFFIC, 010018
RMAL-ENERGY-CONVERSION# ENERGY-TRANSMISSION, OCEAN-THE 015010
OTEC, METHANE, STORAGE# ENERGY-TRANSMISSION, HYDROGEN, 015030
RAGE, THERMOCHEMICAL# ENERGY-TRANSMISSION, OTEC, STO 015031
ERMAL, WI/ ENERGY-CONVERSION, ENGINEERING, CONFERENCE, GEOTH 010008
NG# ENGINEERING, ECONOMICS, PLANNI 011036
RCH-PROGRAMS/ BIBLIOGRAPHIES, ENVIRONMENT, GEOTHERMAL, RESEA 010031
EARTH-RESOURCES, ENVIRONMENTAL-CONTROL# 010009
MAL, POLL/ ENERGY-PRODUCTION, ENVIRONMENTAL-EFFECTS, GEOTHER 010030
OWER# ECONOMICS, ENVIRONMENTAL-EFFECTS, TIDAL-P 019018
PROCEEDINGS, MEETING, ENVIRONMENTAL-ENGINEERING,# 010002
MAL, HYDROGEN-BASED-ECONOMY,/ ENVIRONMENTAL-IMPACTS, GEOTHER 010038
TIONAL-COOPE/ ENERGY-BALANCE, ENVIRONMENTAL-IMPACTS, INTERNA 010040
S# ENERGY-POLICY, ENVIRONMENTAL-IMPACTS, MEETING 010054
TAIC, POWER-GENERATION# ENVIRONMENTAL-IMPACT, PHOTOVOL 011064
Y-SYSTEMS, FLORIDA, ECONOMIC, ENVIRONMENTAL,# UTILIT 010006
-SYSTEMS, MICHIGAN, ECONOMIC, ENVIRONMENTAL# UTILITY 010005
S, EDUCATION, FUEL-CELLS# EPA-VAN, HEAT-PUMPS, COLLECTOR 010049
NG, HEATING# ERDA, DESIGN, BUILDINGS, COOLI 011058
RESEARCH, ERDA, DEVELOPMENT, PROGRAM# 011039
NSF, ERDA, ENERGY, RESEARCH,# 011065
GS# REVIEW, ERDA, MIRROR, SELECTIVE-COATIN 013060
ERDA, NASA, WIND, TURBINES# 016060
THERMOCHEMICAL, STORAGE, ERDA, REVIEWS# 013050
RESIDENTIAL, PHOTOVOLTAIC, ERDA, SOLAR-CELLS# 018001
WIND, ERDA# 016009
STORAGE, ERDA# 013075
#IND, MAPS, ERDA# 016010
MMERCIALIZATION, INFORMATION, ERDA# CO 011047
NOMICS, GREENHOUSES, HEATING, ERDA# AGRICULTURE, ECO 011020
ONOMICS, GOVERNMENT-POLICIES, ERDA# /ONSTRATION-PROGRAMS, EC 011038
FUELS, BIOMASS, ETHANOL, ETHYL-ALCOHOL# 017016
Y, SOCIO-EC/ BRAZIL, BIOMASS, ETHANOL, HYDROGEN-BASED-ECONOM 010042
FUELS, BIOMASS, ETHANOL, ETHYL-ALCOHOL# 017016
CNOMICS, FLAT-PLATE, REVIEWS, EUROPE# CONCENTRATORS, EC 011044
GEOTHERMAL, HYDROGEN, JAPAN, EUROPE# /Y-POLICY, FUEL-CELLS, 010032
STORAGE, SALTS, EUTECTICS, HEAT-PIPES# 013058
PHASE-CHANGE, STORAGE, EUTECTICS, HEATING# 013046
EUTECTICS, SALTS, POWER-PLANT# 013079
LANTS# TRANSFER-FLUID, EUTECTICS, TOWER-FOCUS-POWER-P 013022
AL-ENERGY-CONVERSION, MODELS, EXPERIMENTS# OCEAN-THERM 015009
FACTORY-WASTE, PATENT, STORAGE 019046

NFORMATION-SYSTEM#
ERSION, STORAGE, WIND-ENERGY,
CN# CONSERVATION, ECONOMICS,
PROJECT-SAGE, ECONOMICS,
CONCENTRATORS, PHOTOVOLTAIC,
OMIC-IMPACT, EDUCATION, LAWS,
MARKET,
-FL/ ARCHITECTURE, BUILDINGS,
ORS'#
S, DEMONSTRATION, ECONOMICSS,
N, STORA/ ADHESIVES, COOLING,
NGDOM# CONCENTRATORS,
IR-FORCE#
CONCENTRATORS, ECONOMICS,
ANADA, ARCHITECTURE, BIOMASS,
ATES, GERMANY, CONCENTRATORS,
EN, POWER-PLANTS, INSOLATION,
AL,# UTILITY-SYSTEMS,
HEAT-TRANSFER#
WIND, TURBINE,
60-CYCLE, WINDMILL,
GE, CONCENTRATING-COLLECTORS,

VOLTAIC, FINANCIAL/ INDUSTRY,

ATION/ CONSUMPTION, ECONOMIC,
OAL, COMPARATIVE-EVALUATIONS,
CS# ISRAEL, DEMAND-FACTORS,
ECONOMICS, ENERGY-MODELS,
CN, ECONOMICS, ENERGY-POLICY,
ECONOMICS, ENERGY-MODELS,
EA, ECONOMICS, ENERGY-DEMAND,
EA-WAVES, DEVELOPING-NATIONS,
ICN, ECONOMIC, ENERGY-POLICY,
GEOTHERMAL,
CONSERVATION, DEMAND-FACTORS,
ERGY-RESOURCES, CARBOHYDRATE,
CSLAVIA, ENERGY, UTILIZATION,
IA, BIBLIOGRAPHIES, ECONOMIC,

OPING-NATIONS, ENERGY-POLICY,
-COLLECTORS, WIND#
TEST-FACILITY, ECONOMICS,
NG# ARRAYS,
NTRATORS#
ELECTROLYSIS,
EN, JAPAN, EU/ ENERGY-POLICY,
WIND# ENERGY-TECHNOLOGY,
TTERIES, SOLAR-CELLS#
ENERGY-CONVERSION,
IONIC-CONVERTERS, WAVE-POWER/
CTOR, ELECTRODES, PHOTOLYSIS,

FEDERAL-GOVERNMENT, INDEXES, I 010003
FERTILIZER# CONV 016013
FINANCIAL-INCENTIVES, INSOLATI 012013
FINANCIAL-INCENTIVES# 012016
FINANCIAL-INCENTIVES# /RECAST, 012008
FINANCIAL-INCENTIVES# /N, ECON 012032
FINANCING, HEATING# 012010
FIPE-HAZARDS, STORAGE, WORKING 012007
FLAT-PLATE---SEE-ALSO-'COLLECT
FLAT-PLATE, HEAT-PUMPS, STORAG 011030
FLAT-PLATE, HEATING, INSULATIO 011014
FLAT-PLATE, HEATING, UNITED-KI 011018
FLAT-PLATE, INSOLATION, U.S.-A 011024
FLAT-PLATE, REVIEWS, EUROPE# 011044
FLAT-PLATE, STORAGE# C 011012
FLAT-PLATE, STORAGE# /NITED-ST 011025
FLAT-PLATE# SWED 011068
FLORIDA, ECONOMIC, ENVIRONMENT 010006
FLUIDS, POWER-PLANTS, GLYCOLS, 013061
FLY-WHEELS# 016017
FLYWHEEL, STORAGE# 016044
FLYWHEELS, WIND# STORA 013021
FOOD, BIOMASS, CALIFORNIA# 017024
FOOD, BIOMASS, MATH-MODELS# 015008
FORECAST, CONCENTRATORS, PHOTO 012008
FORECAST, ITALY, WAVE-POWER# 019006
FORECASTING, GEOTHERMAL, POPUL 010048
FORECASTING, GEOTHERMAL# C 010039
FORECASTING, POPULATION-DYNAMI 010051
FORECASTING, RESEARCH-PROGRAMS 010053
FORECASTING, RESEARCH-PROGRAMS 010035
FORECASTING, RESEARCH-PROGRAMS 012001
FORECASTING, TIDAL-POWER# /KOR 010029
FORECASTING, WAVE-POWER# S 019002
FORECASTING# CONSUMPT 010022
FORECASTING# 010019
FORECASTING# 010023
FORECASTING# EN 010047
FORECASTING# YUG 011028
FORECASTING# /RGY-SYSTEMS, IND 010021
FRANCE, BIOMASS, ECONOMICS# 017008
FRANCE, JAPAN, USSR# /S, DEVEL 011037
FRANCE, POWER-PLANT, PARABOLIC 013012
FRESNEL-LENS, HEAT-EXCHANGERS# 011034
FRESNEL, CONCENTRATORS, TRACKI 013074
FRESNEL, THERMOELECTRIC, CONCE 014001
FUEL-CELL, HYDROGEN-PRODUCTION 010045
FUEL-CELLS, GEOTHERMAL, HYDROG 010032
FUEL-CELLS, HAZARDS, OCEAN-OT, 010044
FUEL-CELLS, LITHIUM-SULFUR, BA 010027
FUEL-CELLS, SOLAR-CELLS# 010037
FUEL-CELLS, SOLAR-CELLS, THERM 011069
FUEL-CELLS# SEMICONDU 019020

PUMPS, COLLECTORS, EDUCATION, FUEL-CELLS# EPA-VAN, HEAT- 010049
CMASS, ELECTRICAL-GENERATION, FUEL-PRODUCTION# OI 017010
HYDROGEN, FUEL, THERMOCHEMICAL# 019015
FUELS, BIOCONVERSION, BIOMASS# 017007
SIANA# FUELS, BIOMASS, ARKANSAS, LOUI 017029
-ALCOHOL# FUELS, BIOMASS, ETHANOL, ETHYL 017016
HYDROGEN, FUELS, ECONOMICS# 019050
FUELS, HYDROGEN# 019040
STEAM, DEMONSTRATION, FURNACES# 013076
H-TEMPERATURE, TEST-FACILITY, FURNACES# HIG 013080
STORAGE, BRAYTON-CYCLE, GAS-TURBINE, HEAT-PUMPS# 013037
A, ENERGY-POLICY# OIL, GAS, COAL, CONSERVATION, CANAD 010025
WIND, GENERATION, RESEARCH-PROGRAMS# 016034
WIND, TURBINE, GENERATOR, RESEARCH# 016072
-MODEL# GENERATOR, WIND, TURBINE, MATH 016063
RIZONTAL-AXIS, WIND, TURBINE, GENERATOR# HO 016022
CROPROCESSOR# WIND, GENERATORS, CONTROL-SYSTEM, MI 016037
WIND, GENERATORS, ECONOMICS,# 016011
CDELS# TURBINE, GENERATORS, HELIOSTATS, MATH-M 013030
VERSION# GENERATORS, THERMOELECTRIC-CON 014000
GENERATORS, WIND, CANADA# 016029
BATTERIES, SOLAR-CELLS, WIND, GENERATORS# 016028
, REVIEWS# ECONOMICS, GEOGRAPHIC, NIGHT-SKY, COOLING 011053
INDIA, GEOTHERMAL, BIOMASS# 010046
GEOTHERMAL, FORECASTING# 010019
T/ HANDBOOK, BIOMASS, CANADA, GEOTHERMAL, HEAT-PUMPS, OCEAN 011029
U/ ENERGY-POLICY, FUEL-CELLS, GEOTHERMAL, HYDROGEN, JAPAN, E 010032
NOMY,/ ENVIRONMENTAL-IMPACTS, GEOTHERMAL, HYDROGEN-BASED-ECO 010038
, WIND, RESEARCH# GEOTHERMAL, INDIA, TIDAL-POWER 010024
CTION, ENVIRONMENTAL-EFFECTS, GEOTHERMAL, POLLUTION# /-PRODU 010030
PTION, ECONOMIC, FORECASTING, GEOTHERMAL, POPULATION# /ONSUM 010048
BIBLIOGRAPHIES, ENVIRONMENT, GEOTHERMAL, RESEARCH-PROGRAMS# 010031
INES# RESOURCES, GEOTHERMAL, REVIEWS, WIND-TURB 011049
ION, ENGINEERING, CONFERENCE, GEOTHERMAL, WIND# /RGY-CONVERS 010008
CLEUM-INDUSTRY, ECONOMETRICS, GEOTHERMAL# PETR 010041
IVE-EVALUATIONS, FORECASTING, GEOTHERMAL# COAL, COMPARAT 010039
TING, DESALINATION, INSOLATI/ GERMANY, COLLECTORS, SPACE-HEA 011059
IC-GENERATORS# PATENT, GERMANY, CONCENTRATORS, ELECTR 011061
LATE, STORAGE/ UNITED-STATES, GERMANY, CONCENTRATORS, FLAT-P 011025
-POWER, HEAT-PUMPS, SOLAR-CE/ GERMANY, ECONOMICS, ELECTRICAL 011056
AGE, STEAM, OFF-PEAK-DEMANDS, GERMANY, POWER-PLANTS# STOR 013010
WASTE, GERMANY, REVIEWS# 017030
WIND, DENMARK, GERMANY, UNITED-KINGDOM# 016019
/ EARTH-RESOURCES, ECONOMIC, GLOBAL-ASPECTS, SOCIAL-IMPACT, 010028
NSFER# NATO, ENERGY-POLICY, GLOBAL-ASPECTS, TECHNOLOGY-TRA 010052
FLUIDS, POWER-PLANTS, GLYCOLS, HEAT-TRANSFER# 013061
ENERGY-STORAGE# ECONOMICS, GOVERNMENT-POLICIES, OFF-PEAK- 013081
ISLATION, CONGRESS, ECONOMIC, GOVERNMENT-POLICIES, PUBLIC-UT 012033
E/ INDUSTRY, ECONOMIC-POLICY, GOVERNMENT-POLICIES, LEGAL-ASP 012031
ENERGY-TECHNOLOGY, GOVERNMENT-POLICIES, JAPAN# 011043
STRATION-PROGRAMS, ECONOMICS, GOVERNMENT-POLICIES, ERDA# /CN 011038
, BIOMASS, ECONOMIC-ANALYSIS, GOVERNMENT-POLICIES# /ATERIALS 017001
L, CONSERVATION, INVESTMENTS, GOVERNMENT-POLICIES# /ER-BARRE 012029

NESS, AUTOMOBILES, ECONOMICS, GOVERNMENT-POLICIES# BUSI 012027
CN# HEATING, COOLING, GRAIN-DRYING, CANADA, INSOLATI 011016
WIND, TURBINES, GREAT-LAKES, MATH MODELS# 016035
WINDS, GREAT-LAKES, MATH-MODELS# 016055
WIND, GREAT-PLAINS, VERTICAL-AXIS# 016003
AGRICULTURE, ECONOMICS, GREENHOUSES, HEATING, ERDA# 011020
AGRICULTURE, BUILDINGS, GREENHOUSES, SOLAR-DRYING# 011021
-PLANT, METHANE, NATURAL-GAS, GREENHOUSES# POWER 017013
ATIONAL# ENERGY-CONSUMPTION, GROSS-NATIONAL-PRODUCT, INTERN 012026
TORAGE# GROUND-WATER, HEAT-TRANSFER, S 013055
FORCE-FACILITIES, COMPUTER-P/ GUIDELINES, CONSERVATION, AIR- 010014
SYSTEMS, SYSTEMS-ENGINEERING/ GUIDELINES, ENERGY-CONSERVING- 010045
WIND, LOUISIANA, GULF-OF-MEXICO, SITE-SELECTION 016067
THERMAL, HEAT-PUMPS, OCEAN T/ HANDBOOK, BIOMASS, CANADA, GEO 011029
FACTORS, UTILITIES# HANDBOOK, CONSUMPTION, DEMAND- 010012
FACTORS, RESEARCH-PROGRAMS, / HANDBOOK, CONSUMPTION, DEMAND- 010013
NERGY-TECHNOLOGY, FUEL-CELLS, HAZARDS, OCEAN-OT, WIND# E 010044
R-PLANT, OCEAN-THERMAL-POWER, HAZARDS# MATERIALS, POWE 015028
NITINOL-ENGINE, HEAT-ENGINES, ALLOYS# 013004
Y# PATENT, CONCENTRATORS, HEAT-ENGINES, MECHANICAL-ENERG 013064
HEAT-EXCHANGER, WIND# 019027
OCEAN-THERMAL-POWER-PLANT, HEAT-EXCHANGERS, ECONOMICS# 015002
URBINE# MODEL, HEAT-EXCHANGERS, INSULATION, T 013085
-ENERGY-CONVERSI/ BIOFOULING, HEAT-EXCHANGERS, OCEAN-THERMAL 015022
-ENERGY-CONVERSION# HEAT-EXCHANGERS, OCEAN-THERMAL 015020
-POWER# AMMONIA, HEAT-EXCHANGERS, OCEAN-THERMAL 015029
BIOFOULING, HEAT-EXCHANGERS, OTEC# 015013
TURBINE# CONVERSION, HEAT-EXCHANGERS, POWER-PLANTS, 013033
BINES/ PATENT, CONCENTRATORS, HEAT-EXCHANGERS, SEAWATER, TUR 013044
ODEL, OCEAN-THERMAL-POWER# HEAT-EXCHANGERS, SIMULATION, M 015014
OTEC, HEAT-EXCHANGERS, SIMULATION# 015021
E, MATH-METHOD# HEAT-EXCHANGERS, STIRLING-CYC 013063
BRAYTON-CYCLE, HEAT-EXCHANGERS, STORAGE# 013006
R-HEATERS# HEAT-EXCHANGERS, STORAGE, WATE 011033
POWER-PLANT, HEAT-EXCHANGERS, STORAGE# 013072
ITY, ECONOMICS, FRESNEL-LENS, HEAT-EXCHANGERS# TEST-FACIL 011034
AN-THERMAL-ENERGY-CONVERSION, HEAT-EXCHANGERS# OCE 015012
SALT, STORAGE, ECONOMIC, HEAT-EXCHANGERS# 013028
OCEAN-THERMAL-POWER, PROPANE, HEAT-EXCHANGERS# 015015
STORAGE, DEMONSTRATION, HEAT-PIPES, POWER-PLANTS# 013068
CHEMICAL, STORAGE, CATALYSTS, HEAT-PIPES, REVIEWS# 013059
STORAGE, SALTS, EUTECTICS, HEAT-PIPES# 013058
CONTROL, CARNOT-CYCLE, HEAT-PIPES# 013000
RANKINE-CYCLE, HEAT-PUMP, TURBINE# 013007
ION, FUEL-CELLS# EPA-VAN, HEAT-PUMPS, COLLECTORS, EDUCAT 010049
BIOMASS, CANADA, GEOTHERMAL, HEAT-PUMPS, OCEAN THERMAL# /K, 011029
CNING, UTILITIES, SIMULATION, HEAT-PUMPS, PENNSYLVANIA# /ITI 012020
ECONOMICS, ELECTRICAL-POWER, HEAT-PUMPS, SOLAR-CELLS# /ANY, 011056
TION, ECONOMICSS, FLAT-PLATE, HEAT-PUMPS, STORAGE# /EMONSTRA 011030
PACIFIC-NORTHWEST, HEAT-PUMPS, STORAGE# 016070
OWER# CANADA, BIOMASS, HEAT-PUMPS, WAVE-POWER, WIND-P 011052
, BRAYTON-CYCLE, GAS-TURBINE, HEAT-PUMPS# STORAGE 013037
, CONFERENCE, THERMOELECTRIC, HEAT-PUMPS# PROCEEDINGS 014004

CN, SPACE-HEATING#
HANE# WASTE-TREATMENT,
OCEAN-THERMAL-EXCHANGERS,
TS, STORAGE# CONCENTRATORS,
NERGY-CONVERSION, BIBLIOGRAP/
GROUND-WATER,
LUIDS, POWER-PLANTS, GLYCOLS,
COMPUTER-PROGRAM,

, CANADA, INSOLATION#
COMMERCIAL, STORAGE,
TURE, ECONOMICS, GREENHOUSES,
N, PUMPS, COOLING#
HESIVES, COOLING, FLAT-PLATE,
STORAGE,
AGRICULTURE, COOLING,
UNDERGRADUATE, EDUCATION,
NORWAY,
PROGRAM-PLAN, COOLING,
STORAGE,
CONCENTRATORS, FLAT-PLATE,
, COOLING, ECONOMIC-ANALYSIS,
MARKET, FINANCING,
CONTROL-SYSTEM, COOLING,
, DESIGN, BUILDINGS, COOLING,
LDINGS, COOLING, INFORMATION,
CANADA, COOLING, ECONOMICS,
E-CHANGE, STORAGE, EUTECTICS,
TS, MATH-MODE/ CONCENTRATORS,
SOLAR-THERMAL-POWER,
PLANTS#
COOLING# HEATING,
TURBINE, GENERATORS,
AGE#
GE# BOILERS, ECONOMICS,
AGE# ELECTRIC-GENERATION,
PLANTS, WIND#
-PLANTS#
CTRIC-INDUSTRY, POWER-PLANTS,
ROCK-BEDS# STORAGE,
K-BED, SALTS#
Y, FURNACES#
STORAGE,
FURNACES, WATER-HEATERS#
WIND, BLADES,
, GENERATOR#
WIND, TURBINE,
MATH-MODELS, PHOTOVOLTAIC#

NT#
STEAM-GENERATION,
EC/ BRAZIL, BIOMASS, ETHANOL,

HEAT-STORAGE-WELL, AIR-POLLUTI 013053
HEAT-TRANSFER, INSOLATION, MET 017025
HEAT-TRANSFER, MATERIALS# 015027
HEAT-TRANSFER, MATH-MODEL, SAL 013070
HEAT-TRANSFER, OCEAN-THERMAL-E 015001
HEAT-TRANSFER, STORAGE# 013055
HEAT-TRANSFER# F 013061
HEAT-TRANSFER# 013084
HEAT-TRANSFER# 013019
HEATING, COOLING, GRAIN-DRYING 011016
HEATING, COOLING# 013057
HEATING, ERDA# AGRICUL 011020
HEATING, HELIOSTATS, IRRIGATIO 011041
HEATING, INSULATION, STORAGE# 011014
HEATING, OFF-PEAK-POWER# 013001
HEATING, PROCESS-HEAT# 011008
HEATING, RESIDENTIAL# 011005
HEATING, SOLAR-CELLS# 011060
HEATING, THERMAL-POWER# 011003
HEATING, TOXICITY# 013025
HEATING, UNITED-KINGDOM# 011018
HEATING, UTILITY-PRICING# /NGS 012015
HEATING# 012010
HEATING# 016065
HEATING# ERDA 011058
HEATING# NATO, BUI 011055
HEATING# 011031
HEATING# PHAS 013046
HELIOS, SIMULATION, POWER-PLAN 013008
HELIOSTAT# 013029
HELIOSTATS, COLLECTORS, POWER- 013038
HELIOSTATS, IRRIGATION, PUMPS, 011041
HELIOSTATS, MATH-MODELS# 013030
HELIOSTATS, PILOT-PLANTS, STOR 013031
HELIOSTATS, PILOT-PLANT, STORA 013011
HELIOSTATS, PILOT-PLANTS, STOR 013066
HELIOSTATS, TOWER-FOCUS-POWER- 013056
HELIOSTATS, TOWER-FOCUS, POWER 013009
HELIOSTATS# CONVERSION, ELE 010026
HIGH-TEMPERATURE, MATH-MODELS, 013067
HIGH-TEMPERATURE, STORAGE, POO 013032
HIGH-TEMPERATURE, TEST-FACILIT 013030
HIGH-TEMPERATURE# 013043
HISTORY, SOLAR-COOKERS, SOLAR- 011045
HORIZONTAL-AXIS, RURAL# 016030
HORIZONTAL-AXIS, WIND, TURBINE 016022
HORIZONTAL-AXIS# 016038
HOTTEL-WHILLIER-BLISS, MODEL, 018002
HUD, NBS, STORAGE, COLLECTORS# 012014
HYDRIDES, STORAGE# 013047
HYDROELECTRIC-POWER, POWER-PLA 019010
HYDROGEN-BASED-ECONOMY# 010056
HYDROGEN-BASED-ECONOMY, SOCIO- 010042

ONMENTAL-IMPACTS, GEOTHERMAL, HYDROGEN-BASED-ECONOMY, WIND# 010036
PRODUCTION, CATHODES# HYDROGEN-GENERATORS, HYDROGEN- 019034
MICAL# ELECTROLYSIS, HYDROGEN-PRODUCTION, THERMOCHE 019019
MICAL# HYDROGEN-PRODUCTION, THERMOCHE 019030
TROCHEMICAL, HYDROGEN# HYDROGEN-PRODUCTION, PHOTOELEC 019033
HYDROGEN-GENERATORS, HYDROGEN-PRODUCTION, CATHODES# 019034
CLAR-CELLS# HYDROGEN-PRODUCTION, PATENT, S 013017
ISTRY/ BIOMASS, CHLOROPLASTS, HYDROGEN-PRODUCTION, PHOTOCHEM 011015
PHOTOELECTROLYSIS, HYDROGEN-PRODUCTION# 010032
ELECTROLYSIS, FUEL-CELL, HYDROGEN-PRODUCTION# 019045
PHOTOLYSIS, PHOTOCHEMICAL, HYDROGEN-PRODUCTION# 019039
TOR, ELECTRODES, ELECTROLYSIS HYDROGEN-PRODUCTION# /MICONDUC 019053
LTAIC# NASA, HYDROGEN-PRODUCTIVITY, PHOTOVO 019028
HYDROGEN, FUEL, THERMOCHEMICAL 019015
HYDROGEN, FUELS, ECONOMICS# 019050
LICY, FUEL-CELLS, GEOTHERMAL, HYDROGEN, JAPAN, EUROPE# /Y-FO 010032
PHOTOELECTRO-CHEMICAL, HYDROGEN, MODEL# 019003
GE# ENERGY-TRANSMISSION, HYDROGEN, OTEC, METHANE, STORA 015030
EPARATION# HYDROGEN, OXYGEN, EFFUSIONAL-S 019012
AL-ENERGY-CONVERSION# HYDROGEN, STORAGE, OCEAN-THERM 015011
PIPELINE, HYDROGEN# 019016
FUELS, HYDROGEN# 019040
UCTION, PHOTOELECTROCHEMICAL, HYDROGEN# HYDROGEN-PRO 019033
SIVE, RESOURCES, POWERPLANTS, HYDROTHERMAL# NONWATER-INTEN 011001
COMPARATIVE-EVALUATIONS, ILLINOIS, ECONOMICS# 012002
CT, SOLAR-HEATED, RESIDENCES, ILLINOIS# ECONOMIC-IMPA 012028
AL-INCENTIVES'# INCENTIVES---SEE-ALSO-'FINANCI
AX-CREDITS# INCENTIVES, BARRIERS, LOANS, T 012004
REGULATING, ECONOMIC-POLICY, INCENTIVES, PUBLIC-UTILITIES# 012030
ECONOMICS, ENERGY-POLICY, INCENTIVES, SUBSIDIES# 012006
RATOR# INCENTIVES, WIND, TURBINE-GENE 016012
GY-CONVERSION, ENERGY-POLICY, INCENTIVES# /OCEAN-THERMAL-ENER 015019
FEDERAL-GOVERNMENT, INDEXES, INFORMATION-SYSTEM# 010003
NERGY, BIBLIOGRAPHY, UPDATED, INDEXES, NASA# E 010000
C, FORECASTI/ ENERGY-SYSTEMS, INDIA, BIBLIOGRAPHIES, ECONOMI 010021
INDIA, GEOTHERMAL, BIOMASS# 010046
WER# INDIA, SITE-SELECTION, WAVE-PO 019043
ARCH# GEOTHERMAL, INDIA, TIDAL-POWER, WIND, RESE 010024
CONOMICS, ENERGY-POLICY# INDUSTRIAL, ENERGY-PLANNING, E 010055
, DEMONSTRATION# INDUSTRY-ACCEPTANCE, BUILDINGS 011062
, MEETING, ADHESIVE, SEALANT, INDUSTRY, CONSERVATION# /DINGS 010001
ERNMENT-POLICIES, LEGAL-ASPE/ INDUSTRY, ECONOMIC-POLICY, GOV 012031
ORS, PHOTOVOLTAIC, FINANCIAL/ INDUSTRY, FORECAST, CONCENTRAT 012008
CATION, PUBLIC# INFORMATION-DISSEMINATION, EDU 011006
INFORMATION-DISTRIBUTION# 010050
INFORMATION-SERVICE, ARIZONA# 011011
FEDERAL-GOVERNMENT, INDEXES, INFORMATION-SYSTEM# 010003
COMMERCIALIZATION, INFORMATION, ERDA# 011047
NATO, BUILDINGS, COOLING, INFORMATION, HEATING# 011055
E-LABORATORY,# EDUCATION, INFORMATION, LAWRENCE-LIVERMOR 011046
GISLATION, LIFE-CYCLE-COSTS# INITIATIVES, ACCESS-RIGHTS, LE 012005
STORAGE, INORGANIC, PHOTOCHEMICAL# 010052
COLING, DEHYDRATION, STORAGE, INORGANIC# BUILDINGS, C 013005

STORAGE, INORGNAIC, THERMOCHEMICAL# 013027
CCESS-HEAT, ELECTRICAL-POWER, INSOLATION, ECONOMIC-ANALYSIS# 013003
SWEDEN, POWER-PLANTS, INSOLATION, FLAT-PLATE# 011068
SIMULATION, INSOLATION, MATH-MODELS# 011032
STE-TREATMENT, HEAT-TRANSFER, INSOLATION, METHANE# WA 017025
RANCMETER/ ENERGY-CONVERSION, INSOLATION, PYRHELIOMETERS, PY 011067
FLAT-PLATE, INSOLATION, U.S.-AIR-FORCE# 011024
OOLING, GRAIN-DRYING, CANADA, INSOLATION# HEATING, C 011016
BIOMASS, NORTH-AMERICA, INSOLATION# 017021
MODEL, SIMULATION, INSOLATION# 013035
TY, AGRICULTURAL-ENGINEERING, INSOLATION# PROBABILI 012022
NOMICS, FINANCIAL-INCENTIVES, INSOLATION# CONSERVATION, ECO 012013
SPACE-HEATING, DESALINATION, INSOLATION# /MANY, COLLECTORS, 011059
D-USE# COMMUNICATION, STUDY, INSTITUTIONAL-CONSTRAINTS, LAN 010007
ANAGEMENT, ENERGY-TECHNOLOGY, INSULATION, RESEARCH-PROGRAMS# 010015
COOLING, FLAT-PLATE, HEATING, INSULATION, STORAGE# /ESIVES, 011014
MODEL, HEAT-EXCHANGERS, INSULATION, TURBINE# 013085
COVER, PATENT, INSULATION# 013071
S, CONSERVATION, EDUCATIONAL, INTEGRATED-UTILITY-SYSTEM# /IC 012000
LANCE, ENVIRONMENTAL-IMPACTS, INTERNATIONAL-COOPERATION# /EA 010040
ESEARCH, DEVELOPMENT# INTERNATIONAL-ENERGY-AGENCY, R 011054
AR-CELLS, THERMOELECTRIC# INTERNATIONAL, CONFERENCE, SOL 011000
OPMENT# INTERNATIONAL, RESEARCH, DEVEL 011026
TION, GROSS-NATIONAL-PRODUCT, INTERNATIONAL# ENERGY-CONSUMP 012026
OST-PER-BARREL, CONSERVATION, INVESTMENTS, GOVERNMENT-POLICI 012029
HEATING, HELIOSTATS, IRRIGATION, PUMPS, COOLING# 011041
STING, POPULATION-DYNAMICS# ISRAEL, DEMAND-FACTORS, FORECA 010051
FORECAST, ITALY, WAVE-POWER# 019006
-CELLS, GEOTHERMAL, HYDROGEN, JAPAN, EUROPE# /Y-POLICY, FUEL 010032
TIONS, ENERGY-POLICY, FRANCE, JAPAN, USSR# /S, DEVELOPING-NA 011037
HNOLOGY, GOVERNMENT-POLICIES, JAPAN# ENERGY-TEC 011043
Y, INSTITUTIONAL-CONSTRAINTS, LAND-USE# COMMUNICATION, STUD 010007
STORAGE, LATENT-HEAT, PHOTOCHEMICAL# 019024
ES, MATH-MODELS, SALTS# LATENT-HEAT, STORAGE, CARBONAT 013051
EDUCATION, INFORMATION, LAWRENCE-LIVERMORE-LABORATORY, 011046
, ECONOMIC-IMPACT, EDUCATION, LAWS, FINANCIAL-INCENTIVES# /N 012032
-POLICY, GOVERNMENT-POLICIES, LEGAL-ASPECTS# /STRY, ECONOMIC 012031
LDING-PERMITS, REGULATIONS# LEGAL-PROBLEMS, LIABILITY, BUI 012018
C, GOVERNMENT-POLICIES, PUBL/ LEGISLATION, CONGRESS, ECONOMI 012033
CONSERVATION, LEGISLATION, ENERGY-POLICY,# 010050
INITIATIVES, ACCESS-RIGHTS, LEGISLATION, LIFE-CYCLE-COSTS# 012005
FFSHORE, WIND, ENERGY-POLICY, LEGISLATION# O 016041
ELECTRIC, PATENT, LENSES, SOLAR-CELLS# 013078
EGULATIONS# LEGAL-PROBLEMS, LIABILITY, BUILDING-PERMITS, R 012018
ARIZONA-STATE-UNIVERSITY, LIBRARIES# 011007
, ACCESS-RIGHTS, LEGISLATION, LIFE-CYCLE-COSTS# INITIATIVES 012005
ROCKS# LIQUID, STORAGE, POWER-PLANTS, 013054
AR-CELLS# FUEL-CELLS, LITHIUM-SULFUR, BATTERIES, SOL 010027
INCENTIVES, BARRIERS, LOANS, TAX-CREDITS# 012004
E-SELECTION# WIND, LOUISIANA, GULF-OF-MEXICO, SIT 016067
FUELS, BIOMASS, ARKANSAS, LOUISIANA# 017029
INSULATION, RESEARCH-PROGRA/ MANAGEMENT, ENERGY-TECHNOLOGY, 010015
MANURE, BIOMASS, METHANE# 017020

WIND, MAPS, EPCA# 016010
BIOMASS, ECONOMICS, MARICULTURE# 017005
MARKET, FINANCING, HEATING# 012010
THERMAL-POWER, HAZARDS# MATERIALS, POWER-PLANT, OCEAN- 015028
AL-EXCHANGERS, HEAT-TRANSFER, MATERIALS# OCEAN-THERM 015027
WIND, TURBINES, GREAT-LAKES, MATH MODELS# 016035
STRUCTION, ECONOMIC-ANALYSIS, MATH-ANALYSIS# /AR-SYSTEM, CON 012024
T-EXCHANGERS, STIRLING-CYCLE, MATH-METHOD# HEA 013063
CONCENTRATORS, HEAT-TRANSFER, MATH-MODEL, SALTS, STORAGE# 013070
GENERATOR, WIND, TURBINE, MATH-MODEL# 016063
AN-THERMAL-ENERGY-CONVERSION, MATH-MODEL# OCE 015005
TIDAL-ENERGY, CANADA, MATH-MODEL# 019007
WIND-SPEEDS, MATH-MODEL# 016013
OS, SIMULATION, POWER-PLANTS, MATH-MODEL# /NCENTRATORS, HELI 013008
MATH-MODELS, BIOMASS# 017004
WIND, MATH-MODELS, BLADES# 016032
ATMOSPHEREIC-MODEL, MATH-MODELS, CLIMATIC-IMPACT# 013065
ER# ATLANTIC, MATH-MODELS, PACIFIC, WAVE-POW 019035
HOTTEL-WHILLIER-BLISS, MODEL, MATH-MODELS, PHOTOVOLTAIC# 013002
STORAGE, HIGH-TEMPERATURE, MATH-MODELS, ROCK-BEDS# 013067
NT-HEAT, STORAGE, CARBONATES, MATH-MODELS, SALTS# LATE 013051
BOILERS, MATH-MODELS, STORAGE# 013023
-POWER# MATH-MODELS, TIDAL-POWER, WAVE 019008
L, COLLECTORS, CONCENTRATORS, MATH-MODELS,# MODE 013073
SEA, POWER-PLANTS, MATH-MODELS# 015006
AMERICA, PACIFIC, WAVE-POWER, MATH-MODELS# NORTH- 019036
WINDS, GREAT-LAKES, MATH-MODELS# 016035
SEA-POWER-PLANTS, MATH-MODELS# 015016
SALTS, METALS, MATH-MODELS# 013040
SOLAR-POWER-SYSTEMS, MATH-MODELS# 013026
BINE, GENERATORS, HELIOSTATS, MATH-MODELS# TUR 013030
-POWER, DEAN-STREAM-FUNCTION, MATH-MODELS# WAVE 019022
WINDMILL, BLADES, MATH-MODELS# 016061
SIMULATION, MATH-MODELS# 015026
BIO-GAS, ONTARIO, BIOMASS, MATH-MODELS# 017019
FOOD, BIOMASS, MATH-MODELS# 015008
OCEAN-THERMAL-POWER, MATH-MODELS# 015017
SIMULATION, INSOLATION, MATH-MODELS# 011032
WIND, SITE-SELECTION, MATH-MODELS# 016020
ROCKY-MOUNTAIN, NEW-ENGLAND, MATH-MODELS# /, PACIFIC-COAST, 016026
CONCENTRATORS, HEAT-ENGINES, MECHANICAL-ENERGY# PATENT, 013064
CUSTRY, CONSERV/ PROCEEDINGS, MEETING, ADHESIVE, SEALANT, IN 010001
RING,# PROCEEDINGS, MEETING, ENVIRONMENTAL-ENGINEE 010002
OLICY, ENVIRONMENTAL-IMPACTS, MEETINGS# ENERGY-P 010054
SALTS, METALS, MATH-MODELS# 013040
METHANE, BIOMASS# 017023
SEWAGE-PLANT, METHANE, ECONOMICS# 017002
SES# POWER-PLANT, METHANE, NATURAL-GAS, GREENHOU 017018
WASTE, METHANE, PYROLYSIS# 017026
S, BIOMASS# METHANE, SOLID-WASTE, ANAEROBE 017014
TRANSMISSION, HYDROGEN, OTEC, METHANE, STORAGE# ENERGY- 015030
BIOSYNTHESIS, METHANE, WASTES# 017012
ALCOHOL, BRAZIL, BIOMASS, METHANE# 017033

MANUFE, BIOMASS, METHANE# 017020
T, HEAT-TRANSFER, INSOLATION, METHANE# WASTE-TREATMEN 017025
APPLICATIONS, MEXICO, CLIMATOLOGY# 011048
TAL# UTILITY-SYSTEMS, MICHIGAN, ECONOMIC, ENVIRONMEN 010005
S# WIND, MICHIGAN, SIMULATION, ECONOMIC 016025
, GENERATORS, CONTROL-SYSTEM, MICROPROCESSOR# WIND 016037
IES# STORAGE, MIDWEST, WIND, ELECTRIC-UTILIT 016059
ES# WIND, MINNESOTA, SIMULATION, UTILITI 016039
REVIEW, ERDA, MIRROR, SELECTIVE-COATINGS# 013060
STRATION-PROGRAMS, EDUCATION, MIUS# DATA-COMPILATION, DEMON 010017
RS, MATH-MODELS,# MODEL, COLLECTORS, CONCENTRATO 013073
HEATING# UTILITIES, MODEL, ECONOMICS, RESIDENTIAL- 012021
TION, TURBINE# MODEL, HEAT-EXCHANGERS, INSULA 013085
IC# HOTTEL-WHILLIER-BLISS, MODEL, MATH-MODELS, PHOTOVOLTA 013002
HEAT-EXCHANGERS, SIMULATION, MODEL, OCEAN-THERMAL-POWER# 015014
MODEL, POWER-PLANT, OCEAN-OT# 015000
MODEL, SIMULATION, INSOLATION# 013035
WIND, MONITORING, MODEL, TOPOGRAPHY# 016027
S# WIND, CANADA, MODEL, UTILITIES, VERTICAL-AXI 016051
TOELECTRO-CHEMICAL, HYDROGEN, MODEL# PHO 019003
REPORT, WIND, SITE-SELECTION, MODEL# 016050
AS# MODELS, CONFERENCES, NATURAL-G 012017
AN-THERMAL-ENERGY-CONVERSION, MODELS, EXPERIMENTS# OCE 015009
, TURBINES, GREAT-LAKES, MATH MODELS# WIND 016035
WIND, MODELS# 016008
ATA-ANALYSIS, SITE-SELECTION, MODELS# WIND, D 016047
WIND, MONITORING, MODEL, TOPOGRAPHY# 016027
TATION, AEROSPACE-TECHNOLOGY, NASA-PROGRAMS# /TURE, TRANSPOR 010033
HOTOVOLTAIC# NASA, HYDROGEN-PRODUCTIVITY, P 019028
ERDA, NASA, WIND, TURBINES# 016060
BLIOGRAPHY, UPDATED, INDEXES, NASA# ENERGY, BI 010000
RMATION, HEATING# NATO, BUILDINGS, COOLING, INFO 011055
PECTS, TECHNOLOGY-TRANSFER# NATO, ENERGY-POLICY, GLOBAL-AS 010052
POWER-PLANT, METHANE, NATURAL-GAS, GREENHOUSES# 017018
UM, ECONOMICS, ENERGY-POLICY, NATURAL-GAS, WELL-DRILLING# /I 012019
MODELS, CONFERENCES, NATURAL-GAS# 012017
HUD, NBS, STORAGE, COLLECTORS# 012014
WIND, ENERGY-CONVERSION, NET-ENERGY# 016016
RESEARCH, WIND, NETHERLANDS# 016066
ACIFIC-COAST, ROCKY-MOUNTAIN, NEW-ENGLAND, MATH-MODELS# /, P 016026
ES, ECONOMICS# NEW-GUINEA, DEVELOPING-COUNTRI 011070
WINDS, NEW-MEXICO, SITE-EVALUATION# 016058
WIND, RESOURCE, NEW-ZEALAND# 016006
ECONOMICS, GEOGRAPHIC, NIGHT-SKY, COOLING, REVIEWS# 011053
ALLOYS# NITINOL-ENGINE, HEAT-ENGINES, 013004
POWERPLANTS, HYDROTHERMAL# NONWATER-INTENSIVE, RESOURCES, 011001
BIOMASS, NORTH-AMERICA, INSOLATION# 017021
OWER, MATH-MODELS# NORTH-AMERICA, PACIFIC, WAVE-P 019036
NORWAY, HEATING, SOLAR-CELLS# 011060
NSF, ERDA, ENERGY, RESEARCH,# 011065
-THERMAL, PHOTOVOLTAIC, WIND, NSF# BIOMASS, OCEAN 011027
NADA, GEOTHERMAL, HEAT-PUMPS, OCEAN THERMAL# /K, BIOMASS, CA 011029
HNOLOGY, FUEL-CELLS, HAZARDS, OCEAN-OT, WIND# ENERGY-TEC 010044

MODEL, POWER-PLANT, OCEAN-OT# 015000
N, BIOFOULING, CORROSION# OCEAN-THERMAL-ENERGY-CONVERSIO 015024
N, HEAT-EXCHANGERS# OCEAN-THERMAL-ENERGY-CONVERSIO 015012
N# OCEAN-THERMAL-ENERGY-CONVERSIO 015007
BIOFOULING, HEAT-EXCHANGERS, OCEAN-THERMAL-ENERGY-CONVERSIO 015022
N# HYDROGEN, STORAGE, OCEAN-THERMAL-ENERGY-CONVERSIO 015011
N# HEAT-EXCHANGERS, OCEAN-THERMAL-ENERGY-CONVERSIO 015020
N, SYSTEMS-ANALYSIS# OCEAN-THERMAL-ENERGY-CONVERSIO 015025
N, ENERGY-POLICY, INCENTIVES/ OCEAN-THERMAL-ENERGY-CONVERSIO 015019
N# BIOFOULING, OCEAN-THERMAL-ENERGY-CONVERSIO 015004
N, BIBLIOGRAP/ HEAT-TRANSFER, OCEAN-THERMAL-ENERGY-CONVERSIO 015001
N, ENERGY-POLICY# OCEAN-THERMAL-ENERGY-CONVERSIO 015013
N# OCEAN-THERMAL-ENERGY-CONVERSIO 015003
N, MATH-MODEL# OCEAN-THERMAL-ENERGY-CONVERSIO 015005
N, MODELS, EXPERIMENTS# OCEAN-THERMAL-ENERGY-CONVERSIO 015009
N# ENERGY-TRANSMISSION, OCEAN-THERMAL-ENERGY-CONVERSIO 015010
-TRANSFER, MATERIALS# OCEAN-THERMAL-EXCHANGERS, HEAT 015027
T-EXCHANGERS, ECONOMICS# OCEAN-THERMAL-POWER-PLANT, HEA 015002
MATERIALS, POWER-PLANT, OCEAN-THERMAL-POWER, HAZARDS# 015028
HEAT-EXCHANGERS# OCEAN-THERMAL-POWER, PROPANE, 015015
LS# OCEAN-THERMAL-POWER, MATH-MODE 015017
XCHANGERS, SIMULATION, MODEL, OCEAN-THERMAL-POWER# HEAT-E 015014
AMMONIA, HEAT-EXCHANGERS, OCEAN-THERMAL-POWER# 015029
IND, NSF# BIOMASS, OCEAN-THERMAL, PHOTOVOLTAIC, W 011027
ER-PLANTS# STORAGE, STEAM, OFF-PEAK-DEMANDS, GERMANY, POW 013010
UTILITIES, RESIDENTIAL# OFF-PEAK-ELECTRICITY, STORAGE, 012023
ONOMICS, GOVERNMENT-POLICIES, OFF-PEAK-ENERGY-STORAGE# IC 013081
STORAGE, OFF-PEAK-ENERGY, WASTE-HEAT# 013014
STORAGE, HEATING, OFF-PEAK-POWER# 013001
OFFSHORE-PLATFORMS, WAVE-POWER 019025
LEGISLATION# OFFSHORE, WIND, ENERGY-POLICY, 016041
CONSERVATION, ENERGY-POLICY, OIL-SHALE# 010016
CANADA, ENERGY-POLICY# OIL, GAS, COAL, CONSERVATION, 010025
BIO-GAS, ONTARIO, BIOMASS, MATH-MODELS# 017019
OTEC, BIOFOULING# 015023
ION# OTEC, HEAT-EXCHANGERS, SIMULAT 015021
NERGY-TRANSMISSION, HYDROGEN, OTEC, METHANE, STORAGE# E 015030
ENERGY-TRANSMISSION, OTEC, STORAGE, THERMOCHEMICAL# 015031
BIOFOULING, HEAT-EXCHANGERS, OTEC# 015018
OTEC# 015032
HYDROGEN, OXYGEN, EFFUSIONAL-SEPARATION# 019012
NEW-ENGLAND, MATH-MOD/ WIND, PACIFIC-COAST, ROCKY-MOUNTAIN, 016026
STORAGE# PACIFIC-NORTHWEST, HEAT-PUMPS, 016070
ION# WIND, POWER, PACIFIC-NORTHWEST, SITE-SELECT 016002
LS# NORTH-AMERICA, PACIFIC, WAVE-POWER, MATH-MODE 019036
ATLANTIC, MATH-MODELS, PACIFIC, WAVE-POWER# 019035
SOLAR-CELL, STUDENT-AUTHORED, PAPERS# 010004
FRANCE, POWER-PLANT, PARABOLIC-COLLECTORS, WIND# 013012
-PROGRAMS, TH/ DEMONSTRATION, PARABOLIC-COLLECTORS, RESEARCH 013000
THERMIONIC, COLLECTORS, PARABOLIC# 014005
E-LEGISLATURES, ENERGY-BILLS, PART-ONE# STAT 012009
LEGISLATURES# PART-TWO, ENERGY-BILLS, STATE- 012011
, TRACKING, TURBINES# PATENT, CONCENTRATORS, STORAGE 013020

CHANGERS, SEAWATER, TURBINES/ PATENT, CONCENTRATORS, HEAT-EX 013044
GINES, MECHANICAL-ENERGY# PATENT, CONCENTRATORS, HEAT-EN 013064
, ELECTRIC-GENERATORS# PATENT, GERMANY, CONCENTRATORS 011061
COVER, PATENT, INSULATION# 013071
ELECTRIC, PATENT, LENSES, SOLAR-CELLS# 013078
-POWER# PATENT, POWER-GENERATION, WAVE 019029
PATENT, PUMPS, WAVE-POWER# 019049
HYDROGEN-PRODUCTION, PATENT, SOLAR-CELLS# 019017
FACTORY-WASTE, PATENT, STORAGE# 019046
DESALINATION, PATENT, STORAGE# 019047
POWER-PLANT, PATENT, TIDAL-POWER# 019009
URBINE# PATENT, WATER-CURRENT-POWER, T 019048
AEOLIAN-WINDMILL, PATENT, WIND# 016048
ROTOR, PATENT, WIND# 016043
PENNSYLVANIA, ENERGY-POLICY# 011013
TIES, SIMULATION, HEAT-PUMPS, PENNSYLVANIA# /ITIONING, UTILI 012020
CS, GEOTHERMAL# PETROLEUM-INDUSTRY, ECONOMETRI 010041
CS, HEATING# PHASE-CHANGE, STORAGE, EUTECTI 013046
CANADA, PHOTO-OXIDATION# 017009
TION# PHOTOLYSIS, PHOTOCHEMICAL, HYDROGEN-PRODUC 019039
POLYMERS, PHOTOCHEMICAL, STORAGE# 019021
STORAGE, LATENT-HEAT, PHOTOCHEMICAL# 019024
STORAGE, INORGANIC, PHOTOCHEMICAL# 019052
OPLASTS, HYDROGEN-PRODUCTION, PHOTOCHEMISTRY# /IOMASS, CHLOR 011015
N, MODEL# PHOTOELECTRO-CHEMICAL, HYDROGE 019003
HYDROGEN-PRODUCTION, PHOTOELECTROCHEMICAL, HYDROGEN 019033
ODUCTION# PHOTOELECTROLYSIS, HYDROGEN-PR 019032
TUNGSTEN, ELECTRODE, PHOTOELECTROLYSIS# 019005
SEMICONDUCTOR, ELECTRODES, PHOTOLYSIS, FUEL-CELLS# 019020
ROGEN-PRODUCTION# PHOTOLYSIS, PHOTOCHEMICAL, HYD 019039
ALGAE, BIOMASS# PHOTOSYNTHESIS, DEMONSTRATION, 017027
REVIEW, ALGAE, BIOMASS, PHOTOSYNTHESIS# 017015
S# RESIDENTIAL, PHOTOVOLTAIC, ERDA, SOLAR-CELL 018001
TRY, FORECAST, CONCENTRATORS, PHOTOVOLTAIC, FINANCIAL-INCENT 012008
ENVIRONMENTAL-IMPACT, PHOTOVOLTAIC, POWER-GENERATION 011064
BIOMASS, OCEAN-THERMAL, PHOTOVOLTAIC, WIND, NSF# 011027
NASA, HYDROGEN-PRODUCTIVITY, PHOTOVOLTAIC# 019028
ER-BLISS, MODEL, MATH-MODELS, PHOTOVOLTAIC# HOTTEL-WHILLI 013002
POWER-PLANTS, PHOTOVOLTAICS, POWER-SATELLITE 013015
ENERGY-POLICY, PHOTOVOLTAICS, POWER-SATELLITE 013016
ILERS, ECONOMICS, HELIOSTATS, PILOT-PLANT, STORAGE# BO 013011
HELIOSTATS, PILOT-PLANTS, STORAGE# 013031
CTRIC-GENERATION, HELIOSTATS, PILOT-PLANTS, STORAGE# ELE 013066
PIPELINE, HYDROGEN# 019016
ENGINEERING, ECONOMICS, PLANNING# 011036
URBAN, PLANNING# 011066
SION, CONSERVATION, ECONOMIC, POLLUTION-CONTROL# /RGY-CONVER 010020
ONMENTAL-EFFECTS, GEOTHERMAL, POLLUTION# /-PRODUCTION, ENVIR 010030
GE# POLYMERS, PHOTOCHEMICAL, STORA 019021
DEMAND-FACTORS, FORECASTING, POPULATION-DYNAMICS# ISRAEL, 010051
MIC, FORECASTING, GEOTHERMAL, POPULATION# /ONSUMPTION, ECONO 010048
ATION, ECONOMICS, WIND, ELEC/ POWER-GENERATION, COAL-GASIFIC 010034
SYMPOSIUM, WORKSHOP, POWER-GENERATION, POWER-PLANTS 013002

SYSTEMS, ECONOMICS, ELECTRIC, POWER-GENERATION, STORAGE# /C- 011030
PATENT, POWER-GENERATION, WAVE-POWER# 019029
SULFATES, STORAGE, POWER-GENERATION# 013082
NMENTAL-IMPACT, PHOTOVOLTAIC, POWER-GENERATION# ENVIRO 011064
STORAGE, POWER-PLANT, ECONOMICS# 013049
STORAGE# POWER-PLANT, HEAT-EXCHANGERS, 013072
GAS, GREENHOUSES# POWER-PLANT, METHANE, NATURAL- 017018
MODEL, POWER-PLANT, OCEAN-DT# 015000
ER, HAZARDS# MATERIALS, POWER-PLANT, OCEAN-THERMAL-POW 015028
ORS, WIND# FRANCE, POWER-PLANT, PARABOLIC-COLLECT 013012
ER# POWER-PLANT, PATENT, TIDAL-POW 019009
WIND, POWER-PLANT, ROTOR# 016062
HYDROELECTRIC-POWER, POWER-PLANT# 019010
ELTECTICS, SALTS, POWER-PLANT# 013079
, ECONOMICS# POWER-PLANTS, ELECTRIC-UTILITY 013013
ANSFER# FLUIDS, POWER-PLANTS, GLYCOLS, HEAT-TR 013061
CNVERSION, ELECTRIC-INDUSTRY, POWER-PLANTS, HELIOSTATS# C 010026
-PLATE# SWEDEN, POWER-PLANTS, INSOLATION, FLAT 011063
SEA, POWER-PLANTS, MATH-MODELS# 015006
NTRATORS, HELICS, SIMULATION, POWER-PLANTS, MATH-MODEL# /NCE 013008
CWER-SATELLITE# POWER-PLANTS, PHOTOVOLTAICS, P 013015
LIQUID, STORAGE, POWER-PLANTS, ROCKS# 013054
STORAGE# POWER-PLANTS, SOLAR-FURNACES, 013017
S# COOLANTS, POWER-PLANTS, STORAGE, TURBINE 013042
CONVERSION, HEAT-EXCHANGERS, POWER-PLANTS, TURBINE# 013033
L, STORAGE, STEAM, ECONOMICS, POWER-PLANTS# CHEMICA 013018
HELIOSTATS, TOWER-FOCUS, POWER-PLANTS# 013009
, WORKSHOP, POWER-GENERATION, POWER-PLANTS# SYMPOSIUM 013002
HELIOSTATS, COLLECTORS, POWER-PLANTS# 013038
E, DEMONSTRATION, HEAT-PIPES, POWER-PLANTS# STORAG 013068
M, OFF-PEAK-DEMANDS, GERMANY, POWER-PLANTS# STORAGE, STEA 013010
ENERGY-POLICY, PHOTOVOLTAICS, POWER-SATELLITE# 013016
POWER-PLANTS, PHOTOVOLTAICS, POWER-SATELLITE# 013015
-SELECTION# WIND, POWER, PACIFIC-NORTHWEST, SITE 016002
CNWATER-INTENSIVE, RESOURCES, POWERPLANTS, HYDROTHERMAL# N 011001
ARIZONA, PRIVATE-SECTOR# 011022
NEERING, INSOLATION# PROBABILITY, AGRICULTURAL-ENGI 012022
OELECTRIC, HEAT-PUMPS# PROCEEDINGS, CONFERENCE, THERM 014004
ENTAL-ENGINEERING,# PROCEEDINGS, MEETING, ENVIRONM 010002
, SEALANT, INDUSTRY, CONSERV/ PROCEEDINGS, MEETING, ADHESIVE 010001
, INSOLATION, ECONOMIC-ANALY/ PROCESS-HEAT, ELECTRICAL-POWER 013003
GRICULTURE, COOLING, HEATING, PROCESS-HEAT# A 011008
'PROGRAM ' NOT INDEXED
, THERMAL-POWER# PROGRAM-PLAN, COOLING, HEATING 011003
UISITION, ENERGY-POLICY# PROJECT-INDEPENDENCE, DATA-ACQ 010011
CIAL-INCENTIVES# PROJECT-SAGE, ECONOMICS, FINAN 012016
OCEAN-THERMAL-POWER, PROPANE, HEAT-EXCHANGERS# 015015
ECONOMIC-POLICY, INCENTIVES, PUBLIC-UTILITIES# REGULATING, 012030
CONOMIC, GOVERNMENT-POLICIES, PUBLIC-UTILITIES# /CONGRESS, E 012033
ION-DISSEMINATION, EDUCATION, PUBLIC# INFORMAT 011006
TING, HELIOSTATS, IRRIGATION, PUMPS, COOLING# HEA 011041
PUMPS, WAVE-POWER# 019023
PATENT, PUMPS, WAVE-POWER# 019049

PUMPS, WIND# 016059
, INSOLATION, PYRHELIOMETERS, PYRANOMETERS# /ERGY-CONVERSION 011067
NERGY-CONVERSION, INSOLATION, PYRHELIOMETERS, PYRANOMETERS# 011067
WASTE, METHANE, PYROLYSIS# 017026
STORAGE, CONCENTRATORS, PYROLYSIS# 013034
ERGY-POLICY, ENERGY-TECHNOLO/ RAIL-TRAFFIC, CONSERVATION, EN 010018
ECONOMICS, RANKINE-BRAYTON# 013045
INE# RANKINE-CYCLE, HEAT-PUMP, TURB 013007
, WASTE-ENERGY# STORAGE, RANKINE-CYCLE, SALTS, TURBINES 013041
STORAGE, SODIUM-PYROSULFATE, RANKINE-CYCLE, SULFATES# 013039
ICATIONS, SYSTEMS, ECONOMICS, RANKINE-CYCLE# /OMMERCIAL-APPL 011010
WIND, RECIPROCATOR, AIRFOILS# 016046
ECONOMIC-ANALYSIS, GOVERNMEN/ REFERENCE-MATERIALS, BIOMASS, 017001
NCENTIVES, PUBLIC-UTILITIES# REGULATING, ECONOMIC-POLICY, I 012030
N, WIND, VERTICAL-AXIS# REGULATION, STORAGE, CONVERSIO 016031
LIABILITY, BUILDING-PERMITS, REGULATIONS# LEGAL-PROBLEMS, 012018
CZECHOSLOVAKIA, REPORT, CONCENTRATORS# 011042
MODEL# REPORT, WIND, SITE-SELECTION, 016050
RATION, PARABOLIC-COLLECTORS, RESEARCH-PROGRAMS, THERMAL-POW 013000
CONSUMPTION, DEMAND-FACTORS, RESEARCH-PROGRAMS, UTILITIES# 010013
WIND, GENERATION, RESEARCH-PROGRAMS# 016034
, ENERGY-MODELS, FORECASTING, RESEARCH-PROGRAMS# ECONOMICS 010053
, ENERGY-MODELS, FORECASTING, RESEARCH-PROGRAMS# ECONOMICS 012001
NERGY-TECHNOLOGY, INSULATION, RESEARCH-PROGRAMS# /AGEMENT, E 010015
, ENERGY-POLICY, FORECASTING, RESEARCH-PROGRAMS# / ECONOMICS 010035
IES, ENVIRONMENT, GEOTHERMAL, RESEARCH-PROGRAMS# /IBLIOGRAPH 010031
INTERNATIONAL-ENERGY-AGENCY, RESEARCH, DEVELOPMENT# 011054
INTERNATIONAL, RESEARCH, DEVELOPMENT# 011026
ROGRAM# RESEARCH, ERDA, DEVELOPMENT, P 011039
RESEARCH, WIND, NETHERLANDS# 016066
NSF, ERDA, ENERGY, RESEARCH,# 011065
WIND, TURBINE, GENERATOR, RESEARCH# 016072
AL, INDIA, TIDAL-POWER, WIND, RESEARCH# GEOTHERM 010024
CONOMIC-IMPACT, SOLAR-HEATED, RESIDENCES, ILLINOIS# E 012028
ITECTURE, ECONOMICS# RESIDENTIAL-APPLICATIONS, ARCH 011063
UTILITIES, MODEL, ECONOMICS, RESIDENTIAL-HEATING# 012021
SOLAR-CELLS, RESIDENTIAL-POWER# 018004
A, SOLAR-CELLS# RESIDENTIAL, PHOTOVOLTAIC, ERD 018001
GRADUATE, EDUCATION, HEATING, RESIDENTIAL# UNDER 011005
WIND, ALUMINUM, RESIDENTIAL# 016021
WIND, TURBINE-GENERATOR, RESIDENTIAL# 016014
CTRICITY, STORAGE, UTILITIES, RESIDENTIAL# OFF-PEAK-ELE 012023
WIND, RESOURCE, NEW-ZEALAND# 016006
COUNTRIES, ENERGY-TECHNOLOGY, RESOURCES-MANAGEMENT# /LOPING- 010043
RESOURCES, BIOMASS, ECONOMICS# 017000
RESOURCES, ECONOMIC# 012034
, WIND-TURBINES# RESOURCES, GEOTHERMAL, REVIEWS 011049
HERMAL# NONWATER-INTENSIVE, RESOURCES, POWERPLANTS, HYDROT 011001
CALIFORNIA, RESOURCES, SOLAR-DATA# 011009
'REVIEW ' NOT INDEXED
'REVIEWS ' NOT INDEXED
HIGH-TEMPERATURE, STORAGE, ROCK-BED, SALTS# 013032
IGH-TEMPERATURE, MATH-MODELS, ROCK-BEDS# STORAGE, H 013067

NALYSIS# STORAGE, ROCK, CONSTRUCTION, ECONOMIC-A 013036
IQUID, STORAGE, POWER-PLANTS, ROCKS# L 013054
ATH-MOD/ WIND, PACIFIC-COAST, ROCKY-MOUNTAIN, NEW-ENGLAND, M 016026
ROTOR, PATENT, WIND# 016043
WIND, POWER-PLANT, ROTOR# 016062
ING-COUNTRIES, AGRICULTURE# RURAL, SOCIO-ECONOMIC, DEVELOP 011057
IND, BLADES, HORIZONTAL-AXIS, RURAL# W 016030
CELLULOSE, BIOMASS, SACCHARIFICATION# 017006
RDS, STORAGE, WORKING-FLUIDS, SAFETY# / BUILDINGS, FIRE-HAZA 012007
L# SAILWIND, WINDMILL, WIND-TUNNE 016064
EXCHANGERS# SALT, STORAGE, ECONOMIC, HEAT- 013028
STORAGE, SALTS, EUTECTICS, HEAT-PIPES# 013058
SALTS, METALS, MATH-MODELS# 013040
EUTECTICS, SALTS, POWER-PLANT# 013079
S, HEAT-TRANSFER, MATH-MODEL, SALTS, STORAGE# CONCENTRATOR 013070
STORAGE, RANKINE-CYCLE, SALTS, TURBINES, WASTE-ENERGY# 013041
MPERATURE, STORAGE, ROCK-BED, SALTS# HIGH-TE 013032
AGE, CARBONATES, MATH-MODELS, SALTS# LATENT-HEAT, STOR 013051
BUILDING-TRADES, SAN-DIEGO-COUNTY, EDUCATION# 011035
SEA-POWER-PLANTS, MATH-MODELS# 015016
FORECASTING, WAVE-POWER# SEA-WAVES, DEVELOPING-NATIONS, 019002
SEA, POWER-PLANTS, MATH-MODELS 015006
OCEEDINGS, MEETING, ADHESIVE, SEALANT, INDUSTRY, CONSERVATIO 010001
NCENTRATORS, HEAT-EXCHANGERS, SEAWATER, TURBINES# /ATENT, CO 013044
REVIEW, ERDA, MIRROR, SELECTIVE-COATINGS# 013060
, STORAGE, ENERGY-CONVERSION/ SELECTIVE-SURFACES, CONFERENCE 019000
CTROLYSIS HYDROGEN-PRODUCTIO/ SEMICONDUCTOR, ELECTRODES, ELE 019053
TOLYSIS, FUEL-CELLS# SEMICONDUCTOR, ELECTRODES, PHO 019020
CS# SEWAGE-PLANT, METHANE, ECONOMI 017002
SOLAR-CELL, SHINGLE# 013003
SIMULATION---SEE-ALSO-'MODELS'
ING# WATSON, SIMULATION, CANADA, SPACE-HEAT 012025
WIND, MICHIGAN, SIMULATION, ECONOMICS# 016025
PACE-CONDITIONING, UTILITIES, SIMULATION, HEAT-PUMPS, PENNSY 012020
MODEL, SIMULATION, INSOLATION# 013035
CDELS# SIMULATION, INSOLATION, MATH-M 011032
SIMULATION, MATH-MODELS# 015026
AL-POWER# HEAT-EXCHANGERS, SIMULATION, MODEL, OCEAN-THERM 015014
-MODE/ CONCENTRATORS, HELICS, SIMULATION, POWER-PLANTS, MATH 013008
ORAGE# WIND, SIMULATION, SITE-SELECTION, ST 016053
WIND, MINNESOTA, SIMULATION, UTILITIES# 016039
OTEC, HEAT-EXCHANGERS, SIMULATION# 015021
WINDS, NEW-MEXICO, SITE-EVALUATION# 016058
WIND, SITE-SELECTION, MATH-MODELS# 016020
WIND, DATA-ANALYSIS, SITE-SELECTION, MODELS# 016047
REPORT, WIND, SITE-SELECTION, MODEL# 016050
WIND, SIMULATION, SITE-SELECTION, STORAGE# 016053
INDIA, SITE-SELECTION, WAVE-POWER# 019043
SITE-SELECTION, WAVE-POWER# 019054
WAVE-POWER, SITE-SELECTION# 019044
D, LOUISIANA, GULF-OF-MEXICO, SITE-SELECTION# WIN 016067
ND, POWER, PACIFIC-NORTHWEST, SITE-SELECTION# WI 016002
ION, ECONOMIC, ENERGY-POLICY, SOCIAL-FACTORS# CONSUMPT 010010

ES, ECONOMIC, GLOBAL-ASPECTS, SOCIAL-IMPACT, SOCIO-ECONOMIC, 010028
NTRIES, AGRICULTURE# RURAL, SOCIO-ECONOMIC, DEVELOPING-COU 011057
LOBAL-ASPECTS, SOCIAL-IMPACT, SOCIO-ECONOMIC, TIDAL-POWER# / 010028
ANOL, HYDROGEN-BASED-ECONOMY, SOCIO-ECONOMIC# / BIOMASS, ETH 010042
CLE, SULFATES# STORAGE, SODIUM-PYROSULFATE, RANKINE-CY 013039
ECONOMICS, SOLAR-CELL ARRAYS, TRACKING# 011023
LTAIC'# SOLAR-CELL——SEE-ALSO-'PHOTOVO
SOLAR-CELL, SHINGLE# 013003
PAPERS# SOLAR-CELL, STUDENT-AUTHORED, 010004
SOLAR-CELLS, RESIDENTIAL-POWER 018004
TERS, WAVE-POWER/ FUEL-CELLS, SOLAR-CELLS, THERMIONIC-CONVER 011069
INTERNATIONAL, CONFERENCE, SOLAR-CELLS, THERMOELECTRIC# 011000
SOLAR-CELLS, TRACKING# 011004
BATTERIES, SOLAR-CELLS, WIND, GENERATORS# 016028
NORWAY, HEATING, SOLAR-CELLS# 011060
ELECTRIC, PATENT, LENSES, SOLAR-CELLS# 013078
IDENTIAL, PHOTOVOLTAIC, ERDA, SOLAR-CELLS# RES 018001
HYDROGEN-PRODUCTION, PATENT, SOLAR-CELLS# 019017
NERGY-CONVERSION, FUEL-CELLS, SOLAR-CELLS# E 010037
S, LITHIUM-SULFUR, BATTERIES, SOLAR-CELLS# FUEL-CELL 010027
ELECTRICAL-POWER, HEAT-PUMPS, SOLAR-CELLS# /ANY, ECONOMICS, 011056
WATER-HEATERS# HISTORY, SOLAR-COOKERS, SOLAR-FURNACES, 011045
CALIFORNIA, RESOURCES, SOLAR-DATA# 011009
TURE, BUILDINGS, GREENHOUSES, SOLAR-DRYING# AGRICUL 011021
POWER-PLANTS, SOLAR-FURNACES, STORAGE# 013017
HISTORY, SOLAR-COOKERS, SOLAR-FURNACES, WATER-HEATERS# 011045
NOIS# ECONOMIC-IMPACT, SOLAR-HEATED, RESIDENCES, ILLI 012028
LS# SOLAR-POWER-SYSTEMS, MATH-MODE 013026
CNOMIC-ANALYSIS, MATH-ANALYS/ SOLAR-SYSTEM, CONSTRUCTION, EC 012024
SOLAR-TECHNOLOGY, CONFERENCE# 011002
SOLAR-THERMAL-POWER, HELIOSTAT 013029
S# METHANE, SOLID-WASTE, ANAEROBES, BIOMAS 017014
IND# ENERGY-POLICY, SOUTH-AFRICA, THERMAL-POWER, W 010057
-DEMAND, FORECASTING, TIDAL-/ SOUTH-KOREA, ECONOMICS, ENERGY 010029
SIMULATION, HEAT-PUMPS, PEN/ SPACE-CONDITIONING, UTILITIES, 012020
NSOLATI/ GERMANY, COLLECTORS, SPACE-HEATING, DESALINATION, I 011059
WATSON, SIMULATION, CANADA, SPACE-HEATING# 012025
-STORAGE-WELL, AIR-POLLUTION, SPACE-HEATING# HEAT 013033
LS, PART-ONE# STATE-LEGISLATURES, ENERGY-BIL 012009
PART-TWO, ENERGY-BILLS, STATE-LEGISLATURES# 012011
CONCENTRATORS, TURBINES, STEAM-GENERATION, BRAZIL# 013048
ED-ECONOMY# STEAM-GENERATION, HYDROGEN-BAS 010056
STEAM, DEMONSTRATION, FURNACES 013076
CHEMICAL, STORAGE, STEAM, ECONOMICS, POWER-PLANTS 013018
NY, POWER-PLANTS# STORAGE, STEAM, OFF-PEAK-DEMANDS, GERMA 013010
STORAGE, STEEL# 013077
HEAT-EXCHANGERS, STIRLING-CYCLE, MATH-METHOD# 013063
TOTAL-ENERGY-SYSTEM, STIRLING-ENGINE, BUILDINGS# 013062
IC-UTILITIES# STORAGE, MIDWEST, WIND, ELECTR 016059
WIND, STORAGE, BLADES# 016042
BINE, HEAT-PUMPS# STORAGE, BRAYTON-CYCLE, GAS-TU 013037
LS, SALTS# LATENT-HEAT, STORAGE, CARBONATES, MATH-MODE 013051
, REVIEWS# CHEMICAL, STORAGE, CATALYSTS, HEAT-PIPES 013059

HUD, NBS, STORAGE, COLLECTORS# 012014
ORS, FLYWHEELS, WIND# STORAGE, CONCENTRATING-COLLECT 013021
SIS# STORAGE, CONCENTRATORS, PYROLY 013034
TICAL-AXIS# REGULATION, STORAGE, CONVERSION, WIND, VER 016031
IPES, POWER-PLANTS# STORAGE, DEMONSTRATION, HEAT-P 013068
GERS# SALT, STORAGE, ECONOMIC, HEAT-EXCHAN 013028
LECTIVE-SURFACES, CONFERENCE, STORAGE, ENERGY-CONVERSION# /E 019000
THERMOCHEMICAL, STORAGE, ERDA, REVIEWS# 013050
STORAGE, ERDA# 013075
PHASE-CHANGE, STORAGE, EUTECTICS, HEATING# 013046
COMMERCIAL, STORAGE, HEATING, COOLING# 013057
ER# STORAGE, HEATING, OFF-PEAK-POW 013001
STORAGE, HEATING, TOXICITY# 013025
H-MODELS, ROCK-BEDS# STORAGE, HIGH-TEMPERATURE, MAT 013067
STORAGE, HIGH-TEMPERATURE# 013043
CAL# STORAGE, INORGANIC, PHOTOCHEMI 019052
LDINGS, COOLING, DEHYDRATION, STORAGE, INORGANIC# BUI 013005
ICAL# STORAGE, INORGNAIC, THERMOCHEM 013027
MICAL# STORAGE, LATENT-HEAT, PHOTOCHE 019024
CONVERSION# HYDROGEN, STORAGE, OCEAN-THERMAL-ENERGY- 015011
E-HEAT# STORAGE, OFF-PEAK-ENERGY, WAST 013014
SULFATES, STORAGE, POWER-GENERATION# 013082
S# STORAGE, POWER-PLANT, ECONOMIC 013049
LIQUID, STORAGE, POWER-PLANTS, ROCKS# 013054
TURBINES, WASTE-ENERGY# STORAGE, RANKINE-CYCLE, SALTS, 013041
HIGH-TEMPERATURE, STORAGE, ROCK-BED, SALTS# 013032
CONOMIC-ANALYSIS# STORAGE, ROCK, CONSTRUCTION, E 013036
T-PIPES# STORAGE, SALTS, EUTECTICS, HEA 013058
ANKINE-CYCLE, SULFATES# STORAGE, SODIUM-PYROSULFATE, R 013039
ER-PLANTS# CHEMICAL, STORAGE, STEAM, ECONOMICS, POW 013018
OS, GERMANY, POWER-PLANTS# STORAGE, STEAM, OFF-PEAK-DEMAN 013010
STORAGE, STEEL# 013077
ENERGY-TRANSMISSION, OTEC, STORAGE, THERMOCHEMICAL# 015031
STORAGE, TIDAL-POWER# 019051
PATENT, CONCENTRATORS, STORAGE, TRACKING, TURBINES# 013020
COOLANTS, POWER-PLANTS, STORAGE, TURBINES# 013042
ELECTRICAL-POWER-GENERATION, STORAGE, UNITED-KINGDOM# 013083
L# OFF-PEAK-ELECTRICITY, STORAGE, UTILITIES, RESIDENTIA 012023
STORAGE, WASTE-HEAT# 013052
HEAT-EXCHANGERS, STORAGE, WATER-HEATERS# 011033
ER# CONVERSION, STORAGE, WIND-ENERGY, FERTILIZ 016013
STORAGE, WIND, DIURNAL# 016054
URE, BUILDINGS, FIRE-HAZARDS, STORAGE, WORKING-FLUIDS, SAFET 012007
HELIOSTATS, PILOT-PLANTS, STORAGE# 013031
BOILERS, MATH-MODELS, STORAGE# 013023
POWER-PLANTS, SOLAR-FURNACES, STORAGE# 013017
AYTON-CYCLE, HEAT-EXCHANGERS, STORAGE# ER 013006
, SIMULATION, SITE-SELECTION, STORAGE# WIND 016053
STORAGE# 013037
ACIFIC-NORTHWEST, HEAT-PUMPS, STORAGE# P 016070
FACTORY-WASTE, PATENT, STORAGE# 019046
WIND, ANNUAL-VARIATIONS, STORAGE# 016052
POWER-PLANT, HEAT-EXCHANGERS, STORAGE# 013072

DESALINATION, PATENT, STORAGE# 019047
POLYMERS, PHOTOCHEMICAL, STORAGE# 019021
GROUND-WATER, HEAT-TRANSFER, STORAGE# 013055
60-CYCLE, WINDMILL, FLYWHEEL, STORAGE# 016044
HYDRIDES, STORAGE# 013047
TECTURE, BIOMASS, FLAT-PLATE, STORAGE# CANADA, ARCHI 011012
ICS, HELIOSTATS, PILOT-PLANT, STORAGE# BOILERS, ECONOM 013011
ION, HYDROGEN, OTEC, METHANE, STORAGE# ENERGY-TRANSMISS 015030
ON, HELIOSTATS, PILOT-PLANTS, STORAGE# ELECTRIC-GENERATI 013066
-TRANSFER, MATH-MODEL, SALTS, STORAGE# CONCENTRATORS, HEAT 013070
, ELECTRIC, POWER-GENERATION, STORAGE# /C-SYSTEMS, ECONOMICS 011050
ICSS, FLAT-PLATE, HEAT-PUMPS, STORAGE# /EMONSTRATION, ECONOM 011030
T-PLATE, HEATING, INSULATION, STORAGE# /ESIVES, COOLING, FLA 011014
Y, CONCENTRATORS, FLAT-PLATE, STORAGE# /NITED-STATES, GERMAN 011025
SOLAR-CELL, STUDENT-AUTHORED, PAPERS# 010004
TS, LAND-USE# COMMUNICATION, STUDY, INSTITUTIONAL-CONSTRAIN 010007
S, ENERGY-POLICY, INCENTIVES, SUBSIDIES# ECONOMIC 012006
ATION# SULFATES, STORAGE, POWER-GENER 013082
M-PYROSULFATE, RANKINE-CYCLE, SULFATES# STORAGE, SODIU 013039
TRIC# SURVEY, CONVERTERS, THERMOELEC 014002
ON, FLAT-PLATE# SWEDEN, POWER-PLANTS, INSOLATI 011068
OLICY, NATURAL-GAS, WE/ COST, SYMPOSIUM, ECONOMICS, ENERGY-P 012019
ERATION, POWER-PLANTS# SYMPOSIUM, WORKSHOP, POWER-GEN 013002
'SYSTEMS ' NOT INDEXED
AN-THERMAL-ENERGY-CONVERSION, SYSTEMS-ANALYSIS# CCC 015025
S, ENERGY-CONSERVING-SYSTEMS, SYSTEMS-ENGINEERING# /UIDELINE 010045
INCENTIVES, BARRIERS, LOANS, TAX-CREDITS# 012004
NERGY-POLICY, GLOBAL-ASPECTS, TECHNOLOGY-TRANSFER# NATO, E 010052
NEL-LENS, HEAT-EXCHANGERS# TEST-FACILITY, ECONOMICS, FRES 011034
HIGH-TEMPERATURE, TEST-FACILITY, FURNACES# 013030
ENERGY-POLICY, SOUTH-AFRICA, THERMAL-POWER, WIND# 010057
OGRAM-PLAN, COOLING, HEATING, THERMAL-POWER# PR 011003
OLLECTORS, RESEARCH-PROGRAMS, THERMAL-POWER# /N, PARABOLIC-C 013000
ORAGE'#
THERMAL-STORAGE---SEE-ALSO-'ST
GEOTHERMAL, HEAT-PUMPS, OCEAN THERMAL# /K, BIOMASS, CANADA, 011029
WER/ FUEL-CELLS, SOLAR-CELLS, THERMIONIC-CONVERTERS, WAVE-PO 011069
LIC# THERMIONIC, COLLECTORS, PARABO 014005
REVIEWS# THERMOCHEMICAL, STORAGE, ERDA, 013050
STORAGE, INORGNAIC, THERMOCHEMICAL# 013027
-TRANSMISSION, OTEC, STORAGE, THERMOCHEMICAL# ENERGY 015031
HYDROGEN-PRODUCTION, THERMOCHEMICAL# 019030
HYDROGEN, FUEL, THERMOCHEMICAL# 019015
ROLYSIS, HYDROGEN-PRODUCTION, THERMOCHEMICAL# ELECT 019019
GENERATORS, THERMOELECTRIC-CONVERSION# 014000
JUNCTIONS, ENERGY-CONVERSION, THERMOELECTRIC-POWER# THERMO 014003
FRESNEL, THERMOELECTRIC, CONCENTRATORS# 014001
PROCEEDINGS, CONFERENCE, THERMOELECTRIC, HEAT-PUMPS# 014004
SURVEY, CONVERTERS, THERMOELECTRIC# 014002
NAL, CONFERENCE, SOLAR-CELLS, THERMOELECTRIC# INTERNATIO 011000
SION, THERMOELECTRIC-POWER# THERMOJUNCTIONS, ENERGY-CONVER 014003
EL# TIDAL-ENERGY, CANADA, MATH-MOD 019007
-KINGDOM# TIDAL-POWER, ECONOMICS, UNITED 019042
MATH-MODELS, TIDAL-POWER, WAVE-POWER# 019008

AUSTRALIA, TIDAL-POWER, WAVE-POWER# 019041
GEOTHERMAL, INDIA, TIDAL-POWER, WIND, RESEARCH# 010024
BOOK, ENERGY-POLICY, TIDAL-POWER, WIND# 011040
STORAGE, TIDAL-POWER# 019051
POWER-PLANT, PATENT, TIDAL-POWER# 019009
OMICS, ENVIRONMENTAL-EFFECTS, TIDAL-POWER# ECON 019018
, ENERGY-DEMAND, FORECASTING, TIDAL-POWER# /KOREA, ECONOMICS 010029
OCIAL-IMPACT, SOCIO-ECONOMIC, TIDAL-POWER# /LOBAL-ASPECTS, S 010028
WIND, MONITORING, MODEL, TOPOGRAPHY# 016027
ENGINE, BUILDINGS# TOTAL-ENERGY-SYSTEM, STIRLING- 013062
HELIOSTATS, TOWER-FOCUS-POWER-PLANTS, WIND 013056
DEMONSTRATION, TOWER-FOCUS-POWER-PLANT# 013024
TRANSFER-FLUID, EUTECTICS, TOWER-FOCUS-POWER-PLANTS# 013022
HELIOSTATS, TOWER-FOCUS, POWER-PLANTS# 013009
STORAGE, HEATING, TOXICITY# 013025
TENT, CONCENTRATORS, STORAGE, TRACKING, TURBINES# PA 013020
SOLAR-CELLS, TRACKING# 011004
ECONOMICS, SOLAR-CELL ARRAYS, TRACKING# 011023
RAYS, FRESNEL, CONCENTRATORS, TRACKING# AR 013074
EP-FOCUS-POWER-PLANTS# TRANSFER-FLUID, EUTECTICS, TOW 013022
NOLOGY, NASA-RR/ AGRICULTURE, TRANSPORTATION, AEROSPACE-TECH 010033
TROLYSIS# TUNGSTEN, ELECTRODE, PHOTOELEC 019005
WIND, TURBINE-GENERATOR, RESIDENTIAL 016014
INCENTIVES, WIND, TURBINE-GENERATOR# 016012
R# TURBINE, CONVERTERS, WAVE-POWE 019026
VERTICAL-AXIS, WIND, TURBINE, DARRIEUS# 016024
WIND, TURBINE, FLY-WHEELS# 016017
WIND, TURBINE, GENERATOR, RESEARCH# 016072
HORIZONTAL-AXIS, WIND, TURBINE, GENERATOR# 016022
S, MATH-MODELS# TURBINE, GENERATORS, HELIOSTAT 013030
WIND, TURBINE, HORIZONTAL-AXIS# 016038
GENERATOR, WIND, TURBINE, MATH-MODEL# 016063
DARRIEUS, TURBINE, VERTICAL-AXIS, WIND# 016004
VERTICAL-AXIS, WIND, TURBINE# 016056
HEAT-EXCHANGERS, INSULATION, TURBINE# MODEL, 013085
PATENT, WATER-CURRENT-POWER, TURBINE# 019048
RANKINE-CYCLE, HEAT-PUMP, TURBINE# 013007
WIND, TURBINE# 016015
WIND, TURBINE# 016071
ARRIEUS, VERTICAL-AXIS, WIND, TURBINE# BLADES, D 016005
EAT-EXCHANGERS, POWER-PLANTS, TURBINE# CONVERSION, H 013033
DELS# WIND, TURBINES, GREAT-LAKES, MATH MO 016035
AZIL# CONCENTRATORS, TURBINES, STEAM-GENERATION, ER 013048
TORAGE, RANKINE-CYCLE, SALTS, TURBINES, WASTE-ENERGY# S 013041
WIND, TURBINES, WIND-TUNNEL# 016023
ERDA, NASA, WIND, TURBINES# 016060
LANTS, POWER-PLANTS, STORAGE, TURBINES# COO 013042
VERTICAL-AXIS, WIND, TURBINES# 016001
ENTRATORS, STORAGE, TRACKING, TURBINES# PATENT, CONC 013020
S, HEAT-EXCHANGERS, SEAWATER, TURBINES# /ATENT, CONCENTRATOR 013044
FLAT-PLATE, INSOLATION, U.S.-AIR-FORCE# 011024
ING, RESIDENTIAL# UNDERGRADUATE, EDUCATION, HEAT 011005
WIND, DENMARK, GERMANY, UNITED-KINGDOM# 016019

TIDAL-POWER, ECONOMICS, UNITED-KINGDOM# 019042
WAVE-POWER, UNITED-KINGDOM# 019014
TRATORS, FLAT-PLATE, HEATING, UNITED-KINGDOM# CONCEN 011018
AL-POWER-GENERATION, STORAGE, UNITED-KINGDOM# ELECTRIC 013083
WAVE-POWER, UNITED-KINGDOM# 019013
NG-COUNTRIES, ECONOMIC,# UNITED-NATIONS, WIND, DEVELOPI 011019
TRATORS, FLAT-PLATE, STORAGE/ UNITED-STATES, GERMANY, CONCEN 011025
ENERGY, BIBLIOGRAPHY, UPDATED, INDEXES, NASA# 010000
URBAN, PLANNING# 011066
ENERGY-POLICY, ECONOMICS, USA# 012012
ENERGY-POLICY, FRANCE, JAPAN, USSR# /S, DEVELOPING-NATIONS, 011037
ESIDENTIAL-HEATING# UTILITIES, MODEL, ECONOMICS, R 012021
FF-PEAK-ELECTRICITY, STORAGE, UTILITIES, RESIDENTIAL# O 012023
MPS, PEN/ SPACE-CONDITIONING, UTILITIES, SIMULATION, HEAT-PU 012020
WIND, CANADA, MODEL, UTILITIES, VERTICAL-AXIS# 016051
OL-SYSTEMS, CURRENT-LIMITERS, UTILITIES# CONTR 012003
WIND, MINNESOTA, SIMULATION, UTILITIES# 016039
CONSUMPTION, DEMAND-FACTORS, UTILITIES# HANDBOOK, 010012
D-FACTORS, RESEARCH-PROGRAMS, UTILITIES# /CONSUMPTION, DEMAN 010013
, ECONOMIC-ANALYSIS, HEATING, UTILITY-PRICING# /NGS, COOLING 012015
OMIC, ENVIRONMENTAL,# UTILITY-SYSTEMS, FLORIDA, ECON 010006
NOMIC, ENVIRONMENTAL# UTILITY-SYSTEMS, MICHIGAN, ECO 010005
YUGOSLAVIA, ENERGY, UTILIZATION, FORECASTING# 011028
VERTICAL-AXIS, WIND, TURBINES# 016001
BLADES, DARRIEUS, VERTICAL-AXIS, WIND, TURBINE# 016005
VERTICAL-AXIS, WIND, TURBINE# 016056
DARRIEUS# VERTICAL-AXIS, WIND, TURBINE, 016024
DARRIEUS, TURBINE, VERTICAL-AXIS, WIND# 016004
EUS# VERTICAL-AXIS, WINDMILL, DARRI 016045
ND, CANADA, MODEL, UTILITIES, VERTICAL-AXIS# WI 016051
WIND, GREAT-PLAINS, VERTICAL-AXIS# 016003
N, STORAGE, CONVERSION, WIND, VERTICAL-AXIS# REGULATIO 016031
VORTEX, CONCENTRATOR# 016033
N# VORTEX, WIND, ENERGY-CONVERSIO 016057
NKINE-CYCLE, SALTS, TURBINES, WASTE-ENERGY# STORAGE, RA 013041
STORAGE, WASTE-HEAT# 013052
STORAGE, OFF-PEAK-ENERGY, WASTE-HEAT# 013014
, INSOLATION, METHANE# WASTE-TREATMENT, HEAT-TRANSFER 017025
WASTE, GERMANY, REVIEWS# 017030
WASTE, METHANE, PYROLYSIS# 017026
AGRICULTURAL, WASTES, BIOMASS# 017003
BIOSYNTHESIS, METHANE, WASTES# 017012
PATENT, WATER-CURRENT-POWER, TURBINE# 019048
OLAR-COOKERS, SOLAR-FURNACES, WATER-HEATERS# HISTORY, S 011045
HEAT-EXCHANGERS, STORAGE, WATER-HEATERS# 011033
ACE-HEATING# WATSUN, SIMULATION, CANADA, SP 012025
WAVE-ENERGY, WAVE-POWER# 019001
ON, MATH-MODELS# WAVE-POWER, OCEAN-STREAM-FUNCTI 019022
NORTH-AMERICA, PACIFIC, WAVE-POWER, MATH-MODELS# 019036
WAVE-POWER, SITE-SELECTION# 019044
WAVE-POWER, UNITED-KINGDOM# 019013
WAVE-POWER, UNITED-KINGDOM# 019014
CTIONAL-SPECTRUM# WAVE-POWER, WIND-EFFECTS, DIRE 019038

CANADA, BIOMASS, HEAT-PUMPS, WAVE-POWER, WIND-POWER# 011052
CELLS, THERMIONIC-CONVERTERS, WAVE-POWER, WIND# /LLS, SOLAR- 011069
AUSTRALIA, TIDAL-POWER, WAVE-POWER# 019041
WAVE-POWER# 019031
FORECAST, ITALY, WAVE-POWER# 019006
BELGIUM, WAVE-POWER# 019011
MATH-MODELS, TIDAL-POWER, WAVE-POWER# 019008
WAVE-ENERGY, WAVE-POWER# 019001
LANTIC, MATH-MODELS, PACIFIC, WAVE-POWER# AT 019035
PUMPS, WAVE-POWER# 019023
PATENT, PUMPS, WAVE-POWER# 019049
SITE-SELECTION, WAVE-POWER# 019054
OFFSHORE-PLATFORMS, WAVE-POWER# 019025
PATENT, POWER-GENERATION, WAVE-POWER# 019029
INDIA, SITE-SELECTION, WAVE-POWER# 019043
TURBINE, CONVERTERS, WAVE-POWER# 019020
ELOPING-NATIONS, FORECASTING, WAVE-POWER# SEA-WAVES, DEV 019002
, ENERGY-POLICY, NATURAL-GAS, WELL-DRILLING# /IUM, ECONOMICS 012019
TRUM# WAVE-POWER, WIND-EFFECTS, DIRECTIONAL-SPEC 019038
CONVERSION, STORAGE, WIND-ENERGY, FERTILIZER# 016018
MASS, HEAT-PUMPS, WAVE-POWER, WIND-POWER# CANADA, BIO 011052
WIND-SPEEDS, MATH-MODEL# 016013
SAILWIND, WINDMILL, WIND-TUNNEL# 016064
WIND, TURBINES, WIND-TUNNEL# 016023
SOURCES, GEOTHERMAL, REVIEWS, WIND-TURBINES# RE 011049
WIND, ALUMINUM, RESIDENTIAL# 016021
GE# WIND, ANNUAL-VARIATIONS, STORA 016052
NHANCEMENT# WIND, ARCHITECTURE, BUILDING-E 016007
RURAL# WIND, BLADES, HORIZONTAL-AXIS, 016030
, VERTICAL-AXIS# WIND, CANADA, MODEL, UTILITIES 016051
GENERATORS, WIND, CANADA# 016029
CTION, MODELS# WIND, DATA-ANALYSIS, SITE-SELE 016047
WIND, DATA-COMPILATION# 016036
-KINGDOM# WIND, DENMARK, GERMANY, UNITED 016019
ONOMIC,# UNITED-NATIONS, WIND, DEVELOPING-COUNTRIES, EC 011019
STORAGE, WIND, DIURNAL# 016054
WIND, ELECTRIC-CONVERSION# 016049
COAL-GASIFICATION, ECONOMICS, WIND, ELECTRIC-POWER# /ATION, 010034
WIND, ELECTRIC-POWER-GENERATOR 016000
STORAGE, MIDWEST, WIND, ELECTRIC-UTILITIES# 016059
VORTEX, WIND, ENERGY-CONVERSION# 016057
NERGY# WIND, ENERGY-CONVERSION, NET-E 016016
ON# OFFSHORE, WIND, ENERGY-POLICY, LEGISLATI 016041
WIND, ERDA# 016009
GRAMS# WIND, GENERATION, RESEARCH-PRO 016034
EM, MICROPROCESSOR# WIND, GENERATORS, CONTROL-SYST 016037
WIND, GENERATORS, ECONOMICS,# 016011
BATTERIES, SOLAR-CELLS, WIND, GENERATORS# 016028
XIS# WIND, GREAT-PLAINS, VERTICAL-A 016003
C, SITE-SELECTION# WIND, LOUISIANA, GULF-OF-MEXIC 016067
WIND, MAPS, ERDA# 016010
WIND, MATH-MODELS, BLADES# 016032
CNOMICS# WIND, MICHIGAN, SIMULATION, EC 016025

TILITIES# WIND, MINNESOTA, SIMULATION, U 016039
WIND, MODELS# 016008
RAPHY# WIND, MONITORING, MODEL, TOPOG 016027
RESEARCH, WIND, NETHERLANDS# 016066
OCEAN-THERMAL, PHOTOVOLTAIC, WIND, NSF# BIOMASS, 011027
NTAIN, NEW-ENGLAND, MATH-MOD/ WIND, PACIFIC-COAST, ROCKY-MOU 016026
WIND, POWER-PLANT, ROTOR# 016062
, SITE-SELECTION# WIND, POWER, PACIFIC-NORTHWEST 016002
WIND, RECIPROCATOR, AIRFOILS# 016046
OTHERMAL, INDIA, TIDAL-POWER, WIND, RESEARCH# GE 010024
WIND, RESOURCE, NEW-ZEALAND# 016006
ON, STORAGE# WIND, SIMULATION, SITE-SELECTI 016053
REPORT, WIND, SITE-SELECTION, MODEL# 016050
ELS# WIND, SITE-SELECTION, MATH-MOD 016020
WIND, STORAGE, BLADES# 016042
INCENTIVES, WIND, TURBINE-GENERATOR# 016012
ENTIAL# WIND, TURBINE-GENERATOR, RESID 016014
VERTICAL-AXIS, WIND, TURBINE, DARRIEUS# 016024
WIND, TURBINE, FLY-WHEELS# 016017
HORIZONTAL-AXIS, WIND, TURBINE, GENERATOR# 016022
ARCH# WIND, TURBINE, GENERATOR, RESE 016072
WIND, TURBINE, HORIZONTAL-AXIS 016038
GENERATOR, WIND, TURBINE, MATH-MODEL# 016063
WIND, TURBINE# 016015
DES, DARRIEUS, VERTICAL-AXIS, WIND, TURBINE# BLA 016005
WIND, TURBINE# 016071
VERTICAL-AXIS, WIND, TURBINE# 016056
ATH MODELS# WIND, TURBINES, GREAT-LAKES, M 016035
WIND, TURBINES, WIND-TUNNEL# 016023
VERTICAL-AXIS, WIND, TURBINES# 016001
ERDA, NASA, WIND, TURBINES# 016060
ULATION, STORAGE, CONVERSION, WIND, VERTICAL-AXIS# REG 016031
IEUS, TURBINE, VERTICAL-AXIS, WIND# DARR 016004
HEAT-EXCHANGER, WIND# 019027
TS, TOWER-FOCUS-POWER-PLANTS, WIND# HELIOSTA 013056
, ENERGY-POLICY, TIDAL-POWER, WIND# BOCK 011040
ROTOR, PATENT, WIND# 016043
AEOLIAN-WINDMILL, PATENT, WIND# 016048
PUMPS, WIND# 016069
-PLANT, PARABOLIC-COLLECTORS, WIND# FRANCE, POWER 013012
SOUTH-AFRICA, THERMAL-POWER, WIND# ENERGY-POLICY, 010057
RATING-COLLECTORS, FLYWHEELS, WIND# STORAGE, CONCENT 013021
UEL-CELLS, HAZARDS, OCEAN-OT, WIND# ENERGY-TECHNOLOGY, F 010044
ICNIC-CONVERTERS, WAVE-POWER, WIND# /LLS, SOLAR-CELLS, THERM 011069
RMAL, HYDROGEN-BASED-ECONOMY, WIND# /NMENTAL-IMPACTS, GEOTHE 010038
RING, CONFERENCE, GEOTHERMAL, WIND# /RGY-CONVERSION, ENGINEE 010008
WINDMILL, BLADES, MATH-MODELS# 016061
VERTICAL-AXIS, WINDMILL, DARRIEUS# 016045
60-CYCLE, WINDMILL, FLYWHEEL, STORAGE# 016044
SAILWIND, WINDMILL, WIND-TUNNEL# 016064
S# WINDS, GREAT-LAKES, MATH-MODEL 016055
TION# WINDS, NEW-MEXICO, SITE-EVALUA 016053
DINGS, FIRE-HAZARDS, STORAGE, WORKING-FLUIDS, SAFETY# / BUIL 012007
WER-PLANTS# SYMPOSIUM, WORKSHOP, POWER-GENERATION, PO 013002
N, FORECASTING# YUGOSLAVIA, ENERGY, UTILIZATIO 011028
STORAGE# 60-CYCLE, WINDMILL, FLYWHEEL, 016044