DIVISION OF ADVANCED ENERGY PROJECTS

PROGRAM DESCRIPTION
AND
SUMMARIES
OF FISCAL YEAR 1980 ACTIVITIES

U.S. DEPARTMENT OF ENERGY
OFFICE OF ENERGY RESEARCH
OFFICE OF BASIC ENERGY SCIENCES

OCTOBER 1980

TABLE OF CONTENTS

OFFICE OF BASIC ENERGY SCIENCES

DIVISION OF ADVANCED ENERGY PROJECTS (AEP)

Program Description

What projects are supported?

This Division supports exploratory research on novel concepts related to energy. The research is usually aimed at establishing the scientific feasibility of a concept and, where appropriate, also at estimating its economic viability. Because projects supported inevitably involve a high degree of risk, an indication of a high potential payoff is required. An immediate, specific application of the concept is not an absolute prerequisite for consideration; thus, for example, proposers of schemes leading to the development of x-ray lasers are not requird to justify their proposals by discussing potential applications of such lasers.

The concepts supported are typically at too early a stage of scientific verification to qualify for funding by DOE programs responsible for technology development. Where doubt exists, such programs are consulted, prior to proposal consideration by AEP, in order to establish their possible interest in the project.

Projects not supported

The AEP Division does not support ongoing, evolutionary research. Neither does it support large scale demonstration projects.

Period of support

The period of support varies between one and three years. It is expected that, following such a period, the concept will either be at a stage where it can be supported by a technologically appropriate organization or branch of DOE, or else it will be dropped.

Funding levels

The size of a contract in FY '80 varied between $45,000 and $250,000 per annum.

Who can propose

Unsolicited proposals can be submitted by universities, industrial organizations, nonprofit research institutions or private individuals. Consideration is also given to ideas submitted by scientists working at national laboratories.

Proposal evaluation

Awards are based on the results of an evaluation process which usually involves a review by external reviewers. Regardless of the outcome of the evaluation, proposers receive copies of reviewers' reports.

Questions asked of the reviewers depend on the subject of the proposal. Some typical questions are listed below:

1. Is the proposed concept new? How does it compare with other work in the field?

2. Are there basic flaws in the scientific (technical) arguments underlying the concept?

3. Are the technological requirements of the proposed concept, including material requirements, within the realm of either present or near term future capabilities?

4. Is there anything about the concept which makes its economics manifestly untenable, even under reasonably optimistic assumptions?

5. Is the anticipated benefit to the public high enough to warrant the Government's involvement in the R&D effort?

Preproposals desired

It is suggested that before a formal proposal is prepared, the proposer should submit a brief outline of the proposed work. The outline should provide enough background information to enable a decision as to whether or not the proposed work programmatically fits the mission of AEP.

Proposals

Once a programmatic interest of AEP in the proposed project has been established, a proposal should be submitted along the guidelines specified in DOE/PR-0010, "Guide for the Submission of Unsolicited Proposals." Each proposal must contain:

- A cover page, prepared in a format specified in DOE/PR-0010, Appendix B.

- A 200-300 word abstract, written in plain English, describing the essence of the project in terms understandable to a layman. The abstract should be in a form suitable for inclusion in DOE program presentations.

- o A technical discussion of the proposed concept and a description of the proposed work. While the discussion should be kept brief, there is no formal limitation on the number of pages allotted to this section of the proposal. Since it is this section that will form the basis for the evaluations by technical reviewers, the proposer is urged to make certain that all aspects of the proposed project which are relevant to forming a judgment of the project's merits are adequately covered.

- o A statement of work specifying all tasks to be performed in the course of the proposed work.

- o Description of available facilities.

- o Resumes of key personnel.

- o Detailed information on any support for the proposed or related work, past, present or anticipated, including proposals submitted, or about to be submitted, to other organizations.

- o A cost estimate for the proposed effort.

Further Information

Inquiries should be addressed to:

Dr. Ryszard Gajewski, Director
Division of Advanced Energy Projects
Office of Basic Energy Sciences
ER-18, Mail Stop G-256, G'tn
Department of Energy
Washington, DC 20545

Phone: 301/353-5995

Office of Energy Research

Office of Basic Energy Sciences

Division of Advanced Energy Projects

Fiscal Year 1980 Funding

Operating Funds.....$5,000,000

Capital Equipment Funds....$ 200,000

Distribution of FY 1980 Funds by Sector

Universities	45%
Small Business	25%
Other Industry	4%
Non-Profit	4%
DOE Laboratories	17%
Federal Laboratories	5%
Total	100%

Distribution of FY 1980 Funds by Technology

Conservation	32%
Solar	20%
Fossil	7%
Fission	2%
Multitechnology	11%
Advanced Concepts	28%
Total	100%

SUMMARIES OF PROJECTS ACTIVE IN FY 1980

1. DEMONSTRATION OF SCIENTIFIC AND ECONOMIC FEASIBILITY OF A SOLID-STATE HEAT ENGINE
Randall Olsen

POWER CONVERSION TECHNOLOGY, INC.
11588 Sorrento Valley Road
Suite 18
San Diego, California 92121

Date Started: November 7, 1977 Anticipated Duration: 3 1/2 years

Funding: FY '78 $202,000 FY '79 $200,000 FY '80 $320,000

The Solid-State Heat Engine will convert heat to electricity by exposing leaves of specially selected material to strong, intermittent bursts of heat. On the surface of each leaf, electric charge will appear and disappear in rhythm with the heat bursts. The oscillating charge will give rise to an alternating current.

2.* FERROELECTRIC CERAMICS FOR DIELECTRIC POWER CONVERSION
David Payne
Department of Ceramic Engineering

UNIVERSITY OF ILLINOIS
Urbana, Illinois 61801

Date Started: December 1, 1977 Duration: 2 3/4 years

Funding: FY '78 $71,000 FY '79 $104,000 FY '80 $45,000

A program in direct support of the Solid State Heat Engine (SSHE) project at Power Conversion Technology, Inc. It has identified ferroelectric materials which would make good candidates for a working medium in SSHE.

3.* FUNDAMENTALS AND TECHNIQUES OF NON-IMAGING OPTICS (FOR SOLAR ENERGY CONCENTRATION)
Roland Winston
Enrico Fermi Institute & Department of Physics

UNIVERSITY OF CHICAGO
Chicago, Illinois 60637

Date Started: January 1, 1978 Duration: 2 years

Funding: FY '78 $150,000 FY '79 $150,000 FY '80 $0

A basic research program to examine unexplored areas in the new field of non-image forming optics with particular emphasis on questions relevant to the efficient collection and concentration of solar radiation. (The project resulted in new designs for solar concentrators and, in FY '80, has been transferred to the Division of Engineering, Mathematical and Geosciences.)

*Projects completed

4.* GYROCON TUBE STUDY
Paul Tallerico

LOS ALAMOS SCIENTIFIC LABORATORY
Los Alamos, New Mexico 87545

Date Started: January 1, 1978 Duration: 2 years

Funding: FY '78 $200,000 FY '79 $170,000 FY '80 $0

The copious amounts of VHF and UHF rf power required by such applications as accelerator fuel production, rf heating of fusion plasmas, heavy ion fusion, etc., emphasize the need for high unit power output, high dc-to-rf conversion efficiency electron devices. A device of considerable potential is the gyrocon. Believed to have been first invented by McRae in 1946, it has been shown by Budker and collaborators in the USSR to be capable of producing very high output powers at an excellent dc-to-rf conversion efficiency. The present study indicates that the gyrocon amplifiers should be considered for multimegawatt, narrow-band microwave systems that operate below approximately 3GHz. (Work continues under a different sponsorship.)

5.* ACCELERATION PROCESSES PRODUCED BY EXCITED ATOMS
Robert Hofstadter & J. Dirk Walecka

STANFORD UNIVERSITY
Stanford, California 94305

Date Started: January 1, 1978 Duration: 2 years

Funding: FY '78 $27,000 FY '79 $0 FY '80 $0

A new method of accelerating particles has been suggested. It would employ excited atoms in place of conventional metallic cavities to supply the required electromagnetic accelerating fields. Atoms in a crystal are naturally aligned in straight lines in a manner similar to the cavities in a linear accelerator. A simple analogy thus holds. The energy gradients potentially available from such an "atomic accelerator" are fabulously high and this is one of the most attractive features of the idea. The objective of this project has been to take closer look at the idea and support it with quantitative calculations. Theoretical investigations of the accelerating mechanism for single atoms have been carried out. The energy dependence of the cross section in the forward direction has been calculated and the competing energy loss mechanisms have also been studied. In calculations on hydrogen or hydrogen-like energy level schemes a balance between the most prominent energy level transitions unfortunately indicates a small loss rather than a gain of energy. The situation for multiple excitation of neighboring atoms is not yet known.

6. RADIATION FROM CHANNELED ELECTRONS AND POSITRONS

STANFORD UNIVERSITY
Stanford, California 94305

Richard Pantell
Department of Electrical Engineering

Date Started: February 15, 1978 Anticipated Duration: 3 years

Funding: FY '78 $202,000 FY '79 $218,000 FY '80 $250,000

When an electron or positron beam passes through a crystal the particles, interacting with the electrostatic potential of the lattice, emit radiation. This project investigates this phenomenon as a photon source for the keV energy range, as a means for studying the behavior of channeled particles, and as a technique for measuring the properties of crystals in which the channeling occurs. According to theoretical analyses, now confirmed by experimental evidence, such a source can have a bandwidth of only 10%, is broadly tunable and has an intensity that is an order of magnitude higher than that obtained from Bremsstrahlung. In addition, the radiation should be linearly polarized, highly collimated, and occur in picosecond bursts.

7.* HIGH TEMPERATURE STEAM ELECTROLYSIS

BROOKHAVEN NATIONAL LABORATORY
Upton, New York 11973

Hugh Isaacs

Date Started: March 21, 1978 Duration: 3 years

Funding: FY '78 $102,000 FY '79 $193,000 FY '80 $100,000

The objective of the program was to test the feasibility of constructing a steam electrolysis cell to operate at temperatures up to 1900^{0} K. This process requires heat and provides an attractive option for utilizing the heat from fusion reactors for the production of hydrogen and synthetic fuels. (Cell operation was found to be limited to temperatures below 1700^{0}K because of interactions between doped $LaCrO_3$ cell components and the zirconia electrolyte. Information obtained during the investigation is being transferred to the production of a demonstration unit under the sponsorship of the Office of Fusion Energy).

8. COLLECTIVE FOCUSING ION ACCELERATOR

UNIVERSITY OF CALIFORNIA
Irvine, California 92717

Norman Rostoker & Amnon Fisher

Date Started: April 1, 1978 Anticipated Duration: 3 years

Funding: FY '78 $223,000 (2 years) FY '79 $0 FY '80 $200,000

In this device ions are accelerated along a circular track by an externally applied electric field. They are kept on the track by a space charge of electrons confined in a magnetic field of "bumpy torus" configuration. The anticipated high ion energy, high current beams could be of interest for either accelerator breeding or heavy ion fusion. This proof-of-concept program will result in a working model producing 100 amperes of protons at 2MeV.

9.* HYDROGEN AND OXYGEN FROM WATER IN A ONE-STEP CONTINUOUS PROCESS WHICH USES SOLAR ENERGY -- A THEORETICAL STUDY OF TECHNICAL AND ECONOMIC FEASIBILITY

UNIVERSITY OF MINNESOTA
Minneapolis, Minnesota 55114

Edward Fletcher
Department of Mechanical Engineering

Date Started: April 1, 1978 Duration: 2 years

Funding: FY '78 $81,000 (2 years) FY '79 $0 FY '80 $8,000

This project examined a high temperature (~2500 K) one-step continuous process using solar energy to produce hydrogen and oxygen from water. High temperature dissociation products are to be separated, by effusion in the Knudsen flow regime, into light and heavy fractions, from which hydrogen and oxygen are recovered after cooling and condensation. Economics and materials requirements have been assessed.

10. EFFICIENT ENERGY EXCHANGERS FOR THERMAL AND CHEMICAL CONVERSION

MATHEMATICAL SCIENCES NORTHWEST, INC.
P. O. Box 1887
Bellevue, Washington 98009

Robert Taussig

Date Started: April 19, 1978 Anticipated Duration: 3 years

Funding: FY '78 $201,000 FY '79 $207,000 FY '80 $253,000

In an energy exchanger, an expanding high-temperature gas compresses a lower temperature gas suitable for driving a conventional gas turbine. The suggested application consists of a high-temperature heat source, the energy exchanger, a topping cycle gas turbine and a bottoming cycle (e.g., steam). The objective of the project is to demonstrate experimentally the efficient operation of energy exchangers for use in high Carnot efficiency thermal conversion cycles.

11.* RF PROCESSING OF UTAH TAR SANDS

IIT RESEARCH INSTITUTE
Chicago, Illinois 60616

Jack Bridges

Date Started: June 1, 1978 Duration: 18 months

Funding: FY '78 $200,000 (18 mos.) FY '79 $0 FY '80 $0

The objective of this program was to explore the technical and economic feasibility of using RF heating to extract oil in situ from tar sand. This study is of interest since an estimated reserve of about 25 billion barrels of oil exists in the Utah tar sands. (The project continues under the sponsorship of the Advanced Technology Projects program.)

12. STRONG FOCUSING OF COHERENT, TERAHERTZ SOUND

WILLIAMS COLLEGE
Williamstown, Massachusetts 01267

Fielding Brown
Department of Physics

Date Started: June 1, 1978 Anticipated Duration: 3 years

Funding: FY '78 $77,000 (3 years) FY 79 $0 FY '80 $0

Acoustic waves in crystals, such as quartz or gallium arsenide, will be excited by irradiating the crystal surface with a high power, far infrared D_2O laser ($\lambda vac \simeq 385 \mu m$). Focusing will be obtained by precision shaping of the crystal surface. The anticipated focal region has a size of the order of 1000 Å. The anticipated energy density in the focal region is $10^8 J/cm^3$ for a pulse 100 nsec in duration. The objective of this project is to obtain such high energy concentrations and to explore the ensuing physical phenomena.

13. ELECTROLYTIC DEPOSITION OF LOW COST, HIGH PURITY POLYSILICON SUITABLE FOR USE IN SOLAR CELL DEVICES

Robert Feigelson
Center for Materials Research

STANFORD UNIVERSITY
Stanford, California 94305

Date Started: July 1, 1978 Anticipated Duration: 3 years

Funding: FY '78 $197,000 FY '79 $197,000 FY '80 $220,000

An experimental study to establish the viability of electrolytic deposition as a method of producing inexpensive silicon for photovoltaic layers and crystals. The source material is either as-mined silica or K_2SiF_6, which is an inexpensive by-product of fertilizer manufacture. Inclusion-free layers of silicon have been deposited onto silver or graphite using fluoride solvents at 750°C, the deposits having a purity up to 99.999% and grain size up to 250 μm. The electrodeposition of silicon at temperatures above its melting point has been achieved for the first time, the material being produced as droplets up to 10 mm in size and typically of 0.2 Ωcm resistivity.

14.*A DESIGN STUDY FOR HIGH CURRENT, STEADY STATE AUTO-RESONANT ACCELERATOR

William Drummond

AUSTIN RESEARCH ASSOCIATES, INC.
1901 Rutland Drive
Austin, Texas 78758

Date Started: July 14, 1978 Duration: 1 year

Funding: FY '78 $200,000 FY '79 $20,000 FY '80 $0

The Auto-Resonant ion accelerator is a novel concept in collective charged particle acceleration. In contradistinction to conventional linear accelerators the accelerated ion derives its energy not from externally applied HF field but from the electric field of wave driven by a high intensity relativistic electron beam streaming along the axis of the accelerator. The accelerating electric field of the wave is much stronger than one applied externally, resulting in orders of magnitude shorter accelerators. A pulsed A-R accelerator is presently under construction under a Defense Department contract. This study concentrated on a steady state system which could be of interest for applications such as accelerator breeding and heavy ion fusion. For this design, the projected energy of the accelerated ions is in the GeV range, with beam intensity on the order of 1 ampere. (As a result of the present study, A-R accelerator has been selected for further investigation by the Office of Fusion Energy. The objective is to determine the potential of A-R accelerators for heating plasmas in large tokamaks.)

15. GENERATION OF AN EXTENDED ION SOURCE FOR SHORT-WAVELENGTH LASERS

NAVAL RESEARCH LABORATORY
Washington, D.C. 20375

Raymond Elton
Optical Sciences Division

Date Started: July 27, 1978 Anticipated Duration: 3 years

Funding: FY '78 $54,000 FY '79 $126,000 FY '80 $195,000

Experiments at Naval Research Laboratory revealed large population inversions in carbon ions for the 520 Å region. They were also recently confirmed for ions of boron, nitrogen and lithium. These experiments were performed in low density, optically thin regimes where accurate analysis is possible. In taking the next step to a true x-ray laser an elongated medium is required with sufficient ion density that simulated emission and gain occur along the axis, without corresponding losses in transverse direction. It is an objective of the proposed program to demonstrate that highly stripped expanding carbon ions can be channeled from a point source into a rectangular beam and compressed to densities of 10^{17} - 10^{18} cm^{-3} over a length of about 1 cm for use as a medium for laser amplification in the extreme ultraviolet spectral region. With success, the second objective is to tailor the ion expansion velocity to interact with neutral atoms and electrons in a charge-capture reaction volume to produce population inversions for net gain.

16. DEVELOPMENT OF MATERIALS FOR LUMINESCENT SOLAR COLLECTORS

GTE LABORATORIES
40 Sylvan Road
Waltham, Massachusetts 02154

Alexander Lempicki

Date Started: September 1, 1978 Anticipated Duration: 3 years

Funding: FY '78 $164,000 FY '79 $179,000

A luminescent solar collector consists of a panel absorbing light, ideally, across the solar spectrum. The light is then re-emitted, within the panel at wavelengths optimal for photoconversion. It propagates, by internal reflections towards the edges of the panel, where it is coupled to a photovoltaic converter. The aim of this project was to develop materials for luminescent collectors by exploiting properties of metal ions in inorganic glasses. A variety of glasses, particularly those containing high concentrations of Cr^{3+} have been developed. The main conclusions are that Cr^{3+} in glass has a very limited quantum yield (highest observed is 17 per cent) due to symmetry allowed non radiative pathways. On the other hand energy transfer from Cr^{3+} to Nd^{3+} in some co-doped glasses competed successfully with non-radiative rates and offers the promise of efficient solar collector materials.

17.*ELECTROTHERMODYNAMIC GENERATOR - RESEARCH & DEVELOPMENT WORK PROGRAM
Alvin Marks

MARKS POLARIZED CORPORATION
153-16 10th Avenue
Whitestone, New York 11357

Date Started: September 1, 1978 Duration: 1 1/2 years

Funding: FY '78 $199,000 FY '79 $100,000 (6 months)

In an ETD generator a charged aerosol is injected into a stream of inertial gas. The stream is then subjected to an electrostatic field so directed as to slow down the suspended particles. If the coupling between the aerosol and the gas is strong enough, i.e., if the slip of the aerosol particles with regard to the gas is low enough, the gas flow will be slowed down. The kinetic energy of the gas will decrease, giving rise to an electric current in an appropriately designed outside circuit. Thus, an ETD generator directly converts kinetic energy of a gas into electric energy of a dc current.

18. GRADED INDEX ANTIREFLECTIVE COATINGS FOR GLASS
John Haggerty
Energy Laboratory

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Massachusetts 02139

Date Started: September 1, 1978 Anticipated Duration: 3 years

Funding: FY '78 $154,000 FY '79 $328,000 (2 years)

This project's objective is to develop methods of producing graded index antireflective coatings on glass sheet for cover plate applications. These films will be created by inducing a two-phase microstructure in the glass by appropriate heat treatment, followed by leaching to leave a porous, graded index surface film. The process is based on results demonstrated with high temperature borosilicate glasses. Unlike that work, the present approach concentrates on glasses with compositions and working characteristics that can be processed at lower temperatures required for the float glass process.

19.*STUDY OF MARKS' ELECTROTHERMODYNAMIC (ETD) GENERATOR

Oscar Biblarz
Department of Aeronautics

NAVAL POST GRADUATE SCHOOL
Monterey, California 93940

Date Started: September 1, 1978 Duration: 2 years

Funding: FY '78 $45,000 FY '79 $30,000 FY '80 $26,000

A detailed theoretical analysis of Marks' ETD generator, including effects of fluid and electrical losses, and compressibility has been provided.

20. APPLICATION OF ARC-PLASMA SPRAYING (APS) FOR SOLAR TECHNOLOGY

Joseph Loferski &
Barton Roessler

SOLAMAT, INC.
885 Waterman Avenue
East Providence,
Rhode Island 02914

Date Started: September 18, 1978 Anticipated Duration: 3 years

Funding: FY '78 $150,000 FY '79 $152,000 FY '80 $0

The objective of this program is to study applications of APS to: (i) the preparation of low cost silicon solar cells by deposition of silicon powder on metal substrates, (ii) the preparation of selective absorber coatings for solar thermal collectors consisting of thin APS layers of silicon and silicon-germanium alloys, and (iii) the formation of ohmic contacts and barriers for single crystal and polycrystalline thin film solar cells made from silicon, gallium arsenide, etc. (The formation of ohmic contacts has been successful; further development of the resulting technology is being funded by JPL.)

21.*LABORATORY TESTS OF THE THEORY OF IONOSPHERIC STABILITY UNDER POWER SATELLITES

James Drummond

POWER CONVERSION TECHNOLOGY, INC.
11588 Sorrento Valley Road
Suite 18
San Diego, California 92121

Date Started: December 1, 1978 Duration 1 1/2 years

Funding: FY '79 $107,000 FY '80 $53,000

This project was an attempt to identify in the laboratory the mechanism of a possible instability that could occur in the ionosphere as a result of power transmission from a solar power satellite to the Earth in the form of microwaves. An indication of the instability has been observed in a laboratory experiment simulating ionospheric propagation. (Work continues under Project #47.)

22.*PREPARATION OF THIN FILM FERROELECTRICS FOR DIRECT CONVERSION OF HEAT TO ELECTRICITY

Howard R. Shanks

AMES LABORATORY
Ames, Iowa 50011

Date Started: December 1, 1978 Duration: 2 years

Funding: FY '79 $90,000 FY '80 $120,000

This program which was in support of the Power Conversion Technology, Inc. Solid State Heat Engine, was directed toward the preparation of ferroelectric thin films with high spontaneous polarization. Films were deposited on various metal substrates at elevated temperatures by rf sputtering from various sintered targets. In addition to electrical characterization of the films, Auger depth profiling was used to evaluate interdiffusion and chemical reactions at the ferroelectric-metal interface. This work concentrated on the fabrication of ferroelectric capacitors with stable reproducible properties required for testing of the engine. Thin ferroelectric films were obtained with saturation polarization several times larger than any previously reported for thin film ferroelectrics.

23. LASER EXCITATION OF HIGH LYING ATOMIC AND MOLECULAR STATES BY ULTRAVIOLET MULTIQUANTUM PROCESSES

Charles K. Rhodes
Department of Physics

UNIVERSITY OF ILLINOIS AT CHICAGO CIRCLE
Chicago, Illinois 60680

Date Started: January 1, 1979 Anticipated Duration: 3 years

Funding: FY '79 $50,000 FY '80 $150,000

The recently developed ultraviolet excimer laser technology enables both the copious production of electronically highly excited species and the generation of tunable XUV radiation of extremely high spectral brightness. The primary objective of this program is the experimental determination of the feasibility of high-brightness soft x-ray generation by nonlinear optical processes involving both direct excitation and wave mixing.

24. RESEARCH AND DEVELOPMENT PROGRAM ON A SODIUM HEAT ENGINE

Thomas Hunt & Neil Weber

FORD MOTOR COMPANY
P. O. Box 2053
Dearborn, Michigan 48121

Date Started: January 2, 1979 Anticipated Duration: 3 years

Funding: FY '79 $100,000 FY '80 $27,000

The sodium heat engine (SHE) is a new device for direct thermoelectric energy conversion. It uses the ionically conducting ceramic β"-alumina, to form a high temperature concentration cell for elemental sodium. The vapor pressure (activity) gradient across the cell is maintained by a high temperature heat source on one side of a beta-alumina membrane and a low temperature condenser on the other side. The high temperature region operates in the range of 600-1000°C with the low temperature region at 100-200°C. Theoretical analysis of the SHE shows that under quasi-reversible conditions the efficiency should be more than 90% of Carnot efficiency. Specific output powers in the range of 0.5-1.0 W/cm^2 are projected. The SHE should achieve overall thermal efficiencies of 20-40%. The goal of this project is a quantitative understanding of the SHE electrodes and the electrical and mass transport at the electrode-beta-alumina interface.

25. LIQUID MEMBRANES FOR THE PRODUCTION OF OXYGEN-ENRICHED AIR

Harold K. Lonsdale

BEND RESEARCH, INC.
64550 Research Road
Bend, Oregon 97701

Date Started: April 16, 1979 Anticipated Duration: 2 years

Funding: FY '79 $127,000 FY '80 $85,000

This program is directed toward the development of novel membranes for the production of oxygen-enriched air. With membranes of suitable performance, the cost and energy-efficiency of an oxygen-enrichment process would justify the use of such upgraded air supplies in standard combustion processes, thus extending and conserving available fossil fuel supplies. The approach involves the use of liquid membranes held by capillary forces in the pores of a microporous support membrane. Oxygen is preferentially transported across these membranes by facilitated transport. The liquid membrane will be incorporated into microporous hollow fibers for scaleup studies.

26. THERMOELECTRIC ENERGY CONVERSION FOR SOLAR AND OTHER APPLICATIONS

David Benson

SOLAR ENERGY RESEARCH INSTITUTE
1536 Cole Blvd.
Golden, Colorado 80401

Date Started: June 1, 1979 Anticipated Duration: 3 years

Funding: FY '79 $94,000 FY '80 $218,000

The objective of this project is to examine the option of using either traditional or new thermoelectric materials to produce economical electric power from low grade, thermal resources. Detailed parametric analyses have been used to identify promising thermoelectric generator design options. Research is currently directed at the development of proof-of-concept generators for Ocean Thermal Energy Conversion.

27. COLLECTIVE ACCELERATION OF HEAVY IONS FROM A LASER-PRODUCED PLASMA

Martin Reiser & William Destler
Electrical Engineering Department

UNIVERSITY OF MARYLAND
College Park, Maryland 20742

Date Started: July 1, 1979 Anticipated Duration: 2 years

Funding: FY '79 $30,000 (major funding provided by the National Science Foundation) FY '80 $0

In this program, the collective acceleration of heavy ions produced by laser-target interaction is investigated. An intense, relativistic electron beam (1.5 MeV, 30 kA, 30 ns) is injected through a laser produced plasma into an evacuated drift tube, and ions are extracted from the plasma and accelerated to high energies by virtual cathode formed by the beam electrons immediately downstream of the plasma cloud. The goal of this program is to accelerate heavy ions (e.g., C, A, Fe, etc.) to energies of several MeV per nucleon.

28. NEW MATERIALS FOR ORGANIC PHOTOVOLTAIC CELLS

George Bird
Department of Chemistry

RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
New Brunswick, New Jersey 08903

Date Started: July 1,1979 Anticipated Duration: 3 years

Funding: FY '79 $223,000 (3 years)

Experimental photovoltaic cells with organic absorber layers have already given quantum efficiencies of 30% and total solar energy conversion on the order of 1%. Low exciton mobility and limited radiation stability have prevented improvements in performance. Under this project, new high stability chromophores are being prepared and studied in terms of structure, solid-state packing, electrochemistry and exciton mobility. Promising materials will be fabricated into Al/Al_2O_3/dye/Ag cells for direct measurements.

29. A NOVEL APPROACH TO THE EXPLOITATION OF TIDAL ENERGY

Alexander M. Gorlov
Department of Mechanical Engineering

NORTHEASTERN UNIVERSITY
Boston, Massachusetts 02115

Date Started: July 1, 1979 Anticipated Duration: 2 years

Funding: FY '79 $131,000 (2 years) FY '80 $0

The objective of this program is to develop theoretically, and analyze, a new approach to harnessing tidal energy. The approach is based on replacing conventional rigid dams with light, flexible plastic barriers, and on converting tidal energy into the energy of compressed air.

30. EJECTOR-TURBINE HEAT ENGINE
J. E. Minardi

UNIVERSITY OF DAYTON RESEARCH INSTITUTE
300 College Park Avenue
Dayton, Ohio 45469

Date Started: August 1,1979 Anticipated Duration: 3 years

Funding: FY '79 $287,000 (15 months) FY '80 $373,000 (21 months)

The objective of this project is to test the feasibility of a novel low-power Rankine turbine concept which promises low cost, significant reduction in rpm over similarly rated turbines, and low maintenance, long-life operation at competitive efficiencies. This is accomplished through the use of an efficient two-fluid ejector which lowers the pressure and temperature operating conditions seen by the turbine. Potential applications for this type of turbine would include the generation of electricity and air conditioning of homes. The concept permits engine cycles that cover a broad range of peak temperatures, including those corresponding to stoichiometric combustion of hydro-carbon fuels, waste heat sources, and solar.

31. EVAPORATED LITHIUM-DOPED AMORPHOUS SILICON SOLAR CELLS
P. H. Fang
Department of Physics

BOSTON COLLEGE
Chestnut Hill,
Massachusetts 02167

Date Started: August 1, 1979 Anticipated Duration: 2 years

Funding: FY '79 $131,000 FY '80 $140,000

The objective of this program is to test the feasibility of fabricating amorphous silicon solar cells by electron beam evaporation in vacuum. The role of lithium as an n-dopant and as a compensator for the broken bound of silicon in amorphous structure is being investigated.

32. EFFICIENT ULTRASONIC GRINDING: A NEW TECHNOLOGY FOR MICRON-SIZED COAL

William B. Tarpley, Jr.

ENERGY & MINERALS RESEARCH COMPANY
P. O. Box 389
964 E. Swedesford Road
Exton, Pennsylvania 19341

Date Started: September 15, 1979 Anticipated Duration: 15 months

Funding: FY '79 $174,000 FY '80 $0

The objective of this project is to develop on a laboratory scale an efficient ultrasonic grinding system which can produce 1-10 micron coal with an anticipated energy input in the range of 25-100 kWh/ton. Additionally, the mechanisms of ultrasonic comminution should permit selective grinding, tensile fracture at pyrite and ash inclusions, and easy separation. Experimental work will include consideration of ultrasonic power levels, frequencies, and modes of application as well as throughput rates, evidence of selective fracture, and repeatability of ultrasonic effects. Such a process would expedite conversion of oil fired burners to the use of coal-oil mixtures. The micronized clean coal may also have an application as diesel fuel.

33. SOFT X-RAY LASING ACTION IN A CONFINED PLASMA COLUMN

Szymon Suckewer

PRINCETON UNIVERSITY
PLASMA PHYSICS LABORATORY
Princeton, New Jersey 08544

Date Started: September 13, 1979 Anticipated Duration: 3 years

Funding: FY '79 $54,000 FY '80 $204,000

The objective of this project is an experimental investigation of lasing action in the soft x-ray spectrum region at wavelengths 182 Å and 135 Å corresponding to the 3→2 and 4→2 transition in the C(VI) ion. The basic idea is to use a multi-Z (e.g., carbon, oxygen) thin plasma column confined by a strong longitudinal magnetic field (100-200 kG), first heated by a CO_2 laser and then cooled rapidly by radiation losses. Calculations indicate total gains in excess of 100 for the 3→2 transition, and in excess of 10 for the 4→2 transition, for a 10 cm long plasma column heated by a 10-20 gigawatt CO_2 laser beam.

34. SEMICONDUCTING POLYACETYLENE MATERIALS FOR ENERGY CONVERSION APPLICATIONS
Zoltan J. Kiss

CHRONAR CORPORATION
P. O. Box 177
Princeton, New Jersey 08540

Date Started: August 1, 1979 Anticipated Duration: 2 years

Funding: FY '79 $104,000 FY '80 $124,000

Polyacetylene is emerging as a new class of potentially low cost semiconducting materials. This program aims to optimize different preparation methods, to study doping and polymeric modification techniques, and to evaluate the polyacetylene materials so obtained for photovoltaic energy conversion devices, particularly, for photoelectrochemical solar cells. A laboratory model of a polyacetylene gel photoelectrochemical cell will be constructed.

35. INTEGRATED FUNCTION NONIMAGING CONCENTRATING COLLECTOR TUBE FOR SOLAR THERMAL ENERGY
Roland Winston

UNIVERSITY OF CHICAGO
Chicago, Illinois 60637

Date Started: December 1, 1979 Anticipated Duration: 2 years

Funding: FY '80 $181,000

This project will develop a proof-test unit of a fully stationary evacuated Compound Parabolic Concentrator solar collector capable of achieving efficiencies in excess of 50% at temperatures approaching 300°C.

36. TOPICS OF INTERFACE MECHANICS
Benjamin Levich

CITY UNIVERSITY OF NEW YORK
THE CITY COLLEGE
New York, New York 10031

Date Started: November 1, 1979 Anticipated Duration: 1 year

Funding: FY '80 $75,000 (plus $75,000 from the Division of Mathematical, Engineering and Geo-Sciences)

This project will develop a systematic investigation of the field of Interface Mechanics. Of special practical interest is the influence of surface active substances on the motion of fluid-fluid interface. Following one year of joint funding, the project will be supported fully by the Division of Engineering, Mathematical and Geo-Sciences.

37. COLLECTIVE ACCELERATION OF IONS USING HIGH CURRENT RELATIVISTIC ELECTRON BEAMS
John A. Nation

CORNELL UNIVERSITY
Ithaca, New York 14853

Date Started: January 1, 1980 Anticipated Duration: 2 years

Funding: FY '80 $165,000

This project studies a collective acceleration system which uses an adiabatic increase in the phase velocity of a large amplitude slow space charge wave as a means of accelerating protons trapped in the wave. The objective is to accelerate protons from about 15-20 MeV to between 25 and 30 MeV and hence to demonstrate the feasibility of the proposed approach to the acceleration of high fluxes of protons to high energy.

38. AN H-ATOM INITIATED RAPID COAL GASIFICATION STUDY
Alan Snelson

IIT RESEARCH INSTITUTE
Chicago, Illinois 60616

Date Started: May 12, 1980 Anticipated Duration: 1 year

Funding: FY '80 $84,000

The purpose of this study is to investigate a scheme for coal gasification involving direct interaction of atomic hydrogen with finely ground coal in the presence of iodine as a catalyst. Initial experiments at IITRI indicate that a practical, flow through system might be feasible in which a steady state concentration of atomic hydrogen is maintained in the coal reduction reactor at temperatures of 600° C. In such a system, at hydrogen pressure of 100-200 atm., complete reduction of coal to CH_4 and C_2H_6 appears possible at contact times of 1 sec. The economic impact of a potential gasification process based on the above approach will also be evaluated.

39. TWO-PHASE TURBINES FOR EFFICIENT WASTE-HEAT RECOVERY

David G. Elliott

CALIFORNIA INSTITUTE OF TECHNOLOGY JET PROPULSION LABORATORY
Pasadena, California 91103

Date Started: September 15, 1980 Anticipated Duration: 2 years

Funding: FY '80 $100,000

The concept of two-phase engines is aimed at increasing the efficiencies attainable in low grade heat recovery. It is based on a novel thermal cycle, the efficiency of which compares favorably with that of a Rankine cycle. This is so because in a two-phase engine the working fluid is heated entirely in the liquid phase, thus permitting the heat exchanger to operate with a constant small temperature difference between the working fluid and the source fluid. In addition to improved efficiencies, the proposed cycle results in reduced turbine speeds -- an advantage from the point of view of material requirements. Contemplated applications include heat recovery from distributed solar energy systems, geothermal wells and diesel exhausts. Under the present program, a 50 kW two-phase turbine will be designed, built and tested.

40. EXTREMELY HIGH TEMPERATURE PLASMA RESEARCH

Robert A. Gross

COLUMBIA UNIVERSITY
New York, New York 10027

Date Started: June 1, 1980 Anticipated Duration: 2 years

Funding: FY '80 $101,000

Basic research will be performed on the laboratory production of extremely hot ($T > 50$ keV), dense ($n \sim 10^{16}$ cm^{-3}) plasmas created in a superfast z pinch, and confined for the order of several nanoseconds. Processes to be investigated include: plasma energy loss rates through the ends, electron-ion equilibration rates, radiation emission, possible nuclear fusion events (nucleosynthesis), and potential relativistic gas effects.

41. A FREE ELECTRON LASER EXPERIMENT

A. van Steenbergen

BROOKHAVEN NATIONAL LABORATORY
Upton, New York 11973

Date Started: May 1, 1980 Anticipated Duration: 3 years

Funding: FY '80 $215,000

The purpose of this program is to develop a free electron laser test module driven by the circulating beam of a storage ring. The program will explore the effect of the free electron laser on the parameters of the storage ring as well as involve the development of a coherent wiggler to provide the appropriate mechanism for electromagnetic radiation amplification by repeated interaction between the emitted synchrotron radiation and the electrons passing through the wiggler. It is anticipated that a basic design for a tunable high average power ultraviolet source with a narrow spectral bandwidth may result from these studies.

42. THERMOCHEMICAL CONVERSION OF BIOMASS TO ETHANOL

William J. Huffman

BATTELLE COLUMBUS LABORATORIES
Columbus, Ohio 43201

Date Started: September 30, 1980 Anticipated Duration: 14 months

Funding: FY '80 $128,000

The objective of this project is to test a new, proprietary process for converting sugars to ethanol. In this program, the basic chemistry and kinetics will be investigated and an economic evaluation will be developed.

43. SMALL SCALE DEMONSTRATION OF HYDRAULIC CAPSULE PIPELINE

UNIVERSITY OF MISSOURI
Columbia, Missouri 65211

Henry Liu

Date Started: June 1, 1980 Anticipated Duration: 1 year

Funding: FY '80 $45,000

Hydraulic Capsule Pipeline is a proposed alternative way of transporting cargos such as coal, but also grain, through hydraulic, water filled pipelines. The cargo is contained in a capsule, which floats in the water and is moved along the pipeline by one of a number of proposed schemes. The concept was first proposed some ten years ago in Canada, where an active R&D effort is being pursued. Its energy relevance rests with the potential of significantly decreasing the cost of transporting coal over distances of 50-200 miles. Under the present program, several improvements over the existing state of the art will be explored, one being the application of the Linear Induction Motor principle to capsule propulsion, another a new method for capsule injection into, and ejection out of the pipeline. A small, laboratory scale model of the system will be constructed.

44. COGENERATION OF ELECTRIC ENERGY AND USEFUL CHEMICALS IN A FUEL CELL

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Massachusetts 02139

Costas G. Vayenas & J. Wei

Date Started: September 1, 1980 Anticipated Duration: 2 years

Funding: FY '80 $150,000 (for two years)

All conventional fuel cells suffer from one obvious disadvantage: an expensive fuel is converted into useless oxidation products such as CO_2 and H_2O. It would be extremely desirable to use fuels which would make the fuel cell products more valuable than the fuel itself, i.e. to use a fuel cell in order to cogenerate electrical energy and useful industrial products. Recently nitric oxide and electricity have been produced simultaneously in a fuel cell using ammonia as fuel. The present project examines the oxidative dehydrogenation of ethylbenzene and butane into styrene and butadiene using zirconia cells with appropriate catalytic electrodes.

45. RELIABLE, LOW-COST, LOW POWER CRYOCOOLER TO REACH 4.0 KELVIN

S.H.E. CORPORATION
4174 Sorrento Valley Blvd.
San Diego, California 92121

Ronald E. Sager

Date Started: September 30, 1980 Anticipated Duration: 2 years

Funding: FY '80 $275,000 (first 18 months)

A major obstacle to the widespread use of superconducting devices and instrumentation is the lack of reliable, inexpensive, and convenient refrigerators capable of reaching a temperature of 4 to 5 Kelvin. This project will explore the technical viability of a novel cryocooler employing a Stirling cycle. Potential applications include the full spectrum of cryogenic technologies with special emphasis on applications characterized by low power consumption and dissipation.

46. MODIFICATION OF THE SURFACE TEMPERATURE BY AN ARTIFICIAL CIRRUS CLOUD

STATE UNIVERSITY OF NEW YORK
Albany, New York 12222

Petr Chylek and Bernard Vonnegut

Date Started: September 1, 1980 Anticipated Duration: 3 years

Funding: FY '80 $244,000 (for three years)

Some regions of the earth's atmosphere are often in the state of supersaturation with respect to ice crystal formation while still in the state of subsaturation with respect to water droplets formation. If such regions are seeded with an appropriate seeding agent an artificial cirrus cloud can be formed. Under otherwise clear sky conditions the effect of cirrus cloud is to decrease the average and maximum daytime temperature and to increase the average and minimum nighttime temperature. Consequently an artificially formed cirrus during summer days over densly populated areas can save energy required for air conditioning and reduce the maximum power usage on a given day. During winter nights the surface temperature increase would reduce the consumption of energy required for heating. The objective of the project is to explore, in a preliminary fashion, the practicality of the above concept by theoretical modelling of the effects of cirrus clouds, assessing the technology involved, studying the economics of cloud seeding operations, performing actual seeding experiments and analyzing the achievable energy savings.

47. EXPLORATION OF THERMAL SELF-FOCUSING IN A PLASMA
James Drummond

POWER CONVERSION TECHNOLOGY, INC.
11588 Sorrento Valley Road
Suite 18
San Diego, California 92121

Date Started: September 1, 1980 Anticipated Duration: 1 year

Funding: FY '80 $100,000

Thermal self-focusing is an instability which sets on when a microwave beam of sufficiently high intensity penetrates an electron-ion plasma. This phenomenon is likely to play an important role in the technical evaluation of the Satellite Power System (SPS) concept. This project, an outgrowth of Project #21, will examine the phenomenon of thermal self-focusing quantitatively in a laboratory experiment.

48. IMMOBILIZED EXTRACTION AGENTS FOR URANIUM RECOVERY
Kelly L. Smith

BEND RESEARCH, INC.
64550 Research Road
Bend, Oregon 97701

Date Started: September 8, 1980 Anticipation Duration: 1 year

Funding: FY '80 $89,000

This project explores a new uranium extraction technique applicable to low grade resources available in mine waters, copper dump leach solutions and natural waters, including seawater. The technique employs plasticized polyvinyl chloride fibers containing polymeric derivatives of conventional liquid ion exchange reagents. The fibers would be spun by conventional fiber spinning techniques and produced in the form of very high surface area mats, allowing rapid extraction of uranium even from very dilute feed solutions. The selectivity and high capacity for uranium ions of the immobilized ion exchange reagent could be utilized without the problems of entrainment and solubility loss which prohibit the application of conventional solvent extraction techniques to very low concentration feeds.

INDEX OF INVESTIGATORS

(Project Numbers)