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STATEMENT OF FRANK DEGEORGE

ACTING ASSISTANT SECRETARY

for

CONSERVATION AND RENEWABLE ENERGY

DEPARTMENT OF ENERGY

FY 1982 APPROPRIATION HEARINGS

before the

HOUSE APPROPRIATIONS COMMITTEE

SUBCOMMITTEE ON ENERGY AND WATER DEVELOPMENT

March 10, 1981

Mike —

For your information — See Page 52 especially.
Looks like we did Too good a Job!

ED

Mr. Chairman and Members of the Subcommittee:

I appreciate this opportunity to appear before you today to discuss the Department of Energy's revised FY 1982 budget request for Solar Energy, Alcohol Fuels, Geothermal, Hydropower, Electric Energy Systems and Energy Storage programs under the jurisdiction of this Subcommittee. As you may already know, all of these major renewable energy programs now report to the Assistant Secretary for Conservation and Renewable Energy for programmatic direction.

By way of overview, the revised FY 1982 budget for solar and other renewables in the Energy Technology Appropriations account totals $290.5 million. This amounts to an overall reduction of $478.5 million from the levels reflected in the January 15 budget submittal. In addition, the Administration is proposing rescissions to existing FY 1981 appropriations totalling $158.0 million for these same program areas. Total Federal support for renewable energy, however will remain extremely high, due to continuation of tax credits for renewable technologies. For example tax credits for solar, alcohol fuels, and hydropower are expected to total nearly $0.7 billion in FY 1982 alone and grow rapidly in future years. More detailed budgetary comparisons between the January 15 and revised budgets are summarized by specific technology in the accompanying table.

THE FRAMEWORK FOR THE BUDGET

Before I describe the technology highlights of the Department's FY 1982 revised budget for solar and other renewable energy programs, I would like to comment briefly on both the underlying assumptions that have been factored into the overall formulation of the Reagan energy budget and a very different philosophy regarding Federal involvement in solar and other renewable energy technology development.

Department of Energy
Energy Supply Research and Development
Renewable Energy Revised Budget
(BA in Millions)

	Jan. 15 Submission		Revised Budget		Changes	
	FY 1981[1]	FY 1982	FY 1981[1]	FY 1982	FY 1981	FY 1982
Solar Energy						
Active Solar Htg. & Cooling	40.7	32.5	38.4	11.5	- 2.3	- 21.0
Passive Solar Htg. & Cooling	31.7	31.9	30.2	10.3	- 1.5	- 21.6
Photovoltaics	154.2	161.5	133.2	62.9	- 21.0	- 98.6
Solar Thermal Energy	133.8[2]	85.3	115.7[2]	44.0	- 18.1	- 41.3
Biomass Energy Systems	42.5	55.9	27.2	20.5	- 15.3	- 35.4
Wind Energy Systems	80.3	73.6	54.2	19.4	- 26.1	- 54.2
Ocean Energy Systems	39.0	36.8	34.6	0	- 4.4	- 36.8
International Solar Program	12.0	13.0	10.8	4.0	- 1.2	- 9.0
Solar Information	1.4	12.6	1.4	6.7	0	- 5.9
Solar Energy Research Institute	5.0	23.8	5.0	0	0	- 23.8
M-X/RES	0	9.5	0	0	0	- 9.5
Program Direction	7.2[3]	6.9	6.8	4.0	- .4	- 2.9
SUBTOTAL	547.7	543.4	457.5	183.3	- 90.3	-360.1
Alcohol Fuels	20.9[4]	32.6	18.0	10.0	- 2.9	- 22.6
TOTAL SOLAR PROGRAM	568.6	576.0	475.5	193.3	- 93.1	-382.7
Energy Storage						
Electrochemical	38.5	31.3	27.3	26.2	- 11.2	- 5.1
Physical and Chemical	32.3	27.2	23.6	12.3	- 8.7	- 14.9
Program Direction	1.1[5]	1.0	1.0	.5	- .1	- 0.5
TOTAL	71.9	59.5	51.9	39.0	- 20.0	- 20.5
Geothermal						
Hydrothermal	67.9	35.0	58.6	6.0	- 9.3	- 29.0
Geopressured Resources	35.8	26.4	33.9	20.3	- 1.9	- 6.1
Geothermal Technology Dev.	49.9	28.1	47.6	20.4	- 2.3	- 7.7
Program Direction	2.4	2.0	2.4	1.6	0	- .4
TOTAL	156.0	91.5	142.5	48.3	- 13.5	- 43.2
Geothermal Resource Development Fund						
Reserve Fund	42.0[6]	4.3	20.0	0	- 22.0	- 4.3
Loan Evaluation	1.1	1.1	1.0	0	- .1	- 1.0
Program Direction	.2	.2	.2	.2	0	0
TOTAL	43.3	5.6	21.2	.2	- 22.1	- 5.3
Hydropower						
Small Scale Hydro Power Dev.	11.0	2.7	6.4	0	- 4.6	- 2.7
Feasibility Studies Loan Prog.	10.0	0	- 9.9	0	- 19.9	0
Program Direction	.8	.5	.8	0	0	- .5
TOTAL	21.8	3.2	- 2.7	0	- 24.5	- 3.2
Electric Energy Systems						
Power Delivery	20.0	19.0	17.7	4.9	- 2.3	- 14.1
System Architecture & Integra.	19.0	12.9	16.7	4.1	- 2.3	- 8.8
Generation & Storage Applica.	0	6.3	0	0	0	- 6.3
Program Direction	.9	.8	.6	.9	- .3	- .1
TOTAL	39.9	39.0	35.0	9.9	- 4.9	- 29.1
GRAND TOTAL RENEWABLES	901.5	774.6	723.4	290.7	-178.1	-483.8

1. Differences between FY 1981 Conference allowance mark for individual Solar Technologies is due to the allocation of the FY 1981 $20.2 million reduction.
2. Does not include the FY 1980 $8.0 million deferral for Barstow.
3. Includes $0.4 million for a pay cost supplemental.
4. Total is reduced by proposed rescission of $2.5 million for construction of an ethanol-from-biomass facility and includes proposed supplemental of $52,000 for pay costs.
5. Includes a proposed supplemental of $67,000 for pay costs.
6. Includes $41.982 million reappropriation of unobligated reserve funds.

Underlying Assumptions

Essentially, the Administration's energy policy and revised budget request are based upon the following underlying assumptions:

- o A realistic energy pricing policy which decontrols oil prices, and allows them to rise to world market levels.
- o Elimination of extensive on-budget subsidies for energy production, but retention of substantial energy tax credits.
- o Reformed regulatory policies, especially for coal combustion.
- o Prompt resolution of the regulatory and institutional problems inhibiting the use of nuclear power.

Philosophy for Federal Energy Involvement

In addition to these general underlying assumptions, the budget revisions for FY 1981 and FY 1982 embody a new philosophy regarding the proper role of the Federal government in developing domestic energy supplies and their attendant technologies. This is especially true for solar and other renewable energy development.

Briefly stated, this philosophy allows the Federal government to focus its support on longer-term, high-risk research and development which private industry cannot reasonably be expected to undertake. Accordingly, industry will be expected to support demonstration of promising near-term technologies and to be responsible for their ultimate market or commercial deployment. Thus, it will be the free marketplace-and not government--which will be expected to supply the considerable capital investments required to support the commercial introduction of new and alternative energy technologies into the economy. It is the Administration's firm conviction that the marketplace can achieve this introduction more efficiently and effectively than government, especially if energy prices are allowed to reflect their true replacement costs.

Finally, stimulated by Federal solar tax credits, the Administration notes that the market for solar energy products in particular is expanding rapidly. Deregulation of oil in accordance with the President's policy and increasing natural gas prices, permitted under the Natural Gas Policy Act of 1978, will remove

the subsidies for competing oil and gas resources that have prevented solar and other renewables from achieving their true potential. As a consequence, the President believes it is now possible to shift the focus of the Department's solar and renewable activities away from costly near-term development, demonstration and commercialization efforts and into longer-range research and development projects that are too risky for private firms to undertake. Therefore, the Department will continue direct Federal support for solar and other renewable programs focused on advanced research concepts and exploratory development, but assumes that the private sector will be responsible for developing marketable systems once technical feasibility has been established. Such concepts and philosophies have been incorporated into the FY 1981 and FY 1982 revised budgets before you today.

I would now like to turn to technology highlights for each solar and other renewable technology programs in our FY 1982 revised budget request, and share with you specific goals and objectives, program benefits, recent accomplishments, proposed programs with special emphasis on changes in direction, and responses to previous Congressional concerns where applicable.

ACTIVE SOLAR HEATING AND COOLING

Goals and Objectives

The overall goal of the active solar program is to accelerate the use of active solar systems for residential and commercial buildings. Specific program objectives are to work with industry in the development of longer term active solar technologies (e.g., cost effective and reliable active solar cooling systems; solar assisted heat pumps, and solar ponds).

Benefits

With over 300,000 active solar water and space heating systems in place saving over 1 million barrels of oil equivalent per year, active solar is supplying the largest amount of renewable energy by any insolation-based solar technology.

When the Active Solar Program began in 1974, the solar industry was in an early stage of development. Less than 20,000 systems had been installed and less than 50 manufacturers were in business, employing about 1,000 persons. Annual savings were 10,000 barrels of oil equivalent valued at $0.25 million.

Today, due in part to the strong catalytic effect of the Federal Solar program (including tax credits and rising energy prices) there are over 300,000 active systems annually producing energy equivalent to 1 million barrels of oil worth $35 million. Initial estimates for 1980 indicate that as many as 3,500 manufacturers and installers are now in business. Many of these businesses got their start as a result of the National Solar Heating and Cooling Demonstration Program. In addition, many of these businesses are now participants in the $50 million Solar in Federal Buildings Program. The industry currently has an annual sales volume of $750 million and employs a work force of 18,000 solar professionals.

Federal efforts significantly reduced the risks associated with development of new technologies and introduction of new products to a very competitive market. Also, the information dissemination program has lead to positive consumer attitudes towards the use of solar. Over 17,000 jobs were created during this period and industry revenues increased 100-fold.

Recent Accomplishments

Specific accomplishments include:

- o Developed and tested prototype absorption cooling machines varying in size from 2 ton to 200 ton capacity.
- o Developed and installed prototype rankine cooling machines in 3 to 50 ton size range.
- o Completed prototype design and testing of six high temperature/high performance collectors. Component development included improved glass selective coatings, extended life polycarbonate glazing and better sealants.
- o Analyzed desiccant materials to determine those best suited for solar cooling machines.
- o Developed an integrated gas/solar hot water system.
- o Selected 840 projects for $38 million in awards for the Solar in Federal Buildings Program. Projects from 16 Federal agencies in all 50 states will be constructed with these awards.
- o Constructed and monitored 288 demonstration projects in the commercial sector. All construction should be completed by the end of calendar year 1981.
- o Obtained data from 172 operational sites to provide accurate performance and evaluation information to the industry.
- o Investigated reliability and maintainability problems associated with the design and installation of solar heating and cooling systems and published guidelines for proper system design.
- o Improved storage systems through projects in baffle design, membrane linears, phase change packaging and modular fiber glass tanks.

- Provided information specifically requested on solar and the solar industry to over 1,000,000 persons, comprising a mix of residential building owners, purchasers of solar systems, remodellers, building developers, architects and other audiences including utilities, financial institutions and state and local governments.
- Succeeded in getting the overwhelming majority of organizations normally associated with development and implementation of codes to achieve concensus which is embodied in the model solar document for state and local code officials.
- Made significant progress towards establishing a standards base which furthers the realization of quality assurance systems. To date, approximately 70 of the more than 500 standards eventually required for solar energy products have been developed through the consensus process as supported by DOE.

Proposed Program

With a vibrant and growing industry now in place, and the significant accomplishments already achieved by the program it is proper to phase down DOE intervention into the solar marketplace. Oil price decontrol, tax relief and easing of regulatory burdens coupled with continued Federal tax credits for solar will provide the necessary incentives to producers and consumers to continue healthy growth in active solar usage. Therefore the FY 1982 program will focus on longer term R&D that the private sector is unwilling to undertake on its own.

By focusing efforts on longer-term research for emerging technologies, the program is able to provide research advances beneficial to all active solar systems. Major program emphasis will be on solar cooling technologies with less emphasis on solar-assisted heat pump and solar pond technologies.

The development of active solar cooling technology is an integral of the long-term strategy to maximize energy contributions from active solar heating systems. Three alternative system types have been identified as holding significant promise. These are absorption,

Rankine and desiccant cooling systems. Program activities will continue the partnership with private industry by undertaking high-risk research activities in solar cooling. Proposed efforts include:

- o Establishing the optimum solid desiccant for first generation systems, studying alternative liquid desiccant concepts and completing controls studies for desiccant systems.
- o Computer modelling of the double effect absorption machine performance for system analyses will be developed. Cooling systems analyses will be conducted to determine optimal system configurations, control strategies and evaluate cost performance benefits of proposed system modifications.
- o Efforts to improve collectors, storage, and controls optimized for selected cooling systems will continue.
- o Technology development activities will lead to completion of tests for a 25 ton, water cooled, electric auxiliary cooling unit for a light commercial building and application.

Program efforts in the solar space-heating and cooling applications area will focus on solar-assisted heat pumps and solar ponds. The overriding problem facing solar-assisted heat pumps is the lack of developed hardware for this application since attempts to use conventional heat pump hardware in solar-assisted applications have failed. Understanding and controlling the behavior of thermal and salinity gradients in solar ponds is a primary factor limiting their commercial application. The development of techniques and hardware for extracting heat from the pond is also required before solar ponds can be considered viable. Proposed efforts include:

- o Basic and applied research activities to investigate the behavior and performance of solar ponds to understand the mechanisms that cause movement of the pond layers and how to control this movement to maximize collection and storage efficiency. Additional research will include an investigation into the effects of heat extraction on the thermal stability of the pond, maintenance of clarity of the pond, methods of surface wave suppression, and identification of alternative salts to sodium chloride.

- Technology development activities for solar-assisted heat pumps will be focused on the development and evaluation of a prototype system. Solar pond development activities will address hardware issues such as identification of heat removal techniques of low-cost materials for pond liners.

PASSIVE & HYBRID SOLAR

Goals and Objectives

The passive and hybrid solar energy program has as its goal the accelerated development of new systems, designs and technology that can meet the energy needs of buildings. To achieve this, DOE relies on a partnership with industry to conduct the necessary research and development to bring passive and hybrid technologies into common use.

The programs' objectives are to:

- o Conduct research and development of cooling systems and designs for residential and commercial buildings.
- o Assist industry to develop new materials and refine traditional building materials for use in passive systems.

Benefits

Passive and hybrid technologies have the potential of providing significant energy annually, and of stimulating small business growth and employment opportunities in virtually every part of the nation. The development of passive and hybrid solar technologies will mean more efficient materials, lower cost installed systems and energy conscious construction. The availability of the technology will add sales and generate new business especially in the glass, masonry, and insulation industries. Also, export markets for both hardware and software will become available. Passive solar technologies can be applied to both new and existing residential and commercial building applications throughout the U.S.

Over the past three years the program has provided industry with a technical base of information, new high performance materials and components, design and analysis tools for architects, engineers and builders, new construction methods and facilitated industry cooperation through formation of a passive solar industries council which involves 26 construction trade professional associations and labor unions. DOE's program is critical to this new technology since the building industry has limited capability to undertake research and development by its very fragmented and diverse nature. Over 40 percent of the passive FY 81 budget directly supports small business.

To date the 50,000 passive solar residences that exist can be traced in many ways to the federal passive and hybrid program.

Funds expended on these projects exemplify the use of the fewest federal dollars possible to gain maximum benefit. For example, a project to develop a new type of insulating film for windows began with a $500,000 investment of federal dollars for basic research. This, in turn, spurred private industry to continue the research, develop prototypes, raise capital for market reseach and product refinement, and begin product manufacture and marketing. Statistical analyses indicate that 600,000 barrels of oil were saved as the result of the product's first year of use, and that over a period of 20 years, approximately $21 million would be saved by consumers because of the reduction in fossil fuel usage. While the the long-term savings of $21 million for a $500,000 federal investment is an exceptionally high return for a Federal investment, the majority of activities in the Passive and Hybrid Program are anticipated to yield at least a 40-to-1 and as high as 125-to-1 return for each Federal dollar spent.

Recent Accomplishments

Passive heating for residential use is the most advanced of all passive technologies. In FY 1981 the residential program accelerated activities aimed at providing architects, engineers, building owners and consumers with technical, design and economic information on the applications and benefits of passive heating. In addition, emphasis was placed on the development of prototype passive designs for manufactured and conventionally constructed buildings including design and construction of 350 demonstration projects, instrumentation and monitoring advances, field testing of heating and cooling system designs, and cost-shared development of prototype designs for 25 manufactured buildings.

Because of the sophistication required of passive systems for commercial buildings, this particular program area is oriented toward research and development of solutions to systems engineering problems. Passive heating systems for commercial buildings are in the prototype

system development stage, and cooling will require further basic research.

In FY 1981, exceptional progress was made in developing and compiling analytical and performance data on passive systems for commercial buildings.

Other major accomplishments included experimental tests for "warm and humid" climates, engineering field tests for system prototypes, and development of sophisticated computer energy analysis tools.

Advances being made in the development of new solar materials and components correlate directly to the development and marketability of passive systems and applications.

Specific accomplishments in residential heating included research, development and field testing of transparent insulation, waterwalls, reflective insulating blinds and collector surface materials. The Solar Cities and Towns Program established in 1980 address block-scale solar designs.

Proposed Program

Rising energy prices, accelerated by decontrol of oil, have lessened the need for continued Federal involvement in near-term technology development and commercialization activities for passive and hybrid solar. Responding to market forces, consumers will demand and builders will provide passive and hybrid solar buildings when it is economically sound to do so, making much of the previous passive solar program no longer necessary. Therefore, the FY 1982 request for the Passive and Hybrid Solar Energy Program emphasizes cooling technologies. This is consistent with the Department's emphasis on longer term high, risk/high payoff research and development that the private sector is unwilling to undertake on its own. Planned activities in FY 82 include:

- Residential Building Cooling - basic research, testing and development of analysis tools for evaporative, ventilative, and ground-coupled systems.

- Commercial Building Cooling - basic research and experimental testing of solar driven ventilation, passive lighting and radiative cooling systems will be conducted.
- Research and development on advanced materials such as selective surfaces, glazing films and control devices, and the development of test procedures for these.

PHOTOVOLTAIC ENERGY SYSTEMS

Goals and Objectives

The goal of the PV Energy Systems Program is to work with industry and universities in the research and development of low-cost, high risk, high payoff photovoltaic systems that are capable of providing cost effective energy to residential and central station systems within the United States.

The approach of the program is to work with industry in the development of the high-risk, low-cost technologies. The activities supported range from new silicon polycrystalline sheet and ribbon approaches that show good promise to the longer range thin-film activities in amorphous silicon, cadmium sulphide compounds, gallium arsenide compounds and other materials that are likely to emerge as longer range technology feasibility is established. Similarly, concentrating collectors are being developed by pursuing both higher efficiency photovoltaic materials and lower cost optical concentrator elements. The components of the system other than the module and system concepts and designs are being developed with industry.

Benefits

The most important benefit has been the actual and planned investment of almost $300 million of private funding in the photovoltaic industry. In addition contractors in the program have been willing to cost-share some of the critical development efforts and many of the applications experiments, thereby allowing the program to spread its coverage to more activities than would be possible without the cost-sharing.

In addition to the above leveraging, other benefits to the country include:

- Rapid expansion of the photovoltaic industry which is opening up many new jobs.
- Rapid growth in the shipment of photovoltaic systems, manufactured in the U.S., to other countries, with the positive impact on our balance of-trade situation.

- o Development of higher quality components that are leading to systems with a longer life and resultant lower energy costs.
- o Development of new materials, components, and systems that will result in more reliable, low cost photovoltaic applications.

Recent Accomplishments

A number of new materials have reached the applied research stage. All of these show capability of being developed for manufacture at 40¢ per peak watt or less. They are listed as follows with the latest conversion efficiencies compared with values seen a year ago.

- o Amorphous silicon solar cells of approximately 1 cm^2 have shown over six percent conversion efficiency (4-5% a year ago) at RCA & ECD (private funding); other competing low cost methods have shown four percent efficiency (1-2%). Furthermore, RCA has reduced the time and cost to deposit the solar-cell on to the support structure.
- o The conversion efficiency of the copper sulphide/cadmium sulphide class of cells has increased from 8.2% to over 10%. The newer, more stable, copper indium selenide/cadmium zinc sulphide cells have measured efficiencies of 8.7% which is equivalent to 9.7% with an antireflection coating. This is up from 6% a year ago.
- o Cadmium Telluride solar cells, prepared by a variety of low cost techniques now show efficiencies in the 4% range. Cells produced by these methods were 1-3% efficient a year ago.
- o Photovoltaic electrochemical cells with over 6% efficiency have been developed.
- o The efficiency of cells based on zinc phosphide in association with a magnesium Schottky barrier or with zinc oxide hetero junctions has increased from 1.2% to 3.5%.

- o Polycrystalline silicon cells based on several different production techniques have now exceeded 10% efficiencies. Three exploratory development programs directed at technologies capable of meeting costs of less than 50¢/Wp have been started.
- o Thin film single crystal gallium arsenide cells have shown efficiencies to 17%. A potential efficiency of 22% (compared to 18% for silicon) is estimated.
- o Multiband-gap advanced concentrator cells have shown 16% efficiency relative to a potential of 35%. The materials problems of fabricating and interfacing these multilayered structures of different compositions is being systematically attacked with several promising approaches.

In the Technology Development area industry has achieved $2.80 per peak watt technology readiness for flat-plate modules and concentrator collectors. The program is moving rapidly toward further cost reductions by stimulating several industrial firms to build silicon material plants with low cost processes and using their own funds. It is supporting several promising technologies for the production of sheet silicon that are now nearly reaching the stage necessary to achieve $.70/peak watt.

Other recent accomplishments include:

- o Initiated the operation of two Residential Experiment Stations.
- o Developed 13 residential prototype systems which are in the process of initial performance testing.
- o Several companies have invested their own funds to develop power conditioning equipment in response to DOE's earlier program activities that have developed several more potentially low cost power conditioners.
- o A novel flywheel system for storing and processing PV power has been developed and tested at 1/10 scale.
- o Low cost array structures for arrays of solar cell modules have been designed, developed and tested.
- o The first Performance Criteria and Standards report has been

prepared.

- Sixteen intermediate load experiments have been designed and are constructed or are being constructed.

Proposed Program

The FY 1982 request for Photovoltaics Energy Systems is $62.9 million. This level of funding reflects the philosophy that the program should focus on longer-term, high risk research which industry cannot justify undertaking because the benefits are so far in the future and so uncertain. There is now a growing photovoltaics industry, backed by investments from large corporations and spurred on by rising prices for oil and gas, that will be expected to undertake the demonstration and commercial marketing of photovoltaics on its own.

The request for the Advanced R&D activity is $44 million. Funding for this element is being held level after two years of rapid growth. It will be used for work on advanced concepts such as film polycrystalline silicon devices, amorphous silicon materials and other technologies and material needed to meet the technical feasibility goals of the program.

Our request of $11.9 million for the Technology Development activity will support a basic low-cost solar array program for silicon materials development. The aim is to achieve technology readiness for low cost silicon technologies so that they may be transferred to the private sector.

The remaining $7 million will be used for capital equipment to provide necessary instrumentation and associated test equipment required for laboratory testing of photovoltaics materials and equipment.

BIOMASS ENERGY SYSTEMS

Goals and Objectives

The broad goal of the Biomass Energy Systems Program is to reduce U.S. dependence on oil and natural gas by developing biomass production and conversion systems that exploit renewable regional resources.

In FY 1982, emphasis will be on a broad based, long-range research program that supports development of advanced technologies to produce alternative fuels and petrochemical substitutes. The program will include activities related to biomass feedstock production and harvesting, its conversion to fuels and chemicals, and the development of high risk innovative biomass energy concepts that have potentially high payoffs.

The specific objectives of the production research activities in FY 1982 are to reduce production costs and to develop high yielding biomass energy crops. These activities include continuation of wood species selection and stand establishment, and species selection and production systems development for arid and wet lands. As improved energy crops are developed and yields per acre increase, more biomass may be used for energy without disrupting traditional forest and agricultural markets.

The specific objectives of the biomass conversion technology research and development planned for FY 1982 are to complete tests of selected gasification process development units, develop new thermochemical gasification and liquefaction concepts, and new biochemical conversion concepts.

Research and exploratory development of innovative biomass energy technologies is also an important part of our FY 1982 program. The specific objectives are to develop micro- and marco-algae cultivation systems, biochemical hydrogen production systems, and the technology for anaerobic digestion of crop residues. Activities in this area also provide the underlying exploratory research for totally new biomass energy concepts.

Benefits

In terms of energy produced, biomass has the greatest potential near-term "payoff" of all the solar technologies. Some studies have shown that under certain conditions, biomass can produce as much as 5-17 quads of energy per year by the year 2000, given current trends in demand and energy economics.

Wood from forest land represents the greatest potential source of biomass energy. The U.S. Forest Service estimates that at least 550 million tons of wood is potentially available annually for use as energy feedstocks or for the production of petrochemical substitutes. This is the gross equivalent of 9.3 quads of energy.

The direct combustion of wood already provides 2 percent of our national energy consumption, or 1.5 quads. Technology currently exists for producing two to three times this amount without adverse effects on the environment or the forest products industry. This would be approximately one half of the estimated available supply.

Significant biomass resources potential also exists in the form of agricultural crop residues and specially cultivated terrestrial and aquatic plants.

Recent Accomplishments

Both the Federal Government and private industry have provided support for the development and commercialization of biomass energy technologies during the past few years. The most notable area of progress has been the increased use of wood by the industrial and residential sectors of the economy. This growth has been stimulated by site-specific wood supply information that we have provided to the public.

Most of the wood energy currently used in the industrial sector is consumed by the forest products industry. This industry burns mill residues to generate process heat, steam and electricity and is currently 50% energy self-sufficient. We have recently demonstrated that in many other industries the use of wood with either new or retrofited boilers is cost-effective and that boilers retrofitted to use wood have demonstrated payback periods of less than three years. Both direct combustion and low Btu gasification

of wood have been shown to be commercially competitive with oil and natural gas. As a result, the use of wood is spreading to the food processing and textile industries.

The use of wood energy has also expanded in the residential sector. Annual sales of wood stoves have increased from 160,000 stoves in 1972 to over 1,000,000 today. DOE in cooperation with private industry has characterized emissions factors for residential wood burning stoves. These characterizations provide assistance to industry in the development of safe and environmentally acceptable wood burning stoves.

We have encouraged the use of biomass energy in the agricultural sector. Our efforts to increase this sector's energy self-sufficiency are designed to exploit biomass resources that are readily available and, in many cases, are presently wasted. By using locally collected, low-cost biomass resources as energy, the agricultural sector can have assured supplies of low-cost energy. This will reduce the impact of rising fuel costs on the price of food, and will enable this sector to continue to produce for both domestic consumption and export if oil supplies are interrupted.

One example of biomass energy technology progress for the agricultural sector is the cost-shared construction and operation of a large-scale anaerobic digester at a cattle feedlot in Bartow, Florida. The digester is designed to use the manure from 10,000 beef cattle and has been in operation since the spring of 1979. The Bartow project has demonstrated the feasibility of producing methane gas to generate electricity. The electricity is used in an adjoining meat packing plant with the excess being fed into the local utility grid.

We have completed an assessment that indicates the technical feasibility of producing and processing diesel fuel substitutes from oil seed crops. Use of these diesel fuel substitutes by the agricultural community would, of course, reduce the impact of oil supply disruptions on the availability and cost of agricultural products.

Biomass energy conversion technologies have kept pace with the progress achieved in expanding available biomass feedstocks. Initial proof-of-concept tests of selected technologies for the gasification and liquefaction of wood have been completed at the process development unit stage. However, additional research and development is required for low and medium Btu wood gasification and wood liquefaction technologies.

Longer-term technologies are also being developed. For example, we have completed a prototype freshwater microalgal production facility. This facility will provide information on the biochemical mechanisms controlling hydrocarbon production by these aquatic plants. This and similar research is essential for the development of a number of promising longer-range biomass technologies.

Proposed Program

In FY 1982, we are planning to direct our efforts toward a broad-based, longer-range research and development program emphasizing higher-risk technologies that have high potential payoffs. With oil price decontrol, tax relief, easing of regulatory barriers, and solar tax credits, we can rely on free market forces to stimulate private sector interest in developing the technology and marketing needed to commercialize near-term wood and near-term agricultural biomass energy systems aimed at increasing the agricultural sector's energy self-sufficiency. Therefore, our previous activities in near-term technology development and commercialization are no longer necessary.

We are requesting $20.5 million for the Biomass Program in FY 1982. We plan to allocate $8.8 million for Production and Conversion Systems Development, $11.2 million for Research and Exploratory Development, and $0.5 million for Capital Equipment.

Of the $8.8 million requested for Production and Conversion Systems Development in FY 1982, $4.0 million will be used for research in biomass resource production. The major objectives are to increase the yields of biomass from forest stands through improved silvicultural techniques, and to use marginal lands for the production of herbaceous crops that traditionally have not

been cultivated.

The screening of tree species and the development of cultural practices for high yielding silvicultural farms will continue at 50 selected sites. These are located in New England, the Southeast, the Lake States, the Pacific Northwest and the Southwest. These field experiments include evaluations of various regeneration, stand establishment and management techniques. Productivity rates of 12-30 dry tons per hectare have been demonstrated at these locations. In addition, first generation genetic selection has shown a 25 to 90 percent production improvement for many species.

Efforts will continue to identify herbaceous species that will provide sustained high yields, to define optimum cultivation practices for promising species, and to develop production systems suitable for marginal and arid lands in order to reduce competition for the use of prime agricultural land.

The remaining $4.8 million requested for Production and Conversion Systems will be used to help the private sector develop thermochemical conversion systems that convert biomass resources into the energy form needed by the region. The objective is to produce gaseous and liquid fuels as well as petrochemical substitutes. The thermochemical conversion processes under development include innovative direct combustion, low and medium Btu gasification and the liquefaction of biomass.

A variety of high performance gasification systems will continue to be evaluated to determine which are technically and economically feasible. One major challenge is the production of medium Btu gas and synthetic gas without the addition of pure oxygen. Medium Btu gas can be piped a considerable distance. Synthetic gas can be upgraded to substitute natural gas and reformed into liquid fuels, such as methanol and other higher alcohols. Novel heat transfer techniques are being incorporated in the design of biomass gasifiers to eliminate costly oxygen units. Catalysts are also being employed to direct processes toward a desired gas composition and to eliminate tars and heavy hydrocarbons.

In FY 1982, research and development will also continue on the production of liquid fuels and other hydrocarbons by fast pyrolysis techniques and the catalyzed direct conversion of biomass. In addition, efforts will be initiated to develop novel approaches to convert biomass energy to shaft power.

A total of $11.2 million is requested in FY 1982 for research and exploratory development to identify and investigate long-range technologies that have a high potential for increasing the biomass resource base and the supply of energy and energy related products produced from biomass.

We will continue research to identify and develop the potential of innovative, advanced biomass production and conversion systems. These include hydrocarbon synthesizing microalgae systems on non-arable, unproductive land, and carbohydrate synthesizing macroalgae produced in land based and near shore systems. Yields of these submerged aquatic plants have been demonstrated to be several times greater than that of grasses, forest, and agricultural crops. The screening of microalgal and macroalgal species for optimum biomass yields and capacity to synthesize hydrocarbons and carbohydrates will be completed in FY 1982, and development of harvesting technologies will be continued.

Anerobic digestion research will continue to gain a more complete understanding of the biochemistry of producing methane from crop residues. Significant research and development is needed before this technology is ready for commercial application. Comparisons are being made between thermophilic and mesophilic bacterial systems. Various pretreatment schemes are being tested to improve the anaerobic digestion process by reducing the retention times necessary to convert cellulosic feedstocks.

The demand for hydrogen as a chemical feedstock is growing steadily and the trend is expected to continue. Low cost, reliable hydrogen production systems are needed and several candidate technologies, including electrolysis and thermochemical processes, are being developed by DOE. In the Biomass Program, research is

by photosynthetic bacteria, algae, and in cell-free systems. In addition, basic research in biomass production and conversion technologies will be conducted.

SOLAR THERMAL ENERGY SYSTEMS

Goals and Objectives

The goal of the Solar Thermal Energy Systems Program is to establish feasibility of cost-effective systems for converting sunlight into low-, medium-, and high-temperature heat. Federal efforts have focused on development of complete systems meeting investor criteria for operability, maintainability, and reliability. The Solar Thermal Program addresses technology which is compatible with the way this nation does business, including component designs which can take advantage of mass-production methods to reduce costs.

Solar Thermal concepts under development include concentrating collector systems as well as solar ponds for electricity generation. The concentrating concepts are: tracking parabolic troughs, stationary hemispherical bowls, heliostat-based tower-mounted central receivers, and tracking parabolic dishes. These approaches all use reflective collector surfaces to concentrate the sun's rays on a small area in a receiver to capture solar heat and to increase its temperature dramatically. Solar ponds rely on a physical phenomenon whereby salinity differentials suppress convection, enabling a saline pond to both collect and store heat energy.

Benefits

Solar thermal concepts offer a versatile energy option because they can convert sunlight into heat within a wide range of temperatures, including temperatures above 2,000 degrees Fahrenheit. The heat can be used directly, as in industrial processes; can be converted into electricity; or can be used to drive chemical reactions that produce fuels. Further, the concentrating concepts permit achievement of high energy conversion and land use efficiencies.

Collectively, the alternative collector concepts are complementary and can address a wide range of applications. In addition to differences in temperature capabilities, the concepts also differ in their modularity and adaptability to siting considerations.

The solar thermal option is adaptable and flexible and can be pursued without revolutionary changes in our nation's infrastructure for delivering and utilizing energy. For example, there is flexibility for deployment in simple retrofit and hybrid configurations and total energy applications with concommitant easing of requirements for capital. Solar thermal systems linked to heat-storage systems can become interchangeable with conventional boilers. The potential for displacing oil and other depletable resources is significant. The opportunity for manufacture is not limited to any geographic area. Solar thermal energy systems offer the nation a diversified source of clean, renewable energy with the potential for major impacts in the coming decades.

Recent Accomplishments

The Solar Thermal Energy Systems Program is currently at a key stage in its evolution. The several technical paths being followed involve a development cycle of roughly 10 to 15 years from concept definition to product maturity. As a result of efforts to date, two concepts--parabolic troughs and central receivers--have progressed the furthest. Experience with test facilities and operating systems over the past year has demonstrated technical feasibility of key subsystems and levels of component reliability and durability which are consistent with criteria for specific applications.

We are on the threshold of operating two different energy systems that will be first-of-a-kind for the U.S. One is the 10 megawatt central receiver pilot plant (Solar One) being built near Barstow, California. It is to start operation by the end of 1981. The other system is the total energy parabolic dish project which is to provide electricity and heat for a knitwear factory in Shenandoah, Georgia. Both of these endeavors include contributions by cooperative industrial partners.

The Central Receiver Test Facility at Albuquerque, New Mexico, has been used to support the Barstow project; it also has been used for successful tests of a prototype molten salt receiver geared for utility repowering and central receiver stand-alone applications. Further, we are benefitting from operating data gained from parabolic

trough field experiments, including a 150 kilowatt irrigation pumping system near Coolidge, Arizona. Additionally, a 65-foot prototype of a hemispherical bowl is producing valuable operating data.

Proposed Program

The federal effort under the Solar Thermal Energy Systems Program will continue to focus on necessary development and testing of generic components and systems, where benefits accrue to industry as a whole and where aggressive private research and development by an individual company or utility user could not be justified.

Each of the solar thermal technologies is supported by phased efforts in the following programmatic areas: Research and Advanced Development (RAD), Technology Development, Systems Testing, and Planning and Assessment. The request for Fiscal Year 1982 totals $44 million. I will discuss highlights of the request in terms of the four areas I just noted.

The FY 1982 funding request for the RAD Activity is $21,100,000, which reflects greater emphasis on advanced development. These funds will expand work in the areas of Materials Development, Applied Research, Fuels Processes, and Solar Ponds. We will address solar heat absorbtion and transport requirements, durability and reliability of materials in high-temperature environments, and feasibility of using existing and new polymeric materials in advanced concentrators. We will continue exploratory development and testing of advanced heat receivers and other high-temperature components and subsystems in concert with programs to foster innovation through programs with university faculty and the solar thermal test facility users association. In addition, innovative designs of advanced subsystems and systems will be conducted aimed at meeting far-term needs. There will be continued development of baseline processes for fuels production, as well as feasibility testing of alternate solar fuels processes. Solar ponds work is directed toward research and design studies in support of first-of-a-kind experiments.

Technology Development Activity (TD) provides for development of components and subsystems as building blocks of technically viable systems. The FY 1982 funding request for the TD activity is $11,050,000, reflecting completion of generic feasibility phases of distributed receiver programs. FY 82 funding will be applied to engineering development and test facility operation needed to establish technical feasibility of improved subsystems and components. There will be emphasis on the testing of advanced heliostats for potential utility repowering and industrial retrofit applications and exploratory development of improved heliostat subassemblies. Design studies will be conducted to define cost, scope, and development requirements related to use of Barstow as a repowering test facility. Testing of existing parabolic dish engineering experiments will continue. We will also complete development, testing, and document design information obtained in Brayton and Stirling engine subassembly testing funded in prior years. Support will be provided to complete the evaluation and documentation of the Modular Industrial Solar Retrofit (MISR) program, which was initiated in FY 1980.

The Systems Testing Activity (ST) has responsibility for the construction, operation and testing of solar thermal engineering experiments and pilot plants to prove the technical and engineering feasibility and economic potential of complete systems. The FY 1982 funding request for Systems Testing is $8,000,000, reflecting completion of major field experiment construction. A key development will be operation of the Shenandoah Total Energy Project, the first U.S. test of a complete parabolic dish system. Resources also will be applied to operation of the Barstow Pilot Plant to obtain data relevant to small grid-connected applications. In FY 1982 the repowering and retrofit design study efforts conducted over the previous five years will be summarized, documented and disseminated.

The FY 1981 appropriation provided final increments for Barstow and Shenandoah. Construction funding is not requested for FY 1982 for the Small Community Experiment pending a review to evaluate the appropriate size of experimental systems.

An additional $3,850,000 is requested for Planning and Analysis Activity and capital equipment.

Response to Previous Congressional Concerns

The proposed efforts include support of modifications to the Central Receiver Pilot Plant to minimize the need for future hardware activity in relation to repowering applications. No funds are requested for further central receiver construction projects, pending evaluation of the pilot plant experience. Likewise, funds are not requested for construction of the planned 1 MWe Small Community Parabolic Dish Engineering Experiment. However, design studies and prototype module evaluation will be completed in FY 81.

WIND ENERGY SYSTEMS

Goals and Objectives

The objective of the wind energy systems program is to advance the technology to design, manufacture, and operate wind machines and to transfer this technology to industry. The principal technical challenges are understanding the characteristics of the wind resource, development of materials and design techniques to reduce the stresses machines encounter over their lifetime, and understanding the dynamic interactions of wind machines with the electric utility grid.

Benefits

Wind systems are one of the oldest renewable resources used by man. In the mid 1800's wind provided a significant portion of the U.S.'s non-transportation energy and was a major factor in the development of the West. In the 1920's and 1930's, many of our farms obtained their first electricity from wind turbines. However, the subsequent arrival of low cost fossil fuels caused a trend away from wind systems. That trend has now reversed, and it is anticipated that, in the 1980's, wind systems will become cost-effective again in high wind, high fuel cost locations. Industry and users, in perceiving this economic trend, are expected to be the driving force in the reestablishment of a wind energy industry in the U.S.

Wind systems have several key characteristics which support this trend. They are modular in nature and can be built in a range of sizes. Typically, small multi-kilowatt machines are useful for rural residences or agricultural and irrigation purposes, and large multi-megawatt machines or machine clusters will provide utility electrical generation. Local terrain and climatic conditions focus the conversion of the sun's diffuse energy into areas of concentrated wind energy which leads to more favorable economics at those locations. Wind systems can be factory fabricated and installed rapidly, and can produce the equivalent energy needed to manufacture them in six to nine months. They also represent a potentially significant export product.

The primary value of wind systems, however, is in their potential capability to replace fossil fuels economically, particularly for utilities with oil or gas intermediate and peaking plants.

Recent Accomplishments

The technological basis for systems which could achieve the necessary performance and economics was laid in the 1970's, initially through advanced research and experimental development supported by the DOE, and more recently, by rapidly increasing private engineering development and investment. In the mid-1970's there were about 7 importers or manufacturers of small wind systems, while intermediate and large wind systems were being investigated primarily only under government funding. Today, there are approximately 30 U.S. manufacturers of small systems and at least six firms involved with intermediate and large scale systems.

Under Federal sponsorship, high performance small systems were developed by industry at the 1, 8, and 40 kilowatt sizes for rural residential and agricultural use. Prototypes of these systems are undergoing extensive tests at the DOE's Rocky Flats Test Center. Several of the manufacturers are engineering these systems for commercial sales. Development of additional systems at the 4 and 15 kW sizes is nearing completion. A number of privately designed systems in the 1 to 50 kW range are also being developed and are beginning to enter the market.

At the intermediate and large sizes, DOE has installed four, 125 foot diameter, 200 kW Mod-OA's in test operations with cooperating utilities. Together they have accumulated over 15,000 hours of operation which is providing a base of practical experience for the utility industry. The Hawaii unit operated for its first three months at a capacity factor of over 70 percent. The Block Island, Rhode Island unit, over the winter months, has averaged almost 12 percent of the Island's energy and on windy nights has reached as high as 50 percent of the power demand. At least three private manufacturers are independently developing intermediate systems. One company, based on the performance of its prototype on Cuttyhunk Island, ME has sold two additional units to utility companies.

The DOE funded 200 foot diameter, 2 megawatt Mod-1 system, being tested at Boone, N.C., has proved the basic technical feasibility of utility class systems. While a number of technical problems arose on what was the first system of such a size attempted in 40 years, these problems have been, or are being resolved, and the information gathered is being applied to the advanced systems. The second generation, 300 foot diameter 2.5 MW MOD-2, by far the world's largest system, recently produced full power during its initial testing at Goodnoe Hills, WA. Two additional units will be completed this spring and will allow for the testing of the first multi-unit system and investigation of multi-unit electrical stability and aerodynamic questions.

Two manufacturers are independently entering the large system field. One unit of a Swedish developed system has been sold to the Water and Power Resources Administration and a privately developed unit has been sold to a public utility company.

Several other utilities are planning to purchase test units and at least two have announced long range plans which include significant quantities of wind energy in their future generation mix. The tax credits for renewable energy systems and the interconnection requirements of the Public Utility Regulation Policy Act have led to the formation of several private corporations that intend to procure wind systems and sell the electric output to utilities. Three potential large scale projects are believed to be in the planning and negotiating stage.

Proposed Program

In view of these rapid changes, the DOE is concentrating its resources on projects and activities which will best foster the growth of the private sector in establishing a wind industry. In FY 1982 the primary thrusts of the requested $19.4 million will be on identifying and resolving the major remaining technical uncertainties, providing test data from wind systems to validate both engineering and economic projections, providing information on wind characteristics for design and siting, and identifying and ameliorating barriers to the manufacturing and utilization of wind systems.

Under the Planning, Management and Analysis element, studies will continue to assess and evaluate the technology and economics of wind energy in a variety of applications and conditions. Research will continue on questions of television interference, noise, regulatory and other deterrents to wind systems.

Research on Wind Characteristics will concentrate on three areas. We will refine our understanding of gusts and small scale turbulence to support the design of more reliable and efficient systems. We will conduct research on determining and reducing uncertainty in forecasting the wind to allow utilities to calculate more accurately the value of wind energy. Wind prospecting techniques will be refined and results published.

The major program activity in 1982 will be in the Technology Development element. Testing of small systems will continue at the Rocky Flats Test Center to obtain performance, aerodynamic, structural and electrical information. In addition to testing DOE funded systems, the test center will commence operating on a cost-reimbursement basis for small systems manufactures by providing high quality, detailed test data. Research will continue on the development of analytical tools for improved design of the structural, aerodynamic and electrical components of wind systems. Research will also continue on high risk, but potentially high payoff innovative concepts. Testing and analysis of blade fatigue properties, the major question related to system lifetime, will be undertaken.

Testing of the 1 kW to 40 kW small wind systems and the Mod-0/0A, Mod-1 and Mod-2 intermediate and large experimental systems will continue and will provide the major practical experience on performance, stresses, and systems interactions. These data will assist industry in the development of future systems, and the utility and user communities in the assessment and evaluation of wind energy.

With the rapidly increasing interest and potential investment in wind energy by industry, we believe that this approach is most beneficial to the development of wind energy and the attainment of a significant use of wind power over the next decade.

OCEAN ENERGY SYSTEMS

Goals and Objectives

The Ocean Energy Systems program performs basic research, and applied research and technology development of components, subsystems and techniques which have the potential to extract significant and usable amounts of energy from the oceans in a reliable, economic and environmentally acceptable manner.

Benefits

The oceans occupy two thirds of the earth's surface and represent the largest solar thermal collector on earth. Furthermore, energy generation from the oceans thermal differences suffers no shutdown from daily cloudcover or sunsets. This energy option is renewable and available 24 hours a day, with an estimated extractable resource of billions of barrels of oil equivalent per year. Studies and tests to date have identified no significant negative environmental consequences.

The closed cycle ocean thermal energy conversion (OTEC) concept is the most technically developed of the ocean energy options and has received the majority of funding support. Concepts and devices for wave energy, ocean current energy, and open cycle OTEC (which uses sea water as the heat transfer fluid and can potentially produce potable water) have been explored. Ocean thermal systems have applications to both island and mainland electric utilities and to energy intensive material production. Initial applications are projected for the United States Islands such as Hawaii, Puerto Rico, the Virgin Islands and Guam where electric power is provided almost exclusively by imported oil and the ocean thermal resource is great. Comparative economic studies show that existing OTEC designs could be competitive with conventional energy sources as a baseload option for islands by 1985, and as a baseload option for the Gulf Coast by 1992.

Recent Accomplishments

In August of 1979 the State of Hawaii, in conjunction with a private industrial consortium, deployed and operated the Mini-OTEC Experiment -- a seabased OTEC which generated net electric power (10 KWe) as well as 40 KWe housekeeping power. The net power produced met prior performance projections and clearly established the technical feasibility of OTEC as a baseload energy source.

A major program milestone was achieved on December 23, 1980 when the OTEC-1, a 1 MWe capacity sea-based, power system development test facility, was deployed and initiated full scale operations. In the short period that OTEC-1 has operated the following has been accomplished:

- o The world's deepest mooring for a large vessel (over 4000 feet) was successfully deployed
- o The largest cold water pipe (CWP) to date, 2300 feet long and a diameter equivalent to 7 ft., was successfully assembled on a beach, floated to the site, vertically oriented, keel hauled and attached to the ship
- o The CWP has permitted continuous pumping of cold deep water even during several Kona storms (winds to 50 knots, sea waves to 18 feet) and subsurface ocean currents higher than 1.5 knots
- o A 4 MWe equivalent heat exchanger configuration is the first generation technology being demonstrated and is projected to be cost effective for island markets by 1985.

Land based tests on heat exchanger elements have already demonstrated at least two effective cleaning techniques for maintaining the efficiency of heat exchanger surfaces for at least 9 months. Preliminary designs of cold water pipe concepts have been completed. Several cost effective and structurally competent designs were identified. Further analytical evaluation of electric riser power cables indicate a high probability of the cable being able to survive for a 30 year life. Electric cable tests are being initiated to verify these projections this year.

In summary, sufficient progress has been made to date to indicate that OTEC is technically feasible and could compete in several commercial market areas.

The Department is developing a plan required by the Ocean Thermal Energy Conversion Research, Development, and Demonstration Act (P.L. 96-310) to define alternative approaches to achieve the goals of this act. The accomplishments to date have brought this technology to the point where industry can take a more active role in its further commercial development. Furthermore, foreign initiatives by the Japanese in the South Pacific island nation of Nauru and the European Economic Community in the Ivory Coast could result in a 10 MWe to 40 MWe operating OTEC plant by 1985.

Proposed Program

Given the recent accomplishments in OTEC technology, including clear evidence provided by "Mini-OTEC" that this technology is technically feasible, further development of OTEC technology suitable for pilot and commercial scale demonstrations can be left to the private sector. Therefore, the Department is requesting no funds for the ocean energy systems program in FY 1982.

INTERNATIONAL SOLAR

Goals and Objectives

The goal of this activity is to continue cooperative efforts with the government of Saudi Arabia. Specific objectives for this program have been to augment U.S. domestic R&D efforts, decrease U.S. R&D costs through cost (or task) sharing, accelerate technical development and cost reduction of solar equipment, and gather new ideas on a worldwide basis.

Benefit

The most important advantage of activities with Saudi Arabia (referred to as the SOLERAS program) has been the reduction in costs of undertaking large R&D projects, which can benefit substantially the U.S. domestic solar technology programs and increase the involvement of U.S. industry in international trade. The effort is funded through a 50-50 costsharing arrangement with Saudi Arabia.

In addition to cost leveraging, other benefits to the U.S. in the past have included the following:

- Fills gaps in the U.S. solar technology programs such as advanced solar cooling demonstrations, comparison of alternative solar-powered desalination designs, and construction and operation of solar-powered, closed-cycle, environmental, agricultural systems for food production in arid climates.
- Accelerates U.S. technical progress by increasing opportunities for obtaining early system design and performance results, as with the 350 kWe photovoltaic concentrator systems to be installed in Saudi Arabia. This technology represents the most advanced state of the art in photovoltaic systems, and will be the world's largest photovoltaics system at the time it is installed.
- Identifies markets and export products for U.S. industry and provides international exposure for U.S. firms and products.

Other broader benefits accruing to the U.S. as a result of this activity include: improving the U.S. balance of trade, decreasing global dependence on oil, supporting U.S. programs for developing countries, serving as a valuable instrument of U.S. foreign policy, and increasing the worldwide use of solar energy resources.

Recent Accomplishments

- o Initiated construction of a 350 KW (peak electric) photovoltaics village power system employing a concentrator system.
- o Initiated construction of four advanced solar cooling systems to be installed in commercial buildings in the U.S. Southwest.
- o Initiated preliminary designs of five environmental agricultural systems (closed, self-regenerative) for food production in desert or low-water availability regions.

Proposed Program

The FY 1982 request for this activity will directly support the Department's solar R&D programs and will focus on longer-term, high risk R&D.

It is comprised of $4.0 million in new budget authority for continuation of the SOLERAS program. Planned activities for the SOLERAS program in FY 1982 include:

- o Completion of the first operational test cycle of the four advanced solar cooling systems in the U.S. Southwest.
- o Completion of the preliminary design phase of five solar energy water desalination systems, and award of up to two contracts for detailed plant design and construction.
- o Completion of the basic construction of the 350 KW_p (electric) photovoltaic village power system, system acceptance, and initial system performance evaluation.
- o Completion of five preliminary design studies for environmental agricultural systems, and selection of systems for detailed design and construction.

Response to Previous Congressional Concerns

In the past, Congressional concerns have focused on the method by which the Department's international solar programs have been funded. Through FY 1980, all international solar commitments were funded out of related domestic technology programs. With the submittal of the Department's FY 1981 budget request, a separate line-item was established for international solar activities that were commitments but could not be justified on an integrated programmatic basis as part of a domestic solar technology program. This was done to prevent those international agreements made primarily for reasons other than attaining domestic solar program objectives from competing for funds against the various solar technology programs. International agreements that contributed significantly toward attaining the goals of the domestic solar programs were justified, and budgeted, as part of particular programs and did not receive funds from the "solar international" line item. As a consequence, domestic solar programs continued to fund related portions of selected international solar agreements in FY 1981.

SOLAR INFORMATION SYSTEMS

Goals and Objectives

The overall objective of the Solar Information System Program is to develop an integrated national network that efficiently transfers relevant solar energy technical information to energy decision makers.

The central thrust of this program has been the development of the Solar Energy Information Data Bank (SEIDB). The SEIDB was initiated in FY 1979 at the Solar Energy Research Institute (SERI) and operated in FY 1980 and FY 1981 as a national network with the direct participation of the Regional Solar Energy Centers (RSECs) and the National Solar Heating and Cooling Information Center (NSHCIC) and with close coordination with selected DOE information activities, particularly the Energy Information Administration (EIA) and the Technical Information Center (TIC). Liaison with other appropriate Federal information activities is also maintained to maximize utilization of existing technical information and data and to minimize duplication of effort.

The SEIDB represents an effective access to solar energy information and allows comprehensive data retrieval and dissemination service with central coordination. This greatly facilitates information transfer among national, state, and local levels, and between the public and private sectors.

Benefit

Critical to the rapid and widespread use of solar energy is the deliberate development of systems for transferring or making available the results of federal research and development to the private sector. For example: scientists need the latest solar research results to enhance their own efforts; engineers and installers need performance data to design solar systems; potential owners of solar energy systems need cost information to make purchase decisions; manufacturers need materials data to provide improved products.

The program benefits derived from a solar information program

are significant. They include among other things:

- The elimination of duplication of efforts.
- The closer coordination of information activities among Federal agencies.
- More cost effective information dissemination approaches.
- The reduction of expenses for small businesses.
- Elimination of wasteful searches for information concerning the state-of-the-art of various research and development projects.
- Educational benefits.
- Cost-effective ways to maintain awareness of alternative energy sources.
- A centralized source of credible information products.

Recent Accomplishments

Considerable progress has been made in the solar information program over the last year. These activities include:

- o The Office of Information and Interprogram Applications was created under the Deputy Assistant Secretary for Field Operations and International Programs and has the responsibility for the development and implementation of all information policies, plans and procedures in support of conservation and solar programs.
- o A Conservation and Solar Energy Steering Committee for Information Planning and Development was chartered on June 6,1980 to provide management guidance and oversight for information policy development.
- o The refinement and consolidation of SEIDB activities has increased the current capabilities of the Department to address and satisfy the information needs of energy decision makers. In FY 1981 the following SEIDB services were performed by SERI:

  -Nine data bases were developed including bibliographic, calendar, models, manufacturers, legislation, international, education, installation, and insolation.

-32,000 data base records were developed.

-400,000 inquiries were answered.

-8,000 technical solar documents were collected.

-4,000,000 solar-related documents were mailed.

- Under other information dissemination activities, a host of information publications including education directories, manufacturers directories, solar events, vocational training directory, technical reports bulletins, information locator, data bank training bulletins and insolation data directories were forwarded to interested decision makers under this program in FY 1981.

Proposed Program

The central thrust of the Solar Information Systems Program to date has been the development of the SEIDB. It will continue to serve as a primary basis upon which to build a more efficient network to adequately serve the conservation and solar information needs of the information user community. The program is structured to provide inquiry, data collection, and dissemination services to meet high priority needs. Focus will be first to the research community followed by financial sector and equipment manufacturers, architects, etc. Information products will be geared to meet this prioritized system. Data base activities and information products will turn from general information to those that are responsive to the identified priority needs.

In addition, DOE will develop a solar information gathering, packaging and dissemination framework for users within DOE and among Federal agencies having a solar energy mandate. This framework will emphasize combining like activities to avoid duplication and to reduce costs, (i.e., elimination of an additional computer at SERI and consolidation/utilization of computer files at TIC).

Responses to Previous Congressional Concerns

A major congressional concern in this area has been lack of coordination among various federal conservation and solar energy information programs. Much of this concern centers on criticism regarding the overlap and confusion within the federal solar information program. The Department has taken the following steps to correct this shortfall:

- DOE has identified the main agencies and departments currently conducting related outreach and dissemination activities. This inventory will now be used to define roles and responsibilities among the various parties.
- The Assistant Secretary for Conservation and Renewable Energy has chartered a Steering Group of Deputy Assistant Secretaries evaluate and guide the integration of departmental information activities.
- A focal point has been established to provide oversight for information efforts and to recommend for implementation measures to reduce duplication and improve efficiency.

SERI PERMANENT FACILITY

Goals and Objectives

The purpose of this project is to evaluate and, if appropriate, propose permanent facilities for the Solar Energy Research Insitute (SERI) which is currently housed in interim, leased space in Golden, Colorado. The following objectives have been established for the SERI permanent facility project:

- To evaluate the cost effectiveness of providing a permanent facility for SERI.
- To design a physical plant that provides adequate facilities to meet the programmatic mission and objective of SERI.
- To incorporate life-cycle cost-effective solar energy and energy conservation techniques into the design.
- If the evaluation indicates it is appropriate to do so, build a facility that produces minimal environmental impacts and that complements the natural features of the site.

Benefits

SERI has been established to provide the nation with a center of excellence dedicated to serving the needs of the public and industry in the development of solar energy to the status of a major alternative energy source. SERI serves as a much needed focal point for the national solar energy effort. It implements programs in research, in the fields of photovoltaics, biomass, wind energy systems, storage, industrial process heat, passive solar, ocean systems, active heating and advanced solar energy research as well as programs in analysis and planning, academic and university research, international programs and information systems on a national and international basis. It is necessary to evaluate whether SERI's continuing programs could best be served on a cost-effective basis by physically providing a permanent facility for such research, data accumulation and dissemination, and interaction of the management, scientific researchers, and staff. The SERI permanent facility would be designed to provide the minimum required space necessary to meet the functional program objectives.

Recent Accomplishments

- Environmental assessment approved by DOE in March 1980.
- Preliminary design (Title I) completed in August 1980 for a $98,500,000 total estimated cost integrated facility.
- DOE's Energy Systems Acquisition Advisory Board decided in November 1980 to redirect the design baseline for a phased modular approach and within a maximum cost ceiling of $75,000,000.
- A detailed design of the essential field experiment test area and its associated support facilities (e.g. roads, utilities, storage areas, shops and enclosed assembly areas) is being developed.

Proposed Program

Given the redirection of the DOE solar program undertaken by the new Administration, SERI's current mission and staffing levels are likely to change. Until a new mission, staffing level, and facility requirements for SERI are established, it would be unwise to continue with design and construction of a permanent facility that is based on a now outdated mission for this organization. Therefore, no funding for a SERI permanent facility is being requested in FY 1982 until the underlying issues regarding the organization itself are resolved. Once SERI's new mission is defined and an appropriate staffing level agreed upon, it will be possible to evaluate whether SERI could best be served on a cost effective basis by construction of a permanent facility.

While additional funding in FY 1982 is not being requested, essential project activities will continue with the appropriations of $14,900,000 made available to date. Specifically, this will consist of completion of transfer of title to the site from the state of Colorado to the Federal government and design and construction of the field experiment test area and its associated support facilities.

Responses to Previous Congressional Concerns

Conference report 96-1366 stipulated that no funding was to be used for facility construction until the Committees are provided a complete report with consideration to a phased, modular construction concept. The Department intends to comply with this request following a reassessment of the needs for the facility consistent with the deferred funding request. A report as requested would accompany any future request for funding construction of the facility.

Conference report 96-1366 also requests the identification and justification of funding for the four Regional Solar Energy Centers (RSEC's) and the Solar Energy Research Institute (SERI) to permit full assessment by the Committees on Appropriations of the effectiveness of these programs. The Department intends to comply with the request and will furnish the information on RSEC and SERI funding for FY 1981 and FY 1982 in the near future.

Congress has also expressed concern as to the effectiveness of SERI and the RSEC's and DOE's reorganization of the solar program for management of SERI and the RSEC's as reflected in the General Accounting Office report EMD-80-106 dated August 18, 1980. DOE's response to the GAO recommendations reflects actions that had already been implemented by DOE which address all concerns. These include an institutional (multi-year) planning process, improved coordination and review of work between SERI and the RSEC's, and overall DOE management of SERI and RSEC's in one office. These provisions for improved effectiveness and management of SERI and the RSEC's are being maintained.

ALCOHOL FUELS

Introduction

The Office of Alcohol Fuels manages several programs that are primarily implemented through a network of DOE regional and field offices and national laboratories. The Solar Energy Research Institute (SERI) has major responsibility for managing technology development activities and manages information dissemination activities. The Idaho National Engineering Laboratory (INEL) provides engineering and technology support for the design, construction and testing of small scale alcohol fuels plants. INEL has also been the primary resource for the review of solicited and unsolicited proposals for technical and financial assistance programs. The Oak Ridge National Laboratory is responsible for performing environmental and safety compliance studies. The Argonne National Laboratory has major responsibility for environmental research and development. The Bartlesville Energy Technology Center provides engineering and technology support primarily for engine and vehicle system development.

Goals and Objectives

The goals and objectives of the office are to encourage the continued development of alcohol for fuel use. Developing new methods of producing alcohol which expand the raw material resource base will provide the private sector with the baseline data needed to pursue some of these areas in an effort to increase the market share for alcohol in blends and pure form.

Benefits

The removal of price controls from domestic crude oil will make alcohol fuels increasingly competitive. Tax credits and exemptions will continue which will result in a minimum subsidy of $16.80 per barrel.

Through R&D efforts, new feedstocks and technologies will be developed bringing more alcohol into the market. Existing tax credits and exemptions -not direct Federal expenditures -- will provide the

necessary incentives for private lending institutions to support continued production facilities. These domestic investments, and the positive effects on the economy resulting from them, will achieve the goals of reducing our dependence on imported oil while reducing government intervention in the market.

Through previous funding authorizations such as the Federal Nonnuclear Research and Development Act of 1974, P.L. 93-577, as amended, and Public Law 96-126, we have awarded 44 feasibility study grants and 2 cooperative agreements related to alcohol fuel projects. The feasibility study awards include potential plant sites in 38 states amounting to $20.2 million, these represent a production capacity of 1.2 billion gallons of ethanol annually.

Recent Accomplishments

When the Office was established as a task force in February 1980, no publicly available data existed on the activities of the burgeoning alcohol fuels industry nationally. To address this need, the National Alcohol Fuels Information Center and Data Base was established at SERI's Colorado headquarters to monitor production capacity. As part of the information and education process, training programs in a dozen community colleges have been organized for students to learn all elements of alcohol fuel production, from chemistry to economics.

The research arm of SERI, directed by the Office, has produced major results. Work with methanol powered engines has indicated that 50 percent greater efficiency can be achieved -- meaning more miles per gallon. Bench tests have ended, and road work will soon begin using the newly designed dissociated methanol engine in a Chevrolet Citation.

Feedstock research has led to processes of converting cellulosic forage grasses into ethanol much more efficiently than the standard conversion of wood and other cellulosic material. Further, methanol work at SERI has produced an oxygen/biomass gasifier using syngas (H_2+CO) to maximize the yield of methanol from biomass. Researchers at the pilot plant in Kansas have developed a steam

explosion process which, coupled with standard treatment of cellulosic material, shows great promise for producing ethanol from woody biomass.

The Tennessee Valley Authority (TVA) has built and operated a small-scale still which allows an individual farmer to use almost any starchy biomass feedstock to produce ethanol to operate farm equipment and vehicles.

The Office has also recently concluded an agreement with the Bureau of Alcohol, Tobacco and Firearms, which is the permitting authority for all ethanol plants, to grant access to the information it collects. This will provide us with the most accurate production capacity data possible regarding projected ethanol fuel production. The Energy Information Administration (EIA) is also involved in the collection and analysis of Alcohol Fuels data.

Section 272 of the Energy Security Act requires the Office of Alcohol Fuels to report to Congress assessments concerning the potential of alcohol as a motor vehicle fuel, in both blended and pure or "neat" alcohol forms. This study is nearing completion but the preliminary findings substantiate several earlier studies that indicate a great potential for neat alcohol as a fuel in automobiles and light trucks. The modifications necessary to retrofit a gasoline powered vehicle to use alcohol are minimal and the alcohol has some inherent advantages over gasoline in that it is a clean burning, high octane fuel. The use of pure alcohol is technically and environmentally sound and the Office of Alcohol Fuels will be carefully monitoring progress in this area.

Proposed Program

It is anticipated that the decontrol of oil prices will produce a sharp change in the marketplace creating an even more favorable economic situation for alcohol fuels. In view of this anticipated increase, the Federal Government need not conduct its own marketing activities or provide subsidies to the new industry because:

- o The 4¢ per gallon excise tax exemption, coupled with the decontrol of crude oil prices, will make gasohol highly competive with gasoline at the pump. In addition, approximately 30 states provide tax credits for gasohol. The Federal excise tax exemption will result in estimated tax expenditures of approximately $200 million in 1982, and could total over $2 billion over the next 5 years.
- o Private investments in alcohol fuels projects are made even more attractive because certain types of plant and capital equipment are elicible for an investment tax credit of 20%. In 1982, this will result in tax expenditures of over $200 million.
- o The President's program for economic recovery is designed to result in a significant increase in the amount of capital formation in the private sector for all types of investment projects. This should increase capital availability for alcohol fuels, projects without the need for government intervention through loan guarantees and other financial incentives. Also, unlike other forms of alternative fuels, alcohol fuels projects are a less risky investment because the technology is proven and the economic feasibility can be estimated relatively accurately.

Therefore, the primary thrust of the new budget is in the area of research and development and the Office has $10 million that will be used primarily for this purpose. The research and development efforts will be conducted in two major categories of (1) process technology and development and (2) utilization development.

The process technology, as the title implies, will be focusing on all elements of the actual production of alcohol. The primary objective is to develop advanced technologies through the proof-of-concept stage utilizing the most efficient feedstocks and processes in terms of energy and raw material cost and availability. Areas that will be key elements of the program include acid and enzymatic hydrolsis, fermentation technology, energy efficiency and by-product

utilization. Methanol development through biomass gasification and other methods will also be studied.

The utilization development activity will be concentrating on all areas relating to the use of both ethanol and methanol for surface transportation. Studying advanced alcohol engine systems, which can use higher alcohol gasoline blends and neat alcohol, will provide the testing and evaluation necessary for designing optimum performance vehicles.

An industrial liaison program will provide results to the private sector and develop commercial demonstrations.

GEOTHERMAL ENERGY

Goals and Objectives

The goal of the Geothermal Energy Program is to support commercial development and utilization of geothermal resources as economic and environmentally acceptable sources of thermal energy for electric power generation and direct heat applications, as well as methane from geopressured resources. Specific objectives for FY 1982 are to complete the hydrothermal commercialization activities that have successfully fostered a viable hydrothermal industry, and to perform the necessary R&D to determine the technical and economic feasibility of the extraction of methane, thermal, and hydraulic energy from geopressured resources, as well as thermal energy from hot dry rock.

Benefits

The success of the hydrothermal program has made a large alternative energy source ready for utilization by the private sector for both generation of electricity and direct heat applications. The U.S. Geological Survey has estimated that the energy equivalent of 55 to 85 billion barrels of oil will be economically available for utilization from hydrothermal resources.

The Federal program to determine the technical and economic feasibility of utilization of the potentially much larger geopressured and hot dry rock resources will delineate the extent to which these, too, will be available for economic exploitation in the future.

Recent Accomplishments

Working closely with industry, the Federal hydrothermal program has successfully eliminated key technical, economic and institutional barriers to development of hydrothermal resources. As a result of these efforts, as well as Government financial incentives totaling only several hundred million dollars, industry has announced plans for investment of over $5 billion in hydrothermal power plants in California, Nevada, Utah and New Mexico, that will yield over 4,000

MW capacity by 1990.

Similar rapid development of direct heat applications makes it clear that industry is prepared to move forward promptly with hydrothermal resources. However, long range technology development is required in support of all types of geothermal energy utilization and is provided for in the budget.

In the geopressured resources program, tests were conducted in six existing oil and gas wells, "wells-of-opportunity," in FY 1980 and FY 1981. The early tests of geopressured aquifers confirmed the existence of significant amounts of methane in all geopressured brines, while more recent tests have demonstrated the existence of high gas-to-water ratios of 40-65 standard cubic feet of gas per barrel of water from low-salinity brines. Tests are also continuing on the first well designed specifically for reservoir evaluation, in Brazoria County, Texas. Another design well has been drilled in Cameron Parish, Louisiana and is being readied for a two year test program. An additional well is currently being drilled in Vermilion Parish, Louisiana.

The technical feasibility of extracting thermal energy from hot dry rock on a small scale was demonstrated in FY 1980 and FY 1981 through operation of a 5 MW thermal loop at Fenton Hill, NM, which included the experimental generation of electrical power. The first well for a much larger heat extraction system has been completed and work is progressing on the second.

The geothermal program also includes the Geothermal Loan Guaranty Program which was designed to assist developers in securing private financing for commercial-scale projects involving both electric utility and direct heat applications of hydrothermal energy. Five projects were guaranteed under this program, which has successfully introduced lenders to hydrothermal energy as a valid and reasonable investment.

Proposed Program

The FY 1982 request for the Geothermal Energy Program is $48.375 million an additional $.2 million for program direction for the five existing loan guaranty projects. $6.0 million is requested for the

Hydrothermal Industrialization activity to allow completion of the Baca 50 MW Flash Steam Demonstration plant. $20.336 million is requested for the Geopressured Resources Program and will be used primarily to drill two additional design wells, support ongoing design well testing, and conduct two wells-of-opportunity tests in support of reservoir evaluation and resource definition. The request for Geothermal Technology Development, which includes the Hot Dry Rock Program, is $20.439 million which will be used to support long-term, high payoff development of energy conversion techniques, exploration technology, reservoir engineering, reservoir stimulation, and drilling technology. $10.0 million is requested for hot dry rock development in support of the 20-50 MW thermal loop at the Fenton Hill site. In addition, the Federal Republic of Germany and the Government of Japan are contributing $2.5 million each to the Fenton Hill project under a four year IEA agreement.

SMALL-SCALE HYDROPOWER PROGRAM

Goals and Objectives

The goal of the hydropower program has been to re-establish a vigorous small hydropower industry in the United States. The strategy has been that the Federal Government would "step in" to re-awaken interest in this resource and then "step out," leaving development to non-Federal sectors.

Specific program objectives are to: assess the resource potential; develop cost-reduction techniques for small hydro technology; demonstrate immediate commercial feasibility; reduce front-end financial risks for developers; and reduce regulatory and environmental barriers at the Federal and state level.

The small hydro program was begun in 1977 in response to the need to increase our national energy supplies, diversify energy sources, and lessen our dependence on imported oil. Hydro was considered a prime candidate for development in that it is domestic, widely dispersed, renewable, non-polluting, and relatively benign in terms of its environmental impacts. It is also a mature technology, and the many small sites, collectively, are capable of making a significant supply contribution in the near term.

At that time, the small hydro industry had been in a depressed state as a result of decades of decline in the use of waterpower for electric power generation, particularly at small sites. Thousands of hydroelectric plants have been abandoned in the past because of their inability to compete with low-cost oil and large central station thermal plants. Increases in oil prices are helping to stimulate a rebirth of interest in the hydropower resource, but years of neglect have created a serious shortcoming in our institutional, technical, and financial capability to assure a renewal of the industry.

As a result of these constraints, most significant hydropower developments undertaken in recent years have been by the Federal government through the U.S. Army Corps of Engineers and the Water and Power Resources Service (Interior).

Program Benefits

The Department's small hydro program has served to stimulate a resurgence of state, local government and private interest in exploiting this attractive resource and to resuscitate an essentially quiescent industry. Our activities have helped to alleviate technical and non-technical constraints and to create an economic, legal, and institutional climate more conducive to the development of the resource by these sectors.

Recent Accomplishments

Developing an up-to-date assessment of the small hydro resource base has been largely carried out by the Corps of Engineers. We provided funds to enable the Corps to assess the small-scale potential and make this information available to interested developers. An initial assessment has been published and widely distributed, and the Corps is now revising and refining that assessment. We expect their new study to indicate, for example, that there are over 1,000 prime existing dams up to 30 MW size that could be retrofitted to produce 7,600 MW of capacity.

Our next important activity was to work cooperatively with developers to demonstrate renewed economic feasibility in the context of today's changing energy market (as well as today's institutional and environmental constraints). We initiated a demonstration program, and presently have 20 demonstration projects underway. These demonstrations were selected to prove the economic feasibility of small hydro in a number of different areas, under differing circumstances, and to stimulate the domestic hydropower equipment industry. The DOE share totals $27 million out of an overall estimated cost of $212 million. The 20 projects will bring 134 MW of power on line by the end of 1985.

Because small hydro projects are capital-intensive, require a long leadtime before revenue generation, and are only beginning to emerge as economically competitive with conventional power production, the front-end financial risks have been substantial. To help ameliorate this situation, Congress authorized the feasibility and licensing loan program in Title IV of the Public Utility Regulatory Policies

Act of 1978 (PURPA). The program provides loans up to $50,000 each for feasibility studies and for expenses incurred in obtaining a Federal Energy Regulatory Commission (FERC) license and other required permits. To qualify, projects must be at existing dams and have a capacity between 100 kW and 30,000 kW. A loan may be cancelled if a project is found not to be feasible. Otherwise, repayment must be made over 10 years, beginning 4 years after the loan is made.

The program became operational in April 1980. To date we have received about 350 applications. About two thirds have been reviewed and 150 loans or loan offers have been made. These contracts have a total face amount of $5,873,000.

We believe that significant progress has also been made in the mitigation of restrictive Federal and state laws, procedures and environmental requirements. Through research contracts with the Johns Hopkins University and the Franklin Pierce Law Center, legal and institutional impediments have been identified and solutions recommended. Utilizing the findings of the studies, we have funded the National Conference of State Legislatures to provide technical support for state legislatures in implementing legislation and procedures to minimize regulatory and other barriers. We have also worked closely with FERC to improve and expedite the Federal permitting and licensing process.

In most areas of the country, low rates paid for electricity produced by small-scale facilities have added to the financial risk of development. However, FERC, pursuant to Title II of PURPA, has provided what we believe will be a significant boost for the re-establishment of the small hydro industry by developing a sound procedure for states to follow in determining attractive rates. Regulations have been published requiring each state public utility commission to establish rates using the avoided or marginal cost concept. The Franklin Pierce Law Center's Energy Law Institute, with funding and direction from DOE, has provided technical assistance to the state PUC's in this effort. When such rates are in place, they should serve as an important aid in helping small power producers negotiate favorable power-purchase contracts with their local public utilities.

In the environmental area, the cost of fish transport facilities, for example when added to the cost of retrofitting dams for power generation, could make projects economically infeasible. Meeting requested minimum stream-flow requirements below the projects could have a similar impact. DOE is funding research to provide technical and cost guidance for developers and to resolve issues between FERC and the U.S. Fish and Wildlife Service on minimum streamflow requirements.

Because hydropower is a mature technology, DOE research and development efforts, outside the environmental area, have been limited to cost-reduction techniques and a few highly specialized applications. We are, for example, examining the use of pumps as low-cost turbines. Another research activity involves 12 conceptual studies and one field test for ultra low-head applications (less than 10 feet).

We believe that the states need to exert a leadership role if the small hydropower development potential is to be realized. State and developer related activities of the hydro program are being implemented in the field by the DOE regional offices. Through these efforts, we have encouraged the states to simplify their procedures, identify potential sites and, in turn, encourage developers to undertake projects.

Proposed Program

The objectives of the small hydropower program have largely been achieved as evidenced by the rapid increase in the number of license applications before FERC. As a result we are not requesting any additional appropriations for this small-scale hydropower program. This does not imply a phase-out of Federal involvement in small hydro. To the contrary, there will still be strong federal incentives for continued development of hydropower. The major elements of this involvement include:

- realistic energy pricing policies, such as the decontrol of domestic crude oil prices, which increase the economic a attractiveness of small hydro
- A 21% investment tax credit for private hydropower projects
- Credit assitance through USDA programs for publicly-owned

hydropower projects

- o Deregulation of small hydro through the raising of the threshold of projects partially exempt from FERC jurisdiction to 15 MW.

These actions will ensure a continued strong hydropower program in the U.S. without the need for direct spending programs in the DOE budget.

ENERGY STORAGE RESEARCH & DEVELOPMENT

Introduction

The Energy Storage Research and Development Program serves as the nucleus for virtually all research and development related to energy storage within the Department. The program supports the end-use sectors in our Conservation program and also the Renewable Energy programs.

Program Goals and Objectives

The program goal is to help industry provide the technologies required to supply reliable, low-cost, safe, and environmentally acceptable energy storage systems. The mechanisms used to attain this goal are primarily cost-sharing contracts with industry on advanced storage technologies and more fundamental research. In addition, we draw on the vast resources of our national laboratories, other Government agencies, agreements with foreign Governments, and the university and technical communities.

Benefits

The research sponsored by the Energy Storage Research and Development Program provides a firm technology base on which industry can proceed with its developments of new, energy-efficient, and renewable products. Implementation of this strategy requires close coordination with applied research laboratories in industry as well as with academia in order to ensure that the research being undertaken is supportive of industry, that our efforts do not duplicate those of industry, and that, as a result of our work, we neither supplant nor lessen industry research efforts. The benefits of cost effective energy storage technologies are: increased energy productivity, increased substitution of coal, nuclear, and renewables for petroleum and natural gas, increased use of renewable but intermittent energy sources, and increased effectiveness of baseload electric power generating and distribution capacity.

Recent Program Accomplishments

While this research program supports many other energy supply and end use programs, one useful way to categorize its recent accomplishments is by ultimate end-use. The following summarizes the accomplishments of our development of energy storage technologies:

For Transportation Technologies:

- Battery researchers from national laboratories and industry are close to achieving program goals in battery performance in vehicles. The batteries being developed include: nickel/zinc, nickel/iron, zinc/chlorine, and improved lead-acid. Performance goals range from 41 to 69 wh/kg (energy density or range) for up to 1300 cycles (lifetime), depending on the battery type.
- The National Battery Test Laboratory (NBTL), where cells and modules developed by research teams undergo verification testing, now operates on a continuous basis.
- A prototype aluminum/air cell (whose "mechanical" recharge feature is similar to gasoline refueling) has been successfully tested at full size with a recrystallizer that removes the products formed on battery discharge. It has an energy density of 340 Wh/kg.

For Building Heating and Cooling Technologies:

- Life and stability tests of experimental phase-change materials in unique packages have been performed, and the phase-change materials were used in an air-conditioning field test.
- Prototype design and economic studies for a sulfuric acid-water chemical heat pump have been completed, and a residential-size salt-alcohol system has been constructed.
- A laboratory-size hybrid chemical heat pump has been successfully tested, and a rapid cycling system using waste heat has proceeded into further development.

For Solar and Conventional Utilities Technologies:

- Construction has been completed on the Battery Energy Storage Test (BEST) facility that will test large-scale utility load-leveling batteries. Installation and checkout of test equipment is underway and the Electric Power Research Institute will assume support in FY 1982.
- In the exploratory electrochemical technology area, experimental sodium/sulfur cells now exhibit 500-900 cycles (vs. a goal of 2000 for loadleveling), and a zinc/bromine module storing 80 kWh (a convenient size for load-leveling plants) has been assembled for laboratory evaluation.
- Design and fabrication of a 10 kWh prototype superconducting energy storage magnet have been completed for power stabilization in the Bonneville Power Administration grid.

For Industrial Technologies:

- A 200 kW prototype electrolyzer system using 2.5 ft^2 solid polymer electrolyte cells has been assembled and tested.
- An analytical study is underway to define whether customer-owned battery storage for industrial and small business areas would achieve a significant peak electric demand reduction and thus an oil saving.
- To reduce energy consumption in electrolytic process industries, air cathodes (for chlor-alkali) and hydrogen anodes (for zinc refining) are being experimentally developed and tested in full-size electrolytic cells.

Proposed Program

There are two program areas in the storage program. For the Electrochemical Storage area the request is $26.25 million and for the Physical and Chemical Storage we are requesting $12.25 million. The program direction request is $0.50 million.

The emphasis in the program will be to concentrate available resources on developing the technologies needed for industry to increase productivity significantly and on long-term research and development since nearer term storage technologies will be

developed by the private sector as the market develops. Areas that will continue to receive emphasis in the Electrochemical Energy Storage area include:

- Technology base and supporting research projects on electrolytes, electrodes, electrochemical materials, fuel cells, and electrochemical process fields.
- Evaluation of metal-air battery modules and fuel cells for mobile applications.
- Exploratory technology development in advanced electrochemical systems for load-leveling.
- Applications-oriented R&D related to dispersed site systems (customer-side-of-the-meter systems) and solar concepts.

In the Physical and Chemical Energy Storage emphasis will be placed on:

- Thermal energy storage technology base development
- Activities aimed at applications in buildings
- Chemical heat pump development
- Flywheel materials research
- Underground storage supporting research
- Reservoir stability experiments with compressed air
- Stabilizing magnet development.

ELECTRIC ENERGY SYSTEMS

Introduction

The electrical energy network in the United States provides energy to all sectors of the economy for a variety of different purposes--including an indispensable power link during national emergencies and for national defense. Because the electric network is so reliable, it frequently is taken for granted.

In addition, the system must be more efficient to control costs. Transmission losses are inherent in all systems. Electric system losses consume about 220 billion kilowatt hours per year equivalent to 380 million barrels of oil per year. Much of these losses can be attributed to low voltage equipment--primarily transformers and conductors.

As a result of crude oil price decontrol and other Federal incentives, diversified electric sources--both conventional and renewable will become an increasing share of electrical energy supply to support future U.S. economic growth. It is seldom mentioned that new dispersed facilities, when integrated with conventional large scale plants, require advanced control methods and new network designs. To accomplish this, an advanced transmission and energy distribution system is required with different characteristics than that which exists today.

Goals and Objectives

The Electric Energy Systems (EES) principal function is to evaluate electric network problems from a "systems" perspective and to undertake longer-term, high risk research to meet the future needs of the system. No other program in the Federal government shares this responsibility. To accomplish this, EES has four major objectives:

- Perform a long-term "system architecture" function to help successfully integrate into the electric power system large remote generating facilities with new electric sources that are frequently intermittent and unpredictable.

- o Reduce system losses through the research on advanced transmission and distribution technologies.
- o Improve the long-term national electrical system efficiency, reliability, and adaptability under normal and emergency conditions by the use of advanced control system technology.
- o Protect the environment by performing research on the impacts and harmful effects of high voltage electric fields.

Our efforts are concentrated on the "systems" approach because the experience to date shows that we can achieve over-all economy, efficiency and reliability only by integrating generation, transmission, distribution and utilization of electric energy into one comprehensive system.

Program Accomplishments

The accomplishments of the EES R&D program span hardware and software, studies and assessments. By the end of FY 1981 we expect these accomplishments:

- o Completed first significant field test of a 100 meter single conductor superconducting cable.
- o Started full-scale laboratory test of $\pm$ 600 kV dc cable, having completed test prototype.
- o Developed a laboratory model compact gas-insulated transformer which will be 60% smaller and have 20% less energy loss than current transformers.
- o Completed small animal biological tests on the effects of high intensity electric fields on living organisms. Some effects have been identified, but do not as yet indicate that they pose a risk to humans.
- o Fabricated components at MIT for an advanced superconducting generator.
- o Demonstrated the effects on distribution systems of heating and cooling storage, including the Olympic Village in Lake Placid, New York.

Proposed Plans

The DOE requested FY 1982 EES budget is $9.9 million. The program has divided this funding into $4.9 million for power delivery program activities, $4.1 million for system architecture and integration program activities, and about $0.9 million for program direction. This will enable critical high-risk research activities to be performed while transferring all the near-term demonstration and feasibility evaluations to the private sector.

PARTNERSHIP WITH INDUSTRY

As the program levels in the Department's revised FY 1982 budget for solar and other renewable energy technologies reflect, we are embarked on a new course regarding the appropriate Federal role in energy development. Quite simply stated, this budget explicitly eliminates excessive Federal involvement in solar and other renewable energy development. Concomitantly, this revised request contains as implicit redirection as well -- a closer partnership with industry. I would now like to explore with you two aspects of this implied redirection.

Clarification of Roles

In the past, the Department's energy technology programs were not clear on the appropriate role to be played by the Federal sector in technology development. Program managers were responsible for the entire spectrum of technology development and transfer from research, development, demonstration, through commercial deployment. The government role and relationship between industry and government were not clearly defined. Government perceived that specific technologies such as solar and geothermal were not being developed as rapidly as possible due to high technology risks and large front-end capital investments. On the other hand, industry perceived that government might subsidize demonstration or near-commerical hardware projects with the result that necessary investments were delayed, thereby creating the climate for a very real market failure. In Conservation and Solar Energy, past emphasis on technology development was oriented toward end-use applications rather than supply-side technology development. Not surprisingly, industry played a secondary role in all phases of technology development as a result.

The revised FY 1982 budget before you today, in addition to recent organizational realignments along fuel or supply-side lines within the Department, clearly sorts out and delineates the appropriate roles to be played both by industry and government in solar and renewable energy technology development. As I attempted to convey at