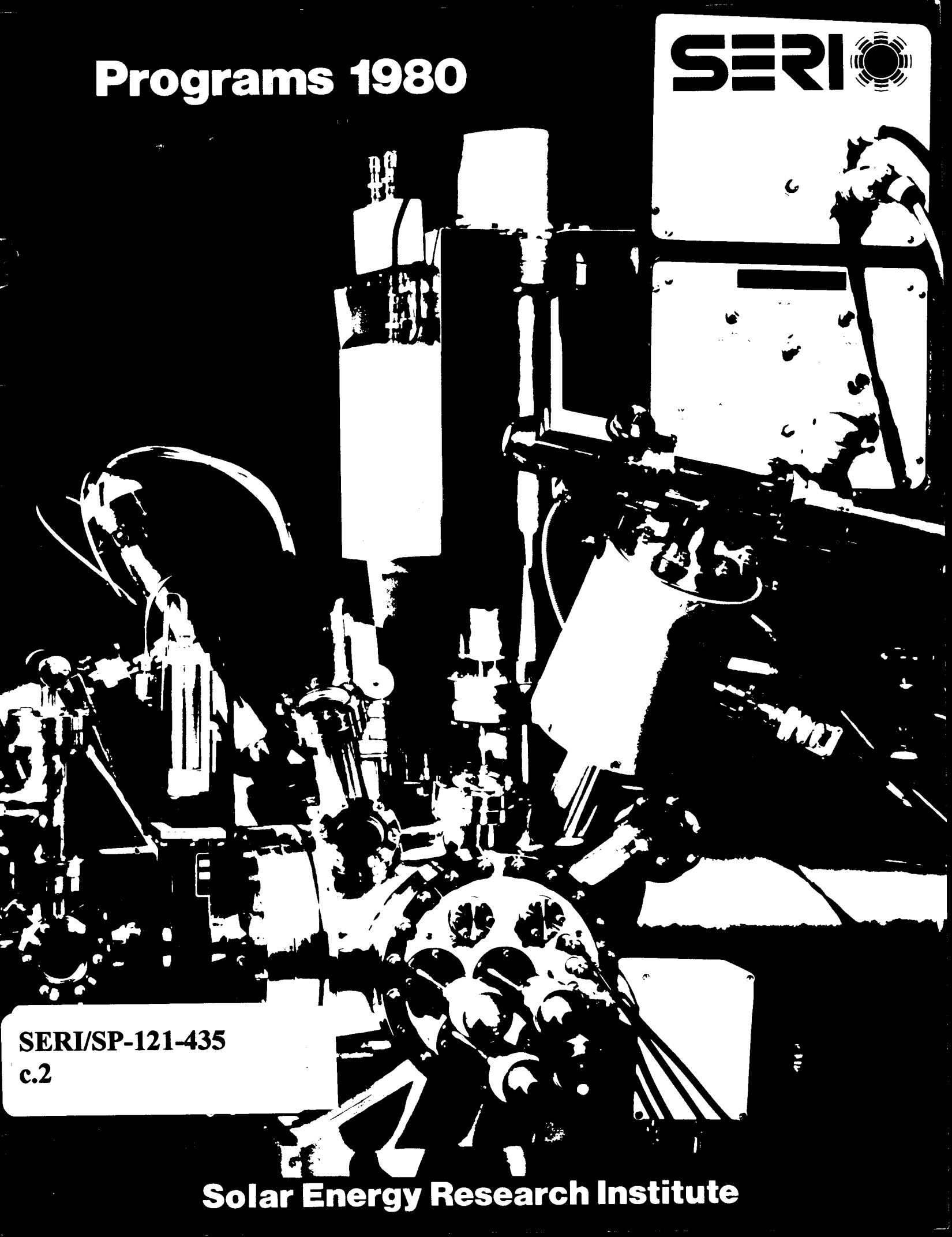


Programs 1980

SERI 



SERI/SP-121-435

c.2

Solar Energy Research Institute

Introduction

The Solar Energy Research Institute—or “SERI” as it is more commonly known—began operations in its interim facilities in Golden, Colorado, July 5, 1977. SERI is a direct and important contributor to the National Solar Energy Program through its research and development activities. Additionally, the Institute provides planning, management, analysis, and evaluation of solar programs for the U.S. Department of Energy (DOE).

SERI, operated for DOE by the Midwest Research Institute of Kansas City, Missouri, was mandated by Congress in Section 10 of Public Law 93-473 (the Solar Energy Research, Development and Demonstration Act). Although the exact scope was not defined in the act, the Institute’s long-term mission is being clarified to complement the overall national energy strategy.

SERI is the nation’s premier solar center, established to accelerate the development and to stimulate the widespread use of solar energy technologies. Recognizing the universal promise of solar energy, SERI’s arena is both national and international.

The Institute’s mission includes the timely development of solar technologies that are economical, reliable, environmentally acceptable, socially attractive, and effectively matched with the nation’s end-use needs. This charter is pursued through wide-ranging in-house research, development, and demonstrations, and through the management of external contracts in these areas. SERI is also responsible for providing useful feedback from the user community to those engaged in research and development.

SERI is an independent source of objective analysis and is the nation’s lead center for information about solar resources and the technologies to tap them. It is responsible for the development and dissemination of materials to educate

consumers about solar applications, and it collaborates closely with other organizations to encourage the development of a viable solar marketplace. SERI also provides the business and professional communities with accurate information about the state of the art of solar technologies, explanations of public policies and programs, and such other assistance as is needed to promote a mature solar industry.

The Institute assists in formulating and implementing national programs to encourage efficient energy use and to foster the transition to solar energy. In the international arena, SERI encourages widespread solar development, efficient energy use, and a robust exchange of technical information.

SERI is a catalyst. Because of the Institute, solar energy will be more rapidly put to maximum use.

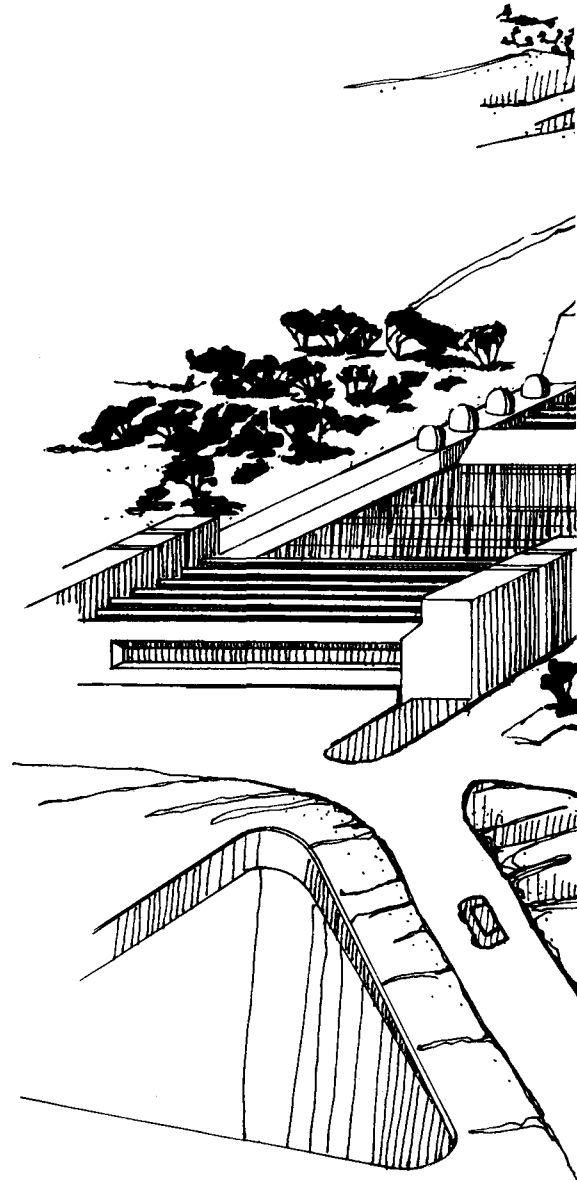
SERI has been operating in four general roles: as planner, evaluator, performer, and manager. In all these roles, SERI strives to serve the National Solar Energy Program’s primary objective of contributing significantly to the accelerated introduction of solar energy use in the United States and abroad.

Within each of SERI’s programs, activities are broken down into tasks and subtasks. This document will describe the scope and objectives, as well as provide a narrative overview, of the programs constituting the SERI mission in fiscal year 1980 (FY80). They are:

1. Photovoltaics
2. Biomass Energy Systems
3. Wind Energy Systems
4. Solar Energy Storage
5. Industrial Process Heat
6. Passive Technology
7. Solar Thermal Technology
8. Ocean Systems
9. Active Solar Heating and Cooling
10. Advanced Solar Energy Research

11. Planning, Analysis, and Social Science
12. Information Systems
13. International Programs
14. Academic and University Research Program
15. Commercialization Activities

A substantial portion of SERI’s programs will include subcontracted research in many areas. In most cases, SERI will provide the technical oversight and management of this research. The balance of work will be conducted in-house as SERI’s laboratory capabilities grow in interim facilities. The opening of the permanent facilities is anticipated in the early 1980s.

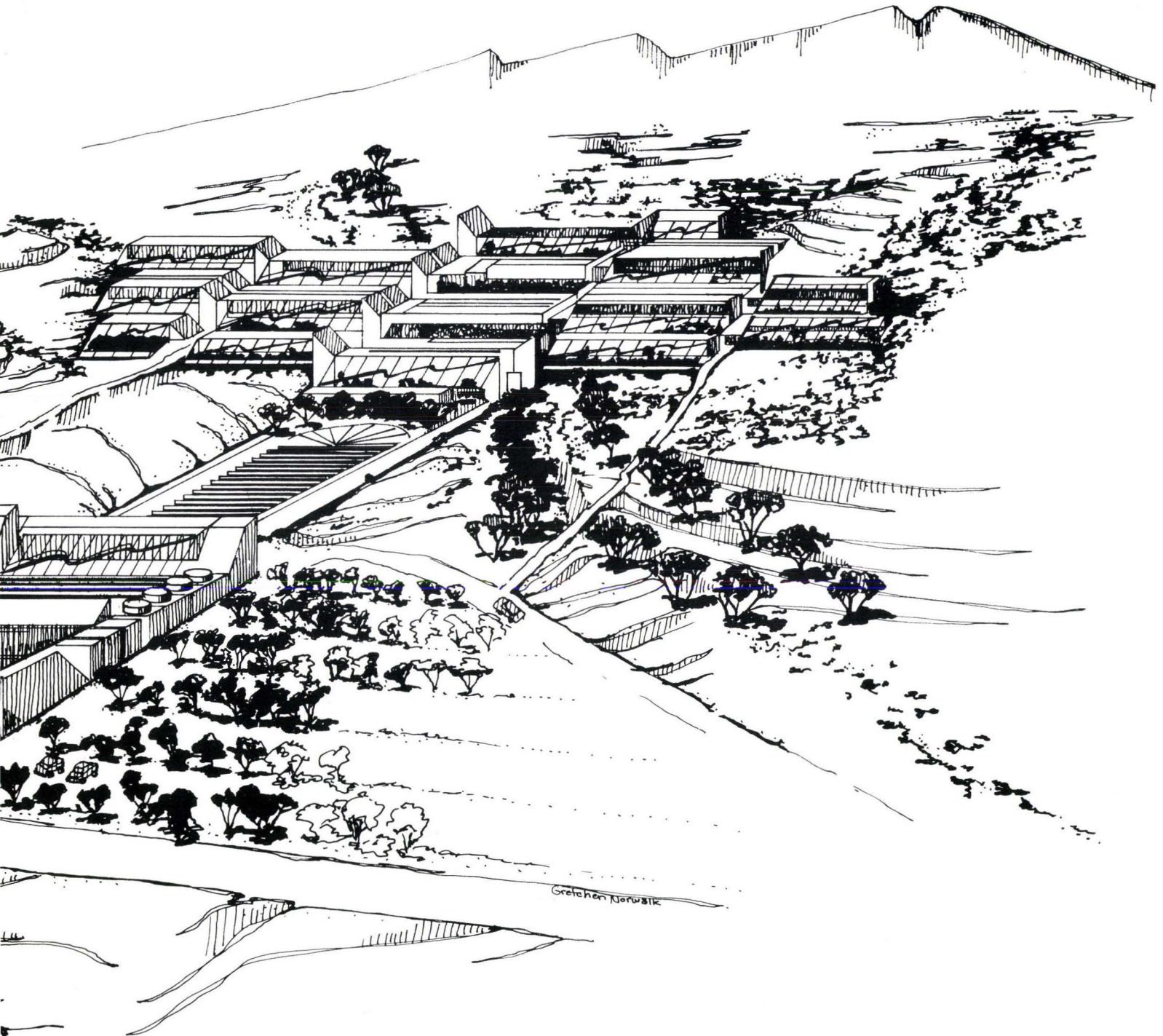


SOLAR ENERGY RESEARCH INSTITUTE
Solar Energy Information Center

PROPERTY OF
U.S. GOVERNMENT

MAY 14 1982

GOLDEN, COLORADO 80401



Photovoltaics

An annual domestic market on the order of 1 - 2 MW currently exists for photovoltaics used in terrestrial systems. Most applications are economically justifiable only for situations that are "off-the-grid" such as communication relay stations, cathodic projection systems, remote village arrays providing essential electrical service, and water pumping installations.

Efforts to develop more efficient systems and less expensive production processes are being pursued to reduce photovoltaic costs to levels where they can eventually compete with conventional electrical systems.

DOE has assigned SERI lead center responsibility for the Advanced Research and Development activities relating to photovoltaics. There are four major objectives of SERI's overall photovoltaic program. The first is to conduct research on promising new photovoltaic materials and conversion devices and to bring the most advanced concepts through the exploratory development phase to the point of technical feasibility.

Secondly, the program is structured to develop further the basic understanding of photovoltaic materials and phenomena so as to facilitate development of new and better photovoltaic devices. A third objective is to develop an understanding of photovoltaic-related facets of the institutional, economic, environmental, and government policy areas to provide effective program planning and integration.

Finally, the program seeks to stimulate the formation and adoption of industry-established material, component, subsystem, and system performance criteria and standards for the design, application, and operation of reliable and safe photovoltaic power systems.

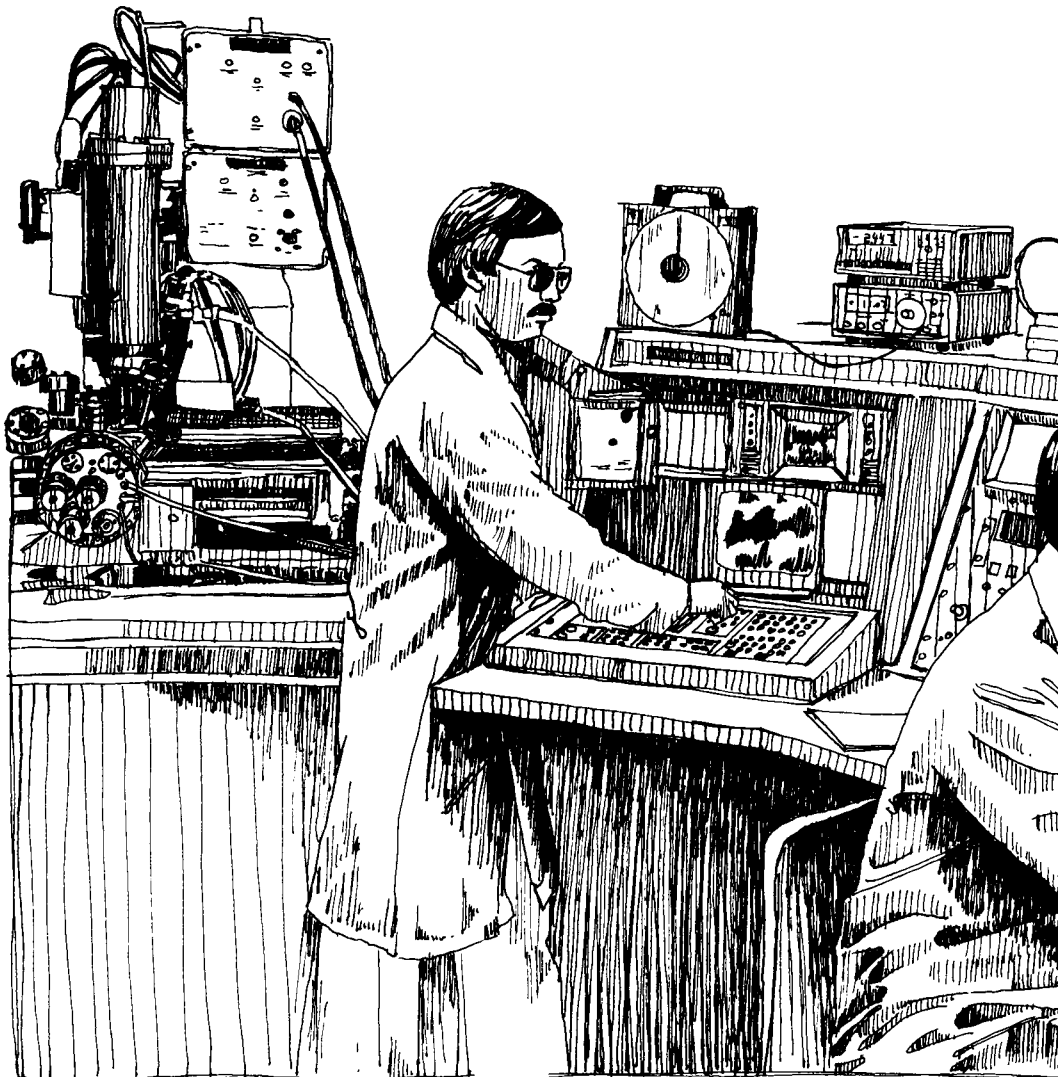
Support objectives include performance of system design and analysis for advanced materials

research and international programs, as well as research supporting the systems engineering and applications activities of the National Photovoltaic Program. Improving the versatility and reliability of material and device measurements, advancing the understanding of critical materials and device parameters, and establishing test and measurement laboratory facilities to provide measurement support are SERI program objectives. The collection and dissemination of photovoltaic research, development, and application data through the Solar

Energy Information Data Bank (SEIDB) and the Technical Information Dissemination Program (TID) are additional support responsibilities of SERI's photovoltaic program.

The program has been structured around five tasks that include:

- **Lead Center Activities.** SERI activities include program planning and management, coordination of technical assessments, administrative support, and the integration of individual program tasks and subtasks into the overall program.



Biomass

- **Subcontracted Research.** SERI's Photovoltaic Lead Center plans and manages sub-contracts with university, industrial, and government laboratories. Emphasis is directed toward more advanced photovoltaic materials, specifically cadmium sulfide, polycrystalline silicon, amorphous silicon, and polycrystalline gallium arsenide. Emerging materials and concepts not as well known as those listed previously (but promising from the standpoint of low cost or more efficient application) will be investigated. Included are: amorphous materials other than silicon, basic studies to identify those mechanisms that limit the conversion efficiency of new technology photovoltaics, and an innovative concepts program.

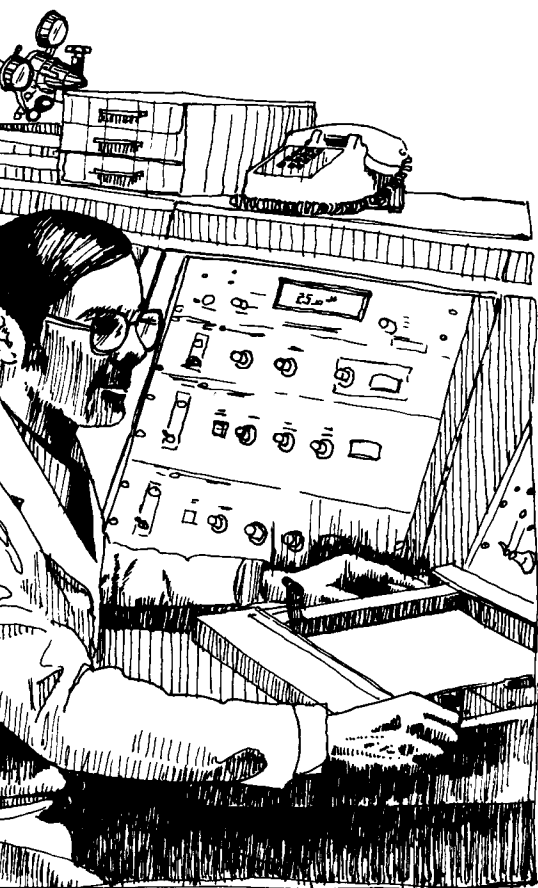
- **Internal Research.** SERI's in-house photovoltaic research activities represent the strongest single photovoltaic research group in the United States. SERI's research emphasizes applied photovoltaic device studies in technologies that could provide practical intermediate-efficiency (10%) amorphous or polycrystalline thin-film cells, and very high-efficiency (30%) single crystal multijunction concentrator devices.
- **Technical Support.** This task includes photovoltaic R&D test and measurements; materials research; availability of materials; environmental, health, and safety research; economic and policy analyses; system analyses and design; and international marketing plans.
- **Quality Assurance and Standards.** Continuing work undertaken in FY79, this task includes the development of performance criteria and test methodologies, development of accreditation and certification procedures, development of validation methodologies, and coordination with standards and code organizations. In all cases, the strategy is to support development of standards through the voluntary consensus system. Management of internal SERI work will be guided by the Photovoltaic Performance Criteria and Test Standards Coordinating Council, which is composed of representatives from the photovoltaic industry, public interest groups, consensus standards organizations, government contractors, and government officials.

The various possible uses of biomass as a renewable source of energy present social and economic problems in addition to the technical challenges inherent in the emerging biomass technologies. There are different sources of biomass that have diverse physical and chemical characteristics. Most biomass is bulky (and therefore expensive to transport) and must generally be produced, converted, and utilized locally, usually with small-scale systems. Keeping these characteristics of the biomass resource in mind, it becomes clear that central to the Biomass Program is the need to identify and develop biomass energy systems suited to a large variety of possible applications.

Some of the technologies for biomass conversion are sufficiently advanced to begin placing emphasis on market development; e.g., direct combustion of wood. Others, such as conversion of wood to ethanol, require technology development. Far-term options, including certain biological conversion techniques, require rigorous applied research. Careful consideration of all biomass options is appropriate to establish sound programs for commercialization, technology development, and economic assessment.

In addition to providing administrative, planning, and other support to the Federal Biomass Program, SERI's research objectives in the biomass area include six primary thrusts. The first is to initiate R&D programs in biomass production and supply (including basic research on plant productivity, assessment of the standing biomass resource, and investigations of factors controlling the feasibility of alcohol crop production, crop residue for grain drying, and industrial process heat markets for forest residue use).

A second is to develop knowledge in thermal conversion of biomass (including flash pyrolysis kinetics and other advanced conversion technologies) and economic



comparisons of thermal conversion systems. Initiation of a bioconversion R&D program to investigate novel bioreactor systems, conduct microbial genetic studies (to identify and develop beneficial strains), and enzyme studies regarding lignocellulose degradation and conversion is a third objective of SERI's biomass program.

A fourth is to establish a systems analysis team to review and compare opportunities for workable biomass energy systems (including small-scale wood combustion, alcohol from grain, and methane production). Programs to educate and train potential users of biomass are planned. Finally, SERI's program includes providing technical direction, management, and evaluation of DOE's National Biomass Program.

SERI's Biomass Energy Systems Program for FY80, besides general administration, management, planning, and support to the research tasks, includes the following tasks:

- Production and Supply R&D. Examination of capabilities of remote sensing techniques to inventory and assess the biomass energy resource of standing forests is included in this task. Basic research to increase biomass productivity by improving control of biochemical mechanisms is another subtask. New industrial process heat markets for residues will be identified and analyzed after completion of a survey identifying unused waste wood producers. The use of crop residues and unconventional crops will be examined as sources for production of alcohol fuels. Additionally, program planning and scoping for new assessment of the standing forest energy resource were initiated in FY80 using local and state support. The near-term aim is to identify and implement energy systems based on wood combustion.
- Thermochemical and Electrochemical Conversion. Fundamental research in the thermal decomposition of biomass is being pursued for modeling reactor performance and design. Electrochemical conversion of biomass chemical energy to electricity, via fuel cells, is being explored. New molten salt and other low-temperature processes for producing chemicals from biomass are being examined.
- Gasification. A number of avenues investigating biomass gasification are being explored, including design and construction of an oxygen downdraft gasifier and a small, experimental flash pyrolysis gasifier.
- Bioconversion R&D. An international symposium on bioconversion will be sponsored by SERI in FY80. Laboratory research, aimed at discovering processes to convert biomass to fuels and chemical feedstocks, includes developmental work with methanol-producing microorganisms, flocculating yeast strains, and other microorganisms that can produce hydrocarbons in culture.
- Biomass Energy Systems Analysis. Analyzing the most appropriate biomass systems and identifying which applications merit major research emphasis to develop technologies that can be commercialized are fundamental to the overall biomass program. Alcohol fuels are being surveyed as part of this effort, and near-term use of wood for direct combustion is being considered in other system studies.
- Systems Commercialization. Identification, education, and assistance of potential or actual users of biomass are important efforts. Workshops, training sessions, and technical information transfer are being pursued as facets of this task.
- Technical Program Management. In addition to providing technical services to DOE, SERI has assumed technical management and direction for a number of subcontracted projects. These include aquatic biomass production, research in the "mid-south" biomass program, anaerobic digestion of cellulosic feedstocks, and elements of the biomass fermentation program. New program elements are expected to be added during FY80.

Wind Energy Systems

Several large wind energy conversion systems, producing from 200 kW to 2 MW, currently are being tested at various sites in the United States as part of the on-going Federal Wind Energy Program's effort to develop economical power from the wind. Small wind systems producing electricity or mechanical energy are presently available to consumers, but extensive R&D appears necessary before they can compete with conventional energy sources. Aside from technical and economic considerations, land-use questions, legal issues, and utility integration must be comprehensively addressed if obstacles to widespread use of wind energy are to be overcome.

SERI's program in the wind energy systems area is designed to support DOE's overall goal of providing the basis for commercialization of economically viable systems. Within the goals of the Federal Wind Energy Program, SERI has been assigned a leader-

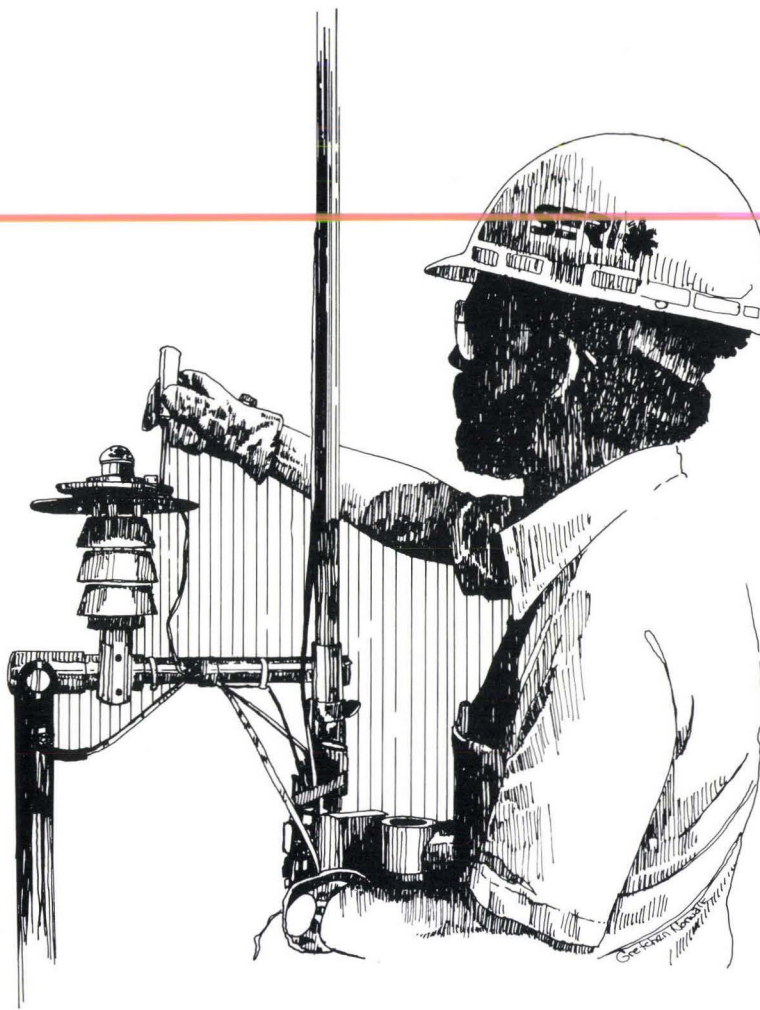
ship role in the research and analysis portion of the nationwide program. Most of the activity planned by SERI for FY80 centers around market and impact studies, systems studies, and information dissemination and commercialization activities.

Program objectives for SERI in the wind energy systems area help define the tasks structured to confront the obstacles to rapid deployment of wind energy systems.

First, determining market, economic, environmental, and legal constraints to wind energy use is a fundamental objective of SERI's program. SERI's lead role in innovative and advanced wind energy conversion systems is targeted to develop, evaluate, and test newly identified and developed systems. The third major objective of SERI's program is to provide information about near- and far-term solar markets.

SERI's lead role in the Research and Analysis element of the Federal Wind Energy Program has been organized in the following three tasks:

- **Market and Impact Studies.** Within the economic, market, and policy area three projects are planned: key U.S. markets for small (less than 100 kW) wind systems are being identified and assessed, detailed assessments of wind energy systems in selected markets chosen as a result of the survey are being undertaken, and a wind strategy analysis—using DOE's current strategy for achieving wind program goals as a starting point—is being initiated. Barriers to increased use of wind energy systems (including building codes, land-use constraints, and other factors) will be studied.
- **Systems Studies.** Development of a standard methodology for evaluating the cost of all wind energy systems during their various developmental stages is a major facet of this task. Other work is being directed toward establishment of wind energy systems goals, rate-related issues, and the economic consequences of wind system ownership.
- **Information Dissemination and Commercialization.** Manufacturers of wind energy systems are being provided with information on technology development, consensus standards, codes, and other market factors under this task. The commercial readiness assessment of specific systems is being updated and used to guide market development and information activities. Additionally, utilities and Federal power agencies are being assisted, with the accent on near-term application wherever appropriate.



Storage

Energy storage assumes a very important role in development of the solar resource because it is often a necessary element in solar energy systems. Storage components are essential to supply power in patterns that conform to user demands for energy when the sun is not shining. Unfortunately, most storage technologies are not yet technically or economically feasible for widespread use.

Research is ongoing in a variety of storage techniques including chemical, mechanical, electrical, and thermal systems. For example, DOE has funded some 100 solar-related projects in the thermal storage area. Storage of heat is emphasized in the solar program. This is not to dismiss the feasibility of storing solar energy by other means (depending upon which form it is converted to), but takes into account the fact that much research in other storage technologies, with applications for utilities and conventional energy sources, is proceeding and may ultimately benefit the development of solar energy systems.

SERI's objectives in the storage area are goal oriented. Achieving a better understanding of advanced thermal storage technologies for solar applications (backed up by improved data and other information) should help those working in the thermal storage area to choose the most promising technologies for specific solar applications.

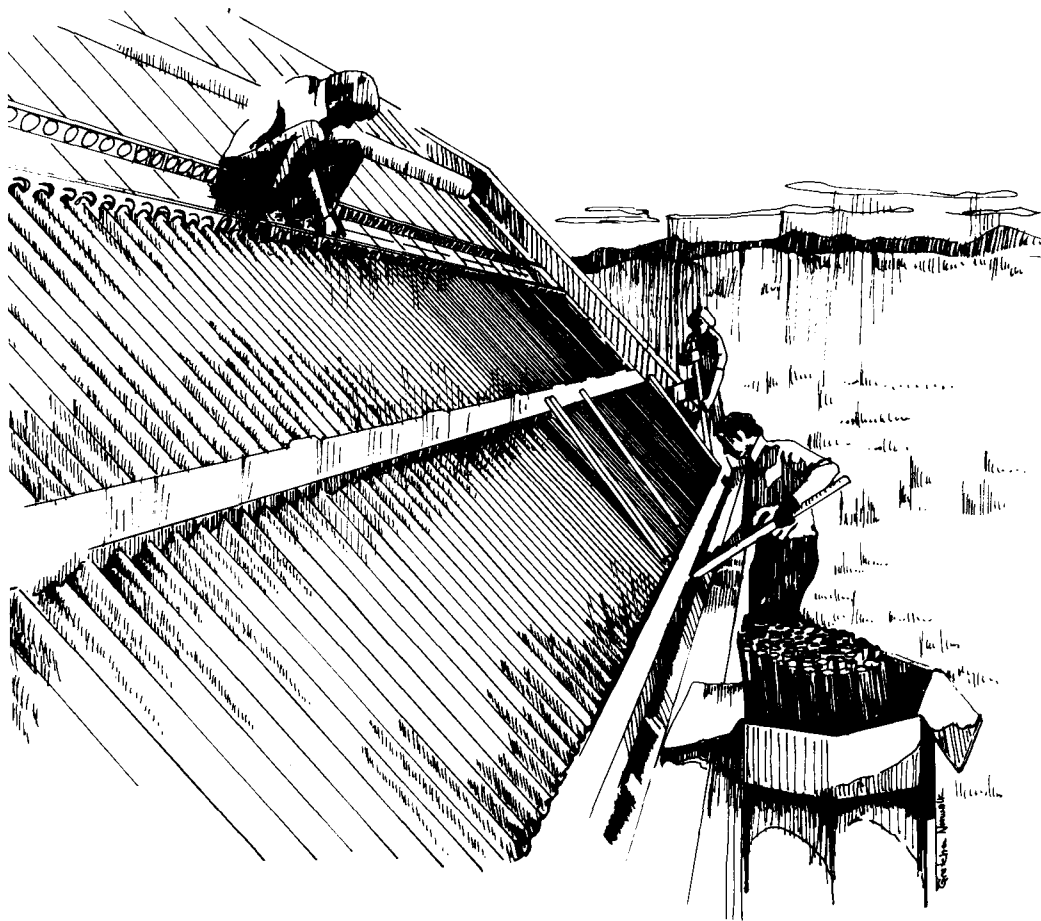
SERI will pursue research and development of advanced thermal energy storage by latent heat of fusion and reversible chemical reactions, allowing assessment of these technologies for particular solar applications. Secondly, SERI will evaluate thermal storage research and development activities and solar application storage requirements and determine whether the storage technologies are adequate and timely for the projected applications. Finally, a comprehensive review of the thermal energy storage area (to provide informa-

tion on international, public, and private activities) will be conducted and incorporated in the SERI Solar Cost Data Bank.

The major tasks of the SERI storage program are:

- Systems Analysis of Thermal Storage. SERI supports DOE's preparation of a plan for Thermal Storage Technologies for Solar Thermal Power Systems. Analysis of the trade-offs involved in thermal storage technologies, analysis of the value of thermal storage, and program coordination are facets of SERI's work in this task. Six target areas have been identified in the overall plan, and a thermal storage technology is to be developed for each. Those targets are: water-steam central receiver, liquid metal/molten salt central receiver, hot air central receiver, small total energy systems, small community systems, and advanced technology (including process heat).

- Advanced Thermal Storage Research and Development. Research on latent heat storage systems that utilize direct contact heat exchange for energy addition and withdrawal is being undertaken at SERI in close cooperation with the other laboratories engaged in similar work (for example, Oak Ridge National Laboratory, NASA Lewis Research Center, and Sandia Livermore Laboratory). Additionally, laboratory work on reversible chemical reactions for thermal energy storage and transport is ongoing.
- Energy Storage Survey and Assessment. Aside from a comprehensive review and documentation of all recently completed and ongoing activities in the low-temperature thermal storage area, state-of-the-art technical surveys and assessments are being prepared. The general issues and economics of thermal energy storage are being analyzed and the economic data included in SERI's Solar Cost Data Bank.



Industrial Process Heat

Industrial use of energy accounts for approximately 37% of the total U.S. energy budget. Much of that energy must be delivered at very high temperatures, but about half, on the order of 15 quads, is used for processes requiring heat below 300°C. Available solar systems can supply energy in that temperature range, but more favorable economics and reliability must be achieved. As energy supply shortages and higher fuel prices occur, and lower cost solar industrial process heat (IPH) systems are introduced, larger markets for solar IPH should develop.

IPH systems vary widely in type and usage. They have different load requirements, temperature levels, process fluids, operating schedules, and competing energy sources. Valuable information about systems has been gathered, but work remains to be done in analyzing and generalizing IPH system design over a full range of process temperatures.

SERI's IPH program, in keeping with the objectives of the National Solar Energy Program, is aimed at accelerating the commercialization of solar energy for industrial applications by reducing system costs, increasing component reliability, understanding and predicting solar IPH system performance, simplifying industrial application interfaces with solar systems, and identifying potential markets.

Program management, administration, and planning of SERI's IPH program will also include development of the National IPH Research and Development Plan. In addition to this work, four major tasks are included in SERI's IPH program:

- **Projects Cost/Performance Analysis and Monitoring.** Maintaining consistency for the numerous IPH tests being performed, ensuring that instrumentation and data acquisition systems reliably evaluate IPH systems, and comparing the cost and performance of the different IPH sites are components of this task. Ultimately, recommendations will be made for the types of applications and design considerations that should be included in future demonstration projects.
- **Applications Analysis and Systems Study.** The future impact and viability of large-scale industrial park IPH systems are being investigated as part of a subtask that also refines performance models and executes detailed industrial case studies. The case studies have provided valuable information about the needs and constraints of industrial plants, as well as comparisons of solar and conservation alternatives. Further development of performance models and production of user manuals will also be completed.
- **Market Analysis and Development.** Using market analysis results from work completed in FY79, commercialization activities will be aimed at appropriate industry segments and geographical regions. Additional data are being collected for industries with IPH needs in the 30-300°C and 300-600°C temperature ranges. Engineering and cost information obtained during the field interview phase is being used as a basis for generating a uniform methodology for the cost evaluation of solar energy process heat systems.
- **IPH Technology R&D.** Establishing major IPH system test facilities continues as a priority in SERI's program. Advanced IPH system component development, materials R&D for IPH systems, and solar pond studies are all included in this task.

Passive Technology

Passive solar systems for both heating and cooling are proving to be cost effective in many examples of residential and commercial buildings. Careful analysis and matching of particular passive systems and the climatic setting where the systems are to be located are very important. While there appears to be a large potential market for passive systems, lack of design methods, lack of marketable design concepts, and lack of awareness and understanding by the building community and the public have slowed the proliferation of passive solar energy use.

Information and knowledge about passive solar systems must be identified, collected, evaluated, and disseminated if accelerated use is to be achieved. Generally, the potential for early commercialization and significant energy impact is high because the materials and techniques central to passive solar systems do not require major changes from current building practices.

SERI's passive program is an integral part of the National Passive Program and represents a balance of technology development and technology utilization. New and existing residential, commercial, and agricultural heating, cooling, lighting, and hot water applications are being considered in SERI's program, as will energy conservation, urban system analysis, and design work. Major directions of the SERI program are: developing predictive methods and design techniques that promote energy-conserving, climate-adaptive structures and urban environments; verifying the fuel-saving performance of passive/hybrid concepts in new and existing building and urban applications; and informing and motivating the public sector and the building community about passive solar use.

Several priority areas must be addressed in order to realize increased use of passive solar energy systems. High payoff

passive/hybrid application opportunities should be identified and developed, technical performance and cost goals should be established, passive/hybrid techniques in selected applications (manufactured buildings, commercial/multifamily buildings, and urban environments) should be generated, and design tools for technical and economic evaluation of passive/hybrid systems should be developed. It is also important to assess the institutional readiness of selected passive/hybrid applications, remove barriers that exist, and assure that information about successful systems is circulated to builders and potential users.

The five major tasks of the SERI program are:

- **Basic Physical Studies.** Studies of the impact of environmental effects and heat exchange processes on the thermal performance of buildings are being conducted, and computer models to predict the effects are being developed. The passive discharge rates of various rock configurations and passive cooling processes are also being studied.

- **Systems Development, Analysis, and Testing.** Passive design concept generation, with an emphasis on exploring larger retrofit and urban applications of passive techniques, is included in this task. Existing passive analysis and design methods will be evaluated and user requirements for design tools carefully specified. Low-cost data acquisition systems will be installed in passive houses throughout the United States, and performance evaluation procedures and formatting requirements will be prepared.
- **Assessment Studies.** Economic, market, institutional, resources, and policy assessment studies are being performed at two levels: direct assessments of a particular market or application area and general assessment of

potential market and energy impact for all passive techniques. Information gained from these studies is being used to develop regional and local passive solar heating and cooling commercialization plans.

- **Technology Transfer, Information, and Commercialization.** Creating a passive system design tool center, supporting designer and builder workshops, and conducting a major solar awareness program should help to inform and motivate people about the benefits of passive solar energy systems.
- **National Program Support.** As the lead support laboratory for the National Passive Program, SERI provides technical, planning, and management assistance to DOE. Specifically, support for program planning and coordination, program management, and project technical monitoring are provided.



Solar Thermal Technology

Solar thermal technology includes converting solar energy to thermal energy, whether the application is electrical generation, process heat, or fuels and chemicals.

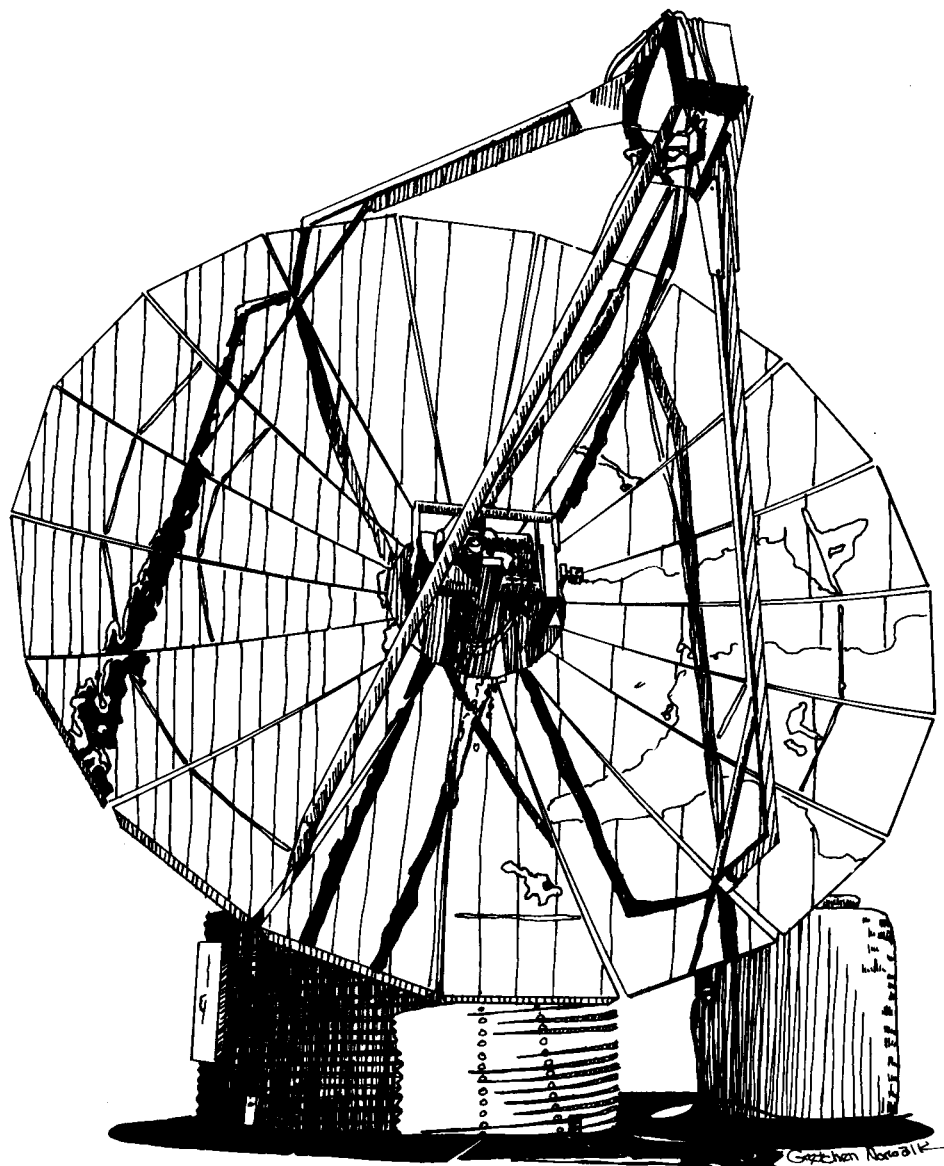
To date, the major U.S. effort has been directed largely at solar thermal systems that produce electricity. Various solar thermal electric power generating systems are under development. Of the generic systems, each having a number of variations, there are two concepts more advanced than the others. The first is based on parabolic troughs (movable concentrator), and the second uses a central receiver.

Another generic system type, the distributed parabolic dish with focally mounted Stirling or other advanced heat engine, shows high potential but is less understood.

Among SERI's roles in the solar thermal area is management of the Advanced Technology Program assigned by DOE. FY80 objectives are: to be a leader in component technology and materials development (with a target of extending the operating range of concentrator/receiver systems beyond 160°C), as well as developing nationally accepted standard performance tests for concentrating collectors. Establishment of cost and performance goals and assistance in the formulation of effective national stratagems by SERI also support DOE's Federal policy and programmatic decisions.

In addition to these major objectives, SERI will begin to develop a comprehensive approach to quality assurance and standards, leading to provision of interim performance criteria documents for those involved with voluntary standards. And, as with all SERI work, dissemination of such technical information to the appropriate audiences will be carried out.

The three major tasks in SERI's Solar Thermal Technology Program are:



- Program Management and Support Activities. Coordination of SERI in-house solar thermal activities, management of the DOE Advanced Technology Program, and evaluation of the progress made by other national laboratories are being carried out within this task. SERI has assumed a lead role for the National Solar Thermal Technology Program. The introduction and development of a comprehensive plan for quality assurance and standards for solar system components are also being accomplished in FY80.
- Component Technology Development. Improving solar thermal component efficiency and cost effectiveness—including thermal and chemical reactor/receiver concepts—is an ongoing objective of this task. SERI has developed a collector performance standard module test facility and is assembling the Advanced Components Research (ACRES) Facility to pursue work in this area.
- Materials Research and Development. There are two specific areas of research and development in the solar thermal area that support the DOE program. The first is selection and development of optical materials. The second is characterization and development of high-temperature heat transfer fluids and containment materials, with emphasis on the compatibility of such materials with the heat transfer fluids.

Ocean Systems

Energy can be extracted from the oceans by tapping tides, waves, currents, and temperature or salinity gradients. Systems that can extract energy from these sources—ocean systems—have the potential for providing continuous and renewable energy for generating base-load electricity or fueling specific energy-intensive processes.

The most advanced of these different ocean energy sources is the Ocean Thermal Energy Conversion (OTEC) scheme. A closed-cycle concept that uses ammonia as the working fluid to drive a Rankine system is the most advanced OTEC concept. An open-cycle concept using seawater as the working fluid also is receiving attention.

With all ocean systems, serious questions about the environmental, economic, and legal ramifications of eventual deployment must be studied.

SERI's objectives in the ocean systems area, in support of DOE's national program, begin with a preliminary assessment of alternate ocean energy systems. Development of a data base for open-cycle OTEC and subsystem design and parameters will promote this concept. Finally, SERI is initiating a program for an investigation into corrosion of aluminum seawater heat exchangers.

SERI's FY80 ocean systems program includes planning, coordination, and program management tasks such as subcontract management, national laboratories coordination, and support for the Solar Cost Data Bank.

Additional distinct tasks in SERI's program are:

- Comparative Assessment of Alternate Systems. Establishment of research priorities for future systems is being examined and critical cost and performance parameters identified. Other alternative cycles will be assessed in coming years.
- Open-Cycle OTEC Research and Development. SERI has responsibility for managing in-house and subcontracted research in this area. A system model for the open-cycle, steam turbine concept is being updated; the basic transport mechanisms of the mist lift concept are being analyzed; and an effective method of flash evaporation at low temperature will be developed. A parallel program serves to develop a direct contact condenser suitable for OTEC open-cycle application.
- Closed-Cycle OTEC Research Support. Development of a program for qualifying aluminum and aluminum-clad materials as heat exchanger components will be conducted for DOE. A comprehensive materials review of alternate ocean systems is necessary to identify unique material requirements that will ensure timely initiation of long-term material studies.

Active Solar Heating and Cooling

Even though active solar heating and cooling components and systems have entered the residential and commercial markets, widespread commercialization is unlikely until the marketplace matures, and confidence in solar systems matches confidence in conventional systems. Technical improvements in solar systems can lower cost, improve performance, or increase durability. Advances in standards for installation and maintenance can increase the likelihood of solar systems competing successfully in the marketplace.

A SERI objective in this area is to conduct research and development work that will yield increasingly cost-effective, efficient, reliable, safe, and durable active solar heating and cooling systems. Another is to assist the solar industry through development of a manufacturing, marketing, installation, and service infrastructure that will eventually be absorbed into the national building industry.

Institutional or nontechnical obstacles also act to impede the widespread use of solar systems. SERI addresses these obstacles by building a positive environment for solar decisions. Evaluation of consumer motivation, maximization of positive support for solar use among key decision makers, and information dissemination are SERI objectives. Specific tasks in SERI's active solar heating and cooling effort include:

- R&D. The development of a viable solar-powered, residential cooling technology and the achievement of improved reliability in solar heating and cooling systems form the basis of SERI's active solar heating and cooling R&D effort. In-house measurements of the degradation of solar system components will provide reliability and performance information on materials.

Advanced Solar Energy Research

- **Market Supply.** Four major elements are included in this task. The building industry support element establishes cooperative efforts among national, regional, state, and local organizations of builders; developers; heating, ventilating, and air conditioning (HVAC) contractors; and planners who choose energy systems in new residential construction. Another facet of the SERI task facilitates the transition of advanced materials components and designs from the R&D stage to the commercialization stage. A Solar Analysis Methods Center will be established to support the design profession in the technologies of active and passive solar heating and cooling and other solar technologies. Assistance also is provided to DOE for the Solar Federal Buildings Program.
- **Market Demand and Commercialization Support.** Stimulating consumer demand by creating a community workshop manual to assist organizations promoting solar use and conducting a solar awareness campaign through the use of media, advertising, and public relations are two aspects of SERI's marketing activities. Industry marketing support, a second facet of this task, includes development and distribution of results stemming from a consumer survey, as well as evaluation of approaches for monitoring fraudulent activities in the solar industry. A final element of this task is support of active heating and cooling commercialization activities at SERI, including the development and distribution of communication products.

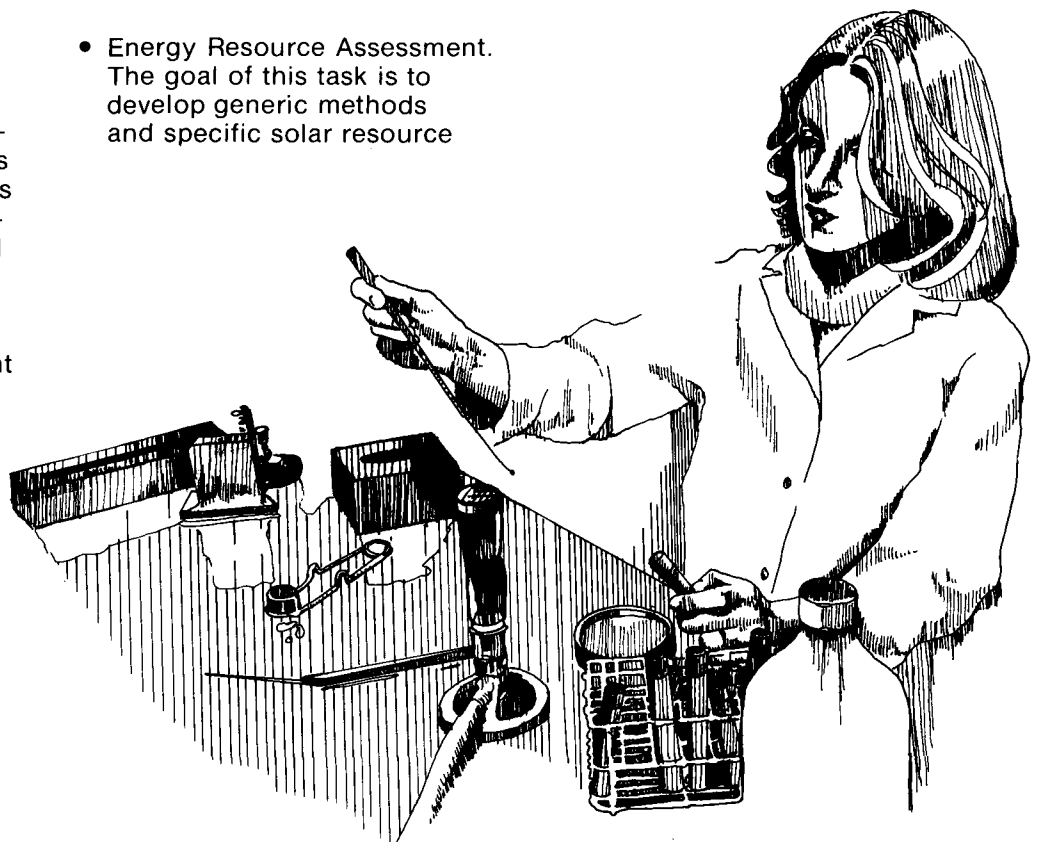
The ultimate goal of the Advanced Solar Energy Research Program is to discover and develop new solar energy conversion and materials options. The program is designed to identify, conduct, and support advanced research in areas not addressed by existing Federal solar technology programs.

There are four major research tasks in SERI's program:

- **Photoconversion.** Basic research in photobiological, photochemical, and photoelectrochemical energy conversion is pursued. Both in-house and subcontracted research are coordinated through SERI.
- **Materials Research.** Work in this area is aimed at achieving an understanding of the degradation mechanisms affecting the performance of materials in a solar-stressed environment (high photon flux, diurnal thermal stresses, and ambient environmental attack). This understanding will be used to modify existing materials or to develop new compositions and/or structures for solar energy applications.
- **Energy Resource Assessment.** The goal of this task is to develop generic methods and specific solar resource

data required for assessing, characterizing, and forecasting solar energy resources and the performance of various solar conversion systems. Specific projects are being initiated to evaluate and develop improved insolation models and algorithms, collect and analyze research data from the SERI Insolation Research Lab, initiate mesoscale data collection and model evaluation, continue development of advanced insolation instrumentation, review satellite determinations of ground-based insolation properties, and provide technical and management support to the DOE Insolation Resource Assessment Program.

- **New Concepts.** New concepts of solar energy collection, conversion, storage, and distribution undergo exploratory research in this task. New concepts that appear viable are nurtured through the early stages of development until they can be incorporated into existing technology programs or until they form the nuclei for new programs.



Planning, Analysis, and Social Science

Contemporary energy problems cannot be solved solely with improvements in technology. The planning, analysis, and social science program area of SERI is designed to provide information and analyses for solar energy policy, planning, and management decisions that link technical knowledge with socioeconomic knowledge. The keys to improving solar energy decision making and public awareness of solar energy lie in obtaining improved socioeconomic data, utilizing more rigorous methods of economic and social analysis, and using the lessons learned from both government and industry experience in innovation and technology development. Topics for consideration in this program area include: current solar technology costs in meeting energy end-use requirements that employ standardized cost methods, the expected effect on employment from use of alternative solar technologies, and the effect of state solar incentives on solar energy use.

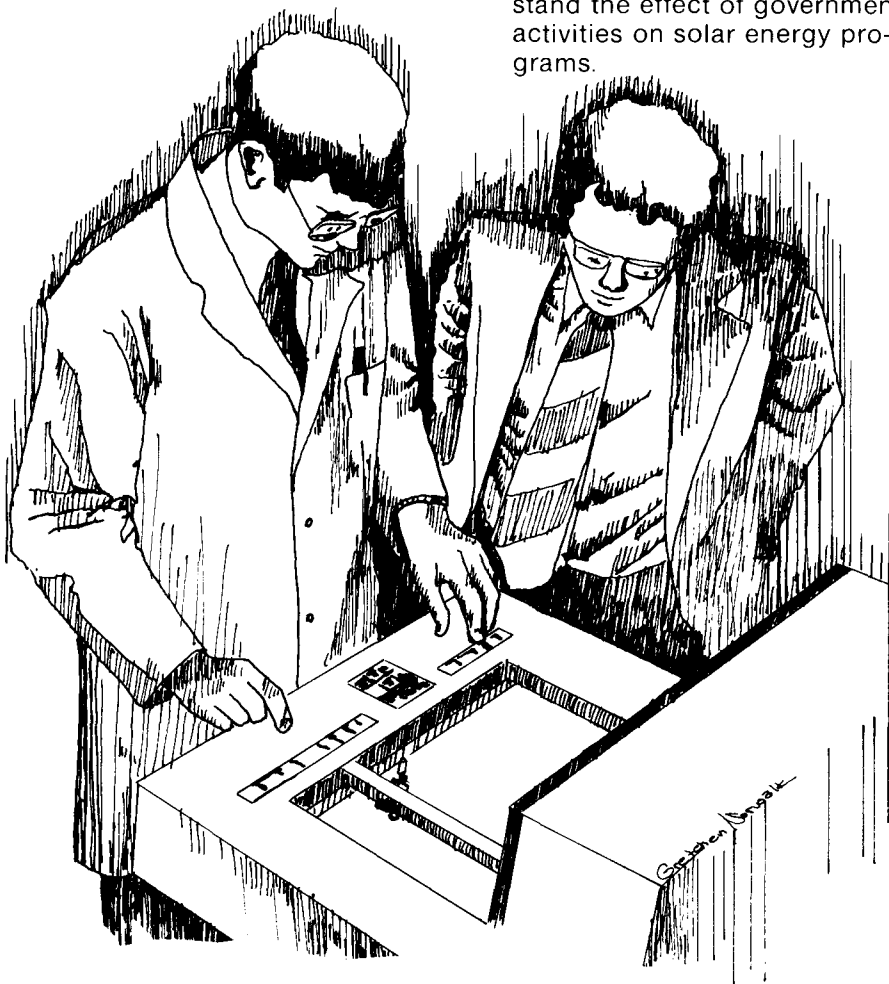
In this area, two SERI objectives have primary emphasis. The first is to provide information and analyses in support of DOE solar energy policy and planning decisions. The second major objective is to develop, improve, and expand fundamental knowledge, baseline descriptive information, methodologies, conceptual approaches, and analytic techniques used in research and analyses specified in the first objective.

There are four tasks in SERI's program. They are:

- **Technology Value and Cost.** Value analysis deals with the value of more than one solar technology or compares the value to end users (usually utilities) of alternative solar technologies. Electric utility planning and production cost simulation models are being expanded to incorporate and analyze solar technologies. A solar cost data bank will be developed and an economic investigation of grid-connected

intermittent solar electric technologies will be conducted. Regional market potential of solar electric technologies also is studied.

- **Social and Environmental Impacts.** Research is conducted in six areas within this task. Those areas are: employment, environment and health, social impact assessment, decentralized solar energy, land use, and macroeconomic impacts. Approximately two-thirds of this work will be conducted in-house and the balance subcontracted.
- **Program Planning and Review.** For the planning segment of this task, research activities are being focused in three directions: methodology development for support of the R&D budget allocation process, planning support for individual solar program areas, and integration of single and multiyear program planning and budget forecasting.
- **Strategy, Policy, and Market Analysis.** Of the two major research efforts within this task, the first is targeted to improve understanding of private industry and individual decisions on the acceptance (or deferral) of solar energy technologies. The second is an effort to delineate the role of government (Federal, state, or local) in stimulating the development and diffusion of a new technology, and to understand the effect of government activities on solar energy programs.



Information Systems

The U.S. Congress recognized the need to create a national network for the efficient exchange of solar information when it legislated solar energy development as a public goal. Lead responsibility for the design, implementation, and operation of this network—the Solar Energy Information Data Bank (SEIDB)—was assigned to SERI by DOE. The role of the SEIDB is made clear by the congressional mandate which states the data bank shall “include technical information . . . on solar energy research, development, and applications . . . technical information on the design, construction, and maintenance of equipment utilizing solar energy; general information on solar energy applications to be disseminated for popular consumption; physical and chemical properties of materials required for solar energy activities and equipment, and engineering performance data on equipment and devices utilizing solar technology.”

The direct participation of the four Regional Solar Energy Centers and the National Solar Heating and Cooling Information Center has been enlisted during development of the SEIDB. Activities of DOE's Energy Information Administration and the National Technical Information Service have been coordinated with the SEIDB. A liaison with other appropriate Federal information components also is maintained.

Services being designed into the SEIDB include on-line access to bibliographic, factual, and numeric data bases; library and inquiry response services; computing services; and information dissemination and publications services.

The Information Systems program for FY80 is divided into four tasks:

- **Data Bank.** Maintenance and expansion of existing data bases and design and development of new data bases covering areas of priority needs that are identified are the major efforts of this task. Cooperation with

DOE and other Federal information organizations is stressed so as to avoid duplication of effort wherever possible.

- **Information Center.** The Solar Energy Information Center will become a significant resource, providing services to broad segments of the solar community. The core collection of solar energy information will include all significant solar publications. Users will be served by direct access, loan service, inquiry and response services, on-line access to computerized bibliographic and patent files, and specialized publications. Materials will be provided in printed, microform, film, and video formats as appropriate to the users.
- **Information Dissemination Task.** The data bank, information center, and computer network provide resources needed for development of products and services. From the results of studies and continued evaluation of the information problems and the needs of the solar community, the products are disseminated and services developed and offered to properly targeted audiences.
- **Computer System Task.** All acquisition, implementation, maintenance, operation, development, expansion, modification, and updating of computer hardware, software, and communication facilities necessary to the effective performance and operation of the SEIDB network are included in this task. During FY80, a particularly critical responsibility will involve the procurement of the computer and communication facilities to support the SEIDB.

International Programs

International solar activities are an important part of SERI's charter. Working closely with DOE, SERI serves as the focus for U.S. negotiation and development of bilateral and multilateral programs for solar energy utilization. These programs include: providing aid to developing nations, encouraging U.S. solar export opportunities, supplying relevant solar information, and furnishing project management.

U.S. industry is taking a closer look at the potential international marketing opportunities for solar hardware. This increased interest is due, in part, to sluggish growth of the U.S. solar market. Also, wide variations in energy prices and distribution networks throughout the world mean that solar technologies will be economically viable in a number of foreign nations before they are in the United States.

Another upsurge of interest in international solar energy activity comes from increased treaty obligations, formal solar-related R&D cooperative agreements, informal agreements at various levels, and other accords for a variety of energy and technology corroborations. Many nations do not have the resources required to make a substantial contribution to solar energy R&D or to implement appropriate renewable energy technologies in their own countries. These developing countries are of major interest to the United States for a variety of political and humanitarian reasons.

SERI's program in this area is divided into seven major tasks:

- **Cooperative R&D Programs.** SERI will participate in the development and negotiations of specific cooperative programs and projects with all nations designated by appropriate U.S. government agencies for such activity. SERI will carry out required management and oversight functions for cooperative

Academic and University Research Program

R&D activities assigned to the international programs area.

- **Export Opportunities.** The prime SERI goal is to undertake market technology and barrier assessments, as well as ensuring that relevant market information is available for support of the solar energy industry's efforts to size up the international market. SERI also works to increase awareness of government funding programs in which the U.S. industry can participate, assist industry to exploit existing and new programs designed to promote U.S. capabilities overseas, and facilitate interaction between government agencies and the U.S. solar industry in efforts to export U.S. solar technology.
- **International Information.** Data and information on foreign solar energy activities are collected and made accessible within this task. This information is disseminated more aggressively as SERI's capabilities in this program area expand. Toward this end, relationships with both American and foreign information-handling organizations will be nurtured.
- **Developing Countries.** SERI will develop a global plan of priorities for harnessing renewable energy resources in developing countries. Other activities in this task include production of a handbook on agricultural applications of renewable energy resources (for dissemination to developing countries), development of an outdoor test demonstration facility to study various applications of renewable energy resources, assessment of renewable energy resource potential in a specific country (to be named later), and performance of a series of policy studies covering a range of issues relating to renewable energy use in developing countries.
- **Mali Project.** SERI provides technical support to the Mali Renewable Energy Project [as agreed to by DOE and the Agency for International Development (AID)]. This includes arrangements for Malian participant training at U.S. institutions.
- **Annual Review.** SERI prepares an Annual Review of International Programs covering all public and private solar activities worldwide. Other planning, budgeting, and review functions are included in this task.
- **SOLERAS.** Saudi Arabia and the United States signed the Project Agreement for Cooperation in the Field of Solar Energy—known as SOLERAS—in October 1977. Areas of cooperation within the agreement include research, development, and demonstration projects on all types of solar energy systems of mutual interest to the Kingdom of Saudi Arabia and the United States.

Historically, basic research conducted at universities has been one of the most fertile sources for new concepts and ideas. This has not been the case with solar research to any large degree because the national solar energy efforts have emphasized development and demonstration programs rather than programs to foster new approaches. University research in solar energy will be expanded, at least modestly, in FY80.

Another weak area in national solar development can be strengthened through the resources of academia, namely professional solar training. Except for the solar space and water heating industry (which needs tradespeople now) the solar industry is lacking in professionals to expedite the research and development needed to form the foundation of a viable industry. Most of these professionals must come from colleges and universities.

SERI's objectives in the area of academic research are to support extensive basic solar research in universities and to stimulate new ideas and concepts needed for the growth and evolution of a vigorous solar industry. In the area of educational activities, SERI's objective is to provide coordination for, and assistance to, solar-related educational activities at post-secondary institutions in the United States for controlled expansion of the solar manpower base—from tradespeople to professional scientists.

Tasks within SERI's program include:

- **University Research Support.** SERI provides technical monitoring of university projects funded under this program. Responses to "Notice of Program Interest" announcements (to be distributed to the academic community in October 1979 and March 1980) will be evaluated and ranked by a paid peer review panel meeting at SERI. Recommendations of this panel will then be transmitted

Commercialization Activities

to the DOE Program Oversight Committee for final selection.

- Solar Education Data Base. This data base, completed from a survey of some 3,000 post-secondary institutions in the United States, will be updated. Information in this data base will be analyzed and repackaged for different audiences.
- Education Development. This task includes: a sabbatical leave program for full-time college or university faculty members to spend six months to a year at SERI, a structured work-study program at SERI for college juniors and seniors, and a funding program for development of new solar courses at the undergraduate level (to be offered during fall term of the 1980-81 academic year). These three programs will involve national announcements, followed by competitive evaluation of responses. An additional, noncompetitive component of this task is preparation of a monograph series on the solar technologies to be distributed to the vocational education community.
- Program Review and Planning. Review of the solar activities of the academic community during FY80 and administrative efforts for the SERI program will be conducted under this task.

Those activities that provide assistance or stimulation to the technical, economic, and social development of solar energy at both supplier and user levels and within the distribution and support system are classified as commercialization activities. SERI's efforts in this area include commercialization planning, infrastructure development, and communications.

Commercialization planning by the Federal Government for specific or general solar technologies has met with limited success. Uncertainty about the effectiveness of these actions, lack of knowledge about the readiness of the technologies, and other factors can explain the generally small effect commercialization activities have had thus far.

Commercialization is presently receiving more attention as a result of President Carter's Domestic Policy Review of Solar Energy, the Commercialization Strategy Reports developed for DOE, and the National Plan for the Accelerated Commercialization of Solar Energy being prepared for Congress.

The three major tasks of SERI's Commercialization Activities Program are:

- Commercialization Planning. Development and implementation, with DOE and the regional solar energy centers, of a commercialization planning process (which will also serve as a framework for other commercialization plans at other levels) are major efforts in this task. Support of the National Plan for the Accelerated Commercialization of Solar Energy is another area of emphasis. Continued analysis of the commercial readiness of solar technologies will be ongoing within this task.
- Infrastructure Development. The five elements of this task, all aimed at developing the solar energy industry infrastructure, include the Law Project (which is concerned with impacts of law on solar commercialization, legal impediments to solar use, and development of legal strategies to promote solar use), publication of the *Solar Law Reporter*, the Foundations Project (which assists private foundations in developing their own solar programs), quality assurance and standards (supporting solar consensus standards and codes development), and financing solar facilities (which addresses financing techniques for solar construction).
- Communications Support to Commercialization. Coordination of activities and a focus on specific audiences and knowledge requirements necessary for the early use of solar technologies is being pursued under this task. A major portion of this work is the Technical Information Dissemination Program assigned to SERI by DOE. Scientific and technical information in five technologies (wind energy conversion, biomass, ocean systems, solar thermal, and photovoltaics) is being packaged and routed to potential users of relevant R&D results. Another major effort is to increase public awareness of the viability of solar energy systems through the use of publications, radio and TV news spots, and other means.

SERI IS NOT AUTHORIZED TO PROCESS REQUESTS FOR GRANTS UNDER ITS PRIME CONTRACT WITH THE U.S. DEPARTMENT OF ENERGY. SUCH REQUESTS SHOULD BE SUBMITTED DIRECTLY TO THE DEPARTMENT OF ENERGY.

Parties interested in being included in SERI's Bidders List should request an information package from:

Subcontracts Branch
SERI
1617 Cole Boulevard
Golden, CO 80401

Major solicitations also appear in the Commerce Business Daily.

For more information about SERI or its programs, please write:

Public Information Office
SERI
1617 Cole Boulevard
Golden, CO 80401

Solar energy activities are also conducted by the four Regional Solar Energy Centers. They are:

Northeast Solar Energy Center
470 Atlantic Ave.
Boston, MA 02110

Region includes:
(CT, MA, ME, NH, NJ, NY,
PA, RI, VT)

Southern Solar Energy Center
61 Perimeter Park
Atlanta, GA 30341

Region includes:
(AL, AR, DC, DE, FL, GA,
KY, LA, MD, MS, NC, OK,
PR, SC, TN, TX, VA, WV, and
the Virgin Islands)

Mid-American Solar Energy Complex
8140 26th Ave., So.
Bloomington, MN 55420

Region includes:
(IA, IL, IN, KS, MI, MN, MO,
ND, NE, OH, SD, WI)

Western Solar Utilization Network
715 S.W. Morrison Street
Suite 800
Portland, OR 97205

Region includes:
(AK, AZ, CA, CO, HI, ID, MT,
NM, NV, OR, UT, WA, WY)



Solar Energy Research Institute

A Division of Midwest Research Institute

1617 Cole Boulevard
Golden, Colorado 80401

Operated for the

U.S. Department of Energy

under Contract No. EG-77-C-01-4042



National Renewable
Energy Laboratory



02LIB092457