SOLAR THERMAL POWER SYSTEMS PROGRAM

DOE/ET-0018/1

PROGRAM SUMMARY JANUARY 1978

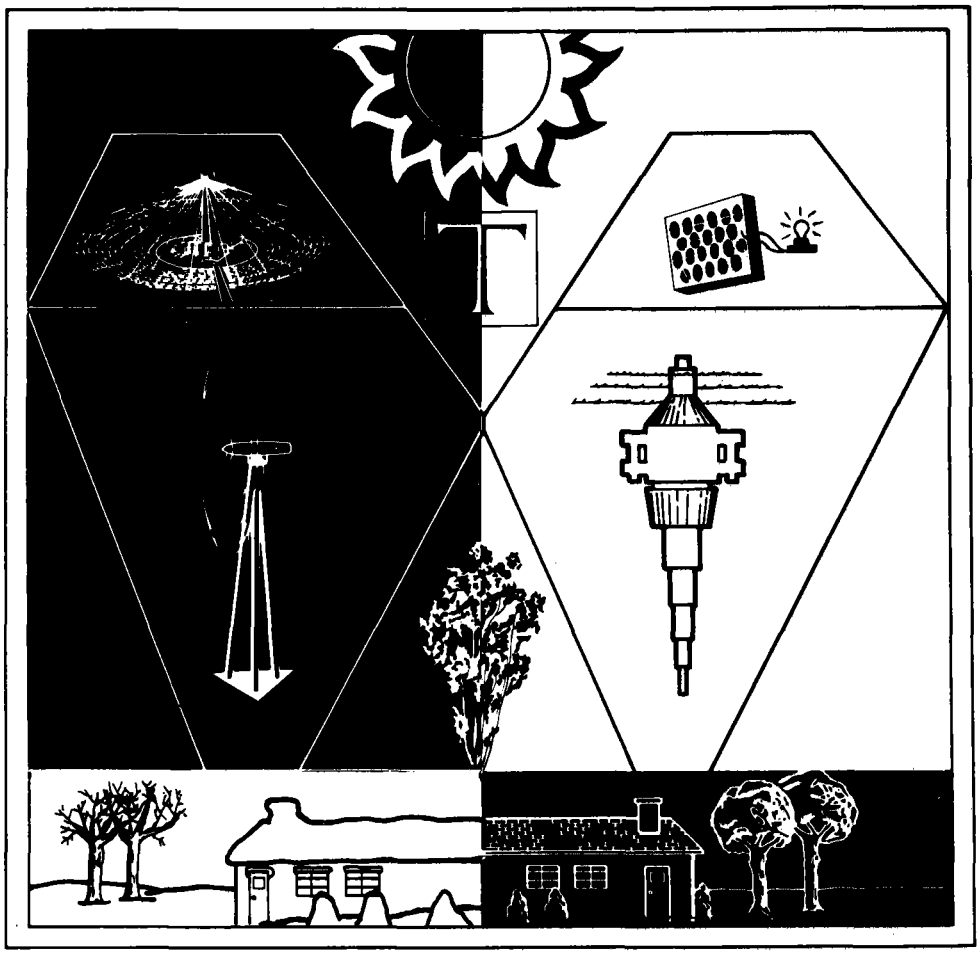
DIVISION OF SOLAR TECHNOLOGY

WASHINGTON, D.C. 20545

U.S. DEPARTMENT OF ENERGY

SOLAR THERMAL POWER SYSTEMS PROGRAM

DOE/ET-0018/1
UC-62



PROGRAM SUMMARY JANUARY 1978

DIVISION OF SOLAR TECHNOLOGY
WASHINGTON, D.C. 20545

U.S. DEPARTMENT OF ENERGY

Preface

On October 26, 1974, the Solar Energy Research Development and Demonstration Act (Public Law 93–473) was signed into law, authorizing a vigorous Federal program of research, development and demonstration. Its goal was to provide the nation with the option of using solar energy as a viable source for meeting future energy requirements. In response to the mandates of this act, major efforts were conducted within the Division of Solar Energy of the Energy Research and Development Administration (ERDA) to work with industry to develop and introduce, at the earliest possible date, economically competitive and environmentally acceptable solar energy systems.

These responsibilities were transferred to the new U.S. Department of Energy (DOE) on October 1, 1977. ERDA's Division of Solar Energy (SOLAR) was reorganized into two distinct organizational components:

- The Division of Solar Technology (SOLAR/ET), which functions as a part of the Office of the Assistant Secretary for Energy Technology.
- The Division of Solar Applications (SOLAR/CS), which functions as a part of the Office of the Assistant Secretary for Conservation and Solar Applications.

As a result of this reorganization, the Solar Heating and Cooling Program, and the Technology Transfer Program, were transferred into SOLAR/CS. An overview of the current DOE organization is shown in Figure 1.

Program planning continues under the guidelines established by PL 93–473 and by three other legislative acts passed by the 93rd Congress: the Solar Heating and Cooling Demonstration Act of 1974 (PL 93–409), the Energy Reorganization Act of 1974 (PL 93–438), the Federal Nonnuclear Energy Research and Development Act of 1974 (PL 93–577). Together these four laws grant DOE and other Federal agencies the general authority to pursue a research program aimed at effective solar energy utilization. Under this authority, SOLAR/ET will work to promote a fully-coordinated solar energy program and to complement efforts in the private sector to develop solar energy resources.

The major programs and subprograms of the Solar Energy Program during 1977 were:

a. Solar Electric Systems
   (1) Solar Thermal Power Systems.
   (2) Photovoltaic Energy Conversion.
   (3) Wind Energy Conversion.
   (4) Ocean Thermal Energy Conversion.
   (5) Solar Satellite Power Systems.
b. Fuels from Biomass
   (1) Production and Collection of Biomass.
   (2) Conversion of Biomass.
c. Technology Support and Utilization
   (1) Technology Transfer.
   (2) Environmental and Resource Assessment.
d. Solar Heating and Cooling
   (1) Barriers and Incentives.
   (2) Demonstration.
   (3) Research and Development.
   (4) Agricultural and Industrial Process Heat.

A Program Summary is issued for each program annually. It is an overview of the ongoing research, development, and demonstration efforts of the preceding fiscal year.

This Program Summary describes each of the Solar Thermal Power Systems projects funded during FY 1977. The accomplishments of the Solar Thermal Power Systems Program are highlighted and plans for continued activities in this technology area are included.

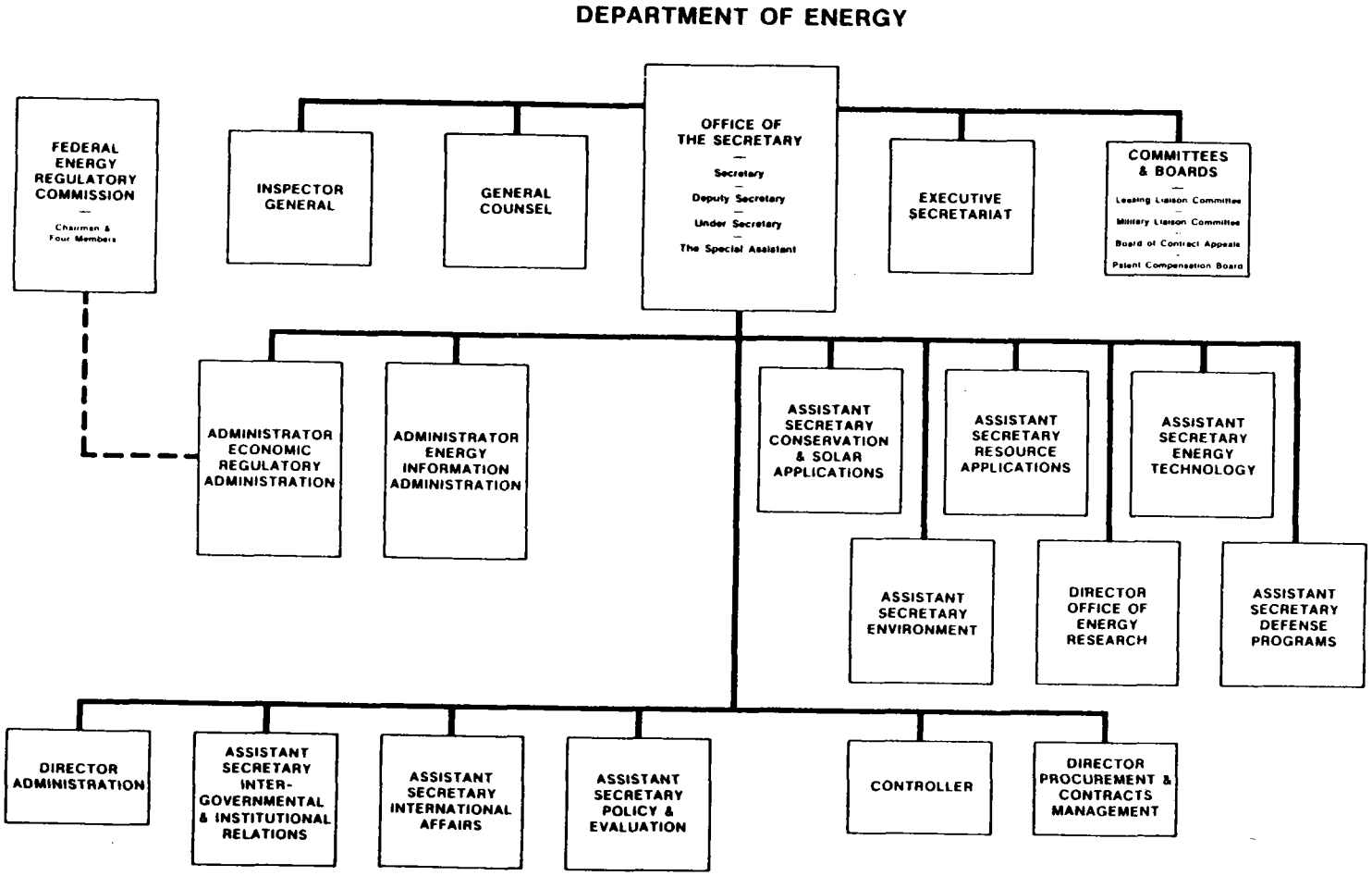


Figure 1. DOE Organization Overview

Table of Contents

TABLES

ILLUSTRATIONS

ILLUSTRATIONS (cont.)

Introduction

The Solar Thermal Power Systems Program is part of the overall Federal strategy aimed at the development and demonstration of environmentally acceptable solar electric systems that are competitive in all respects with conventional means of producing energy. Successful implementation of solar thermal conversion technology will result in reduced dependence upon limited supplies of fossil fuels in all major sectors of the national energy market, beginning with the electric energy supply sector.

What Makes Solar Thermal Energy Conversion Possible?

One two-billionth of the sun's energy reaches the earth; much is reradiated into space by the earth's atmosphere. Significant portions of the energy retained by the earth can be captured and used to produce heated working fluids that drive heat engines. These heat engines, providing useful mechanical energy, can be coupled with conventional generators which produce electrical energy. Conversion technology compatible with solar heat sources is generally well in hand and already used for the bulk of the nation's electricity needs. Thus, solar thermal power systems will be easily integrated with existing systems and dispersed applications.

Two broad classes encompass the variety of possible solar thermal system concepts: distributed receiver and central receiver. The distinction is based on the placement of the receiver relative to the mirror or collector. The use of heliostats (steerable mirrors) allows for the use of a single (central) receiver located in the common focal zone. In the case of unitary concentrating structures such as parabolic troughs and dishes, the receivers must be distributed among the concentrators in order to be placed in their focal zone.

Solar thermal power systems consist of several subsystems:

- Collector/concentrator subsystem
- Receiver/heat transport subsystem
- Heat engine subsystem
- Thermal storage subsystem
- Control subsystems

Collector/Concentrator Subsystem

The collector/concentrator subsystem has as its basic function the interception, concentration and delivery of direct solar radiation to the receiver/heat transfer subsystem. This subsystem consists of a field of concentrating lenses or mirrors to focus the sun upon the receiver. There are two basic distributed receiver collector categories: point focusing and line focusing. The parabolic dish focuses on an absorber at the focal point of the dish. The parabolic trough collector focuses on a long receiver tube and is an example of a line focusing concept (Figure 2). The heliostat/central receiver concept (Figure 3) is also a point focusing system.

Receiver/Heat Transport Subsystem

This subsystem collects the redirected solar radiation from the heliostats or collectors and transfers the solar energy to the working fluid. This fluid is then pumped to a heat engine or thermal storage subsystem. The receiver/heat transport subsystem consists of a receiver support structure, the receiver, pumps, heat exchangers, and a working fluid. Working fluids in the heat transfer subsystem which are being explored today include water, air and other gases, oils and other organic fluids, molten salts, and liquid metals.

Heat Engine Subsystem

The heat engine subsystem links solar thermal conversion subsystems with conventional electric power generating technologies. The heat engine transforms thermal energy from the receiver/heat transport subsystem into useful energy to drive a conventional generator.

Heat engines utilizing Rankine, Stirling and Brayton cycle principles are under investigation. The Rankine cycle uses vaporized fluids, such as water to power a turbine. The Brayton cycle, such as used in conventional jet aircraft engines, uses a gas as a working fluid. The Stirling cycle uses gases, such as hydrogen or helium, as a working fluid.

Thermal Storage Subsystem

This subsystem stores thermal energy generated by collectors and receivers in excess of that required for immediate operation. Stored thermal energy is used to generate electric energy during periods of time when direct solar radiation is not available.

Thermal storage technology employs either the sensible heat or the latent heat-of-fusion properties of various storage media. Examples of sensible heat storage media include oils, molten salts, and combinations of rock or oil;

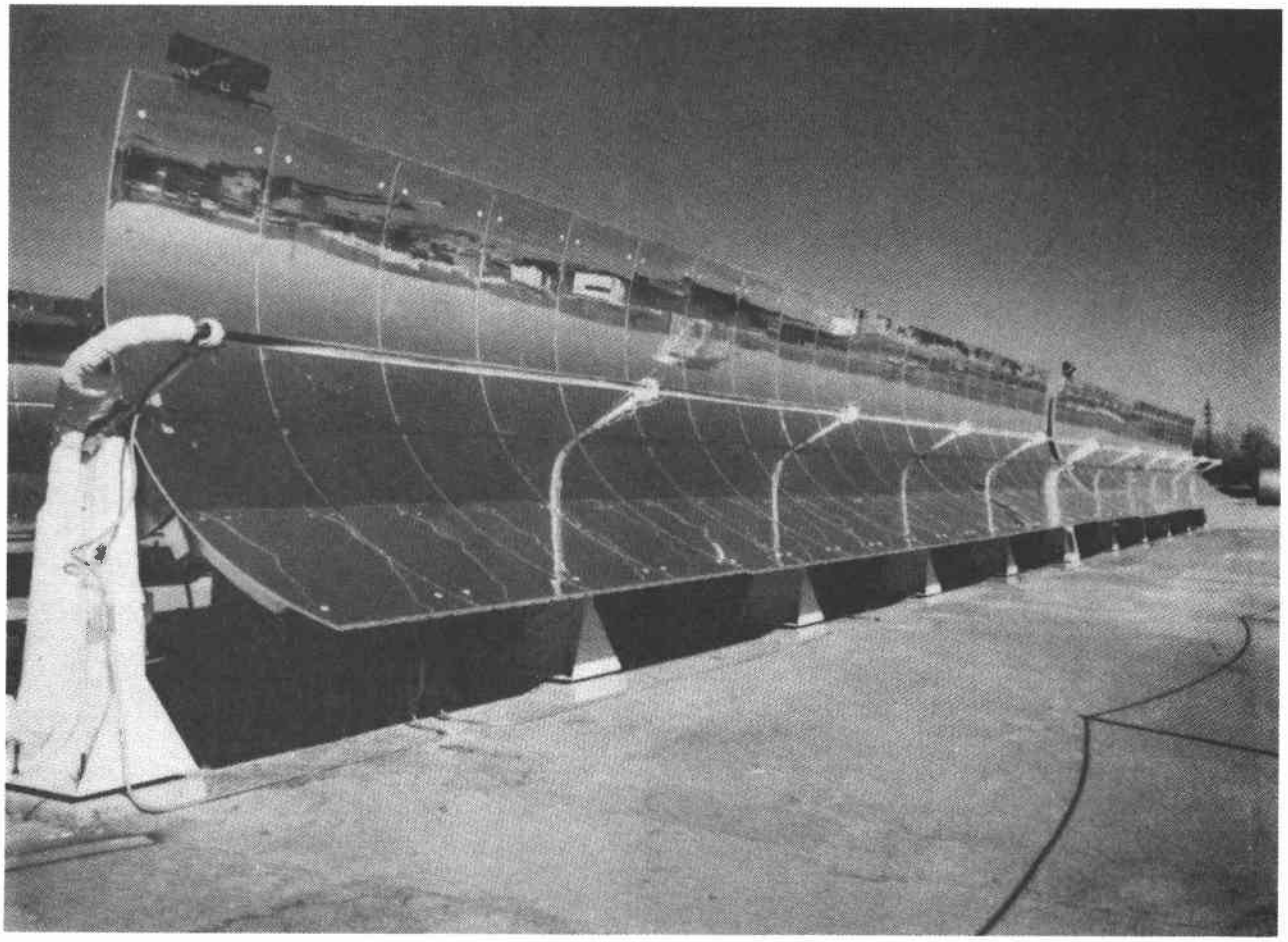


Figure 2. Line Focusing Collector

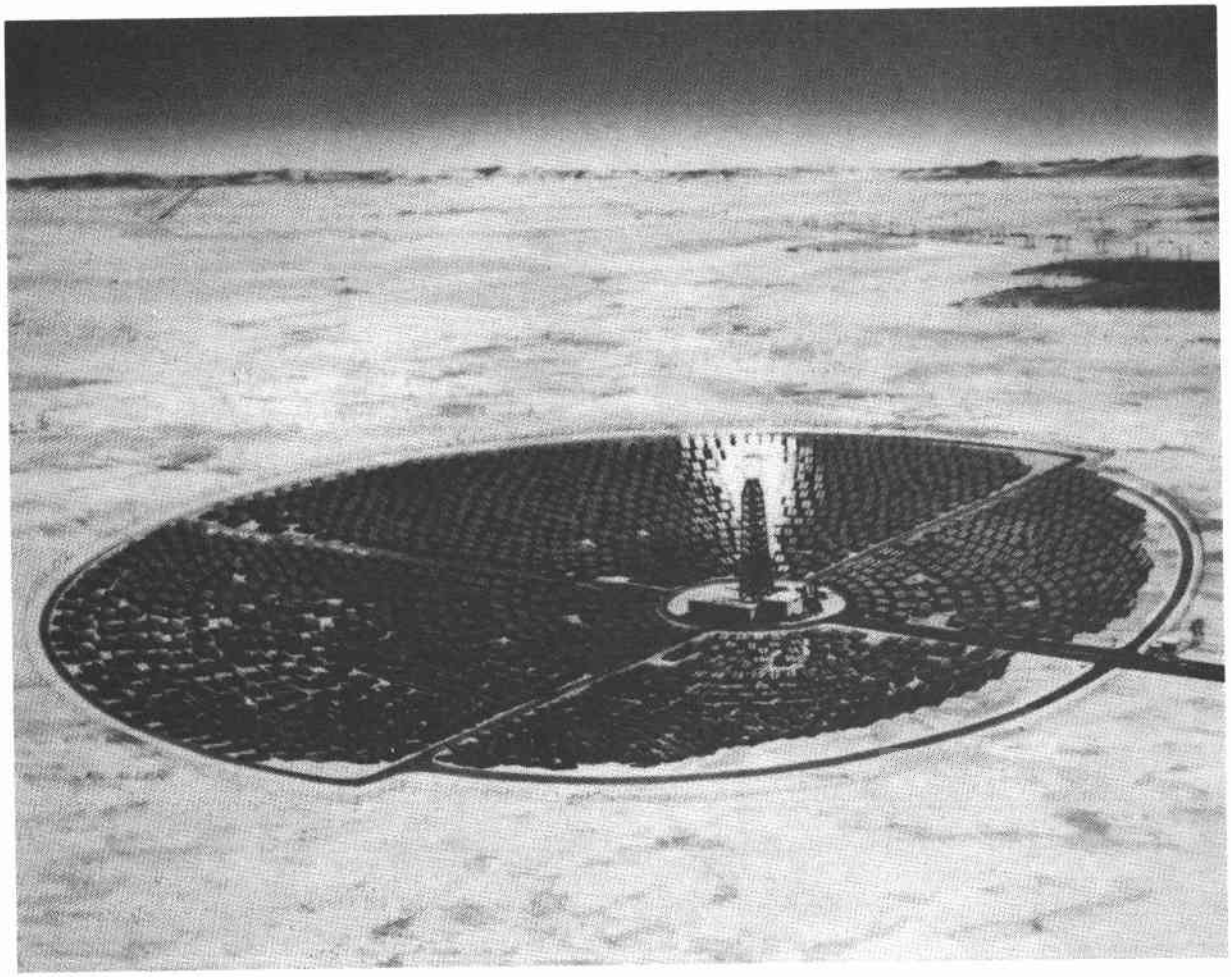


Figure 3. Artist's Conception of a Heliostat/Central Receiver System.

while latent storage involves freeze-thaw characteristics of selected materials such as molten sodium hydroxide or potassium hydroxide.

Control Subsystems

These subsystems perform a wide range of functions associated with operation of a solar thermal power system, from specialized tasks such as heliostat tracking to control of an integrated plant's operation. The control subsystem is composed of a computer, sensors, and control drive elements.

Goals and Objectives

The objectives of the Solar Thermal Power Systems Program are:

- To provide for commercial implementation of dispersed thermal power systems by the early 1980's; and
- To establish solar thermal power as a technically, economically, and environmentally acceptable generation resource for electric utility applications by the mid-1980's.

To help meet these objectives, the following goals have been established:

- A trough type collector installed cost of $10 per square foot by 1985; $17 per square foot by 1980;
- A heliostat installed cost of $10 per square foot by 1985; $25 per square foot by 1980.

Solar Thermal Power Systems Program

The objectives of the Solar Thermal Power Systems Program are accomplished through research, development, and demonstration in three program areas:

- Dispersed Power Applications
- Central Power Applications
- Advanced Thermal Technology

The Dispersed and Central applications areas are designed to extend solar thermal technologies to a broad spectrum of potential users, ranging from large utilities to small communities, commercial/industrial users, and isolated applications such as farms. The Advanced Thermal Technology activities emphasize the development of advanced materials, subsystems, components, and testing in support of the overall program.

Dispersed Power Application Programs focus upon the development of solar thermal technology for applications in which the energy supply system can be integrated at the point of use. Such "on-site" systems are typically much smaller than would be optimum for utility/central station power plants. Comparable conventional systems in current use rely heavily upon fuels such as natural gas, propane, and oil. The use of solar thermal power systems for these applications offers the potential for economically competitive energy production, reduced environmental intrusions, and reduced consumption of critical fossil fuels.

Efforts in the Dispersed Power Applications area include:

- Total Energy Systems
- Small Power Systems
- Irrigation Systems

These smaller applications complement the developmental effort pursued under the Central Power Applications effort.

Central Power Application Programs focus upon large thermal plants ranging from $10MW_e$ to $300MW_e$. These large plants are perceived as forming an integral part of existing electric utility networks. They can be either large $50–300MW_e$ new power plants or retrofit systems for repowering smaller ($10–100MW_e$) older power plants now fueled with natural gas or imported oil. It is anticipated that these plants could eventually comprise 10 to 50 percent of the generating capacity of an individual utility, and account for a comparable share of the utility's requirements for primary energy. In this application, the operation of solar plants would directly and specifically reduce the national consumption of premium fuels such as oil and natural gas.

Two important areas within the Central Power Applications area of the program are:

- Large-scale Systems and Applications
- Central Receiver Subsystems and Components

Advanced Thermal Technology includes the definition of needs for likely future applications, identification of cost-effective candidate systems, and the development of key advanced subsystems. In addition, this segment of the program assesses the current state of the art of solar thermal technology, as well as developing trends.

These functions are performed by the development or characterization of:

- Innovative components and subsystems
- New absorber and reflective materials, working fluids, materials of construction, in support of central and dispersed applications
- Analyses and evaluation techniques

Program Activities

DISPERSED POWER APPLICATIONS

Total Energy Systems

Status:

During 1977, the Solar Total Energy System (STES) activity made progress toward initial operation of three large-scale total energy system experiments at Ft. Hood, Texas; Shenandoah, Georgia; and Blytheville, Arkansas. Also, the Solar Total Energy Systems Test Facility (STESTF) began operating in July 1977.

The large-scale experiments represent specific applications of the total energy concept to industrial, institutional, and military troop housing installations. Conceptual designs for the Ft. Hood and Shenandoah installations were completed in September 1977. The conceptual designs include drawings and specifications for the two systems. Several contractors participated in a competitive development of the designs; each design was reviewed and evaluated, and a single contractor was selected to complete the design on each of the installations. The Blytheville project was funded as a grant to the Mississippi County Community College which has assembled a project team to develop the design.

The total energy system industrial application is tailored to satisfy energy requirements for a knitwear manufacturing facility in Shenandoah, Georgia. The General Electric Company has been selected to complete preliminary design and initiate detailed design during 1978. When completed, the system will supply electricity, process heat, thermal energy for space conditioning, and domestic hot water heating.

The total energy system military troop housing application is tailored to satisfy energy requirements for a troop housing complex at Ft. Hood, Texas. The American Technological University assisted by the Westinghouse Electric Corporation has been selected to complete a preliminary design during 1978. When completed, the system will provide electricity, thermal energy for space conditioning, and domestic hot water heating. Both of these projects will be operational in the fall of 1980.

The total energy system institutional application is tailored to supply the major portion of the electrical and thermal energy requirements for a 50,000 square foot instruction building at the main campus of the Mississippi County Community College (MCCC) in Blytheville, Arkansas. This project will be a total energy system using photovoltaic direct conversion devices at the focus of concentrating collectors to produce electricity while absorbing heat for other uses.

The Solar Total Energy System Test Facility in Albuquerque, New Mexico, is presently in the final phase of construction. STESTF, when completed in early 1978, will consist of an 800 meter^2 collector field, comprised of four different concentrator concepts. One concentrator is operational. Two other concentrator concepts are being installed. The facility consists of a power conversion subsystem, thermal storage subsystems, and heat exchangers, which provide a capability to test a completely integrated total energy system. The Collector Module Test Facility in Albuquerque, N.M., completed testing on six intermediate temperature collector concepts for dispersed power systems in FY 1977. The test results on collectors tested at CMTF are published and widely distributed.

Future Effort:

The detailed system engineering design efforts for the Ft. Hood and Shenandoah total energy systems experiments are continuing and will be completed in the spring of 1979. Procurement of major components and construction will commence thereafter, with the hardware procurement being finalized during 1980 for the Ft. Hood and Shenandoah projects. The MCCC total energy system experiment will be operational in the fall of 1979.

Planning in support of dispersed high temperature thermal applications and alternative total energy concepts is underway and will provide new directions for the total energy program in 1978.

Three additional concentrators complementing the already operational parabolic trough array will become operational in the STESTF:

- A parabolic trough with movable "slats";
- A parabolic trough with fixed mirrors and a movable heat receiver; and
- A parabolic dish

STESTF will thus continue to provide basic engineering performance data for the subsystems to be employed in intermediate temperature range. Continuing experiments at STESTF will offer the opportunity to prove feasibility

of concepts at relatively low cost without the need for full-scale demonstration systems.

The Collector Module Test Facility will provide performance data for mid-temperature concentrating collector concepts during FY 1978. This data will be used to screen candidate collector concepts for intermediate temperature dispersed power applications.

Small Power and Irrigation Systems

Status:

Two developmental solar irrigation projects were initiated during 1977, as part of the effort to provide experimental systems on privately owned and operated farms. One system, installed at Willard, New Mexico, through joint funding by DOE and the State of New Mexico, began operating in July 1977. This system uses a 622 meter ^{2} collector field, a 25hp organic Rankine engine, an irrigation pump, controls, and a thermal storage subsystem to allow the system to operate 24 hours a day. The system is capable of irrigating 100 acres of crops, and pumps 700 gallons of water per minute from a well 110 feet in depth. This operational system is currently providing a demonstrated capability for using small solar thermal systems for irrigation. It is also providing significant operational performance data which will be used in defining requirements for future experiments.

The second experiment, a larger 200hp irrigation system jointly sponsored by DOE and the State of Arizona, is presently under development. This larger system to be located at Coolidge, Arizona, will be operational during 1979. Lower systems costs through higher operating temperatures and higher efficiencies are sought in this experiment.

Both experiments are intended to provide realistic performance and cost information of solar irrigation pumping applications.

Two complementary efforts for small community applications and high temperature collector development for dispersed power applications were initiated in 1977. The objective of these efforts is to extend small power systems technology into applications ranging from isolated self-contained systems to small community systems. Several projects were also initiated to determine the feasibility and requirements of solar powered generating systems for specific communities.

During 1977, proposals were solicited for the phase I conceptual design of an experimental system for the small community program. Multiple contract awards are expected to be made for this phase. These will be narrowed to a single design for the detailed design, construction, and test portion of the program. This initial hardware effect is expected to be followed by the development of additional experimental systems as more cost-effective components become available.

Future Effort:

The operation of the Willard, New Mexico, irrigation system will be continued through 1978 in order to accumulate operating experience. Construction of the Coolidge, Arizona, experiment will commence in 1978, with full operation scheduled for 1979. Solicitations are planned for early 1978 for the first phase of the effort to select a site for a 1 MW_e small community power system experiment. Solicitations for the final phase will be made early in 1979.

CENTRAL POWER APPLICATIONS

Large Scale Systems and Applications

Status:

Preliminary designs and subsystem experiments for a 10 MW_e pilot plant were completed in 1977. The selection of a site near Barstow, California, for the pilot plant preceded completion of this highly successful phase of the large scale applications effort. Based on indications of achieving central receiver system cost goals with the concept selected, work was initiated for preparation of final engineering design of the plant, as well as preparations associated with construction.

Prior to initiating the final design for the 10 MW_e pilot plant, a variety of concepts were evaluated. These concepts were the product of several studies initiated during 1975, which provided detailed analysis relating to the suitability of various collector and receiver concepts.

A consortium headed by the Southern California Edison Company was selected during 1977 to join with DOE in the implementation of this pilot plant effort. The plant will adapt a high temperature solar heat collection subsystem to supply steam to a turbine plant supplied by the utility partners.

A number of critical subsystem and component tests were also completed during 1977. These included testing of several heliostats, receivers, energy storage subsystems, overall plant and heliostat array, and heliostat control and tracking subystems.

Future Effort:

Studies initiated during 1977 will be contained, identifying promising alternative large-scale system concepts for utility applications. Three alternatives include fossil hybirds in lieu of storage coupled systems, large-scale concentrator concepts other than central receiver, and other power cycles and coolants, including variations of the Brayton cycle and sodium or molten salt Rankine cycle systems. These alternative approaches now under serious evaluation in the program are options for prototype utility power plant module following the Barstow experiment.

In the coming year, the repowering of existing oil and gas-fired power plants will also be receiving close attention in terms of a strategy for early utility implementation and industrial base development. In addition, development of heliostat manufacturing technology and low cost design are critical factors, and will receive increasing attention. Studies and project management in support 10 MW_e pilot plant at Barstow will continue. Completion of the Barstow plant is scheduled for 1981; operation will commence at that time with the objective of providing data and information needed to adapt water/steam central receiver technology to both repowering applications and the further development of storage coupled systems.

Central Receiver Subsystems and Components

Status:

Several efforts were initiated during 1977 for the development of advanced low cost heliostat designs. These activities are oriented toward reducing the cost of solar power plant heliostats, which are estimated to represent nearly 50 percent of the allowable plant costs.

A performance analysis of a single-axis focusing heliostat ($18m^2$) and a cavity-type line central receiver also has been completed.

The Albuquerque Solar Thermal Test Facility (STTF) will initiate full power operation early in 1978. The Albuquerque facility provides a capability for testing at flux levels exceeding 5 thermal megawatts. At this time, it will provide the capability for testing and evaluating all major central receiver subsystems and components, including receivers, heliostats, and high temperature thermal storage. Receiver testing is to be emphasized during 1978, and tests will be conducted to verify the receiver design in the 10 MW_e Barstow pilot plant. The STTF will be used as well to test receivers developed through private funding from the Electric Power Research Institute.

The 1978 program effort also will provide for the development of additional alternative low cost heliostat designs, as well as low cost water/steam receivers. Designs of these components will be tested and evaluated during 1979 at the STTF.

ADVANCED THERMAL TECHNOLOGY

Status:

Projects initiated during FY 1977 emphasized advanced component concepts and designs in support of both central and dispersed solar thermal power systems. A high-temperature, 1700°F advanced ceramic receiver for application to gas turbine systems was developed and tested. Studies and development were initiated for liquid metal and molten salt heat receivers as well as a 2000°F air-cooled ceramic receiver for Brayton cycle applications. Lower-cost, advanced collectors and heliostats received attention during FY 1977; testing of prototype units is scheduled for next year. Extensive work was performed in supporting areas, such as improved absorber coatings and reflective surfaces.

During FY 1977, construction of a 400 kW_{TH} Test Facility at the Georgia Institute of Technology was completed, and successful initial operation achieved. This facility will be used to test advanced solar thermal components and subsystems in the coming years.

Future Effort:

The Advanced Technology effort will continue to support the long-term goals of the central and dispersed power program elements. It will be aimed at developing improved coatings, reflective surfaces, and materials of construction and containment. The technical feasibility of new component and process concepts/designs will be experimentally demonstrated, especially for advanced heat receivers. Advanced systems will be identified, and the key solar components and subsystems will be developed and verified. Technology assessments will be performed to characterize the status of candidate technology for advanced solar thermal applications and to identify new solar thermal applications. As part of the technology assessment activity, test facility requirements will be identified and existing facilities will be coordinated to ensure their effective utilization.

OTHER ACTIVITIES

During 1977, the Environmental and Resource Assessment Branch prepared an assessment of environmental factors related to the Solar Thermal Power Systems Program. This assessment addressed environmental and safety issues pertinent to the use of solar thermal technology. An environmental development plan was also initiated and completed during 1977. This plan will be updated and revised on a continuing basis as the Solar Thermal Power Systems Program continues to evolve. The object of this plan is to anticipate impacts of solar thermal technology upon the environment, and to develop siting criteria for both central and dispersed applications.

Considerable effort was devoted to identifying the resources required in applying solar thermal technology, identifying suitable potential sites, assessing materials requirements, and performing environmental and technological assessments.

Conclusion

Many solar thermal systems were built and used in the late 1800's and early 1900's, but fell into disuse with the advent of low-cost electric generation and fuels. Today the Solar Thermal Power Systems Program is successfully applying advanced concepts of these previously used systems and is working towards adapting them to today's energy needs.

The challenge facing the Solar Thermal Power Systems program continues to be one of establishing economic feasibility, rather than technical feasibility. There is no technical limitation that prevents use of solar thermal power concepts. The fundamental question that is being addressed is whether solar thermal power can be economically competitive with other methods of power generation, considering both capital costs and operating costs. Since the technology behind the concepts is proven, a minimum of new technology is required to allow effective and widespread application of solar energy. Maximum use is being made of existing technology in the area of heat engines, high temperature heat transfer systems, materials and control systems. The Solar Thermal Power Systems Program continues to focus its research and development efforts on concentrating collectors, and heat receivers. The impetus in these areas is cost reduction and improved efficiency.

The involvement of industry in all phases of these developmental efforts is particularly crucial for a variety of reasons. First, in order to achieve widespread commercialization, the required capabilities must be established to manufacture and deliver solar thermal systems to potential users. Second, potential users of solar thermal concepts must participate in the developmental efforts to provide a basis in practical experience for integration of solar thermal power systems into the mainstream of the national energy supply network.

Demonstration efforts, which will continually be emphasized, are the means by which the concepts will be proven to be compatible with user requirements and economic constraints. Finally, financial resources must be made available within the industrial sector to successfuly implement solar thermal concepts. To this end, cost sharing of the initial systems is anticipated.

The Solar Thermal Power Systems Program is continually seeking opportunities to accelerate the progress toward technology readiness and cost-effective systems. With respect to dispersed power applications, it is expected that further demonstrations of the total energy system concept will be made. The focus will be upon those applications identified in response to competitive solicitations as providing the best opportunity for a major energy impact through commercialization by industry. In central power applications, repowering of existing fossil-fueled power plants and storage coupled systems are attractive alternatives to an exclusive reliance upon fossil fuels. Both alternatives are expected to accelerate the commercialization of solar thermal central power systems.

In support of continuing program activities, studies will be made to identify and assess both emerging system concepts and new applications. These studies will also categorize potentially attractive applications, define and characterize systems best suited to these applications, and identify the barriers and constraints to widespread commercialization.

In addition, studies will continue investigating the environmental effects of solar thermal technology.

Major milestones of the Solar Thermal Power Systems Program for the 1978–1987 period are summarized in Figures 4, 5, and 6.

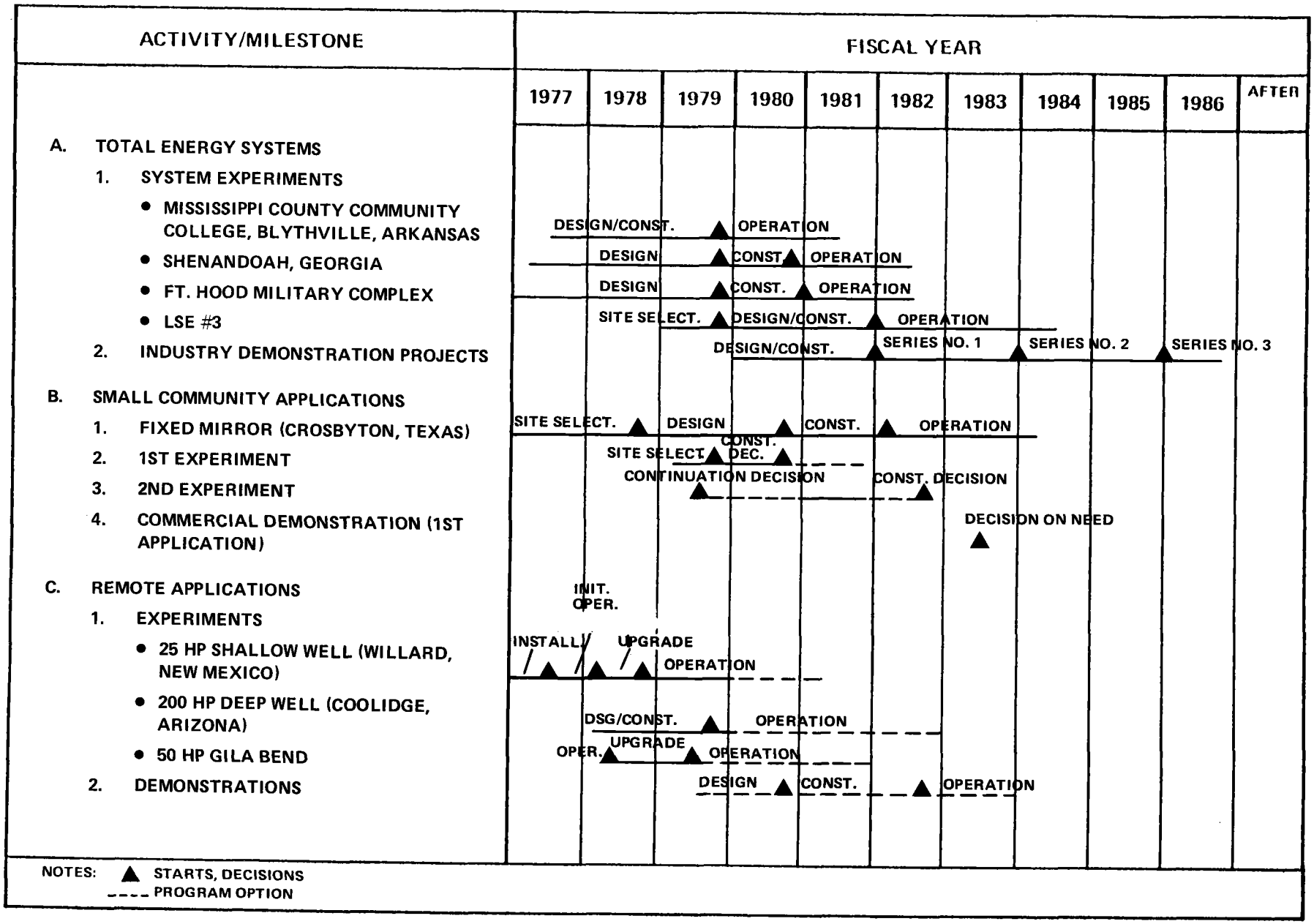


Figure 4. Dispersed Power Applications Milestones

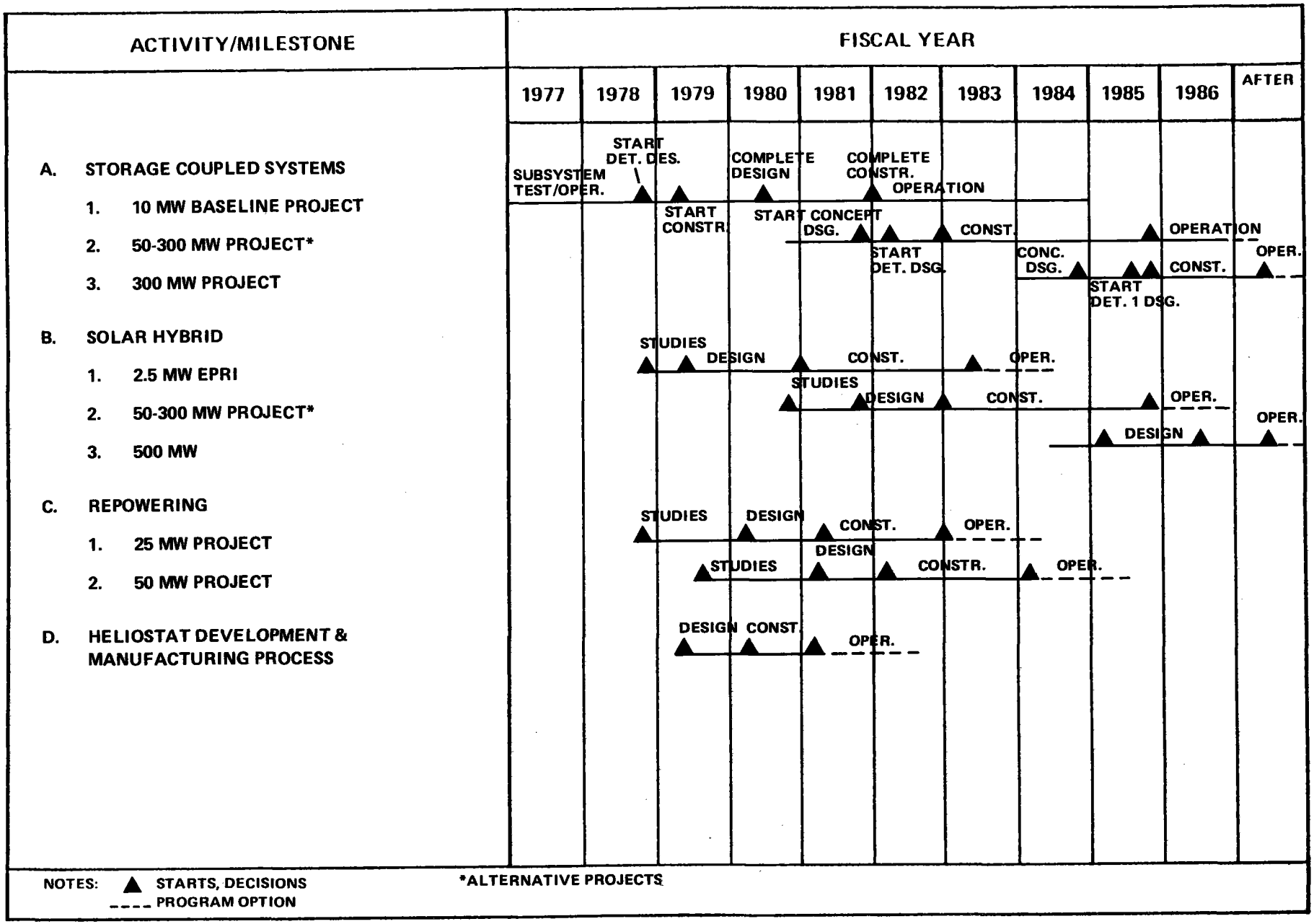


Figure 5. Central Power Applications Milestones

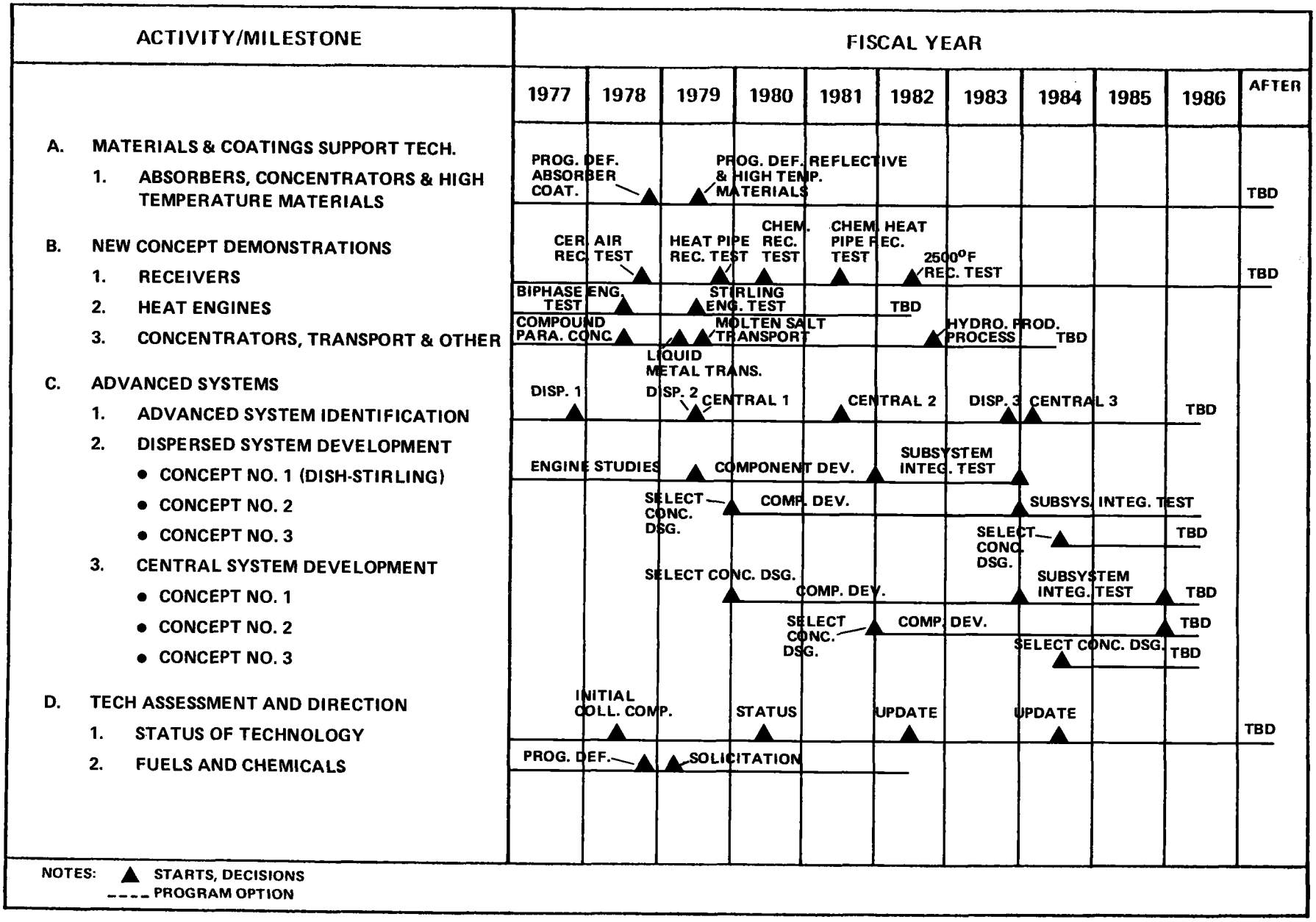


Figure 6. Advanced Thermal Technology Milestones

Project Funding

During fiscal years 1975 and 1976, the Solar Thermal Power Systems Program awarded or renewed 66 contracts. During fiscal year 1977, this number was extended to 99 contracts. The project summary tables list the contracts and a description of each. The complete contract list is broken down by program sub-elements.

Table 1 lists the program elements and their funding.

Table 1

SUMMARY OF SOLAR THERMAL POWER FUNDING

(Dollars in Thousands)

Program Elements	*FY 1976/TQ*[1] *Operating*	*FY 1976/TQ*[1] *Construction/ Capital Equipment*	*FY 1977 Operating*	*FY 1977 Construction/ Capital Equipment*
Dispersed Power Applications				
Total Energy Systems	$ 1,107		$12,883	$ 2,000
Small Power Systems			2,783	2,210
Irrigation Systems	155[2]		4,470	
Distributed Collector Systems	5,173	$ 86	—	
Central Power Applications				
Large Scale Systems and Applications	15,901		10,139	12
Central Receiver Facility	1,803	6,250	11,381	13,806
Advanced Thermal Technology	3,390		7,415	78
TOTALS	$27,529	$6,336	$49,071	$18,016

[1] FY 1976 & Transition Quarter (July-Sept. 1976)

[2] Irrigation and small power systems combined.

Fiscal Year 1977—Project Summary Tables

Table 2

FY 1977 SUMMARY TABLES

Program Element

DISPERSED POWER APPLICATIONS

• *Program Sub-Element*

TOTAL ENERGY SYSTEMS

Organization	*Title*	*Projected Contribution*
Sandia Laboratories	Solar Total Energy Test Facility (Total Energy-Distributed Collectors)	Defines system integration needs; develops experience and expertise in total energy systems.
	Technical Management of DSE Solar Total Energy Activities	Provides technical management of solar total energy activities.
	Distributed Collector Systems Components and Subsystems Development Project	Supports national solar energy efforts utilizing distributed collectors.
Aerospace Corporation	Solar Total Energy Systems Mission Analysis	Identifies attractive applications for total energy systems; explores performance and cost trade-offs; assesses potential markets; defines marketing strategies and timing.
Atomics International	Commercial Applications of Solar Total Energy Systems	Determines applicability of solar total energy technology to the commercial sector.
Institute of Gas Technology	Application Analysis of Solar Total Energy of the Residential Sector	Determines applicability of solar total energy technology to the residential sector.
McDonnell Douglas Corporation	Industrial Application of Solar Energy	Determines applicability of solar total energy technology to the industrial sector.
Resource Planning Associates	Institutional Application of Solar Total Energy Systems	Determines applicability of solar total energy technology to the institutional sector.
Georgia Power Company	Cooperative Agreement for the Conduct of a Solar Total Energy Large Scale Experiment	Demonstrates solar total energy concepts in a light industrial application.
Acurex-Aerotherm	Conceptual Design of a Solar Total Energy Large Scale System, Shenandoah, Georgia	Provides specifications for specific industrial application of solar thermal power technology.
General Electric Company	Conceptual Design of a Solar Total Energy Large Scale System, Shenandoah, Georgia	Provides specifications for specific industrial application of solar thermal power technology.
Stearns-Roger	Conceptual Design of a Solar Total Energy Large Scale System, Shenandoah, Georgia	Provides specifications for specific industrial application of solar thermal power tehnology.

Table 2 (cont.)

FY 1977 SUMMARY TABLES

Program Element

DISPERSED POWER APPLICATIONS

- *Program Sub-Element*

TOTAL ENERGY SYSTEMS

Organization	*Title*	*Projected Contribution*
TRW Energy Systems	Conceptual Design of a Solar Total Energy Large Scale System, Ft. Hood, Texas	Provides conceptual design for application of total energy systems to a troop housing complex.
Westinghouse Electric Corporation	Conceptual Design of a Solar Total Energy Large Scale System, Ft. Hood, Texas	Provides conceptual design for application of total energy systems to a troop housing complex.
American Technological University	Site Coordination and Support for the Ft. Hood Solar Total Energy Military Large Scale Experiment	Provides coordination between military application and system conceptual design contractors.
Mississippi County Community College	A Total Energy Solar Photovoltaic Conversion System for Mississippi County Community College, Blytheville, Arkansas	Provides for design and construction of a solar photovoltaic conversion system to supply total electrical and thermal energy requirements for a 50,000 sq. ft. facility.
Sanders Associates	Solar System Design for Lobster Aquaculture Plant	Applies solar thermal technology to an industrial application.

Table 3

FY 1977 SUMMARY TABLES

Program Element

DISPERSED POWER APPLICATIONS

• *Program Sub-Element*

SMALL SOLAR POWER SYSTEMS

Organization	*Title*	*Projected Contribution*
Jet Propulsion Laboratory	Small Power Systems Technology Project	Serves as Small Power Systems Program Technical Manager. Defines system requirements of solar thermal electric power systems in the 1 to 10 MWe range.
	Dispersed Systems High Temperature Technology Project	Determines technical and economic feasibility of high temperature single point focus distributed solar energy systems.
Aerospace Corporation	Small Power System Application Analysis	Provides application analysis for the Small Power System Program. Determines conditions under which small power plants are feasible.
City of Bridgeport, Texas	Determine the Feasibility of a Solar Powered Electric Generation Facility for City of Bridgeport, Texas	Establishes performance requirements, characterizes electric load, and considers impact of use of solar electric generating plant for a specific community.
Texas Tech University	Crosbyton Solar Power Project	Analyzes cost, nature, and performance of fixed mirror distributed focus collector for a specific community application.
University of Oklahoma	A Study of the Feasibility of Utilizing Solar, Wind, and Geothermal Energy in Hobbs, NM	Evaluates available resources and needs for a site specific application.
Energy Systems International	Planning and Support for IEA Solar Power Project	Provides technical advisory support for international cooperative demonstration.

Table 4

FY 1977 SUMMARY TABLES

Program Element

DISPERSED POWER APPLICATIONS

● *Program Sub-Element*

IRRIGATION SYSTEMS

Organization	*Title*	*Projected Contribution*
Sandia Laboratories	Solar Powered Irrigation	Serves as Irrigation Program Technical Manager. Develops analytic techniques for assessing feasibility of solar-powered irrigation; demonstrates operational farm system.
Aerospace Corporation	Solar Irrigation Systems Mission Analysis	Determines potential market penetration for solar irrigation systems.
Acurex Corporation	Preliminary Design Study 150 kWe Solar Powered Deep Well Irrigation Facility	Achieves competitive and viable design of irrigation facility with high thermodynamic efficiency.
Honeywell, Inc.	Preliminary Design Study, 150 kWe Solar Powered Deep Well Irrigation Facility	Achieves competitive and viable design of irrigation facility with high thermodynamic efficiency.
Black and Veatch	Preliminary Design Study, 150 kWe Solar Powered Deep Well Irrigation Facility	Achieves competitive and viable design of irrigation facility with high thermodynamic efficiency.
Payne, Inc.	Pulsejet Pump for Application to Irrigation Systems	Tests feasibility of pumps operated by hot water produced in solar collectors.
Bechtel Corporation	Technical and Economic Assessment of Solar Water Pumping for Remote Areas	Provides framework for design of cost effective solar irrigation system designs.

Table 5

FY 1977 SUMMARY TABLES

Program Element

CENTRAL POWER APPLICATIONS

• *Program Sub-Element*

LARGE SCALE SYSTEMS AND APPLICATIONS

Organization	*Title*	*Projected Contribution*
Sandia Laboratories	Solar Central Receiver Project Management	Provides program technical management in support of Central Utility and Industrial Systems.
Aerospace Corporation	Major Projects Technical and Management Support	Provides technical assistance in the design and construction of the 10 MWe Pilot Plant; provides test planning for utilization of the Solar Thermal Test Facility.
	Central Power Management Support (Task 1)	Provides technical and management support in development of plans and rationale of central power system programs.
Boeing Engineering and Construction Company	10 MWe Central Receiver Solar Thermal Power System, Phase I	Establishes feasibility of collector subsystems having commercial potential.
Honeywell, Inc.	10 MWe Central Receiver Solar Thermal Power System, Phase I	Establishes feasibility of Central Receiver type plant with commercial potential.
Martin Marietta Aerospace Corporation	10 MWe Central Receiver Solar Thermal Power System, Phase I	Establishes feasibility of Central Receiver type plant with commercial potential.
McDonnell Douglas Astronautics Company	10 MWe Central Receiver Solar Thermal Power System, Phase I	Establishes feasibility of Central Receiver type plant with commercial potential.
Aerospace Corporation	Advanced Central Receiver Power Systems Project	Identifies, analyzes, and develops advanced concepts for central receiver power systems.
Public Service Company of New Mexico	Technical and Economic Assessment of Solar Hybrid Repowering	Establishes conceptual framework for repowering existing fossil-fueled generating stations.
Boeing Engineering and Construction Company	Conceptual Design of Advanced Central Receiver System, Phase I	Provides systems analyses, selection of system configuration, conceptual design of commercial scale plant for the Advanced Central Receiver Power System Program.
General Electric	Conceptual Design of Advanced Central Receiver System, Phase I	Provides a systems analyses, selection of system configuration, conceptual design of commercial scale plant for the Advanced Central Receiver Power System Program.
Martin Marietta Corporation	Conceptual Design of Advanced Central Receiver System, Phase I	Provides a systems analyses, selection of system configuration, conceptual design of commercial scale plant for the Advanced Central Receiver Power System Program.
Rockwell International	Conceptual Design of Advanced Central Receiver System, Phase I	Provides a systems analyses, selection of system configuration, conceptual design of commercial scale plant for the Advanced Central Receiver Power System Program.

Table 5 (cont.)

FY 1977 SUMMARY TABLES

Program Element

CENTRAL POWER APPLICATIONS

- *Program Sub-Element*

LARGE SCALE SYSTEMS AND APPLICATIONS

Organization	*Title*	*Projected Contribution*
FMC Corporation	Line Central Receiver Research Study and Heliostat Experiment	Provides performance estimate of solar thermal electric power plant.
Energy Foundation of Texas	Analysis of Extreme Wind Effects of Solar Tower Systems	Provides data for design of wind resistant components.
Singer Company-Link Division	Engineering/Management Model 10 MWe Central Receiver Pilot Plant	Provides mathematical model of the performance dynamics of the 10 MWe central receiver pilot plant.
Energy Foundation of Texas	Solar Energy System Simulation and Analysis	Provides mathematical simulation and analysis of system components.
Bechtel Corporation	Technical and Economic Assessment of the Feasibility of Solar Distillation for Large Scale Production of Fresh Water	Provides framework for assessing large scale applications for solar technology.

Table 6

FY 1977 SUMMARY TABLES

Program Element

CENTRAL POWER APPLICATIONS

• *Program Sub-Element*

CENTRAL RECEIVER SUBSYSTEMS AND COMPONENTS

Organization	*Title*	*Projected Contribution*
Sandia Laboratories	Solar Thermal Test Facility	Designs, constructs, and implements the solar thermal test facility.
	Testing a One Megawatt Solar Receiver in a DOE Radiant Heat Facility	Provides experience for future development of large full-scale power systems.
Martin Marietta Corporation	1 MWth Bench Model Solar Cavity Receiver Steam Generator Build and Test	Provides validation of design approach for a central receiver solar thermal power plant; effort includes fabrication and test of a cavity steam generator.
Boeing Engineering and Construction Company	Solar Central Receiver Prototype Heliostat Study, Phase I	Provides verification of heliostat design, and preliminary design of complete heliostat system for the solar central receiver power plant effort.
General Electric Company	Solar Central Receiver Prototype Heliostat Study, Phase I	Provides verification of heliostat design, and preliminary design of complete heliostat system for the solar central receiver power plant effort.
McDonnell Douglas Astronautics Company	Solar Central Receiver Prototype Heliostat, Phase I	Provides verification of heliostat design, and preliminary design of complete heliostat system for the solar central receiver power plant effort.
Solaramics, Incorporated	Solar Central Receiver Prototype Heliostat, Phase I	Provides verification of heliostat design, and preliminary design of complete heliostat system for the solar central receiver power plant effort.
University of Minnesota	Hydraulic Stability of Solar Boilers	Provides analysis of model for verifying boiler performance.
University of Illinois	Experimental Study of Convective Losses from Solar Receivers	Provides model for studying characteristics of solar receivers.
Argonne National Laboratory	Mechanical Testing in Support of Structural Design of Solar Energy Central Receivers Power Plant Components	Provides results of material tests and data surveys on candidate materials for solar power plant components.
Foster-Wheeler Development Corporation	An Interim Structural Design Standard for Solar Energy Applications	Proposes structural standards for central receivers and components.

Table 7

FY 1977 SUMMARY TABLES

Program Element

ADVANCED THERMAL TECHNOLOGY

• *Program Sub-Element*

SUPPORTING TECHNOLOGY

Organization	*Title*	*Projected Contribution*
Absorber Coatings		
Argonne National Laboratory	Cost Effective Textured Amorphous-Silicon Thin Film Coating for Solar Thermal Conversion	Increase solar absorptance of state-of-the-art semiconductor-metal absorber stacks.
Cornell University	Optical Properties of Metallic Surfaces, Small Particles and Composite Coatings	Develop theory of composite-material absorber coating; prepare experimental samples.
Energy Foundation of Texas	Surface Morphologies of Efficient Solar Energy Absorbing Materials (Task 6)	Characterizes absorptance and emittance properties of black metal smokes and oxides.
Englehard Minerals and Chemicals Corporation	Improved Absorber Coatings for Thermal Utilization of Solar Energy	Develop new metal oxide absorber films for solar thermal conversion.
Exxon Research and Engineering Company	Optimization of High Temperature Coatings for Solar Applications	Develop point-on high temperature high α, high ε absorber films for solar thermal conversion.
RCA Laboratories	Development of Granular Semiconductors as Selective Absorbers	Develop paint-on high temperature high receivers.
Sandia Laboratories	Black Chrome Process Development	Determine and characterize deposition parameters for optimum performance of black chrome selective absorber coatings; will publish a handbook for use of the solar industry.
Solar Energy Research Institute	Absorber Surface Materials Workshop	Disseminates needs and requirements of absorber materials as applied to receivers.
University of Arizona	Chemical Vapor Deposition of Spectrally Selective Absorbers	Develop advanced performance silicon-metal absorber stacks for future generation receivers.
University of Arizona	High Temperature Optical Properties of Alloys for Central Receiver Solar Power Systems	Documents absorptance/emittance characteristics of boiler-tube steel candidates for central receiver pilot plant.
University of Minnesota	Composition Profiling of Solar Coatings and Materials with Auger Electron Spectroscopy and Electron Spectroscopy for Chemical Analysis	Provide a composition profiling service to DOE contractors developing solar thermal absorber coatings.

Table 7 (cont.)

FY 1977 SUMMARY TABLES

Program Element

ADVANCED THERMAL TECHNOLOGY

- *Program Sub-Element*

SUPPORTING TECHNOLOGY

Organization	*Title*	*Projected Contribution*
Reflective Material		
Battelle-Pacific Northwest Laboratories	Research and Development in Solar Mirror Quality Assurance Performance	Develop quality assurance standards and measuring techniques for the solar industry.
Other		
Lawrence Berkeley Laboratory	Measurement of Circumsolar Radiation	Documents circumsolar contribution to performance collector.
University of Minnesota/ Honeywell, Inc.	Research Applied to Solar Thermal Power Systems	Provides experimental heat transfer, storage capacity and reflector materials data.

Table 8

FY 1977 SUMMARY TABLES

Program Element

ADVANCED THERMAL TECHNOLOGY

● *Program Sub-Element*

NEW CONCEPT DEMONSTRATIONS

Organization	*Title*	*Projected Contribution*
Receivers		
Georgia Institute of Technology	One MWt Bench Model Cavity Receiver Steam Generator Test Program	Provides experience for future development of large full-scale power systems.
Sanders Associates	One Quarter MWt Solar Brayton Receiver Design, Construction and Testing	Verifies potential of Brayton Technology for application to large scale systems.
Dynatherm Corporation	Heat Pipe for Central Solar Receiver	Extends technology for heat exchangers applied to central solar receivers.
Naval Research Laboratory	Development of Converter Heat Exchangers for Solar Thermo-Chemical Energy Collectors	Evaluates design and tests performance of converter heat exchangers.
Collectors		
Argonne National Laboratory	Compound Parabolic Concentrator for Solar Thermal Energy Conversion	Develops collectors for application in the range of 400 to 600°F.
Brookhaven National Laboratory	Solar Powered Steam Generator Heliostat	Develops low cost heliostat for process steam application.
Sun Power Corporation	PARAVAC Solar Collector	Contributes to reduction of collector costs for total energy and irrigation application.
University of Chicago	Non-Imaging Concentrators for Wide-Angle Collection of Solar Energy	Develops prototype advanced concentrator based on results of basic research.
Engines		
Biphase Engines, Inc.	Evaluation of a Two-Phase Turbine System for Solar Electric Power Generation	Provides analyses, design, fabrication, and test of 600°F turbine.
Other		
Oak Ridge National Laboratory	Technical Support and Advanced Concepts Development	Assesses feasibility of near-ground-level central receiver concept; provides assessment of materials, chemistry, and storage technology.
University of Arizona	Optical Design of a Near-Ground-Level Central Receiver	Assesses feasibility of optical design for near-ground-level central receiver concept.
Lawrence Livermore Laboratory	Study of a 25 to 500 kWe Shallow Solar Pond System for Producing Shaft Power	Provides for a conceptual design study to identify applications for shallow solar ponds.
Westinghouse Electric Corporation	Hydrogen Production Process Development	Assesses attractiveness of hybrid system for production of hydrogen.

Table 9

FY 1977 SUMMARY TABLES

Program Element

ADVANCED THERMAL TECHNOLOGY

• *Program Sub-Element*

ADVANCED SYSTEMS

Organization	*Title*	*Projected Contribution*
Jet Propulsion Laboratory	Solar Thermal Power Systems Research and Development Management Project	Supports solar thermal electric advanced development program.

Table 10

FY 1977 SUMMARY TABLES

Program Element

ADVANCED TECHNOLOGY

• *Program Sub-Element*

TECHNOLOGY ASSESSMENT

Organization	*Title*	*Projected Contribution*
Oak Ridge National Laboratory	High-Temperature Industrial Applications of Solar Thermal Technology	Assesses use of solar thermal technology in chemicals and fuels manufacturing processes.
Institute of Gas Technology	Fuels and Chemicals from High Temperature Solar Energy	Assesses possibility of using solar energy to manufacture fuels and chemicals.
Georgia Institute of Technology	400 kWt Test Facility	Provides facility for evaluation and testing of solar thermal conversion components.
STTF User's Association	Solar Thermal Test Facilities	Provides for effective use of solar thermal test facilities by promoting the capabilities of these facilities throughout the scientific and engineering communities.

Current Projects

Summary Statements

DISPERSED POWER APPLICATIONS
PROGRAM ELEMENT
TOTAL ENERGY SYSTEMS
SUB-ELEMENT

TITLE	ORGANIZATION
Solar Total Energy Test Facility (Total Energy-Distributed Collectors)	Sandia Laboratories Albuquerque, NM 87155
AMOUNT	PRINCIPAL INVESTIGATOR
$3,735,000	James A. Leonard

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Albuquerque, NM	12 months—October 1, 1976	E(29–1)–0789

PROJECT SUMMARY:

Objective:

This project is to determine system integration considerations and accumulate experience, technical and cost data for solar total energy and other dispersed power systems for a variety of sites and loads; provide a versatile system which can be used as a national engineering evaluation center for component and subsystem development; and provide a system of sufficient size to require realistic integration of all subsystems. In addition, project objectives include the development of private sector expertise in solar energy; the monitoring of the state-of-the-art, and testing and evaluating subsystems and components developed in other DOE programs and in the private sector; and the generation and dissemination of technical and cost experience resulting from operation and testing on a wide basis.

Approach:

To achieve the described objective, tasks are being pursued in eight areas: Program Management, System Management, Collector Subsystems, Collector Subsystems Subcontracting, High Temperature Storage Subsystems, Prime Mover Subsystems, Heat and Cooling Subsystems, and Solar Collector Module Test Facility.

Status:

The current status of the project follows:

a. Installation of Sheldahl (SUNTEC) Slats Collector Field has been completed.
b. The General Atomics movable receiver collector system has been installed.
c. The Raytheon parabolic dish is scheduled for installation in January 1978.
d. The Multi-tank High Temperature Storage System has been completed.
e. The solar projects building (32 kWe and 200 kWth) has been operating with solar-derived energy.
f. In situ laser ray trace system for checking focus of collector systems has been developed.
g. Module testing of MDAC, Acurex, General Atomic, Raytheon, and Hexcel collectors has been conducted.
h. Two engineers from commercial companies completed training periods to acquire first-hand experience in the design and operation of solar energy components and systems.
i. High level subsystems operating time has been maintained (approximately 90 percent of available working hours for the collector field).

Future Effort:

This project is a continuing effort to accumulate Solar Total Energy technical and cost data experience for a variety of sites and loads. It will: (1) provide a system which can be used as a National Engineering Evaluation Center for concentrating solar collectors and total energy components and systems, (2) develop private sector expertise and experience in solar total energy, (3) monitor the state-of-the-art to ensure that new developments are expeditiously transferred from the private sector, and (4) generate and disseminate technical and cost experience resulting from actual experience and testing.

Refer to the photograph on the following page (Figure 7).

Figure 7. Solar Total Energy Test Facility (top)—Sandia Laboratories, Albuquerque, NM; Collector Module Test Facility (bottom)—Sandia Laboratories, Albuquerque, NM.

TITLE	ORGANIZATION
Technical Management of Solar Total Energy Activities	Sandia Laboratories P.O. Box 5800 Albuquerque, NM 87115
AMOUNT	PRINCIPAL INVESTIGATOR
$1,180,000	J. F. Banas

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Albuquerque, NM	12 months—October 1, 1976	E(29–1)–0789

PROJECT SUMMARY:

Objective:

The purpose of this project is to provide technical management of DOE's solar total energy activities at Sandia Laboratories.

Approach:

Sandia Laboratories are conducting the following activities under this contract:

a. Maintenance of a long-range Solar Total Energy Program Plan in cooperation with the Dispersed Power Systems Branch of DOE/SOLAR.
b. Preparation of annual operating plans based on the long range plan.
c. Technical monitoring of existing DOE-issued contracts pertaining to Solar Total Energy.

Status:

The following details the current status of the project:

a. A contract with Texas A&M to study impact of parallel operation of solar total energy systems with utility companies has been completed.
b. A site selection algorithm has been initiated and completed by Woodward-Clyde.
c. Industrial and commercial application studies have been completed. Residential and institutional application studies are continuing.
d. A troop housing complex at Ft. Hood, Texas, has been selected as the site for Large Scale Experiment (LSE) No. 1. A conceptual design RFP was initiated for this project.
e. A knitwear factory in Shenandoah, Georgia, has been selected as the site of LSE No. 2. A conceptual design RFP was initiated and completed.

Future Effort:

This project is a long-term program to demonstrate the feasibility of the Solar Total Energy concept and to develop in the industrial sector those technologies which offer the prospect of being economically attractive.

Expected progress in FY 78 is as follows:

a. Residential and institutional application studies will be completed.
b. Alternative system concepts with a goal of improving overall system performance will be investigated.
c. The SOLSYS computer code will be made available for remote terminal timeshare use.
d. Contractors will be chosen to carry the balance of the Ft. Hood and Shenandoah projects.

TITLE	ORGANIZATION
Distributed Collector Systems Components and Subsystems Development Project	Sandia Laboratories Albuquerque, NM 87115
AMOUNT	PRINCIPAL INVESTIGATOR
$1,680,000	James A. Leonard

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Albuquerque, NM	12 months—October 1, 1976	E(29–1)–0789

PROJECT SUMMARY:

Objective:

This project aims to develop components and subsystems and to generate technical data in support of national solar programs utilizing distributed receiver collectors.

Approach:

Project requirements include: determining project goals and guiding the project toward those goals; promoting development of sources for reflector structures, reflective materials, optical instruments, and selective coatings and evaluating environmental and technical capabilities of these items; and utilizing experience and technology to design and test improved collector field subsystems for the solar total energy test facility. In addition, the project is to test and evaluate existing commercial collector systems and to promote the design, development and actual performance testing of new collectors system concepts; to develop techniques and instruments for nondestructive testing and evaluation of the optical parameters of collector subsystems during production and/or after field installation; and to determine the prime mover and storage requirements for future dispersed power systems, primarily large scale experiments, and to promote development of subsystems to meet these requirements.

Status:

During FY 77 the major program results have been the following:

a. Fixed price procurements have been made of four commercially available intermediate temperature collectors. These collectors will be evaluated for performance on Sandia's Collector Module Test Facility.

b. Orders have been placed for the development and procurement of three intermediate temperature collectors from commercial sources. These collectors will be evaluated for performance on Sandia's Collector Module Test Facility.

c. A Request For Proposal (RFP) has been initiated for novel collector concepts. As a result of this RFP, four novel collector concepts have been selected for further funding and development.

d. Receiver tubes from General Electric and ITEK are being developed and procured for evaluation on the Sheldahl collector.

e. Reflective structures utilizing various materials and manufacturing techniques have been procured and evaluated.

f. A variety of reflective surfaces and coatings have been procured and evaluated.

g. Extensive environmental testing has been conducted on reflective structures, reflective materials, and selective coatings.

h. An inspection device utilizing laser technology has been developed for the evaluation of surface contours on reflector structures.

i. A RFP for the further development of the black chrome process has been initiated.

TITLE	ORGANIZATION
Distributed Collector Systems Components and Subsystems Development Project	Sandia Laboratories Albuquerque, NM 87115
AMOUNT	PRINCIPAL INVESTIGATOR
$1,680,000	James A. Leonard

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Albuquerque, NM	12 months—October 1, 1976	E(29–1)–0789

PROJECT SUMMARY: (Continued)

Future Effort:

This project should be a long term project to ensure the timely development of components and subsystems for dispersed power systems. Following are the expected results in FY 78.

a. Contracts will be placed to develop commercial sources for thin glass and sagged glass for use in reflectors.
b. A second generation collector design for the Solar Total Energy Test Facility will be procured and evaluated.
c. The collector evaluation and new collector development projects initiated in FY 77 will be completed and new initiatives started.
d. Competitive procurements for low cost collector manufacturing studies will be initiated.
e. Competitive procurement for development of line cavity receivers and receivers for high rim angle collectors will be initiated.
f. A second generation design for the in situ laser inspection apparatus will be initiated and prototypes tested.
g. Apparatus for on-site inspection and evaluation of collector fields will be developed.
h. Competitive procurements for studies and development of new heat transfer fluids and/or storage fluids will be initiated.
i. Prime mover study and development contracts will be placed for prime mover subsystems anticipated for future dispersed power system applications.

TITLE	ORGANIZATION	
Solar Total Energy Systems (STES) Mission Analysis	The Aerospace Corporation P.O. Box 92957 Los Angeles, CA 90009	
AMOUNT	PRINCIPAL INVESTIGATOR	
$500,000	Dr. Mason Watson	
WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Los Angeles, CA.	12 months—March 1, 1977	EY–76–C–03–1101 (Task 3)

PROJECT SUMMARY:

Objective:

The Solar Total Energy Systems (STES) mission analysis objectives are to define and characterize viable STES configurations and applications; to develop techniques and criteria for evaluating relative performance and economics of STES applications; to assess the size and potential penetration rate of STES markets and associated regional and national fuel displacement, and to define system marketing strategies.

Approach:

Specific tasks required to achieve the described objectives include:

a. Definition of application characteristics which are relevant to STES effectiveness; development of screening criteria, and selection of applications which are compatible with candidate STES configurations.
b. Development of thermal and electrical demand profiles of promising STES applications for use in performance optimization studies.
c. Analysis of the relative performance and economics of STES as a function of application characteristics, including effects of size, regional location, and costs of competing conventional systems. Development of estimates of capital equipment cost, annual performance and energy displacement for the system/application combinations. Calculation of performance sensitivities to both technical and economic parameters and identification of areas of new technology requirements.
d. Analysis of STES market size and degree of potential market penetration. Development of forecasts of national and regional fuel savings, including the effect of government incentives and various social, economic and institutional factors. Identification of those applications and regions showing promise of early penetration.
e. Review and analysis of work by other contractors which are pertinent to the data development, analyses, and forecasting aspects of the above tasks.

Status:

Thermal and electric energy demand profiles have been generated for industrial, residential and commercial applications. These have been combined with regional insolation data in a computer simulation to yield STES performance figures of merit as a function of application characteristics and location. Detailed forecasts have also been developed of fuel prices and energy use by fuel type, state, and end user. A computer code has been developed which combines these data with forecasts of STES costs to evaluate market penetration by state and industry. The code is currently being exercised to determine regional and national forecasts of fuel savings due to STES, and effects of variations in technical and economic parameters.

Future Effort:

Future work will use the computer tools and analysis results of the previous effort to examine advanced STES designs and develop new technology requirements. The effect of these on market penetration and fuel savings will also be determined.

TITLE	ORGANIZATION
Commercial Applications of Solar Total Energy Systems	Atomics International
AMOUNT	**PRINCIPAL INVESTIGATOR**
$247,341	S.J. Nalbandian

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Downey, CA	13 months—May 10, 1977	EY–76–C–03–1210

PROJECT SUMMARY:

Objective:

The purpose of this project is to determine the compatibility and the applicability of solar total energy to the commercial sector.

Approach:

Four tasks have been pursued to meet the described objective:

a. Energy requirements within the commercial sector have been defined. Both actual and computed hourly thermal and electric demands have been generated.
b. Conceptual designs, including subsystem optimizations have been executed.
c. Site characteristics favorable to solar total energy have been identified.
d. The economics and market penetration of solar total energy for commercial applications have been studied.

Status:

This project has been completed except for a revision to the final report. This final report will be available through the National Technical Information Service. The report indicated that the best applications appear to be primarily shopping centers. While significant potential market exists, urban siting of most commercial applications leads to land limitations severely constraining the displacement of conventional energy sources by STE. Low thermal loads as compared to electric loads within the commercial sector makes the value of cascading energy questionable. Photovoltaic technology appears most favorable for small applications.

Future Effort:

No continuation of this contract is planned. However, it is expected that the report will require updating in FY80 and a competitive award will be made at that time.

TITLE	ORGANIZATION	
Application Analysis of Solar Total Energy for the Residential Sector	Institute of Gas Technology Chicago, Illinois	
AMOUNT $385,228	PRINCIPAL INVESTIGATOR T.P. Whaley	
WORK LOCATION Chicago, Illinois	DURATION-AWARD DATE 12 months—April 1, 1977	CONTRACT NO. EG–77–C–04–3707

PROJECT SUMMARY:

Objective:

The objective of this project is to determine the compatibility and the applicability of solar total energy to the residential sector.

Approach:

The following four tasks are required to achieve the described objective:

a. Establishment of energy requirements within the residential sector.
b. Identification of innovators and assessment of early market penetration of Solar Total Energy (STE) in residential sectors in the 1980's: Project findings to the year 2020.
c. Production/evaluation of conceptual designs for STE systems in residential applications having minimum 50 kWe electric load.
d. Development of criteria for selecting demonstration sites to promote early market penetration of STE systems in residential sectors.

Status:

The Second Quarterly Report is complete and available through the National Technical Information Service. Preliminary conclusions indicate that very highly seasonal loads within the residential sector lead to poor utilization of collected energy with resultant poor cost effectiveness. Natural gas is expected to be solar's primary competitor due to high priority of the residential sector. Low-rise apartment complexes appear to be the best applications.

Future Effort:

The final report of this study will be complete by April 1978 and available through the National Technical Information Service by June 1978.

TITLE	ORGANIZATION
Industrial Application of Solar Total Energy	McDonnell Douglas Corporation 5301 Bolsa Avenue Huntington Beach, CA
AMOUNT	PRINCIPAL INVESTIGATOR
$175,872	J.E. Rogan

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Huntington Beach, CA	19 months—September 15, 1977	EY–76–C–03–1132

PROJECT SUMMARY:

Objective:

The objective of this project has been to determine the compatibility of solar total energy to the industrial sector.

Approach:

To achieve the described objective, five tasks have been accomplished:

a. Energy-intensive industries within the U.S. have been identified.
b. Real demand information has been obtained for 24 industries.
c. Conceptual designs, including subsystem optimization have been executed.
d. Characteristics of sites compatible with solar total energy have been identified.
e. The economics and market penetration of solar total energy power plants have been studied.

Status:

All tasks have been completed and a final report is available through the National Technical Information Service. The study indicated that Solar Total Energy has diverse applications within the industrial market sector and can displace a large percentage of the conventional energy currently used. Large process heat demands and relatively small electric demands provide applications compatible with a cascaded energy technology.

Future Effort:

It is anticipated that this report will require updating in FY 80 and a competitive award will be made at that time.

TITLE	ORGANIZATION	
Institutional Application of Solar Total Energy Systems	Resource Planning Associates Washington, D.C.	
AMOUNT	PRINCIPAL INVESTIGATOR	
$357,772	H.C. Bailly	
WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Washington, D.C.	12 months—March 7, 1977	EG–77–C–04–3786

PROJECT SUMMARY:

Objective:

The objective of this project is to determine the compatibility and the applicability of solar total energy to the institutional sector.

Approach:

a. *Task 1.* Establishment of energy requirements within the institutional sector
b. *Task 2.* Identification of the segments of the institutional market having the highest potential for penetration by Solar Total Energy (STE) systems.
c. *Task 3.* Development of conceptual designs to assess the technical and economic characteristics of representative systems.
d. Task 4. Examination of the institutional barriers faced by STE systems in these sectors.
e. *Task 5.* Estimation of the pentration of STE systems in these segments and assess the effects of Federal incentive policies.
f. *Task 6.* Development of criteria to select demonstration projects to maximize the national market penetration of STE systems in the institutional market.
g. Task 7. Assessment of the potential for demonstration projects in the recreational sector.

Status:

A load model of typical institutions in various sections of the country has been completed. It appears that due to low thermal to electric energy demand ratios within the institutional sector limited amounts of electricity can be displacement by STE. The most cost effective STE systems are electric peak shaving systems taking advantage of time of day pricing. The Second Quarterly Report on this project is complete and available through the National Technical Information Service.

Future Effort:

The final report of this study will be complete by April 1978 and will be available in June 1978 through the National Technical Information Service.

TITLE	ORGANIZATION
Cooperative Agreement for the Conduct of a Solar Total Energy Large Scale Experiment	Georgia Power Company Atlanta, GA 30302
AMOUNT	**PRINCIPAL INVESTIGATOR**
$273,000	Walter R. Hensley

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Atlanta, GA	6 years—June 14, 1977	EG–77–A–04–3994

PROJECT SUMMARY:

Objective:

This project aims to demonstrate that the Solar Total Energy Systems concept is capable of commercial operation by providing electricity, steam, and hot and cold water at a knit wear factory located in Shenandoah, Georgia.

Approach:

Under the terms of the DOE/Georgia Power Company Cooperative Agreement, Georgia Power Company will provide the following services:

a. *Cost-Shared Services.* Provide site and factory data, evaluate factory energy performance. Provide utilities connections, licenses and permits, planning, liaison, cost, schedule and reporting.
b. *DOE-Funded Services.* Provide interface definition and control drawings. Provide for operation and maintenance of the DOE/Sandia Meteorology Station.
c. *Cooperative Agreement Special Services.* Provide the ancillary equipment, materials and services required to interface the Solar Total Energy System (STES) with the factory and the utility.

Status:

The contractor has provided preliminary data to the conceptual design contractors. This data was updated in October 1977. Actual plant load data will be available for collection during the spring of 1978.
The Meteorology Station is presently in operation.

Future Effort:

The cooperative agreement will continue for the life of the project.

TITLE	ORGANIZATION
Conceptual Design of a Solar Total Energy Large Scale System—Shenandoah, GA.	Acurex-Aerotherm Mountain View, CA 94042
AMOUNT	PRINCIPAL INVESTIGATOR
$305,000	Larry Anderson

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Mountain View, CA	4 months—May 25, 1977	EG–77–C–04–3986

PROJECT SUMMARY:

Objective:

This project has provided a competitive conceptual design for a solar total energy system for a knitwear factory located in Shenandoah, Georgia.

Approach:

To meet the described objective, three tasks have been required:

a. Provide management and supervision for overall project planning, direction, coordination, control of cost and schedule, liaison, reports, and presentations.
b. Provide systems requirements analyses, including loads, energy displacement, life cycle costs, health and safety, environmental, reliability, laws and ordinances, and utility interface.
c. Develop a conceptual design system description, including drawings and specifications. The Acurex design consisted of a field of north-south oriented parabolic troughs using hydrocarbon heat transfer fluid, oil and rock storage, Organic (Toluene) Rankine power conversion system and a mix of absorption and vapor compression air conditioner systems. The system was predicted to supply approximately 60 percent of the factory annual energy requirements.

Status:

The contractor, Acurex-Aerotherm, presented its conceptual design on September 22, 1977, along with two other competitors. General Electric, Space Systems Division was selected to continue this project. The contractor's final report is available through the National Technical Information Service.

Future Effort:

The Shenandoah Solar Total Energy Large-Scale Experiment preliminary design will be performed by the General Electric Company. The preliminary design will take approximately 10 months.

TITLE	ORGANIZATION
Conceptual Design of a Solar Total Energy Large Scale System Shenandoah, GA	General Electric Company Space Systems Division King of Prussia, PA 19101
AMOUNT	**PRINCIPAL INVESTIGATOR**
$301,000	A.J. Poche

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
King of Prussia, PA	4 months—May 25, 1977	EG–77–C–04–3985

PROJECT SUMMARY:

Objective:

This project has provided a competitive conceptual design for a solar total energy system for a knitwear factory located in Shenandoah, Georgia.

Approach:

To meet the described objective, three tasks have been required:

a. Provide management and supervision for overall project planning, direction, coordination, control of cost and schedule, liaison, reports and presentations.

b. Provide systems requirements analyses, including loads, energy displacement, life cycle costs, health and safety, environmental, reliability, laws and ordinances, and utility interface.

c. Develop a conceptual design system description, including drawings and specifications. The General Electric design consisted of a field of two axis tracking parabolic dish collectors, hydrocarbon and rock storage, steam Rankine power conversion system and an absorption chiller. The system would supply approximately 68 percent of the factory annual energy requirements.

Status:

The contractor, General Electric Space Systems Division, presented its conceptual design on September 22, 1977, along with two other competitors. General Electric was selected to continue this project.

Future Effort:

Additional funds will be authorized to this contract to complete the project which is expected to be operational by spring of 1981.

Refer to photograph on the following page (Figure 8).

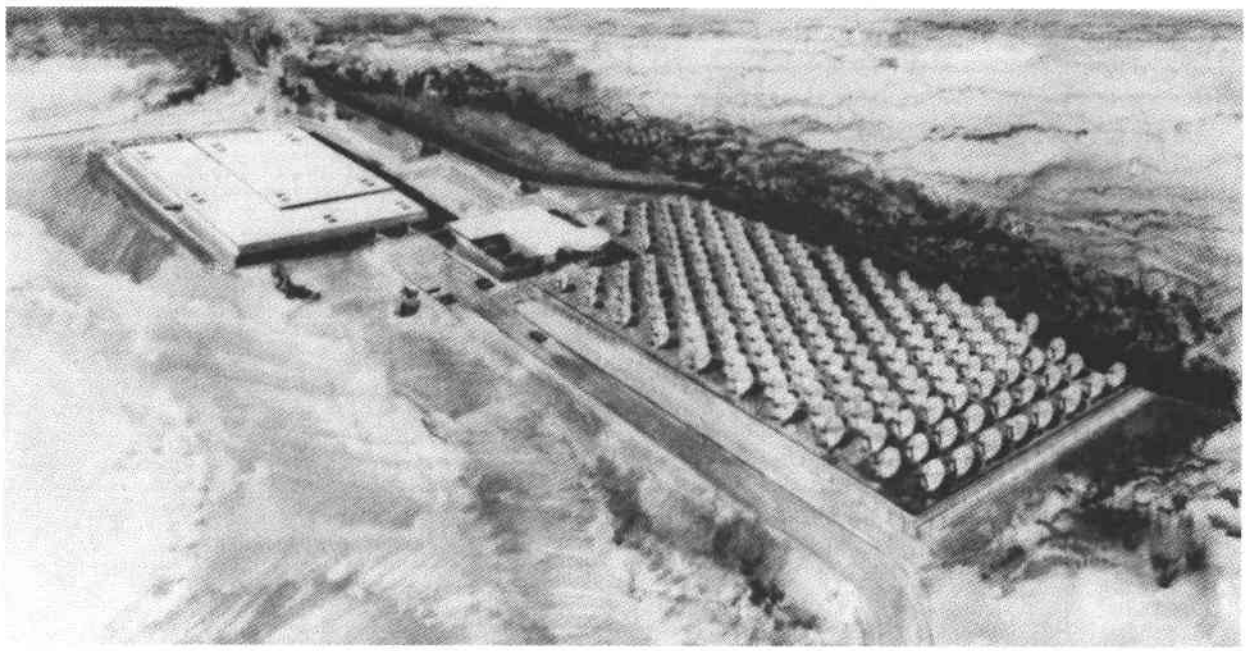


Figure 8. Artist's Sketch: Solar Total Energy Large Scale Experiment, Shenandoah, Georgia.

TITLE	ORGANIZATION
Conceptual Design of a Solar Total Energy Large Scale System—Shenandoah, GA	Stearns-Roger Denver, CO 80217
AMOUNT	**PRINCIPAL INVESTIGATOR**
$305,000	W.R. Lang

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Denver, CO	4 months—May 25, 1977	EG–77–C–04–3987

PROJECT SUMMARY:

Objective:

The project has provided a competitive conceptual design for a solar total energy system for a knitwear factory located in Shenandoah, Georgia.

Approach:

To meet the described objective, three tasks have been required:

a. Provide management and supervision for overall project planning, direction, coordination, control of cost and schedule, liaison, reports and presentations.
b. Provide systems requirements analyses, including loads, energy displacement, life cycle costs, health and safety, environmental, reliability, laws and ordinances and utility interface.
c. Develop a conceptual design system description, including drawings and specifications. The Stearns-Roger design proposed a field of north-south oriented parabolic trough collectors, oil and rock thermal storage, a two-stage supercritical organic Rankine power conversion cycle, and an absorption chiller. The system would supply approximately 35 percent of the factory annual energy requirements.

Status:

The contractor, Stearns-Roger, presented its conceptual design on September 22, 1977, along with two other competitors. General Electric, Space Systems Division was selected to continue this project. The contractor's final report is available through the National Technical Information Service.

Future Effort:

The Shenandoah Solar Total Energy large-scale experiment preliminary design will be performed by the General Electric Company. The preliminary design will take approximately 10 months.

TITLE	ORGANIZATION
Conceptual Design of a Solar Total Energy Large Scale System— Ft. Hood, TX	TRW Energy Systems One Space Park Redondo Beach, CA 90278
AMOUNT	PRINCIPAL INVESTIGATOR
$317,403	Jack Cherne

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Redondo Beach, CA	4 months—May 26, 1977	EG–77–C–04–3989

PROJECT SUMMARY:

Objective:

Under this project the contractor, in competition with another contractor, has provided a conceptual design for a solar total energy system for a troop housing complex at Fort Hood, Texas.

Approach:

Three tasks have been required to achieve the described objective:

a. Providing management and supervision for overall project planning, direction, coordination, control of cost and schedule, liasion, reports and presentations.
b. Providing systems requirements analyses, including loads, energy displacement, life cycle costs, health and safety, environmental, reliability, laws and ordinances, and utility interface.
c. Developing a conceptual design system description, including drawings and specifications. The TRW conceptual design consisted of a field of north-south oriented parabolic troughs, oil/rock storage, organic (toluene) Rankine cycle power conversion system, and a two-stage absorption air conditioner.

Status:

TRW presented its conceptual design on September 22, 1977, along with another competitor, Westinghouse Electric Corporation, Advanced Energy Systems Division, Pittsburgh, Pennsylvania. Westinghouse was selected to perform the systems engineering follow-on effort. TRW's submitted design study is available through the National Technical Information Service.

Future Effort:

The preliminary design phase of the Ft. Hood Solar Total Energy Large-Scale Experiment will be performed by the American Technological University and Westinghouse Electric Corporation.

TITLE	ORGANIZATION
Conceptual Design of a Solar Total Energy Large Scale System Ft. Hood, TX	Westinghouse Electric Corporation Advanced Energy Systems Division P.O. Box 10864 Pittsburgh, PA 15236
AMOUNT	PRINCIPAL INVESTIGATOR
$316,872	Joseph J. Buggy, Jr.

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Pittsburgh, PA	4 months—May 26, 1977	EG–77–C–04–3988

PROJECT SUMMARY:

Objective:

Under this project, the contractor, in competition with another contractor, has provided a conceptual design for a solar total energy system for a troop housing complex at Fort Hood, Texas.

Approach:

Three tasks have been required to achieve the described objective:

a. Provide management and supervision for overall project planning, direction, coordination, control of cost and schedule, liaison, reports and presentations.

b. Provide systems requirements analyses, including loads, energy displacement, life cycle costs, health and safety, environmental, reliability, laws and ordinances, and utility interface.

c. Develop a conceptual design system description, including drawings and specifications. The Westinghouse design consisted of a field of north-south oriented parabolic troughs, multi-tank storage, tandem steam turbines for the power conversion system, and a two-stage absorption air conditioner.

Status:

Westinghouse presented its conceptual design on September 22, 1977 and was selected to complete the systems engineering effort on this project.

Future Effort:

Westinghouse in partnership with the American Technological University will perform the preliminary design of the Ft. Hood Solar Total Energy Large-Scale Experiment. It is expected that this phase will take approximately 8 months.

Refer to photograph on following page (Figure 9).

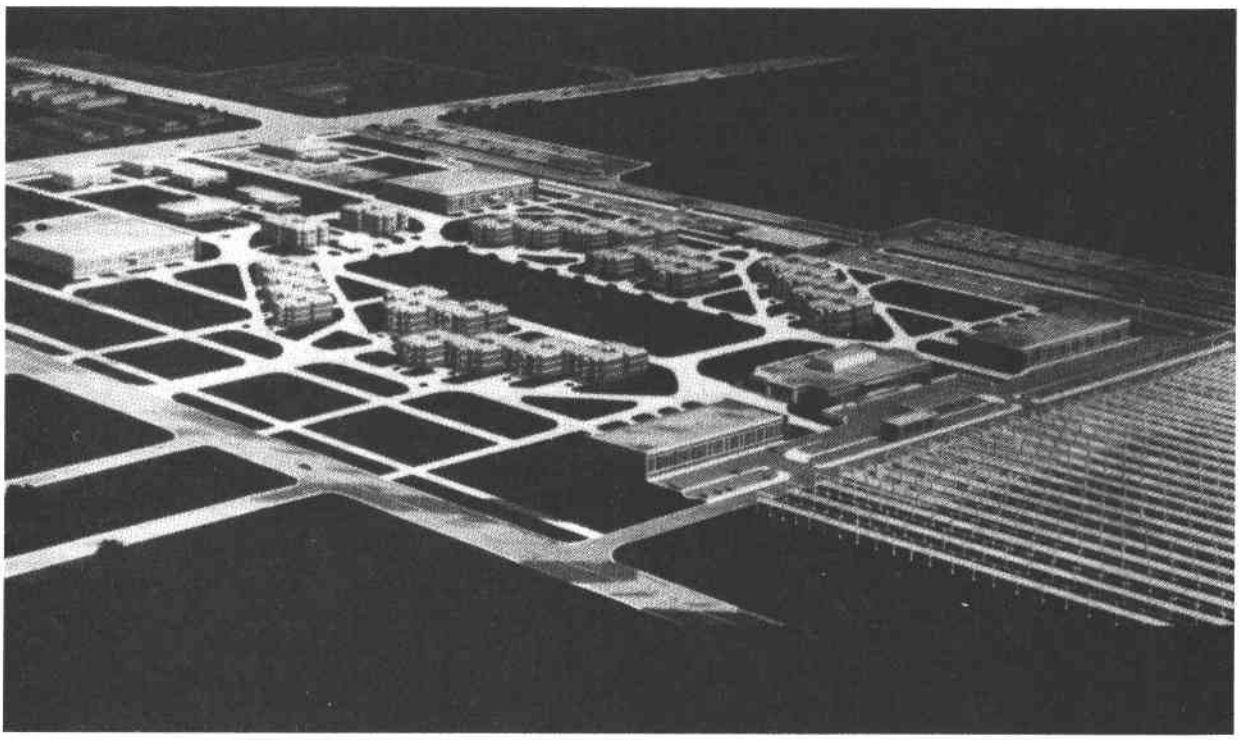


Figure 9. Artist's Sketch: Solar Total Energy Experiment, Fort Hood, TX.

TITLE	ORGANIZATION
Site Coordination and Support for the Fort Hood Solar Total Energy Military Large Scale Experiment	American Technological University (ATU) P.O. Box 1416 Killeen, TX 76541
AMOUNT	PRINCIPAL INVESTIGATOR
$2,104,425	J.J. Kincel

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Killeen, TX	12 months—November 23, 1976	EG–77–C–04–3878

PROJECT SUMMARY:

Objective:

The overall objective of the Fort Hood project is to design, construct, and operate a Solar Total Energy System to provide electricity, space heating, air conditioning, and domestic hot water to a modular troop housing complex at Fort Hood, Texas. The purpose of this contract is to provide site coordination between the military application and the system conceptual design contractors.

Approach:

This activity includes the continued collecting of climatological and loads data and the operation of a 400 ft^2 collector module and test loop.

Status:

The phase of the project which this contract calls for has been completed on schedule. The following tasks were accomplished:

a. ATU has collected data on the electrical and thermal (heating and cooling) loads for the barracks and administration buildings to be used in the project.
b. Climatological data for the specific location of Fort Hood Army Base has been determined.
c. The 400 ft^2 collector module and test loop is operational and a computer program has been established to reduce and analyse the data from this module.

Future Effort:

ATU will be the prime contractor for the next phase of this project, the preliminary design. ATU will utilize the services of Westinghouse Electric Company, Advanced Energy Systems Division, Pittsburgh, Pennsylvania, to perform the systems engineering effort. This phase will take approximately 8 months.

TITLE	ORGANIZATION
A Total Energy Solar Photovoltaic Conversion System for Mississippi County Community College, Blytheville, Arkansas.	Mississippi County Community College Blytheville, Arkansas 72315
AMOUNT	PRINCIPAL INVESTIGATOR
$2,000,000	Dr. Harry V. Smith President Mississippi County Community College

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Blytheville, Arkansas	23 months—July 1, 1977	EG–77–G–05–5565

PROJECT SUMMARY:

Objective:

The objective of this program is to design and construct a Solar Photovoltaic Conversion System (SPCS) to supply the major portion of the electrical and thermal energy requirements for an instructional facility of approximately 50,000 sq ft at the main campus of the Mississippi County Community College.

Approach:

This program is in accord with the objectives of DOE's Solar Total Energy Program which are "to demonstrate the technical, economic, and institutional feasibility of the total energy concept and to promote within an appropriate industrial sector a technology which offers the prospect of being economically competitive with other energy sources." Further, this program is expected to demonstrate the advanced technologies employed in the SPCS by making use of well-characterized but perhaps commercially unproven components, subsystems, and systems.

Status:

Selection of components, subsystems and systems is being made on the basis of cost-effectiveness and design tradeoff studies conducted to assure the highest probability of success for the program. An engineering model of the prototype collector should be ready for test in late February 1978. An engineering model (1 kw) of the prototype (10 kw) battery system is being assembled. A test of the battery model will be conducted in February 1978.

Future Effort:

The project should be completed and operations started in the summer of 1979. The total DOE contribution to this project will be $6.3 million.

Refer to the photograph on the following page (Figure 10).

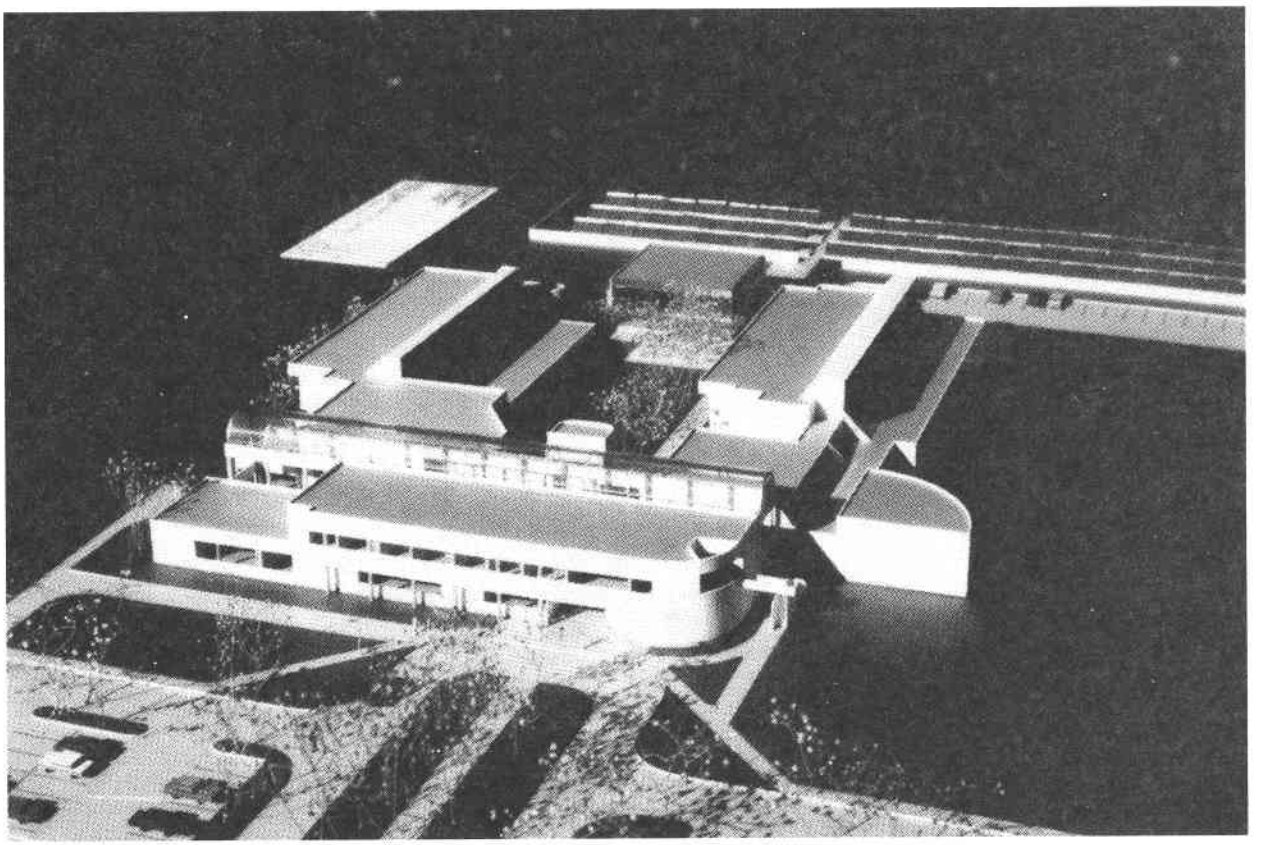


Figure 10. Architectural Model: Solar Total Energy Experiment, Mississippi County Community College, Blytheville, AR.

TITLE	ORGANIZATION	
Solar System Design for Lobster Aguaculture Pilot Plant	Sanders Associates 95 Canal Street Nashua, NH 03066	
AMOUNT $ 77,608	PRINCIPAL INVESTIGATOR Paul W. Chapman	
WORK LOCATION Nashua, NH	DURATION-AWARD DATE 4 months—April 25, 1977	CONTRACT NO. EG–77–C–02–4274

PROJECT SUMMARY:

Objective:

The objective of this system design study is the creation of a nutrient environment for culturing commercial lobster through the use of solar heating. It is hoped that this effort will help lead to the revitalization of the lobster industry in New England.

Approach:

This project requires creating a design study to be used in applying solar collectors, 200 sq ft in area, to heat a 60,000 Btu/hr Barber Nichols refrigerant (F 113) Rankine cycle engine. This engine will circulate and heat sea water to 68°F. At this temperature lobster maturation can take place five to six years earlier than is possible in normal temperature northern sea water.

Status:

The design study has been completed and the final report is in progress. Publication is scheduled for November 1977.

Future Effort:

The study indicated that a total energy system would be the most economical, i.e., generate electricity and use waste heat to circulate and heat sea water. As a result of this effort, Sanders is being evaluated by JPL in anticipation of participating in competitive solicitations in the total energy system program.

Summary Statements

DISPERSED POWER APPLICATIONS PROGRAM ELEMENT SMALL SOLAR POWER SYSTEMS SUB-ELEMENT

TITLE	ORGANIZATION
Small Power Systems Applications Project	National Aeronautics and Space Admin. Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, CA 91103
AMOUNT $667,000	PRINCIPAL INVESTIGATOR V. Truscello, A. Marriott

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Pasadena, CA	5 months—August 4, 1977	NAS7–100

PROJECT SUMMARY:

Objective:

The funding provided by this Interagency Agreement Amendment has been to establish the Small Power System Applications (SPSA) Project in support of DOE's Division of Solar Technology, Solar Thermal Power Office. The overall objective of the SPSA Project is to develop and foster commercialization of solar thermal electric power systems for application in the 1 to 10 MWe range. Potential applications include power systems for small communities, remote or dispersed utilities, rural areas and industrial users. The goal is to install one or more experimental systems in small community utility systems.

Approach:

Initial activities include the preparation of project plans, the establishment of a project organization, and the implementation of certain near-term tasks. With regard to the latter, a major emphasis during this time period is the writing and issuing of an RFP for Phase 1 of the first experimental power plant to be developed, constructed and tested as part of this project. Other tasks involve the definition of small power system design requirements, utility industry integration, commercialization analysis, and the development of experimental power plant siting criteria.

Status:

The following items reflect the accomplishments of the project:

a. The first electric utility workshop was held in October 1977.
b. An RFP for an architectural and engineering study of potential use of solar-powered systems in small utilities was issued in October 1977.
c. In-house systems studies and a cost goal analysis were initiated for the described RFP.
d. Project staffing is nearly complete.
e. A statement of work has been prepared for the systems analysis contract to be reviewed by DOE.
f. Goal task and detailed plans for the overall project have been initiated.

Future Effort:

A 1 MWe electric solar power plant will be established and integrated with an existing utility in a small community. This project scheduled for operation by 1982 requires three tasks:

a. System definition to be completed by the fourth quarter of FY 78.
b. Preliminary design to be completed by FY 79.
c. Final design, construction, and test to be completed by FY 82.

TITLE	ORGANIZATION
Dispersed Systems High Temperature Technology Project	National Aeronautics and Space Admin. Jet Propulsion Laboratory California Institute of Technology 4800 Oak Grove Drive Pasadena, CA 91103
AMOUNT $630,000	PRINCIPAL INVESTIGATOR Dr. J. Lucas

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Pasadena, CA	4 months—August 4, 1977	NAS7–100

PROJECT SUMMARY:

Objective:

The objective of this project is to determine the technical and economic feasibility of high temperature single point focus distributed solar energy systems. This project serves as a support to DOE's Division of Solar Technology by establishing and maintaining a technical and management overview of the Dispersed Systems High Temperature Technology Project, including the preparation of all plans, schedules, costs, and briefings.

Approach:

The achievement of the project objective requires three tasks:

a. Performance of detailed technical cost comparisons of candidate single point focus distributed systems for Dispersed Systems High Temperature Applications.
b. Technical monitoring of a baseline study on a 5 MWe fixed-mirror distributed-focus solar power plant concept.
c. Preparation of industry RFP's for:
   (1) Design and construction of two point-focusing test-bed concentrators for concentrator design comparison,
   (2) Concept definition of superheated steam receivers operating at approximately 50 kWth thermal power,
   (3) Concept definition of gas receivers operating at approximately 50 kWth direct-coupled by Brayton Engines,
   (4) Concept definition of adapting and modifying existing steam engines in the 15 to 25 kWe power range,
   (5) Concept definition of adapting and modifying existing Brayton engines at approximately 15 kWe power, and
   (6) Modeling methodology of manufacturing costs of subsystems.

Status:

A project plan has been completed and a project organization has been established. Present in-house systems engineering efforts include: defining systems and their technology status; evaluating applications studies as a first step in developing system subsystem cost goals; and establishing subsystem interfaces. Preparations for test and evaluation of the test-bed concentrators and follow-on subsystems have been initiated. Contracting for low-cost concentrators, receivers, and engines from RFP responses is being undertaken.

Future Effort:

The RFP's referred to above are presently being prepared and all will be issued between January and April 1978.

TITLE	ORGANIZATION
Small Power Systems Application Analysis	The Aerospace Corporation P.O. Box 92957 Los Angeles, CA 90009
AMOUNT $250,000	PRINCIPAL INVESTIGATOR Dr. Mason Watson
WORK LOCATION Los Angeles, CA	DURATION-AWARD DATE 12 months—March 1, 1977
	CONTRACT NO. EY 76–C–03–1101

PROJECT SUMMARY:

Objective:

The objective of the Small Power Systems Project is to determine the conditions under which Small Solar Thermal Power plants, including total energy plants, can be economically feasible and effective as sources of electric or combined electrical and thermal energy for applications in the 1 to 10 MWe range, and to foster the development and commercialization of modular systems in this size range.

Approach:

Specific tasks supporting the described objectives include:

a. Development of methodologies for assessing the characteristics and requirements of small communities and other possible applications.
b. Comparison of the performance and economics of small solar plants for various applications.
c. Identification of solar system design and application requirements and constraints for promising applications.
d. Assessment of market size and market penetration potential by region and application.
e. Assessment of incentives and barriers to solar system implementation and the development of alternative strategies for commercialization.

Status:

A data base for small power applications has been developed and work is underway to explore various significant issues including costs of service, reliability, cost versus size scaling, financing alternatives available to potential users, and the societal/institutional impacts of solar plant construction and operation.

Future Effort:

It is expected that this project will be continued in FY 1978 at approximately the same level of funding.

TITLE	ORGANIZATION
Determine the Feasibility of a Solar Powered Electric Generating Facility for the City of Bridgeport, TX	City of Bridgeport, TX
AMOUNT	PRINCIPAL INVESTIGATOR
$ 94,000	John Burgess (Carter & Burgess, Inc.) (817) 335-2611

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Bridgeport, TX	6 months—January 31, 1977	EG–77–C–05–5296

PROJECT SUMMARY:

Objective:

The objective of this project is to determine the feasibility of a solar-powered electric generating facility for the City of Bridgeport, Texas. This study considers a total integrated electric generating system whose principal energy source is solar power, but which also includes viable alternative energy sources to drive the generators when sufficient energy from the solar power system is unavailable.

Approach:

In determining the optimum character and location of the integrated solar powered electric generating facility, the following tasks have been undertaken:

a. Consideration of weather data and solar insolation.
b. Consideration of electrical demand profiles for the City of Bridgeport.
c. Consideration of environmental impact of proposed systems.
d. Consideration of aesthetic impact.
e. Consideration of availability of stand-by or off-peak power or load sharing with existing utilities.
f. Consideration of availability of heat sinks.
g. Consideration of potential sites based on "black box" data furnished by DOE concerning the characteristics of the solar plant.
h. Consideration of impact of operation and maintenance of the facility.

Status:

All aforementioned tasks have been completed. The contractor requested a contract extension and funding for five additional tasks. Two of these tasks were approved:

a. Evaluation of economic impact on a small community where a solar electrical generating plant is constructed.
b. Determination of alternate types of fuel available and the cost of stand-by fuel costs versus the cost of stand-by electric power from the existing utility grid.

Future Effort:

The two additional tasks are expected to be completed by March 1978.

TITLE	ORGANIZATION
Crosbyton Solar Power Project	Texas Tech University Lubbock, TX
AMOUNT	PRINCIPAL INVESTIGATOR
$1,250,000	Dr. John D. Reichert

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Crosbyton, TX	15 months—October 1, 1976	EG–77–C–04–3737

PROJECT SUMMARY:

Objective:

The objective of this project is to provide a preliminary design specification and cost estimate for an analog test system which may be constructed and operated in Segment II. Segment II consists of the construction of a small model of one of 10 proposed collectors which will be used to verify the computer and design details established in the preliminary conceptual design of a 5 Mwe Solar Electric Power Plant. In addition, the project is to provide a conceptual design of a recommended Fixed Mirror Distributed Focus (FMDF) solar power system for Crosbyton, and to develop a body of information concerning the nature and utility of FMDF solar power systems along with appropriate capability for extending that body of information.

Approach:

To meet the described objectives, the following deliverables are required:

a. A conceptual engineering analysis of the expected cost, nature, and performance of the FMDF Solar Power System.
b. An overall assessment of the applicability and usefulness of the FMDF concept at Crosbyton, including the integration of the FMDF system physically and operationally with the existing power system at Crosbyton.
c. A description of the possible utility of FMDF solar power systems at other sites and in other roles; i.e., under conditions in which some of the specific constraints of the Crosbyton site and load are modified or relaxed.
d. Explanation of the basis for selection of the design parameters and for the cost estimate of the Analog Test System (ATS).
e. Selection and justification of a specific site for building the ATS and preliminary description of the site characteristics (application of site data).
f. Detailed results, both analytical and experimental, on the following emphasized topics: the receiver subsystem, transient effects, mirrors and panels, control and tracking subsystems, error budgets and impact on system performance, system studies and strategy, and the economic aspects of FMDF solar power systems.
g. A full report on the status and results of the research program which was employed to achieve objectives a through f with recommendations for future areas of effort and rationale for specific emphasis.

Status:

A preliminary report on the progress of this program was issued in February 1977. An extension of the existing contract is in progress for the purpose of adding two tasks to be completed by the second quarter of FY 78. These two tasks will enhance the understanding of the fixed mirror distributed focus concept.

Future Effort:

A final report on the result of this program with recommendations for future areas of effort will be published during the second quarter of FY 78.

TITLE	ORGANIGATION
A Study of the Feasibility of Utilizing Solar, Wind, and Geothermal Energy in Hobbs, New Mexico	The University of Oklahoma Center for Economic & Management Research College of Business Administration 305 West Brooks St. Norman, Oklahoma 73019
AMOUNT $144,746	PRINCIPAL INVESTIGATOR Benjamin Taylor

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Norman, Oklahoma	16 months—June 30, 1976	EY–76–S–05–5231

PROJECT SUMMARY:

Objective:

This study aims to determine the economics of utilizing solar thermal power systems as alternate energy sources for the entire community of Hobbs, New Mexico.

Approach:

The work required to meet the described objective is divided into four tasks:

a. *Task 1.* Determine the load profiles of industrial and residential energy consumed for typical electrical/heating load for all seasons during the year.
b. *Task 2.* Evaluate solar, wind, and geothermal energy as major potential contributors to the community's total energy system.
c. *Task 3.* Determine the technical and economic feasibility of solar, wind, and geothermal energy by demand versus resource data; identify optimum energy mix; and assess institutional barriers/requirements.
d. *Task 4.* Develop a recommended course of action for the community.

Status:

Data for tasks 1 through 3 have been gathered and programs for determining optimum energy mix and community recommendations are being evaluated. A final report is being prepared.

Future Effort:

No continuation of this contract is planned. The results of the study will be utilized in the Small Power Applications project.

TITLE	ORGANIZATION
Planning and Support for IEA Solar Power Project	Energy Systems International P.O. Box 1604 Washington, D.C. 20013
AMOUNT	PRINCIPAL INVESTIGATOR
$ 19,912	Herbert C. Yim (703) 370-8908

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Washington, D.C.	4 months—April 1, 1977	EA-77-X-01-2196 EG-77-X-01-3027

PROJECT SUMMARY:

Objective:

The objectives of this project have been to organize the first of several International Energy Agency (IEA) Solar Power System Management Planning meetings, and to provide systems planning and technical advisory support to the Central Power Branch during the conceptual planning stage of the IEA Small Solar Power Systems Project.

Approach:

To achieve the described objectives, five tasks are required:

a. Definition of Small Solar Power Systems Project technical considerations.
b. Initiation of systems planning for the project conceptual phase.
c. Proposal of project management strategy for international projects.
d. Establishment of short and long range milestones and schedule.
e. Convening of working groups for subsequent planning activities.

Status:

Nine countries have signed an agreement to jointly investigate the feasibility of demonstrating two dissimilar 500 kWe solar electric power plants (distributed collector system and central receiver system) at Almeria, Spain.

Future Effort:

Further support contracts are planned in order to insure adequate and continued liaison of the United States and the IEA participants.

Summary Statements

DISPERSED POWER APPLICATIONS PROGRAM ELEMENT IRRIGATION SYSTEMS SUB-ELEMENT

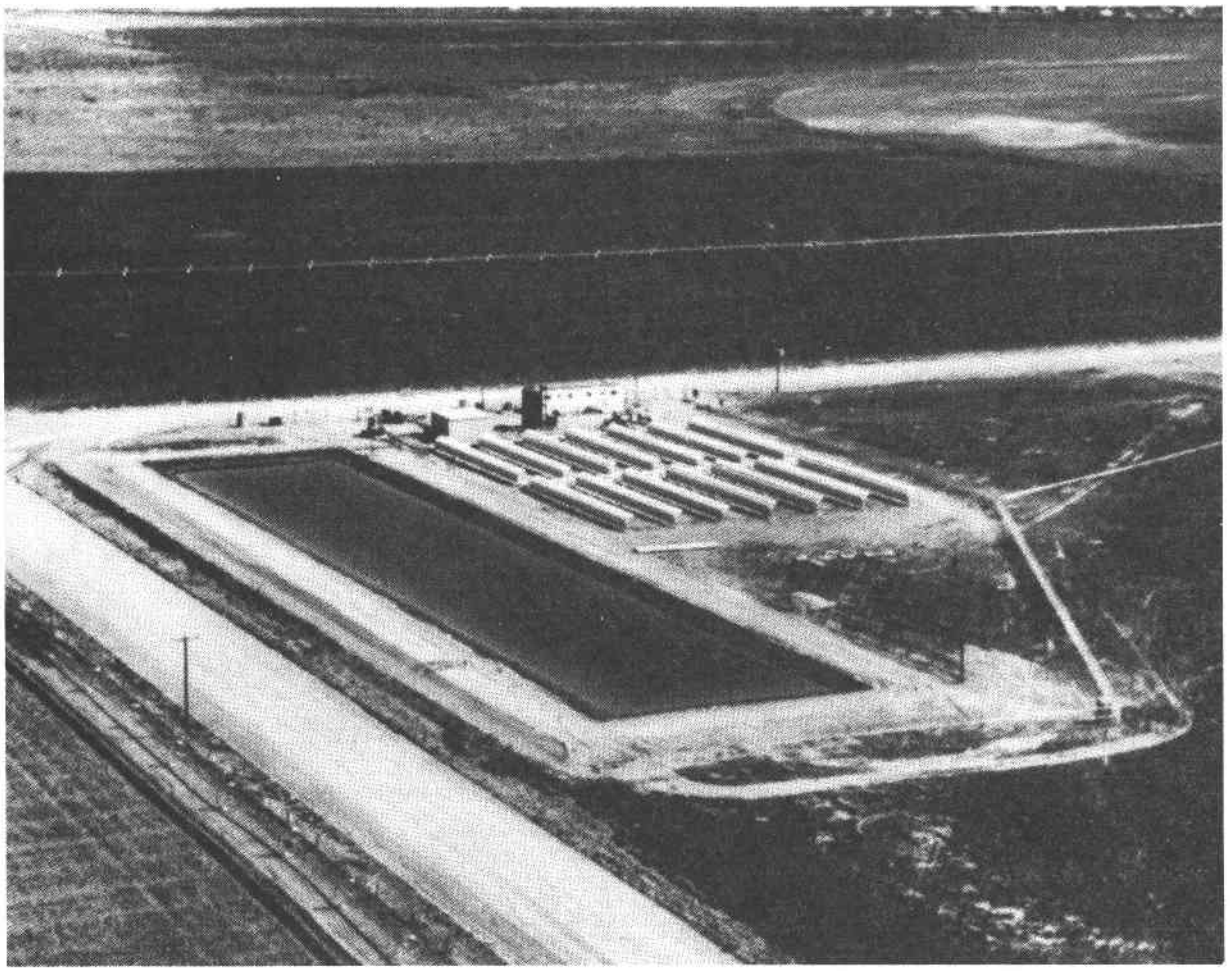


Figure 11. 25 Horsepower Shallow Well Irrigation System, Willard, NM.

TITLE	ORGANIZATION	
Solar Powered Irrigation	Sandia Laboratories Albuquerque, NM 87115	
AMOUNT $2,032,000	PRINCIPAL INVESTIGATOR R.H. Braasch (505) 264-8573	
WORK LOCATION Albuquerque, NM	DURATION-AWARD DATE February 1, 1976	CONTRACT NO. E(29–1)–789

PROJECT SUMMARY:

Objective:

The purpose of this project is to analytically develop techniques and methods for assessing solar-powered irrigation feasibility on both a regional and a national basis and to design, fabricate, and field demonstrate solar-powered irrigation systems on working farms.

Approach:

This project requires the accomplishment of six tasks:

a. Design, construct, and operate a shallow well solar irrigation project in New Mexico, and obtain performance data on its operation.
b. Assist DOE in preparing a Solar Irrigation Program.
c. Provide technical management for the solar irrigation experiment in Arizona.
d. Conduct system analyses on both local and regional bases on the feasibility of solar-powered irrigation.
e. Upgrade the New Mexico experiment to power a center pivot irrigation system and to study and conduct experiments on off-season solar energy usage.
f. Initiate a demonstration system for Solar Irrigation Program, if appropriate.

Status:

The following reflects the accomplishments of the project:

a. The shallow well irrigation project in Willard, New Mexico, began operation in July 1977. A solar irrigation workshop and dedication ceremonies were held at the same time
b. Acurex/Bechtel was selected as the contractor to design the deep-well irrigation experiment in Arizona.
c. The feasibility study of solar-powered irrigation is approximately 50 percent complete.
d. Approximately one half of the RFP's for equipment to upgrade the New Mexico irrigation experiment to power a center pivot irrigation system have been completed. Design for this facility is still in progress.
e. The alternate use study on off-season solar energy is continuing.

Future Effort:

Definition of a third experimental solar irrigation system or a demonstration system for solar irrigation system has not been started. Additional information is required from the deep-well project before this can be done.

Continual assistance will be given to DOE for improving solar-powered irrigation systems from the standpoint of efficiency and cost.

Refer to the photograph on the preceding page (Figure 11).

TITLE	ORGANIZATION
Solar Irrigation Systems Mission Analysis	The Aerospace Corporation P.O. Box 92957 Los Angeles, CA 90009
AMOUNT	PRINCIPAL INVESTIGATOR
$250,000	Dr. Mason Watson

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Los Angeles, CA	12 months—March 1, 1977	EY 76–C–03–1101

PROJECT SUMMARY:

Objective:

This mission analysis is being conducted to determine the technical and economic feasibility and the potential market penetration by solar power systems capable of providing power for irrigation water pumps and other agricultural needs. An additional objective of the mission analysis is to assist DOE in developing and structuring the Solar Irrigation Systems Project.

Approach:

To meet the described objective, six task elements are required:

a. Data Acquisition.
b. Data Analysis and Projection.
c. Review and Assessment of Solar Irrigation System Concepts.
d. Performance Comparison.
e. Economic Analysis.
f. Market Analysis.

Status:

Following identification of 17 western states as the major crop irrigation regions of the nation, 6 states have been selected initially for detailed analysis of irrigation practices and crop production costs. Analyses are underway of various significant issues including the impact of irrigation on U.S. exports, the economics of pumped irrigation by crop and by region, and the costs and feasibility of various alternative energy sources for irrigation.

Future Effort:

It is expected that this project will be continued in FY 1978 by the Solar Energy Research Institute.

TITLE	ORGANIZATION
Preliminary Design Study, 150 kWe Solar Powered Deep Well Irrigation Facility	Acurex Corporation Aerotherm Division 485 Clyde Avenue Mountain View, CA 94042
AMOUNT	PRINCIPAL INVESTIGATOR
$344,850	Gary J. Neuner

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Mountain View, CA	6 months—February 1, 1977	EG–77–C–04–3917

PROJECT SUMMARY:

Objective:

The objective of this project is to achieve an economically viable competitive design of a 150 KWe Solar Powered Deep Well Irrigation Facility through reasonably high thermodynamic efficiency at temperatures of 600°F or higher.

Approach:

The selected design approach had to use components that are advanced in the research and development cycle and had to be capable of reliable, long-life operation. Acurex selected a distributed collector configuration using parabolic trough single-axis tracking concentrators. Heat transfer oil is pumped through the collector field and into storage or into an organic Rankine-cycle turbine subsystem for electrical power generation.

Status:

Acurex-Aerotherm presented its design study in competition with two other contractors for award of a second phase contract involving detailed design, construction, installation, and check out of the irrigation facility. After review, Acurex was awarded the second phase contract for which efforts began in October 1977.

Future Effort:

The 150 kWe Deep Well project second phase efforts are expected to continue through September 30, 1979, and cost $2,800,000.

Refer to the sketch on the following page.

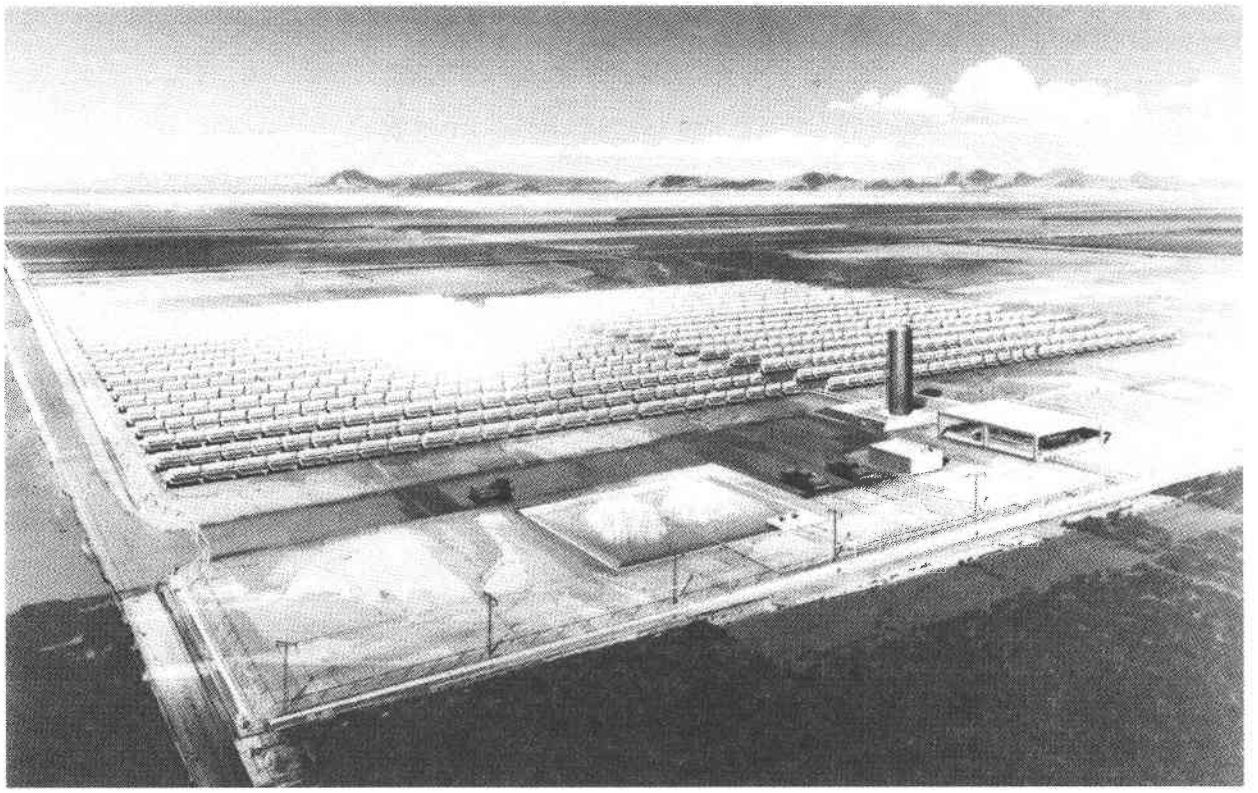


Figure 12. Artist's Sketch: Deep Well Solar Irrigation System, Coolidge, AZ.

TITLE	ORGANIZATION
Preliminary Design Study 150 kWe Solar Powered Deep Well Irrigation Facility	Honeywell, Inc. Energy Resources Center 2600 Ridgway Parkway Minneapolis, Minnesota 55413
AMOUNT $324,285	PRINCIPAL INVESTIGATOR R.A. Evans

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Minneapolis, MN	6 months—February 1, 1977	EG–77–C–04–3918

PROJECT SUMMARY:

Objective:

The objective of this project is to achieve an economically viable competitive design of a 150 KWe Solar Powered Deep Well Irrigation Facility through reasonably high thermodynamic efficiency at temperatures of 600°F or higher.

Approach:

The selected design approach had to use components that are advanced in the research and development cycle and capable of reliable, long-life operation. Honeywell selecteda distributed collector configuration using two-axis tracking parabolic concentrators (dishes) with receivers, open Brayton-cycle heat engines and electrical generators placed at the foci.

Status:

Honeywell presented its design study in competition with two other contractors for award of a second phase contract involving detailed design, construction, installation, and check out of the irrigation facility. After review, Acurex-Aerotherm was awarded the second phase contract. Honeywell's design study may be obtained through the National Technical Information Service.

Future Effort:

None.

TITLE	ORGANIZATION
Preliminary Design Study, 150 kWe Solar Powered Deep Well Irrigation Facility	Black & Veatch, Consulting Engineers 1500 Meadowlake Parkway Kansas City, Missouri 64114
AMOUNT	PRINCIPAL INVESTIGATOR
$312,051	Sheldon L. Levy

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Kansas City, MO	6 months—February 1, 1977	EG–77–C–04–3916

PROJECT SUMMARY:

Objective:

The objective of this project is to achieve an economically viable competitive design of a 150 KWe Solar Powered Deep Well Irrigation Facility through reasonably high thermodynamic efficiency at temperatures of 600°F or higher.

Approach:

The selected design approach must use components that are advanced in the reasearch and development cycle and are capable of reliable, long-life operation. Black & Veatch selected a central receiver/heliostat field configuration utilizing heat transfer salt and a Rankine cycle steam turbine to drive the electrical generation system.

Status:

Black & Veatch presented its design study in competition with two other contractors for award of a second phase contract involving detailed design, construction, installation, and check out of the irrigation facility. After review, Acurex-Aerotherm was awarded the second phase contract. Black & Veatch's design study may be obtained through the National Technical Information Service.

Future Effort:

None

TITLE	ORGANIZATION
Pulsejet Pump for Application to Irrigation Systems	Payne, Inc. 1910 Forest Drive Annapolis, MD 21401
AMOUNT	PRINCIPAL INVESTIGATOR
$ 99,725	Peter Payne

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Annapolis, MD	10 months—August 1, 1977	EG–77–C–01–4121

PROJECT SUMMARY:

Objective:

The objective of this 10-month program is to test the feasibility of using Water Pulse Jet Pumps (WPJP) powered by hot water from flat plate collectors to lift ground water for irrigation purposes.

Approach:

To achieve the described objective entails five tasks:

a. The performance parameters of two existing electrically heated pumps are to be measured for suction heights to 30 feet and total lifts to 50 feet. Modifications will be made to one of these engines to provide cold water injection. Tests are then to be performed to determine if the cold water injected engine can perform better than the non-injection engine.
b. A computer modeling study is to be performed and the program will be validated with data from the task described in a.
c. An optimized WPJP is to be designed, built, and tested from the results of the task described in b.
d. An economic analysis is to be conducted.
e. A utilization plan is to be prepared.

Status:

Authorization of this project was delayed until September 1977. As a result, this project was not started until October 1, 1977.

Future Effort:

Dependent on the results of this contract.

TITLE	ORGANIZATION
Technical and Economic Assessment of Solar Water Pumping for Remote Areas	Bechtel Corporation 50 Beale Street P.O. Box 3695 San Francisco, CA 94119
AMOUNT	PRINCIPAL INVESTIGATOR
$ 11,717	E. Y. Lam

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO. Subcontract to
San Francisco, CA	5 months—July 19, 1977	E(29–1)–789

PROJECT SUMMARY:

Objective:

The objective of this project was to conduct a survey of the currently available solar energy technology and hardware that could be utilized to pump water in remote areas.

Approach:

The approach for this project has entailed five tasks:

a. Review of the literature and contacting of suppliers or potential suppliers of solar water pumps and solar heat engines adaptable for water pumping to provide a technical and economic overview of the state-of-the-art of the technology.

b. Collection of design, operation, maintenance, cost, and fuel-use data on a typical conventional water pump that is currently marketed and enjoying an extensive market for remote areas in the U.S.

c. Selection of candidate solar water pumping concept which has the potential for cost-effective implementation in the near future; the information obtained in the course of performing the two preceding tasks are used as a basic for selection. The selected concept is being modified as necessary to permit comparison of performance with the conventional system examined. Features that are essential for remote area application, such as low maintenance, are taken into consideration. Off-the-shelf components are specified as much as possible in order to establish technical feasibility in the short-term and to aid in economic comparability.

d. Development of estimates of capital and operating costs for the proposed solar water pumping system. These estimates assume large-scale production of the system. The costs estimated are then compared to those of the previously selected, typical conventional water pump. This comparison provides a preliminary evaluation of the economic feasibility of the solar approach. The comparison of operating costs is also expressed as a function of energy cost for the conventional system. This allows a projection of the economic competitiveness of the solar system in the near future.

e. Preparation of a report of study results, providing a general assessment of solar water pumping technology and identification of areas for future conceptual evolution and technological improvements. A bibliography has been included in the report.

Status:

All of the tasks have been completed. The final report based on study results may be obtained through the National Technical Information Service.

Future Effort:

None Anticipated.

Summary Statements

CENTRAL POWER APPLICATIONS PROGRAM ELEMENT LARGE SCALE SYSTEMS AND APPLICATIONS SUB-ELEMENT

TITLE	ORGANIZATION
Solar Central Receiver Project Management	Sandia Laboratories Livermore, CA 94550
AMOUNT	PRINCIPAL INVESTIGATOR
$3,368,000	R.C. Wayne (415) 455-2512

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Livermore, CA	Continuing	E(29–1)–0789

PROJECT SUMMARY:

Objective:

This project provides technical management and other support for the DOE Solar Thermal Central Receiver Program which aims at demonstrating the technical feasibility and economic feasibility of the thermal conversion of solar energy into electricity by means of large central, utility type, power plants.

Approach:

Support is being achieved by providing technical management, coordination, systems analysis, and other services.

Status:

FY 77 activities have included:

a. Technical management for preliminary design contracts for a 10-MW pilot plant and establishment of pilot plant design specification.
b. Coordination of major subsystem research contracts.
c. Assistance in selection of a pilot plant site.
d. Coordination activities to prepare the prototype receivers for solar testing at the Solar Thermal Test Facility.
e. Establishment of technical guidelines for second generation central receiver designs, and assistance in RFP preparation and evaluation of proposals.
f. Performance of in-house R&D in areas related to and in support of the program.

Future Effort:

The following activities are expected to be conducted:

a. To provide technical management of advanced central receiver conceptual design contracts.
b. To initiate advanced receiver and storage development.
c. To provide technical advice to 10-MW Pilot Project Office (Barstow).
d. To provide technical management for low-cost heliostat development contracts.
e. To test Electric Power Research Institute Brayton cycle receivers at the Sandia Radiant Heat Facility.
f. To continue supporting development and advanced materials activities.
g. To continue subsystem research experiment heliostat testing.

TITLE	ORGANIZATION
Major Projects Technical and Management Support	The Aerospace Corporation P.O. Box 92957 Los Angeles, CA 90009
AMOUNT	PRINCIPAL INVESTIGATOR
$1,208,000	Dr. Mason Watson

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Los Angeles, CA	12 months—March 1, 1977	EY–76–C–03–1101

PROJECT SUMMARY:

Objective:

This activity supports the Thermal Power Systems office by providing technical assistance for the design and construction of the 10 MW Pilot Plant and by supporting planning for effective utilization of the Solar Thermal Test Facility.

Approach:

Under the direction of the Thermal Power Projects Office, the Aerospace Corporation will:

a. Assist DOE in providing data to the Utility partner in the discharge of his responsibilities.
b. Draft procurement documentation, identify and specify long-lead items, and identify needed ancillary studies.
c. Support the Pilot Plant source-selection activities.
d. Assist the DOE Solar Ten Megawatt Project Office (STMPO) in technical management of its solar contractors and interfaces with the Utility partner.
e. Perform requested Pilot Plant preliminary system design and integration studies.
f. Maintain an interface with the STTF design, construction, and testing activities and participate in test planning as requested by DOE.
g. Develop a computer program to simulate the STTF performance.

The above tasks may be modified by DOE as the project requirements and emphasis change.

Status:

At the present time, the Pilot Plant activities have intensified with a rapid development of procurement material to support the release of RFP's in October 1977. For the STTF, the computer simulation is about 20 percent complete, with a objective of initial configuration capability before the end of calendar year 1977.

Future Effort:

Both these DOE projects will be continued for several years. Aerospace plans to propose follow-on activities in support of the project for 1978.

TITLE	ORGANIZATION
Central Power Management Support	The Aerospace Corporation P.O. Box 92957 Los Angeles, CA 90009
AMOUNT	PRINCIPAL INVESTIGATOR
$515,000	Dr. Mason Watson (213) 648-5615

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Los Angeles, CA	12 months—March 1, 1977	EY–76–C–03–1101

PROJECT SUMMARY:

Objective:

This activity provides technical and management support to DOE for the development of overall plans and rationale for solar energy programs.

Approach:

The activities include the following:

a. Assist in the preparation of the Solar Thermal Power Section of the 1977 Solar Electric Applications (SEA) Program Plan.
b. Identify promising new technical initiatives and suggest a priority schedule for them. With concurrence from DOE, implement appropriate analytical effort consistent with the established priorities.
c. Maintain detailed technical liaison with Sandia Laboratories in all aspects of the central receiver programs.
d. Conduct or participate in special studies at the direction of DOE.
e. Participate in the technical evaluation of the 10MW Phase 1 conceptual designs.
f. Assist the Task Force in the 10MW Pilot Plant design selection.
g. Review the Solar Thermal Test Facility (STTF) test program for pilot plant subsystems.

Status:

A final draft of the SEA Program Plan has been submitted to DOE for further consideration. Tasks e, f, and g are complete.

Future Effort:

Support of the 10 MWe Pilot Plant by Aerospace will continue.

TITLE	ORGANIZATION
10-MWe Central Receiver Solar Thermal Power System Phase 1 (collector subsystem only)	Boeing Engineering and Construction P.O. Box 3707 Seattle, WA 98124
AMOUNT $635,000	PRINCIPAL INVESTIGATOR Roger Gillette (206) 773-8136 FTS 438-8136

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Seattle, WA	36 months—June 14, 1975	EY–76–C–03–1111

PROJECT SUMMARY:

Objective:

This activity is to design and develop a collector subsystem, which can be integrated with other subsystems to demonstrate the technical feasibility and potential economic feasibility of solar thermal water-steam central receiver type power plants.

Approach:

The Boeing concept uses circular membrane reflectors, formed with aluminized polyester film, to direct sunlight to the central receiver. Transparent air-support plastic enclosures protect the lightweight reflectors from the environment. The reflectors are aimed with a 2-axis gimbal and driven by digital controlled stepper motors under computer control.

Status:

As part of this effort, three heliostats and a drive and control assembly have been fabricated and tested to provide design data and verification. In addition an evaluation program has been conducted on the key plastic materials used for the protective enclosure and reflector. Performance and environmental exposure tests on large-scale heliostats have been conducted over an 8-month period at a Boeing desert test site in northeast Oregon. Environmental exposure test on the same heliostats are presently planned to continue through March 1978. Principal objectives of this test are to determine optical performance, demonstrate operation of the drive and control assembly in the various operational modes, and verify survivability of hardware in the environment. Plastic materials evaluation tests have included measurement of mechanical and optical properties, creep, chemical exposure, cleanability, accelerated simulated sunlight, and actual desert sunshine exposure tests.

Future Effort:

This contract was initiated on June 24, 1975, and was originally scheduled for completion on June 24, 1977. An additional 12 months of desert exposure testing and a manufacturing producibility study were added. Completion is now scheduled for June 30, 1978.

Refer to the sketch on the following page (Figure 13).

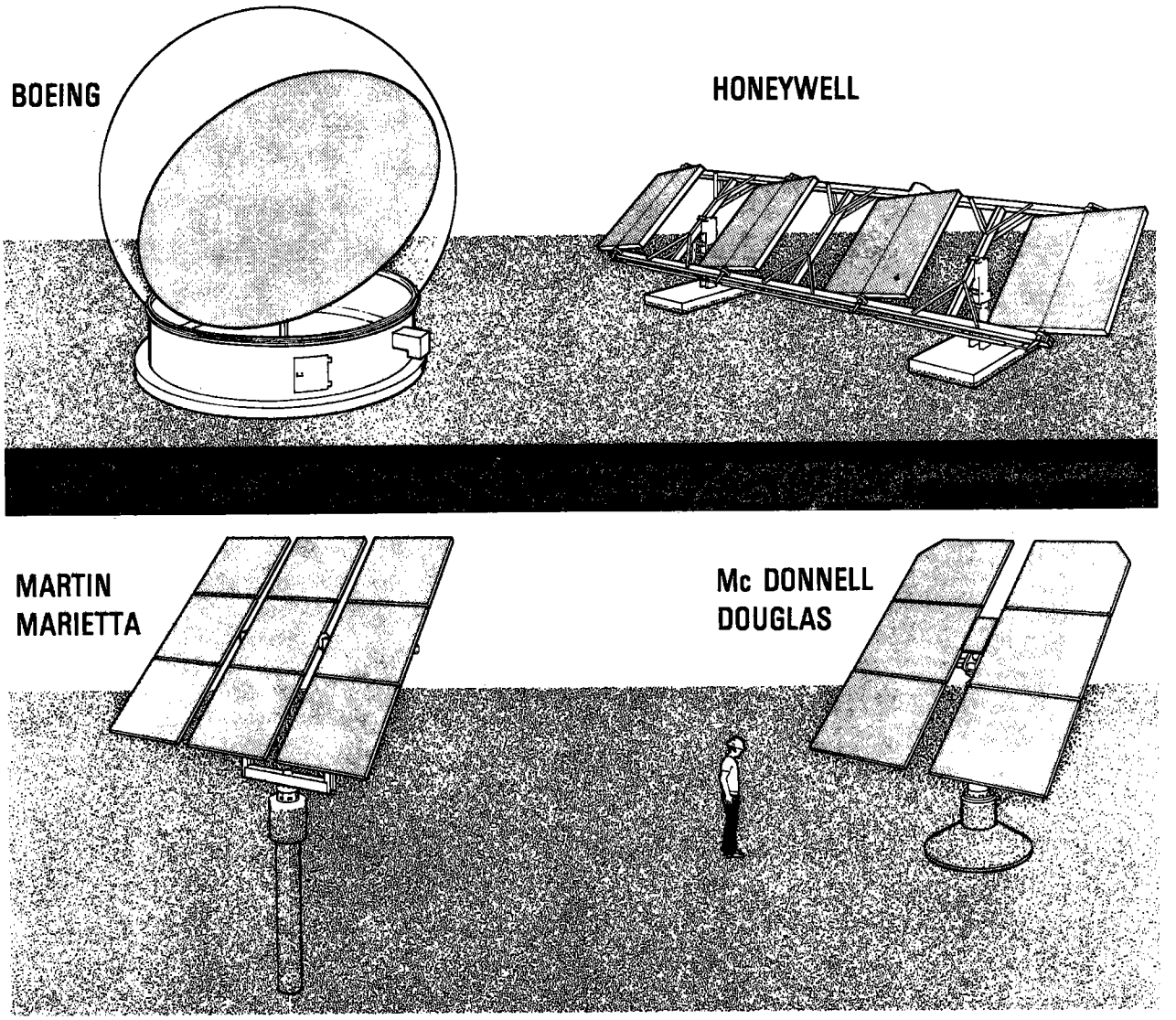


Figure 13. 10 MWe Pilot Plant Heliostat Concepts.

TITLE	ORGANIZATION	
10-MWe Central Receiver Solar Thermal Power System Phase 1	Honeywell, Inc. 2700 Ridgeway Parkway Minneapolis, Minnesota 55413	
AMOUNT $2,767,000	PRINCIPAL INVESTIGATOR Roger Schmidt (612) 378-4078	
WORK LOCATION Minneapolis, MN	DURATION-AWARD DATE 24 months—May 31, 1975	CONTRACT NO. EY 76–C–03–1109

PROJECT SUMMARY:

Objective:

The objectives of the Central Receiver Solar Project have been to establish the technical feasibility of a solar thermal power plant of the central receiver type with signficant commercial potential and to obtain sufficient development, production, and operating data to indicate the economics of operation for commercial power plants of similar design.

Approach:

As part of this project, a series of subsystem and system level activities of progressive scale and complexity have been planned to systematically build the required technological base. The efforts performed under this contract have been directed at the design and testing of three key subsystems: the collector subsystem, the receiver subsystem, and the thermal storage subsystem. To assure that the three subsystem activities are adequately coordinated and to identify the relationship of the subsystem activities to the central receiver system, the contracted effort has included the preliminary design of the central receiver pilot plant.

Status:

This Phase 1 program has resulted in the completion of the preliminary design of a central receiver 10-MWe pilot plant that simulates a projected commercial system and the completion of tests conducted on the collector and receiver subsystems. The end design of the central receiver thus consists of qualified subsystems whose performance has been verified by design, analysis, and/or test.

The baseline central receiver concept defined by Honeywell consists of:

a. Collectors arranged to redirect and concentrate insolation onto the receiver. The collector field is circular with one-half of the field radius south of the field center. The collectors employ rectangular four-facet, tilt-tip, fixed focus heliostats mounted with the facet assembly center of gravity midway between two support posts.
b. Downward facing cavity receiver mounted on a reinforced concert tower. The receiver consists of a two-stage drum type boiler with forced circulation.
c. Thermal storage to buffer the turbine from excessive variations in insolation and to extend plant operation into periods of low or no insolation. The storage system is a two-stage sensible heat thermal storage subsystem utilizing hydrocarbon heat transfer oil and rock as the storage media in one stage and a eutectic salt mixture in the other.

Future Effort:

No further continuation of this Phase I program is planned.

TITLE	ORGANIZATION
10-MWe Central Receiver Solar Thermal Power System Phase 1	Martin-Marietta Aerospace, Denver Division P.O. Box 179 Denver, CO 80201
AMOUNT	**PRINCIPAL INVESTIGATOR**
$3,229,000	Tom Heaton (303) 937-5942 FTS 329-5942

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Denver, CO	24 months—May 31, 1975	EY 76–C–03–1110

PROJECT SUMMARY:

Objective:

The objectives of the Central Receiver Solar Project have been to establish the technical feasibility of a solar thermal power plant of the central receiver type with significant commercial potential and to obtain sufficient development, production and operating data to indicate the economics of operation for commercial power plants of similar design.

Approach:

As part of this project a series of subsystem and system level activities of progressive scale and complexity have been planned to systematically build the required technological base. Phase 1 of this project has included the design, fabrication, and testing of three key subsystem experiments: the collector subsystem, the receiver subsystem, and the thermal storage subsystem. These concepts and activities are to contribute to the subsequent detail design, construction, test, and operation of a complete pilot plant which is itself to be directly related to a potentially attractive commercial central receiver power plant concept. To assure that the three subsystem activities are adequately coordinated and to identify the relationship of the subsystem activities to the central receiver system, the contracted effort also has included the preliminary design of the central receiver pilot plant.

Status:

Fabrication and testing of the three subsystem research experiments has been satisfactorily completed, and the preliminary design for the 10-MWe pilot plant has been submitted. The proposed system includes: a collector field north of the tower-mounted receiver, with nine yoke-mounted, prefocused facets on each heliostat and open loop control; a north-facing cavity receiver using commercial water-steam, natural-circulation boiler practice; and a two-stage sensible heat thermal storage subsystem utilizing hydrocarbon heat transfer oil and a eutectic salt mixture as the storage media.

Future Effort:

No further continuation of this Phase I program is planned.

Refer to the sketch on the following page (Figure 14).

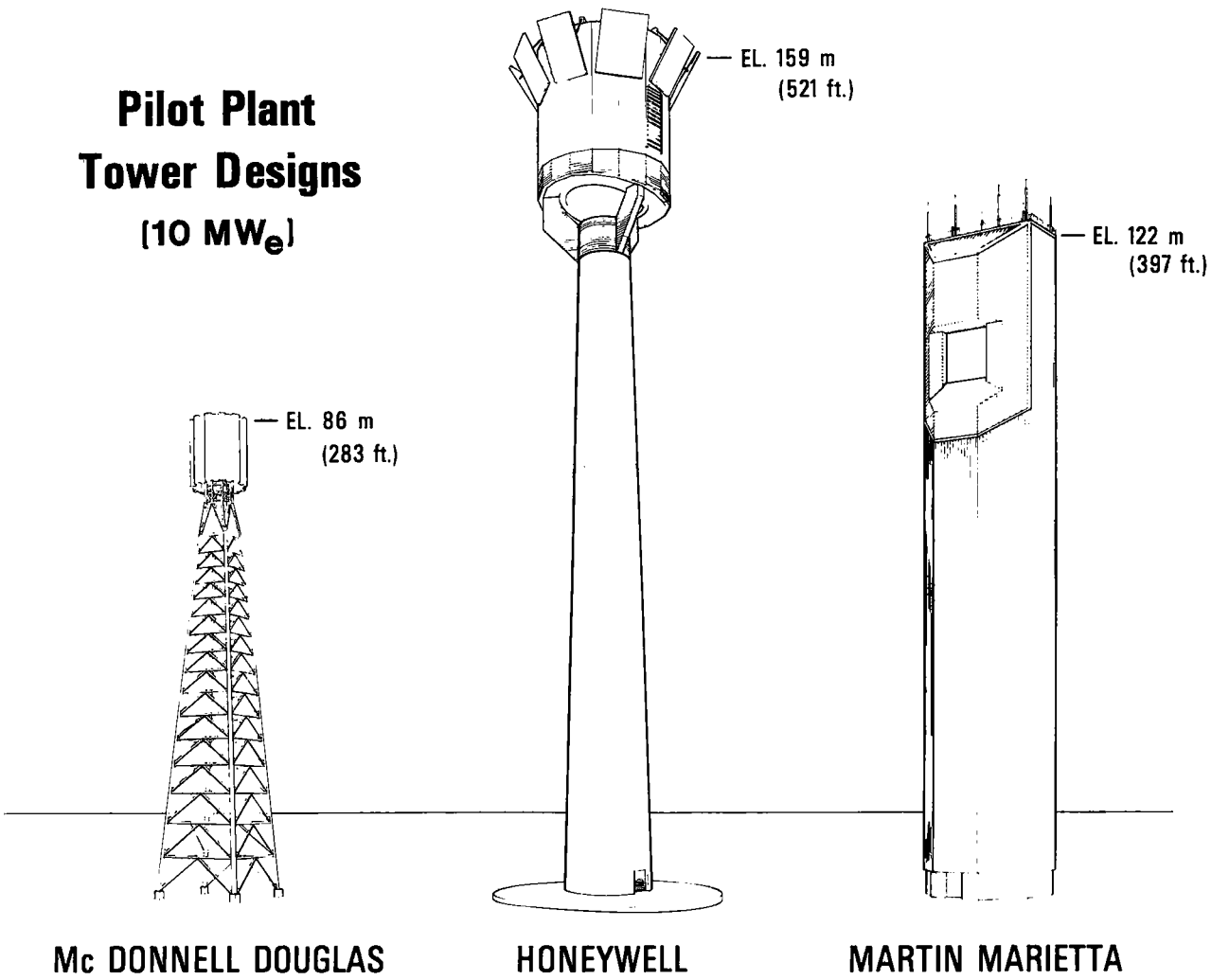


Figure 14. 10 MWe Pilot Plant Tower Designs.

TITLE	ORGANIZATION
10-MWe Central Receiver Solar Thermal Power System Phase 1	McDonnell Douglas Astronautics Company 5301 Bolsa Avenue Huntington Beach, CA 92647
AMOUNT $1,944,000	PRINCIPAL INVESTIGATOR Ray Hallett (714) 896-3664

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Huntington Beach, CA	24 months—June 20, 1975	EY–76–C–03–1108

PROJECT SUMMARY:

Objective:

The objectives of the Central Receiver Solar Project have been to establish the technical feasibility of a solar thermal power plant of the Central Receiver type with significant commercial potential and to obtain sufficient development, production, and operating data to indicate the economics of operation for commercial power plants of similar design.

Approach:

As part of this project a series of subsystem and system level activities of progressive scale and complexity have been planned to systematically build the required technological base. The efforts performed under this contract have been directed at the design and testing of three key subsystems: the collector subsystem, the receiver subsystem, and the thermal storage subsystem. To assure that the three subsystem activities are adequately coordinated and to identify the relationship of the subsystem activities to the central receiver system the contracted effort has included the preliminary design of the central receiver pilot plant.

Status:

This Phase 1 program has resulted in the completion of the preliminary design of a central receiver 10 MWe pilot plant that simulates a projected commercial system, and the completion of tests conducted on the collector, receiver, and thermal storage subsystems. The end design of the central receiver thus consists of qualified subsystems whose performance has been verified by design, analysis and/or test.

The baseline central receiver concept defined by McDonnell Douglas consists of:

a. Collectors arranged to redirect and concentrate insolation onto the receiver. The collectors employ canted, flat, rectangular panels mounted on a central pedestal and arranged to provide for inverted or face down storage.
b. An external receiver mounted on a steel tower in a 360° configuration. The receiver consists of 24 modular panels which utilize the single pass to superheat concept.
c. Thermal storage to buffer the turbine from excessive variations in insolation and to extend plant operation into periods of flow or no insolation. The thermal storage system is a sensible heat storage system with dual storage media (hydrocarbon fluid and rock). The thermocline principle is used to store both hot and cold storage media in a single tank.

Future Effort:

One panel from the MDAC Subsystem Research Experiment (SRE) receiver from phase I will be modified to add instrumentation and additional structural integrity and tested at the Solar Thermal Test Facility (STTF). The duration of the test period will be approximately 3 months. The estimated cost for this effort is $1,326,000.

TITLE	ORGANIZATION
Advanced Central Receiver Power Systems Project	The Aerospace Corporation P.O. Box 92957 Los Angeles, CA 90009
AMOUNT $525,000	PRINCIPAL INVESTIGATOR Dr. Mason Watson (213) 648-5615
WORK LOCATION Los Angeles, CA	DURATION-AWARD DATE 12 months—March 1, 1977
	CONTRACT NO. EG–76–C–03–1101

PROJECT SUMMARY:

Objective:

The objectives of the project are to identify advanced concepts for central receiver power systems which have the potential for a significant reduction in the cost of electricity relative to that estimated for water-steam solar central receiver power plants.

Approach:

Specific project tasks entail the following:

a. Identify promising solar power plant concepts and analyze their economic potential.
b. Develop a computer simulation program whereby shared storage concepts can be evaluated.
c. Initiate studies for determining societal benefits or dislocations related to the advanced solar concepts.
d. Develop a detailed financial analysis model for power plants based upon current utility practice. That model should allow the determination of the effects on rate structure of variations in inputs such as tax rates, debt-equity ratio, land value, inflation, and fuel costs.
e. Provide technical support for evaluations of contractor studies.
f. Assist in the preparation of technical portions of RFP's and provide advisory support for proposal evaluations.

Status:

The project is progressing consistent with the management plan with a mid-term review scheduled for September 1977. Recommendations have been made to pursue the Brayton cycle as an advanced solar thermal system. A financial analysis model is being checked out and is operating.

The shared storage computer simulation model has been developed, is now operational, and has provided initial results to aid in better identifying the role of energy storage in the utility/solar thermal plant/consumer arena.

Future Effort:

The completed studies will be utilized for the planning of future central receiver program thrusts.

TITLE	ORGANIZATION
Technical and Economic Assessment of Solar Hybrid Repowering	Public Service Company of New Mexico Albuquerque, New Mexico 87103
AMOUNT	PRINCIPAL INVESTIGATOR
$200,000	J. Maddox

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Albuquerque, NM	12 months—August 1, 1977	EG–77–C–03–1608

PROJECT SUMMARY:

Objective:

This activity provides for an assessment of the technical and economic feasibility of solar augmentation (repowering) of an existing fossil-fueled electric generating station.

Approach:

A two-phase, incrementally-funded effort is being carried out which is resulting in:

a. A market survey and cost/benefit analysis.
b. A conceptual design for solar hybrid repowering of an existing gas/oil fired unit.
c. A work plan to accomplish future phases of a demonstration program.

Future Effort:

If the results of the assessment are positive, an experiment to prove the key aspects of the repowering concept may result.

TITLE	ORGANIZATION
Conceptual Design of Advanced Central Receiver System, Phase I	Boeing Engineering & Construction Seattle, WA
AMOUNT $619,202	PRINCIPAL INVESTIGATOR J.B. Schroeder
WORK LOCATION Seattle, WA	DURATION-AWARD DATE 12 months—September 30, 1977
	CONTRACT NO. EG-77-C-03-1726

PROJECT SUMMARY:

Objective:

The activity will produce a conceptual design for an advanced central receiver power system, a Brayton cycle type.

Approach:

Elements of the Phase I effort include (1) parametric analyses of subsystem alternatives; (2) selection of an overall system configuration; (3) conceptual design of a commercial scale plant; (4) assessment of selected systems; and (5) preparation of a Development Plan for the Advanced Central Receiver Power System.

Boeing has selected a design which uses very high temperature (816°C) air to transfer power from the tower receiver to a closed Brayton cycle power conversion system. The major subsystem are lightweight heliostats protected by plastic domes; a high-temperature cavity receiver utilizing high pressure air working fluid; direct cycle air turbine EPGS; sensible heat thermal energy storage, and a centralized Master Control.

Status:

Work commenced on October 1, 1977, and is preceeding on schedule.

Future Effort:

One or more cost-type contracts will be awarded, probably from among the Phase I contractors, for the follow-on Phase II, Preliminary Design beginning in FY 1979.

TITLE	ORGANIZATION
Conceptual Design of Advanced Central Receiver System, Phase I	General Electric Corporate Research & Development Schenectady, NY
AMOUNT	PRINCIPAL INVESTIGATOR
$675,900 (proposed)	G.R. Fox

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Schenectady, NY	12 months—September 30, 1977	ET–77–G–03–1725

PROJECT SUMMARY:

Objective:

This activity will produce a conceptual design for an advanced central receiver power system utilizing a sodium receiver with a steam Rankine cycle.

Approach:

Elements of the Phase I effort include (1) parametric analyses of subsystem alternatives; (2) selection of an overall system configuration; (3) conceptual design of a commercial scale plant; (4) assessment of selected system; and (5) preparation of a Development Plan for the Advanced Central Receiver Power System.

GE Proposes a design which utilizes liquid sodium to transfer power from the receiver tower to two Rankine-cycle power conversion systems at turbine inlet conditions of 1000°F and 2400 psi. The collection system is composed of light-weight mylar heliostats protected by a plastic air-filled enclosure. The thermal storage system is sensible heat using liquid sodium alone or in combination with iron packing.

Status:

Contract negotiations are still in progress in December 1977.

Future Effort:

One or more cost-type contracts will be awarded, probably from among the Phase I contractors, for the follow-on Phase II, Preliminary Design beginning in FY 1979.

TITLE	ORGANIZATION
Conceptual Design of Advanced Central Receiver System, Phase I	Martin Marietta Corporation Denver, CO
AMOUNT	PRINCIPAL INVESTIGATOR
$631,000	Thomas R. Tracey

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Denver, CO	12 months—September 30, 1977	EG–77–C–03–1724

PROJECT SUMMARY:

Objective:

This activity will provide systems analyses of a conceptual design for an advanced central receiver power system utilizing a molten salt receiver and a steam-Rankine cycle.

Approach:

Elements of the Phase I effort include (1) parametric analyses of subsystem alternatives; (2) selection of an overall system configuration; (3) conceptual design of a commercial scale plant; (4) assessment of selected systems; and (5) preparation of a Development Plan for the Advanced Central Receiver Power System.

Martin-Marietta proposes a design which utilizes a molten salt heat transfer fluid in a steam-Rankine Cycle.

Insolation striking the heliostats is focused into tower-mounted cavity receivers where it is converted to thermal energy in a high-temperature salt at 1050°F. The energy transport and steam generator subsystem provides handling of the high-temperature salt and delivery of primary steam at 950°F, 1800 psig and reheat steam at 950°F, 402 psig. The storage subsystem is predominantely the hot, 1050°F, and cold, 550°F, storage tanks since the heat exchanger equipment has been incorporated in the steam generator. The electric power generator system features a reheat steam turbine.

Status:

Work commenced on October 1, 1977, and is proceeding on schedule.

Future Effort:

One or more cost-type contracts will be awarded, probably from among the Phase I contractors, for the follow-on Phase II, Preliminary Design beginning in FY 1979.

TITLE	ORGANIZATION
Conceptual Design of Advanced Central Receiver System, Phase I	Rockwell International Atomics International Division (AI) Canoga Park, CA
AMOUNT	PRINCIPAL INVESTIGATOR
$613,128	Thomas Springer

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Canoga Park, CA	12 months—September 30, 1977	EG–77–C–03–1483

PROJECT SUMMARY:

Objective:

This activity will provide and develop a conceptual design for an advanced central receiver power system utilizing a liquid sodium receiver and a steam-Rankine cycle.

Approach:

Elements of the Phase I effort include (1) parametric analyses of subsystem alternatives; (2) selection of an overall system configuration; (3) conceptual design of a commercial scale plant; (4) assessment of selected system; (5) preparation of a Development Plan for the Advanced Central Receiver Power System.

Atomics International has selected a design which utilizes liquid sodium at 1100°F as the heat transfer fluid between the receiver and the steam generators, which in turn supply the turbine generator. For thermal storage, AI will conduct system studies on liquid sodium molten salt and hot air/rock.

Status:

Work commenced on October 1, 1977, and is proceeding on schedule.

Future Effort:

One or more cost-type contracts will be awarded, probably from among the Phase I contractors, for the follow-on Phase II, Preliminary Design.

TITLE	ORGANIZATION
Line Central Receiver Research Study and Heliostat Experiment	FMC Corporation Engineering Systems Division 328 Brokaw Road Santa Clara, CA 95052
AMOUNT $126,000	PRINCIPAL INVESTIGATOR Dan DiCanio

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Santa Clara, CA	12 months—September 1, 1976	E(04–3)–1246

PROJECT SUMMARY:

Objective:

This research study has had two objectives:

a. To estimate and optimize (by conceptual design) the performance of a solar thermal electric power plant, using a single-axis focusing heliostat and a cavity-type line central receiver.
b. To build a 60-ft (18.3 m) heliostat and test its performance by: (1) measuring the reflected flux density at the ideal plane of a simulated receiver, and (2) demonstrating its ability to automatically aim and focus.

Approach:

To accomplish the first objective a single-axis focusing heliostat and a cavity-type line central receiver has been used. To test the heliostat's performance, the reflected flux density at the ideal plane of a simulated receiver has been measured and its ability to automatically aim and focus has been demonstrated.

Status:

The performance analysis has been completed. The specific effort has included calculation of steam temperature, heat flux distributions, and steam generation capacity for various configurations and operating conditions to minimize electrical power costs An economic analysis of a 100-MWe power plant indicated the concept to be a possible competitor for the central receiver concept.

Future Effort:

A solicitation for the study of line focus systems for central power systems is to be released in FY 1978 and will preempt further system studies under this contract.

TITLE	ORGANIZATION
Analysis of Extreme Winds on Solar Tower Generators, Task 7	Energy Foundation of Texas 4800 Calhoun Boulevard Houston, TX 77004
AMOUNT	**PRINCIPAL INVESTIGATOR**
$ 34,100	J.E. Minor

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Houston, TX	12 months—June 1, 1977	EG–77–C–04–3975

PROJECT SUMMARY:

Objective:

This activity has two objectives. The first is support of the 10 MWe Pilot Plant by analyzing and predicting the effects of extreme winds on the tower and on the heliostat field. The second is to advise and assist in methods of designing components that will be wind resistant.

Approach:

Wind data for the site will be evaluated to determine the probability of wind vectors.

Status:

The data are being accumulated and transferred into the data base.

Future Effort:

Damage probabilities will be assessed.

TITLE	ORGANIZATION
Engineering/Management Tool, Math Model 10 MWe Central Receiver Pilot Plant	Singer Company—Link Division 11800 Tech Road Silver Spring, MD 20904
AMOUNT	PRINCIPAL INVESTIGATOR
$246,000	Stan Kremzner

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Silver Spring, MD	24 months—June 25, 1976	EX–76–C–01–2419

PROJECT SUMMARY:

Objective:

This activity is to develop and provide a dynamic mathematical model of the 10 MWe Central Receiver Pilot Plant.

Approach:

This model uses conservation of mass and energy as its basic approach to the mathematical representation, down to the component level, of the physical plant. This model incorporates the performance dynamics of the complete plant including system transients. Individual subsystem performance of collectors, receivers, thermal storage, and electric power generation, plus integrated system performance are simulated.

The model uses a general software structure written in Fortran IV. This program is written so that it is not dependent on any given computer configuration. The computer used at Singer is an SEL 32/50.

The solar flux pattern as seen at the receiver is computed on the basis of geometry of the collectors, reflectivity of the mirrors (as given by each Phase I contractor, and included as a variable, subject to computer operator control) and a standard set of insolation data (which is also subject to computer operator control).

Environmental effects such as clouds, haze, etc., are included, and vary the flux pattern and intensity, accordingly. The insolation data based used is for Barstow, California.

The collector flux at the receiver results in thermal heat transfer to the tubes of the receiver. The transfer rate is modeled as a function of flux density. Distribution of the flux has been assigned in accordance with Phase I contractor design data. Receiver thermodynamic properties including tube heat transfer from outer to inner wall, flow, flow rate, and radiation have been incorporated into the receiver such as superheaters and attemperators, and to heat exchangers, and finally to the electric power generation subsystem or thermal storage subsystem.

Status:

All of the components of the thermal storage subsystems have been modeled including desuperheaters, condensers, subcoolers, feedwater, low and high temperature tanks for oil/salt, etc., and the subsystems control system.

Inclusion of the Electric Power Generation Subsystem (EPGS) in the model closes the overall plant mass and energy balance computation loops. The model of the EPGS includes turbine, generator, feedwater, and all balance of plant elements. The baseline turbine has a high pressure admission port for receiver produced steam. A mixed mode of operation of receiver plus thermal storage steam is included in the model. Finally, the turbine can be tied to an electrical distribution net and load control mechanized as a function of steam flowing through the turbine. The overall design performance of the solar thermal electric plant can then be assessed upon fixing, or with variable (but predetermined) initial conditions.

Future Effort:

The model calculation time will be reduced and the model will be utilized for study of the 10 MWe Pilot Plant at Barstow, California.

TITLE	ORGANIZATION
Solar Energy System Simulation and Analysis Task 4	Energy Foundation of Texas 4800 Calhoun Boulevard Houston, TX 77004
AMOUNT	PRINCIPAL INVESTIGATOR
$ 90,000	L.L. Vant-Hull

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Houston, TX	12 months—June 1, 1977	EG–77–C–04–3975

PROJECT SUMMARY:

Objective:

This effort is to develop an improved mathematical simulation of various system components and concepts for a central receiver power plant.

Approach:

The subprograms to be improved are the blocking and shading properties of heliostat fields, the imaging properties of arbitrarily dished heliostats, the receiver performance and insolation modeling. In addition, a mathematical simulation of the receiver operation (up to about 1000°C) will be performed.

Status:

Development of the subprogram is underway.

Future Effort:

As the subprograms are developed, they will be debugged and verified by comparison with prior evaluations: the model will then be utilized as an improved production code.

TITLE	ORGANIZATION
Technical and Economic Assessment of the Feasibility of Solar Distillation for Large-Scale Production of Fresh Water	Bechtel Corporation 50 Beale Street P.O. Box 3965 San Francisco, CA 94119
AMOUNT $ 11,684	PRINCIPAL INVESTIGATOR E.Y. Lam (415) 768-6895

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO. Subcontract to
San Francisco, CA	7 months—July 19, 1977	E(29–1)–0789

PROJECT SUMMARY:

Objective:

This effort will produce an assessment of the technical and economic feasibility of solar distillation for the large-scale production of fresh water.

Approach:

Six tasks have been required to accomplish this study:

a. Review the literature and present a technical and economic overview of the state-of-the-art of large-scale solar distillation, and describe the more prominent concepts that have been proposed.
b. Select from the literature a candidate solar distillation concept which has the potential for short-term cost-effective implementation. This concept has formed the baseline for a preliminary assessment of the solar distillation potential in general.
c. Identify potential technical and application constraints and modify the baseline concept to improve its performance or lower its cost. These modifications have been derived from the literature or have been originated by Bechtel.
d. Review installation and operating cost data in the literature for the baseline concept and assess cost validity based on available Bechtel cost information. Similarly, identify and estimate cost differences that may be expected as a result of implementing the identified modifications to the baseline concept.
e. Compare the lowest anticipated installation and operating costs of the foregoing improved solar distillation plant scheme with a typical conventional non-solar desalinization plant of the same installed capacity operating under similar site conditions. This comparison has been expressed as a function of full cost for the conventional plant to allow a projection of the economic competitiveness of the solar plant in the future.
f. Prepare a report of study results providing a general assessment of the solar distillation technology and identification of areas for future conceptual evolution and technological improvements. In addition, comment on the potential of the candidate concepts not selected for this study. A bibliography is included in the report.

Future Effort:

No continuation is anticipated. The assessment will provide a data base establishing the need and potential for a new R&D program.

Summary Statements

CENTRAL POWER APPLICATIONS
PROGRAM ELEMENT
CENTRAL RECEIVER SUBSYSTEMS AND COMPONENTS
SUB-ELEMENT

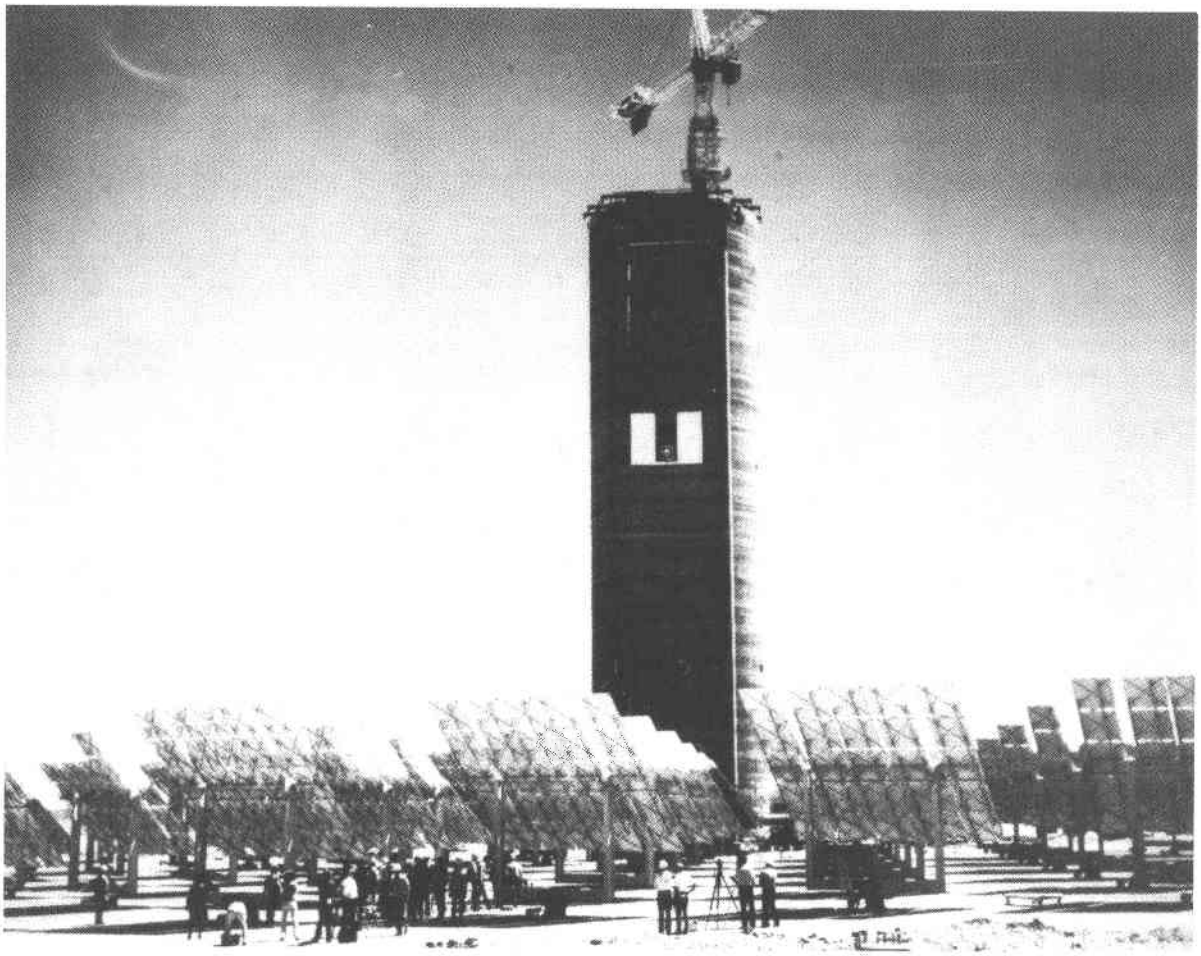


Figure 15. Solar Thermal Test Facility (STTF), Sandia Laboratories, Albuquerque, NM.

TITLE	ORGANIZATION
Solar Thermal Test Facility	Sandia Laboratories Albuquerque, NM 87115
AMOUNT	PRINCIPAL INVESTIGATOR
$2,150,000	A. Narath, J. Otts (505) 264-2280

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Albuquerque, NM	Continuing	E(29–1)–0789

PROJECT SUMMARY:

Objective:

This activity provides design, planning, and independent evaluation of technical options relating to the construction of the Solar Thermal Test Facility (STTF) which is nearing completion, and to provide for operation of the facility in the testing of diverse components.

Approach:

The STTF will be utilized to test prototype water steam receivers; and other components, subsystems, and concepts related to solar energy as developed by industry, universities, and government agencies; test heliostats and heliostat control concepts; and to test overall control concept requirements. In addition, the facility may be utilized for high temperature research and testing of materials, prototype components, subsystems, and new components.

Status:

The facility demonstrated a 1.8 MWt power capability in May 1977, and is scheduled for full power operation early in 1978.

Future Effort:

Receivers fabricated under other contracts will be tested upon completion of the facility.
Refer to the photograph on the preceding page (Figure 15).

TITLE	ORGANIZATION
Testing a One Megawatt Solar Receiver in a DOE Radiant Heat Facility	Sandia Laboratories Livermore, CA 94550
AMOUNT	PRINCIPAL INVESTIGATOR
$200,000	Alan C. Skinrood (415) 455-2501

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Livermore, CA	14 months—October 1, 1975	E(29–1)0789

PROJECT SUMMARY:

Objective:

This activity provided a shakedown test of the 1-MWth Bench Model Cavity Receiver Steam Generator with radiant heat prior to testing with solar radiation at Odeillo, France.

Approach:

The heat flux distribution expected with the solar furnace, Odeillo, France, was approximately duplicated with electric heaters. The distribution was verified, at low power, with a receiver simulator. The actual receiver was tested initially at low power. Then power was gradually increased to the expected Odeillo level. The effects of startup, shutdown and cloud transients expected at Odeillo were determined.

Status:

The project objectives have been satisfactorily completed. Testing in the radiant heat facility has demonstrated the predicted operation.

Future Effort:

Final evaluation reports have extended the project through FY 1977 although the testing had been completed in FY 1976.

TITLE	ORGANIZATION
1 MWth Bench Model Solar Cavity Receiver Steam Generator Build and Test	Martin Marietta Corporation Aerospace/Denver Division P.O. Box 179 Denver, CO 80201
AMOUNT	PRINCIPAL INVESTIGATOR
$236,000	Tom Heaton (303) 937-5942 FTS 8-329-5942

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Denver, CO	20 months—January 1, 1975	E(04–3)–1068

PROJECT SUMMARY:

Objective:

The objective of this project is to fabricate and test a 1 MW (thermal) cavity receiver steam generator suitable for the central receiver type of solar thermal conversion system for the generation of electricity, together with the necessary circulation system, controls, mounting fixtures, closure mechanisms, and flux redirecting devices to adapt it to solar test facilities. The system is designed to permit testing at the Radiant Heat Facility at Sandia Laboratories, in Albuquerque, N.M., the 1 MWth C.N.R.S. Solar Furnace at Odeillo, France, and the DOE Solar Thermal Test Facility at Sandia-Albuquerque.

Approach:

This contract effort supports the Solar Thermal Power Program by (a) providing validation of the North-facing cavity approach to design of a Central Receiver Solar Thermal Power Plant, (b) providing a basis for correlating radiant-heat simulator test results with those obtained with solar illumination, (c) providing a steam generator suitable for use at the STTF at the 1 MWth level, and (d) supporting international exchange of solar data and technology.

Status:

To date, the cavity steam generator has been successfully operated under both radiant-heat simulation conditions at Sandia, and concentrated solar illumination at Odeillo. Necessary modifications have been made to adapt the system to the STTF, for possible use at some future date.

Future Effort:

There are at present no specific plans concerning continuation of this contract effort.

TITLE	ORGANIZATION
Solar Central Receiver Prototype Heliostat, Phase I	Boeing Engineering and Construction Co. P.O. Box 3707 Seattle, WA 98124
AMOUNT	PRINCIPAL INVESTIGATOR
$468,420	Roger B. Gillette (206) 773-2441

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Seattle, WA	9 months—September 30, 1977	EG–77–C–03–1604

PROJECT SUMMARY:

Objective:

The 9-month initial phase of this two-phase effort supports the Solar Central Receiver Program by:

a. Establishment of a heliostat design . . . that, in quantity production, will yield significant reductions in capital and operating costs . . . as compared with existing designs.
b. Stimulation of broader industry participation in the DOE solar energy program.
c. Identification of needs for near term and future R&D in heliostat(s) . . . which would offer significant payoffs in the further reduction of the cost of electrical energy from solar central receiver power plants."

Approach:

During Phase I, the following tasks will be conducted:

a. Verification of proposed heliostat concept against requirements for utilization of heliostats in a solar central receiver power plant.
b. Preliminary design of complete heliostat system (including foundation, drives, and controls) with supporting bench model/component tests.
c. Conceptual design of processes and hardware for manufacture, assembly, installation and maintenance of heliostats.
d. Estimation of heliostat life-cycle costs at various projected levels of production.
e. Planning for Phase II activities.

The proposed concept represents a further development of the approach pursued under Contract EY–76–C–03–1111, in which a stretched plastic-film reflector is housed within a transparent, air-supported spherical plastic-film enclosure. The present effort will involve exploration of increased performance and reduced cost resulting from increased reflector size, positive focusing, improved enclosure materials and fabrication, and other advances on the former design.

Status:

The contract was awarded on September 30, 1977. A project initiation meeting was held on October 25, 1977, and the contractor is presently reviewing the DOE provided system specifications and cost accounting system for applicability to the proposed design.

Future Effort:

One or more contractors under this Phase I procurement may be selected by the Government, in the fourth quarter of FY 1978, to continue into Phase II, during which the selected preliminary heliostat designs may be continued into detail design, prototype fabrication and test, and the associated production process concept and lifecycle cost estimates further refined.

TITLE	ORGANIZATION
Solar Central Receiver Prototype Heliostat Study, Phase I	General Electric Company Energy Systems Program Department One River Road Schenectady, NY 12345
AMOUNT	PRINCIPAL INVESTIGATOR
$996,574	Richard H. Horton (518) 385-0822

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Schenectady, NY	10 months—September 30, 1977	EG–77–C–03–1468

PROJECT SUMMARY:

Objective:

The 9-month initial phase of this two-phase effort supports the Solar Central Receiver Program by:

a. Establishment of a heliostat design . . . that, in quantity production, will yield significant reductions in capital and operating costs . . . as compared with existing designs.
b. Stimulation of broader industry participation in the DOE solar energy program.
c. Identification of needs for near term and future R&D in heliostat(s) . . . which would offer significant payoffs in the further reduction of the cost of electrical energy from solar central receiver power plants."

Approach:

During Phase I, the following tasks will be conducted:

a. Verification of proposed heliostat concept against requirements for utilization of heliostats in a solar central receiver power plant.
b. Preliminary design of complete heliostat system (including foundation, drives, and controls) with supporting bench model/component tests.
c. Conceptual design of processes and hardware for manufacture, assembly, installation and maintenance of heliostats.
d. Estimation of heliostat life-cycle costs at various projected levels of production.
e. Planning for Phase II activities.

The proposed concept involves a stretched plastic-film reflector on a lightweight support structure, protected by a framed plastic-film enclosure with transparent panels for the passage of sunlight. The altitude/azimuth drive system will make use of direct-drive linear motors.

Status:

The contract was awarded on September 30, 1977. Following initial project organization activities, contract activity on the 9-month Phase I effort will commence on about November 1, 1977, with review of the specifications provided by DOE as applied to the proposed concept.

Future Effort:

One or more contractors under this Phase I procurement may be selected by the Government, in the fourth quarter of FY 1978, to contine into Phase II, during which the selected preliminary heliostat designs may be continued into detail design, prototype fabrication and test, and the associated production process concept and life-cycle cost estimates further refined.

TITLE	ORGANIZATION
Solar Central Receiver Prototype Heliostat, Phase I	McDonnell Douglas Astronautics Company 5301 Bolsa Avenue Huntington Beach, CA 92647
AMOUNT	PRINCIPAL INVESTIGATOR
$501,000	Dr. C.R. Easton (213) 896-3067

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Huntington Beach, CA	9 months—September 30, 1977	EG–77–C–03–1605

PROJECT SUMMARY:

Objective:

The 9-month initial phase of this two-phase effort supports the Solar Central Receiver Program by:

a. Establishment of a heliostat design . . . that, in quantity production, will yield significant reductions in capital and operating costs . . . as compared with existing designs.
b. Stimulation of broader industry participation in the DOE solar energy program.
c. Identification of needs for near term and future R&D in heliostat(s) . . . which would offer significant payoffs in the further reduction of the cost of electrical energy from solar central receiver power plants."

Approach:

During Phase I, the following tasks will be conducted:

a. Verification of proposed heliostat concept against requirements for utilization of helistats in a solar central receiver power plant.
b. Preliminary design of complete heliostat system (including foundation, drives, and controls) with supporting bench model/component tests.
c. Conceptual design of processes and hardware for manufacture, assembly, installation and maintenance of heliostats.
d. Estimation of heliostat life-cycle costs at various projected levels of production.
e. Planning for Phase II activities.

The proposed approach involves further exploration of the preliminary design developed under Contract EY–76–C–03–1108 for opportunities for improvement of performance and/or reduction in life-cycle cost. A baseline-perturbation approach will be utilized, in which the cost benefit of various departures from the existing baseline will be assessed.

Status:

The contract was awarded on September 30, 1977. A project initiation meeting was held on October 7, 1977, and the contractor is presently reviewing the DOE provided system specifications and cost accounting system for applicability to the proposed design.

Future Effort:

One or more contractors under this Phase I procurement may be selected by the Government, in the fourth quarter of FY 1978, to continue into Phase II, during which the selected preliminary heliostat designs may be continued into detail design, prototype fabrication and test, and the associated production process concept and life-cycle cost estimates further refined.

TITLE	ORGANIZATION
Solar Central Receiver Prototype Heliostat, Phase I	Solaramics, Incorporated 1301 El Segundo Blvd. El Segundo, CA 90245
AMOUNT	PRINCIPAL INVESTIGATOR
$451,302 (proposal)	Harold E. Felix (213) 322-9302

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
El Segundo, CA	9 months—November 14, 1977	ET–78–C–03–1745

PROJECT SUMMARY:

Objective:

The 9-month initial phase of this two-phase effort supports the Solar Central Receiver Program by:

a. Establishment of a heliostat design . . . that, in quantity production, will yield significant reductions in capital and operating costs . . . as compared with existing designs.
b. Stimulation of broader industry participation in the DOE solar energy program.
c. Identification of needs for near term and future R&D in heliostat(s) . . . which would offer significant payoffs in the further reduction of the cost of electrical energy from solar central receiver power plants."

Approach:

During Phase I, the following tasks will be conducted:

a. Verification of proposed heliostat concept against requirements for utilization of heliostats in a solar central receiver power plant.
b. Preliminary design of complete heliostat system (including foundation, drives, and controls) with supporting bench model/component tests.
c. Conceptual design of processes and hardware for manufacture, assembly, installation and maintenance of heliostats.
d. Estimation of heliostat life-cycle costs at various projected levels of production.
e. Planning for Phase II activities.

The proposed approach involves application of glass-foam, ultra-thin glass, and glass/fly ash ceramic technology to the construction of heliostats of the configuration selected for the 10-MWe Solar Central Receiver Pilot Plant. State-of-the-art technology is also applied in the "adaptive control" concept for hybrid open/closed loop heliostat tracking.

Status:

A letter contract with an interim funding of $170,000 was awarded on November 14, 1977. A contract initiation meeting was held December 12, 1977, and the contractor is presently reviewing the system specifications and cost accounting system provided by DOE for applicability to the proposed design.

Future Effort:

One or more contractors under this Phase I procurement may be selected by the Government, in the fourth quarter of FY 1978, to continue into Phase II, during which the selected preliminary heliostat designs may be continued into detail design, prototype fabrication and test, and the associated production process concept and life-cycle cost estimates further refined.

TITLE	ORGANIZATION	
Hydraulic Stability of Solar Boilers	University of Minnesota Dept. of Chemical Engineering 151 Chemical Engineering Building Minneapolis, MN 55455	
AMOUNT $ 47,000	PRINCIPAL INVESTIGATOR H.S. Isbin (612) 373-2310	
WORK LOCATION Minneapolis, MN	DURATION-AWARD DATE 15 months—September 15, 1977	CONTRACT NO. Subcontract to E(29–1)–0789

PROJECT SUMMARY:

Objective:

This effort provides for the evaluation of solar receivers relative to two phase hydraulic stability.

Approach:

Four tasks are being carried out in connection with this project.

a. A numerical calculation technique for analyzing the two-phase (water-steam) flow in parallel channels is being developed. The calculational technique will be based on the drift flux model of Patankar-Spalding. The numerical model of the flow will predict the critical heat fluxes and susceptibility of the parallel channel flows to to thermal-hydraulic instabilities. The model will be suitable for analyzing the transient conditions that will exist in the solar boiler.
b. The geometrics to be investigated include those typical of solar boilers with nonuniform heat flux distributions.
c. Analytical studies are being merged with experiments conducted by the DOE Central Receiver System contractors.
d. The accuracy of the model predictions are being verified by comparison with experimental results. A systematic sensitivity study of the significant modeling parameters including geometrical variations is being performed. Appropriate analytical techniques and tools for future work is being provided.

Status:

Task a. has been initiated.

Future Effort:

The model will be applied to the external receiver configuration selected for the 10 MWe Pilot Plant at Barstow, California.

TITLE	ORGANIZATION
Experimental Study of Convective Losses from Solar Receivers	Department of Mechanical and Industrial Engineering University of Illinois Urbana, IL 61801
AMOUNT	PRINCIPAL INVESTIGATOR
$ 55,000	A.M. Clausing (217) 333-0366

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO. Subcontract to
Urbana, IL	12 months—June 15, 1977	E(29–1)–0789

PROJECT SUMMARY:

Objective:

This activity supports receiver design by establishing convective losses of both cavity and non-cavity receivers for various wind vectors.

Approach:

To determine the loss, the following will be conducted:

a. Establish techniques by which the combined influences of natural and forced convection on the convective heat loss can be modeled and experimentally studied.
b. Design and build a cryogenic facility for the experimental investigation.
c. Test models of solar receivers and obtain expressions which enable the prediction of the convective loss.

Status:

An examination of the ratio of the characteristic velocity due to buoyant influences of the wind velocity has indicated that the effects of both natural and forced convection have significant influences on the convective losses from solar receivers. A cryogenic wind tunnel has been proposed to enable the use of model tests with perfect modeling of both influences. Water table studies are also being utilized to obtain information on the flow field in and around solar receivers, including flow instabilities.

The flow visualization studies are underway. Both still pictures and color movies are being used to record the separated flow patterns. The design of the cryogenic wind tunnel has been initiated and is partially completed.

Future Effort:

The data will be applied to the receiver for the 10 MW Pilot Plant to provide a more accurate determination of convective loss.

TITLE	ORGANIZATION
Mechanical Testing in Support of Structural Design of Solar Energy Central Receiver Power Plant Components	Argonne National Laboratory 9700 South Cass Avenue Argonne, IL 60439
AMOUNT $435,000	PRINCIPAL INVESTIGATOR Dwight Diercks (312) 739-7711 Ext. 4087

Argonne, IL	DURATION-AWARD DATE	CONTRACT NO. Subcontract to
WORK LOCATION	29 months—July 6, 1977	E(29–1)–0789

PROJECT SUMMARY:

Objective:

This activity provides materials testing, and materials data surveys for candidate materials for receivers and ancillary components utilized by water-steam types of receivers.

Approach:

The project requires the performance of three tasks:

a. To conduct elevated-temperature biaxial cyclic loading plus compressive-holdtime tests on Type 316H stainless steel tubing specimens to verify the adequacy of failure criteria currently being used in the design of solar receivers.
b. To survey available information on sodium effects on candidate materials for advanced solar thermal generators and superheaters. The survey will include information on mechanical properties, sodium compatibility, mass transfer effects, and recommendations for future testing.
c. To consult with Sandia Laboratories and Foster-Wheeler to identify materials and test conditions for mechanical properties testing in support of ASME code development for solar receivers.

Status:

Materials testing is in progress.

Future Effort:

Materials testing will continue into FY 1979.

TITLE	ORGANIZATION
An Interim Structural Design Standard for Solar Energy Applications	Foster-Wheeler Development Corporation 12 Peach Tree Hill Road Livingston, NJ 07039
AMOUNT	PRINCIPAL INVESTIGATOR
$ 99,750	A.C. Gangadharan (201) 533-3601

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO. Subcontract to
Livingston, NJ	19 months—May 20, 1977	E(29–1)–0789

PROJECT SUMMARY:

Objective:

The purpose of this project is to develop structural design standards for solar central receivers and components.

Approach:

Four tasks are required to achieve the described objective:

a. Study the range of loads, environment, and possible failure modes that fall under the scope of the American Society of Mechanical Engineers (ASME) Boilers and Pressure Vessel Code, and identify the available rules and criteria dealing with failure modes.
b. Survey the available literature on the failure rates of components designed under various sections of the ASME code. Categorize these failure rates and make a comparative evaluation of the reliability achieved by use of the code. Define the level of reliability, availability and safety desired in central receiver solar thermal power system components.
c. Select existing code rules that ensure the desired levels of reliability etc., modify the rules that are inconsistent with those levels, and determine the acceptable design limits and rules for solar design.
d. Identify the development and test program that is required to generate the design limit data for conditions not covered in present codes and standards, and unique to the central receiver solar program. Data concerning properties of materials are to be provided under a parallel Sandia subcontract (92–7648) with the Argonne National Laboratory.

Status:

Tasks a. and b. have been initiated. Data is being gathered for analysis and evaluation.

Future Effort:

A structural design standard will be proposed and supporting test and development programs will be identified.

Summary Statements

ADVANCED THERMAL TECHNOLOGY PROGRAM ELEMENT

SUPPORTING TECHNOLOGY SUB-ELEMENT

TITLE	ORGANIZATION
Cost Effective Textured Amorphous Silicon Thin Film Coating for Solar Thermal Conversion	Argonne National Laboratory (ANL) Energy and Environmental System Division 9750 South Cass Street Argonne, IL 60439
AMOUNT $ 75,000	PRINCIPAL INVESTIGATOR R.W. Griffith

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Argonne, IL	13 months—May 19, 1976	W–31–109–ENG–38

PROJECT SUMMARY:

Objective:

The objective of this program is to increase the absorptance of present state-of-the-art Si-metal selective absorber stacks from about 0.8 to better than 0.9. The potential application is for operation up to about 600°C for future generation solar thermal receivers. Improved performance is to be accomplished by investigating the unique properties of doped amorphous silicon rather than pure crystalline silicon as the absorber layer.

Approach:

Two principle project tasks are to perform theoretical analyses and to acquire film samples and measure optical properties of selected doped amorphous silicon alloys. The investigation is determining the feasibility of (a) reducing the energy band gap of silicon below 1.1eV and (b) lowering the surface reflection losses normally associated with high-index semiconductor films. These objectives are to be accomplished by preparing 1 micron films of doped amorphous silicon (to extend long wavelength limit of solar absorptance) and to alter the surface morphology of these films (to reduce Fresnel losses in the visible wavelength).

Status:

A shift to a longer absorptance wavelength edge (thereby increasing the total absorptance) has been demonstrated with Boron-doped amorphous silicon films. Thermal stability, and resistance to thermal shock appears satisfactory up to temperatures of about 600°C. Work has been completed and a final report has been prepared.

Future Efforts:

The project future plans are unknown at present pending a review of an extension proposal submitted by Mr. R.W. Griffith.

TITLE	ORGANIZATION
Optical Properties of Metallic Surfaces, Small Particles and Composite Coatings	Cornell University Laboratory of Atomic and Solid State Physics Ithaca, NY 14853
AMOUNT	PRINCIPAL INVESTIGATOR
$160,000	A.J. Sievers

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Ithaca, NY	12 months—May 1, 1977	EG–77–S–03–1456

PROJECT SUMMARY:

Objective:

The objective of this program is to perform theoretical and experimental studies on the optical properties of metal-dielectric composites. These composite materials may provide future generation selective absorber coatings operating at temperatures up to approximately 600°C with absorptances above 0.9.

Approach:

A theoretical program will predict the properties of metal particles embedded in suitable dielectrics such as Al_2O_3. The results of the theoretical studies will then be used to produce promising candidate materials for further study. In successive reiterations, the information obtained from the properties' measurements is correlated with theory, and successive generations of composites are to be designed incorporating variations in composition of metals, variations in concentration profiles of the metal component, and variations in the dielectric material in order to secure increasingly improved solar selective properties.

Status:

A modified Maxwell-Garnet theory has been developed which shows satisfactory agreement with optical measurements performed on sample composites. Composites prepared to date have included Ni-Al_2O_3 and Va-MgO Systems. Metal particles are ca. 100 Å diameter.

Typical performances are $\alpha \cong 0.94$ and $\epsilon \cong 0.1$. Unfortunately, these coatings become unstable in air at about 500°C.

Future Efforts:

Additional composites will be prepared, performances measured, and thermal life cycle testing performed to eliminate unattractive materials early in the program. Refinements of the theoretical models will continue.

TITLE	ORGANIZATION
Surface Morphologies of Efficient Solar Energy Absorbing Materials, Task 6	Energy Foundation of Texas 4800 Calhoun Boulevard Houston, TX 77004
AMOUNT	PRINCIPAL INVESTIGATOR
$ 80,000	A. Ignatiev

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Houston, TX	12 months—June 1, 1977	EG–77–C–04–3975

PROJECT SUMMARY:

Objective:

This is a theoretical and experimental program to investigate the contribution of surface morphology to the absorptance and emittance properties of black coatings. Coatings to be studied include black metal smokes (e.g. gold) and black metal oxides (e.g. black chrome). A better understanding of the contribution of the surface morphology to selective absorber performance provides the possibility of superior performance and lower cost materials for next generation coatings. The study of black chrome is particularly significant for solar thermal programs since all total energy and irrigations systems employ black chrome as the absorber coating. A secondary objective is to determine the mechanisms responsible for the photo-induced and thermal-induced degradation of metal blacks.

Approach:

A theoretical and experimental study of the role of granularity and porosity in defining the optical absorptance and emittance of "black" coatings is to be undertaken. Optical properties of classic inert-gas evaporated "blacks" are being studied and categorized as to dependence on particle size and density. Comparisons are being made between optical and structural properties of classical and commercial "blacks". The basic aspects of the absorptance and emittance of "blacks" in solar spectrum is being determined by theoretical calculations utilizing a structural model for the "blacks".

Status:

Preliminary observations on the absorptance of black metal smokes (gold and chromium) show good agreement with a theoretical model based on a log-normal distribution of strands of non-touching microspheres. Black chromium on nickel films have been prepared and analyzed for surface structure and optical performance. Satisfactory agreement between predicted and observed reflectance of black chrome has been obtained based on a black chrome model consisting of an 0.035 μ layer of close-packed Cr_2O_3 particles and an 0.065 μ layer of Cr particles imbedded in a Cr_2O_3 matrix.

Future Efforts:

In addition to black chrome, it is planned to look at other commercial blacks including black nickel and pyromark.

TITLE	ORGANIZATION
Improved Absorber Coatings for Thermal Utilization of Solar Energy	Englehard Industries Division Englehard Minerals and Chemicals Corp. Edison, NJ 08817
AMOUNT	PRINCIPAL INVESTIGATOR
$254,000	H. Myers

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Edison, NJ	24 months—July 1, 1976	AER–75–17470 (NSF Contract)

PROJECT SUMMARY:

Objective:

Develop new metal oxide absorber films for solar thermal conversion. Initial research on gold-based films will be expanded to include lower cost metal substitutes for gold.

Approach:

Organic-metallic films are fired to produce stable selectively absorbing coatings with potential applications to solar thermal technology.

Status:

The absorptance for doped gold has been increased from about 0.54 to 0.8 with $\varepsilon_t = 0.06$. A coating of Ag/CuO has been developed which demonstrates an absorptance of 0.8 with $\varepsilon_t < 0.1$.

Future Efforts:

The research and development coatings program will be funded by NSF through FY 78 and technically managed by DOE. This continued effort is to improve coatings (goal of 0.9 minimum absorptance) through film structure studies and antireflective coatings. High temperature studies will be conducted to show thermal stability up to 900°C in both vacuum and air environments.

TITLE	ORGANIZATION
Optimization of High Temperature Coatings for Solar Applications	Exxon Research and Engineering Co. P.O. Box 8 Linden, NJ
AMOUNT	PRINCIPAL INVESTIGATOR
$ 79,251	A.H. Muenker

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Linden, NJ	10 months—July 15, 1977	EG–77–C–02–4270

PROJECT SUMMARY:

Objective:

The objective of this project is to develop nonselective high absorptivity, high temperature paints for solar thermal applications.

For high temperature applications (500°C to 900°C) where very high concentration ratio collectors are required, "selectivity" is, in many cases, no longer a significant attribute of a receiver coating. Therefore, a high emissivity may be tolerated provided the candidate absorber has a high absorptivity, is low cost, and is durable. Previously developed high temperature inorganic coatings have been unsatisfactory in one or more of the areas of absorptivity, cost, and durability.

Approach:

The present study should produce a coating superior in all three characteristics. The project task elements achieve this objective by optimizing a coating previously developed for space applications. The approach modifies existing paint-on inorganic coatings by altering the chemistry of the binders and fillers of candidate paints in order to maximize the solar absorptance above 0.95, and maximize thermal and mechanical stability of the coatings. The chemistry (nickel, zinc, iron oxide, cobalt iron oxide, barium oxide and strontium oxide) of fillers and binders (organo-silicates) are modified to produce high absorptivity inorganic black paints.

Status:

Initial screening of candidate pigments indicates that highest $\alpha(\approx.96)$ pigments available are Co_3O_4, CoO, FeMn-CuOx and Cu-CrO_x. In some cases, α of .98 has been observed and the paints prepared from these pigments exhibit no measureable degradation after 24 hours in air at 700°C. Four pigments eliminated because of low α and/or irreversible degradation after heating in air at 500°C are PbS, $CuWO_4$, $CoOWO_3$, and $CoOCrO_3$.

Future Efforts:

Identification of most promising pigments will continue.

TITLE	ORGANIZATION
Development of Granular Semiconductors as Selective Absorbers	RCA Laboratories David Sarnoff Research Center Princeton, N. J. 08540
AMOUNT	PRINCIPAL INVESTIGATOR
$100,000	J. I. Gittleman

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Princeton, NJ	12 months—August 1, 1977	EG77-C-02-4557

PROJECT SUMMARY:

Objective:

Current state-of-the-art Si-metal selective absorber stacks for potential use in advanced receivers operating up to temperatures of approximately 600°C have demonstrated unsatisfactorily low absorptances of about 0.8. This is due both to the intrinsic absorptive properties of crystalline silicon as well as to high surface reflection losses. Typical techniques for achieving low reflection losses have, in the past, included the addition of (costly) anti-reflection layers or surface morphology modifications. The present program is an attempt to reduce reflection losses by developing appropriate graded-index semiconductors.

Approach:

The strategy of this program is to employ the unique optical characteristics of graded index-of-refraction deposition techniques as a means of defeating the high Fresnel reflection losses (and hence lowered absorptance) of discrete Si-metal selective absorber stacks. The tasks to be performed will include the search for semiconductor-matrix combinations such as silicon, germanium, or metal oxides as the semiconductor component dispersed in a transparent matrix such as aluminum oxide or calcium floride. Graded composition co-deposits will then be prepared on suitable metal substrates and the optical properties measured. Thermal cycling and life tests will be performed on promising composites.

Status:

Graded co-deposits of Si-CaF_2 and Ge-CaF_2 have been prepared in films $\sim$1 μm thick. Graded Si concentrations varying from 10% to 50% were obtained. A preliminary conclusion is that both the Si-CaF_2 and the Ge-CaF_2 films behave as if they were semiconductors with a single energy gap and with an absorptance depending on concentration. A unsolved problem is the poor adherence of the co-deposits on such subtrates as silicon or SiO_2 when films are annealed to ca. 600°C.

Future Efforts:

Improve film adherence, improve control over the steepness of the composition gradient and explore other semiconductor, dielectric combinations.

TITLE	ORGANIZATION
Black Chrome Process Development	Sandia Laboratories Albuquerque, NM 87115
AMOUNT	PRINCIPAL INVESTIGATOR
$200,000	James A. Leonard (505) 264–8508 (FTS) 8–475–8508

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Albuquerque, NM	15 months—August 1, 1977	E(29–1)–0789

PROJECT SUMMARY:

Objective:

This new program authorizes Sandia Laboratories, Albuquerque, to issue a Request For Proposal (RFP) in the area of black chrome absorptive coatings.

Approach:

The RFP would be sent to various industrial concerns having extensive in-house metallurgical laboratory and plating capabilities. The two tasks under the RFP are:

Phase I—Characterize the Process Variables for the Black Chrome Process

This phase would be approximately 12 months long and would consist of the following major tasks:

a. Determine and characterize the process variables for the Black Chrome Process.
b. Determine and characterize the long-term stability and durability of Black Chrome at operating temperatures up to 350°C.

Phase II—Publication of Process Handbook

This task would be approximately 4 months long and would consist of editing and publishing a process handbook or specification based on the results of Phase I. The process handbook would be written in such a way as to be of value to commercial plating companies. Authorization and funding to proceed with this task would be issued pending the successful outcome of Phase I.

It is estimated that Phase I would be accomplished through the issuance of approximately $150,000 in outside contracts.

Status:

An RFP for Phase I is being drafted by Sandia/Albuquerque. Contract award is expected in the third quarter of FY 78.

Future Efforts:

Once a contract for Phase I is issued, SLA will initiate the following tasks:

a. Monitor and administer the contract.
b. Plan and direct the experimental work. Planning would be a joint effort with the contractor and inputs to the experimental plan would be sought from other qualified organizations such as NASA Lewis Research Center.
c. Maintain a small in-house project to confirm contract results. Within the project would be small fixed price buys of Black Chrome specimens from commercial platers to stimulate interaction between laboratory and platers and to confirm laboratory results.

Phase II will be accomplished in FY 79.

TITLE	ORGANIZATION	
Absorber Surface Materials Workshop	Solar Energy Research Institute (SERI) Golden, CO	
AMOUNT	PRINCIPAL INVESTIGATOR	
$ 40,000	Dr. J.C. Grosskreutz	
WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Golden, CO	6 months—July 1, 1977	EG–77–C–01–4042

PROJECT SUMMARY:

Objective:

A coatings workshop is to be held to cover the various needs for, and requirements of, absorber surface materials as applied to receivers considered in the central or dispersed power systems for the Solar Thermal Power Program.

Approach:

The following represents a tentative workshop agenda:

Users Presentation

a. Central Receivers.
b. Dispersed Systems.
c. Other (Process Heat, EPRI, etc.).

Measurement and Characterization; State-of-the-Art Materials

a. History.
b. Measurement, Analysis.
c. Black Chrome.

Semiconductors/Metal Selective Absorber Stacks

a. Silicon.
b. Composites.
c. Dispersions.

Advanced Coatings

a. High Temp. Properties.
b. Organometallics.
c. Metal Nitrides.

Status:

The workshop was held December 6, 7, and 8, 1977. Some significant conclusions reached are:

1) A need has been recognized to define the absorptance and emittance of coatings as a function of operating temperature, angle of incidence, and wavelength in a standardized manner in order that different researchers can realistically compare and report absorber performance; a corollary of this is the need to standardize on a suitable definition of the solar spectrum in which the absorber will be tested.
2) A centralized information center, probably SERI, needs to be established to either confirm performance of absorbers developed for DOE or to coordinate the activities of one or more test facilities that will certify absorber performance.

Future Efforts:

Similar workshops are to be held annually.

TITLE	ORGANIZATION
Chemical Vapor Deposition of Spectrally Selective Absorbers	University of Arizona Optical Science Center Tucson, AZ 85721
AMOUNT	PRINCIPAL INVESTIGATOR
$ 94,630	B.O. Seraphin H.S. Gurev

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Tucson, AZ	24 months—April 30, 1976	E(29–2)3709

PROJECT SUMMARY:

Objective:

Develop selective absorbers of the silicon-metal "stack" type for use in high temperature receivers (up to ca. 700°C.) with $\alpha > 0.8$ and $\varepsilon \leq 0.15$.

Approach:

Multi-layer films are deposited on a stainless steel substrate using CVD techniques. The unique virtues of CVD are that (1) deposition is possible at atmospheric pressure and (2) continuous deposition of the various layers is accomplished as the substrate moves through the reaction chamber in a quasi-mass production manner.

Status:

The first year's efforts documented the satisfactory performance of silver as the high IR reflecting element of the stack. The silicon absorber on the order of about 1μ thick, is deposited via a continuous Chemical Vapor Deposition (CVD) process onto the vacumm-deposited silver film. Suitable intermediate films have been developed to prevent diffusion between the base metal, silver, and silicon elements. In addition, surface films of SiO_2 or SiN_2 have been employed to reduce the high surface reflection losses from the silicon. An achievement of the program has been to prevent agglomeration (and consequent deterioration) of the silver layer at temperatures up to about 700°C.

The best achievable performance has been an α of about 0.8 and an ε of about 0.1. Although ϵ is acceptable, α is undesirably low.

Future Efforts:

A second year effort on this program will explore the usefulness of the refactory metals W and Mo in place of the silver in order to achieve still higher temperature capability and to develop an all CVD deposition technique. Initial deposits of W and Mo by CVD have shown that such films may be deposited with a very high IR reflectance (essential for good selectivity) comparable to that of the bulk metal. Appropriate anti-diffusion barrier layers will also be developed.

TITLE	ORGANIZATION
High Temperature Optical Properties of Alloys for Central Receiver Solar Power Systems	University of Arizona Optical Science Center Tucson, AZ 85721
AMOUNT	PRINCIPAL INVESTIGATOR
$ 90,000	B.O. Seraphin K. Masterson

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Tucson, AZ	15 months—January 1, 1976	E(29–2)–3673

PROJECT SUMMARY:

Objective:

The program objective is to measure the absorption/emission characteristics of uncoated boiler tube steels at 500°C. The steels selected for study are those specified for the three 10 MWe receiver designs.

Approach:

The program was divided into four phases: (1) select suitable alloys, (2) prepare the alloy surface, (3) determine total hemispherical emittance and spectral reflectance, and (4) test the optical properties' durability. Up to 10 alloys were selected based on their suitability for central-receiver boiler tube applications (based on oxidation resistance, creep and stress rupture strength, fabricability, commercial availability in tubular form, and use by the 10 MWe contractors). The surfaces were prepared in a two-stage treatment to remove scale and to control oxidation. Optical measurements were performed both before and after temperature cycling to simulate the "steady-state" use conditions expected in the three receivers. The total hemispherical emittance at elevated temperatures up to 600°C and the spectral reflectance were measured. The stability of the optical properties of the surfaces was tested for various surface treatments. This was done at accelerated oxidation rates.

Status:

A final report has been submitted, and is being reviewed. Some provisional conclusions reached in this program were:

1. Pyromark-coated steels performed better than oxidized steels as receiver surfaces; typical α was $\sim$ 0.95 with $\epsilon \cong$ 0.9. In addition, pyromark coated samples showed good stability to high temperature cycling.
2. Typical performance of oxidized steels as receiver surfaces were $\alpha \cong$ 0.85 to 0.9; $\epsilon \cong$0.5. No significant difference was observed in the room-temperature α vs. high-temperature α of oxidized steels after several thermal cycles had occurred up to $\sim$ 700°C.
3. A recommended choice for an exposed receiver for the 10 MW plant would be pyromark on Inconel steel.

Future Efforts:

No further support for this program is contemplated.

TITLE	ORGANIZATION
Composition Profiling of Solar Coatings and Materials with AugerElectron Spectroscopy (AES) and Electron Spectroscopy for Chemical Analysis (ESCA)	University of Minnesota Minneapolis, MN 55455
AMOUNT	PRINCIPAL INVESTIGATOR
$ 54,971	C.K. Wehner

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Minneapolis, MN	12 months—April 15, 1977	E(11–1)2953

PROJECT SUMMARY:

Objective:

The primary objective of this program is to use the facilities and in-house expertise of the University of Minnesota to provide "cost-free" AES and ESCA profile analyses of sample films submited by DOE contractors engaged in coatings R&D for Solar Thermal Power programs.

Approach:

DOE contractors have been encouraged to submit coatings samples for profile composition analysis using both Auger Electron Spectroscopy and Electron Spectroscopy for Chemical Analysis.

Status:

Analyses have been performed for numerous DOE contractors; a first year report on this program has been published. Among samples received for analysis in the past year have been about 200 samples of boron-doped amorphous silicon for Auger analysis (in support of the amorphous silicon selective absorber program at Argonne National Lab.), about 17 samples of CVD-deposited Mo on glass for Auger analysis (in support of the CVD silicon-metal selective absorber program at the U. of Arizona), about 20 samples of black nickel and black chromium coating for ESCA analysis from Honeywell, 1 sample of Inconel attacked by high temperature molten salts for Auger analysis (in support of the Honeywell Central Receiver Phase I Support) and several samples of carbon on crystalline silicon films from Honeywell (in support of the DOE photovoltaic effort in solar electric).

Future Efforts:

The University of Minnesota will be supported in this service function when the present contract expires.

TITLE	ORGANIZATION
Research and Development in Solar Mirror and Quality Assurance Performance	Battelle-Pacific Northwest Laboratories Richland, WA 99352
AMOUNT	PRINCIPAL INVESTIGATOR
$100,000	Dr. M.A. Lind

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Richland, Wa	12 months—April 1, 1977	EY–76C–06–1830

PROJECT SUMMARY:

Objective:

The objective of this program is a materials-oriented program aimed at establishing Quality Assurance (QA) standards and developing measurement techniques for use throughout the entire solar industry. This program will provide a technical overview for the solar reflector technology, a development of reflector standards and testing procedures, and long-term component applications data to support all solar energy projects involving reflectors.

Approach:

The program contains three primary tasks:

Task a. *Solar Mirror Materials Evaluation*
- (1) Degradation mechanisms.
- (2) Correlation of natural vs accelerated aging.
- (3) Evaluation of surface measurement techniques.
- (4) Surface contamination and dust accumulation.

Task b. *Information Dissemination and Standards Development*
- (1) Industry interaction.
- (2) Publication in journals.
- (3) ASTM interaction.

Task c. *Instrumentation Development*
- (1) Specularity measurement.
- (2) Transmittance/reflectance measurement.
- (3) Mirror figure measurement.

Status:

Most of the first year effort has gone to identify materials problems under task a. This was accomplished by extensive literature search, visits to solar collector contractors and materials manufacturers, and in-house studies on degradation mechanisms. A first year report has been prepared and is currently under review.

Future Efforts:

Second year funding of $150,000 has been authorized to continue tasks a and b and to start developing solar-unique test instrumentation under task c.

TITLE	ORGANIZATION
Measurement of Circumsolar Radiation	Lawrence Berkeley Laboratory (LBL) Berkeley, CA 94720
AMOUNT	PRINCIPAL INVESTIGATOR
$180,000	Michael Wahlig (FTS) 8–451–5787

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Berkeley, CA	12 months—October 1, 1976	

PROJECT SUMMARY:

Objective:

The objective of this project is to measure the circumsolar flux. The circumsolar flux, defined as the additional radiation out to about ±3 degrees from the 1/2 degree solar disc, will be measured as a function of angle, wavelength, and atmospheric conditions.

Approach:

Four complete circumsolar telescopes have been built, debugged, and distributed by the project to several DOE program users. Data is accumulated on magnetic tape by the users and then sent to LBL for processing and printout on microfiche.

Status:

The four telescopes are located at Barstow, California for the 10 MWe pilot plant, on the Georgia Institute of Technology campus at the 400 KWth test facility, at Argonne National Laboratory in support of the Compound Parabolic Concentrator (CPC) program, and at the Solar Thermal Test Facility at Albuquerque, N.M.

The telescope currently at ANL had been at Ft. Hood, Texas, until recently. Initial analysis performed on data taken at Barstow, CA., Ft. Hood, TX., and Albuquerque, N.M. have shown that on an instantaneous basis, clear sky conditions sometimes exist for which the circumsolar flux contribution to incident insolation is negligible. These same three areas also have occasional periods when the circumsolar flux contribution ranges from 5% to 30% of the direct solar flux. A more realistic assessment of the circumsolar significance for system performance is provided on a monthly basis in which all types of sky conditions are encountered. On a month-by-month basis, these same three stations have demonstrated that the circumsolar flux contribution ranges from less than 1% to about 5%. The exact average loss will depend on the particular location and season of year. Detailed performance figure comparisons between Ft. Hood, TX and Barstow, CA, are not currently available. A detailed analysis of anticipated system losses at the various sites for specific system designs is currently in progress at LBL.

There is no data available yet from the Chicago site of ANL.

Future Efforts:

Circumsolar radiation measurements will be continued under the Environmental and Resource Assessment Program.

TITLE	ORGANIZATION
Research Applied to Solar Thermal Power Systems	University of Minnesota/Honeywell, Inc. Department of Mechanical Engineering 125 Mechanical Engineering Building Minneapolis, MN 55455
AMOUNT	PRINCIPAL INVESTIGATOR
No FY 1977 Funds	R. C. Jordon

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Minneapolis, MN	12 month—October 1, 1976	E(11–1)–2595

PROJECT SUMMARY:

Objective:

To experimentally determine the heat transfer coefficients of a molten salt medium for use in thermal storage subsystems and to conduct research related to parabolic trough collectors.

Approach:

The University of Minnesota is performing experiments of phase change energy storage; in particular, the determination of heat transfer coefficients during melting of the storage medium ($NaNO_3$/NaOH eutectic, M.P. 450°F) and measurement of the size/shape of the melt region and its temperature distribution.

The Honeywell work is divided into three tasks: (1) continuation (resumption) of reflector material lifetime tests in the Arizona desert, (2) application of a black chrome coating to a stainless steel heat pipe and evaluation in a scale model parabolic trough at an Arizona test site, and (3) conceptual design/upgrade of a scale model parabolic trough to an optimized size/version.

Status:

The phase change energy storage research pursued by the university is original and promising and has been brought to the attention of the energy storage group at Oak Ridge and Lewis Research Center. The reflector material lifetime tests by Honeywell are being evaluated; over 2 years exposure has been attained with a variety of materials.

Future Efforts:

The technical effort of this contract has been completed and no further work is contemplated.

Refer to the photograph on the following page (Figure 16).

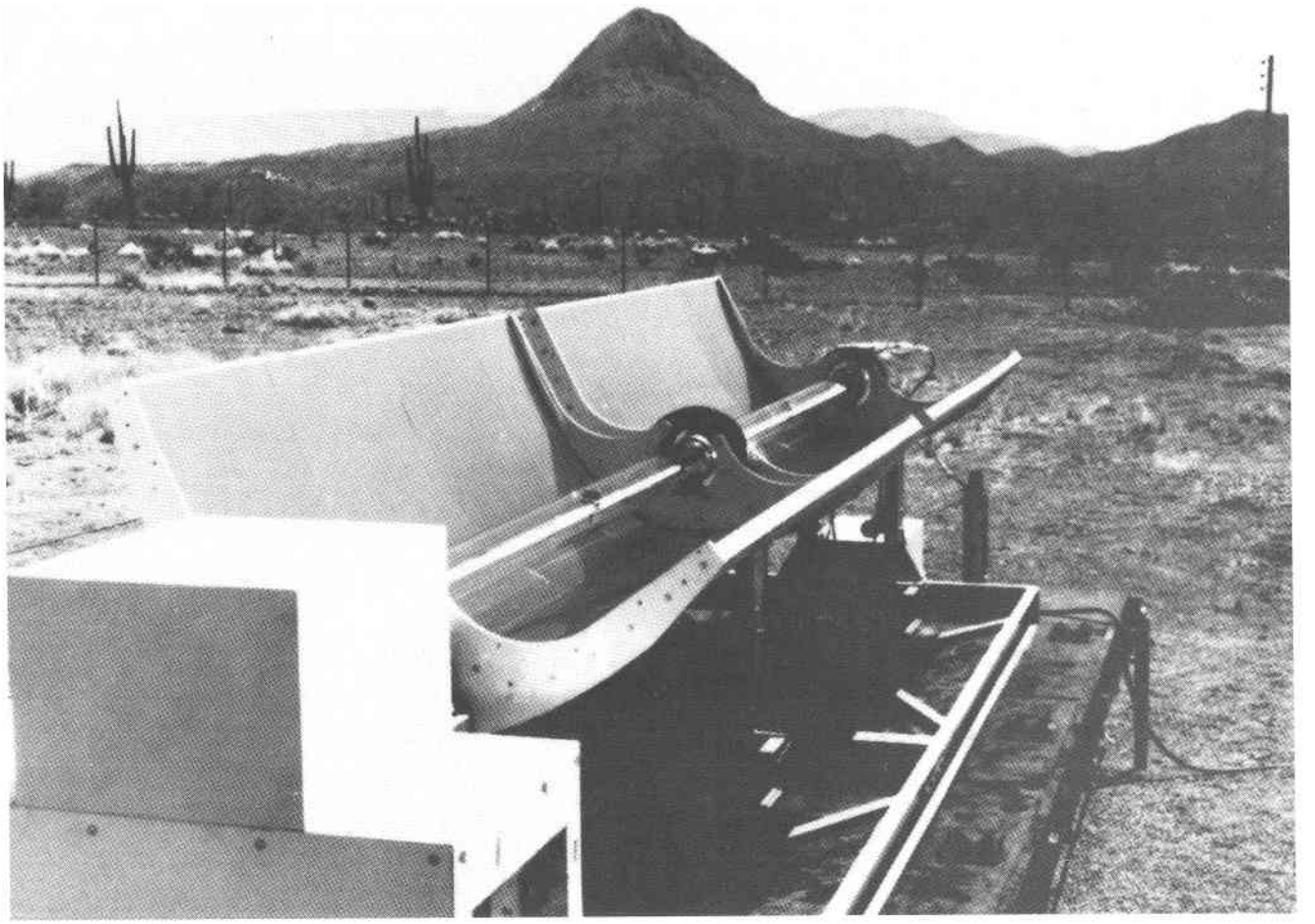


Figure 16. Research Applied to Solar Thermal Power Systems. Scale Model Parabolic Trough.

Summary Statements

ADVANCED THERMAL TECHNOLOGY
PROGRAM ELEMENT
NEW CONCEPT DEMONSTRATIONS
SUB-ELEMENT

TITLE	ORGANIZATION
1–MWth Bench Model Cavity Receiver Steam Generator Test Program	Georgia Institute of Technology Engineering Experiment Station Atlanta, GA 30332
AMOUNT	PRINCIPAL INVESTIGATOR
$252,718	C. Thomas Brown (404) 894-3671

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Atlanta, GA	32 months—April 1, 1975	EY–76–S–05–4921

PROJECT SUMMARY:

Objective:

This project has supported testing of the Martin Marietta 1-MWth Bench Cavity Receiver in the Radiant Heat Facility at Albuquerque, New Mexico, at the CNRS Solar Furnace at Odeillo, France and at the Solar Thermal Test Facility at Albuquerque, New Mexico.

Approach:

GIT has been responsible for coordinating the testing at the CNRS solar facility at Odeillo, France, as well as providing technical and physical support for the water treatment of receiver feedwater, experimental stress analysis, and other facility coordination for the Radiant Heat and Solar Thermal tests.

Status:

The Radiant Heat and Solar Furnace (Odeillo, France) tests were completed. The planned test at the STTF was cancelled.

Future Efforts:

No future testing is planned.

TITLE	ORGANIZATION	
One Quarter Megawatt (thermal) Solar Brayton Receiver Design, Construction and Testing	Sanders Associates 95 Canal Street Nashua, NH 03069	
AMOUNT $956,000	PRINCIPAL INVESTIGATOR Dr. Armand Poirier (603) 855-5090	
WORK LOCATION Atlanta, GA	DURATION-AWARD DATE 14 months—July 25, 1977	CONTRACT NO. EG–77–C–03–1533

PROJECT SUMMARY:

Objective:

The project objective is to fabricate and test a 250-kw_{th} silicon carbide honeycomb receiver at atmospheric pressure and 2000°F. This work extends the previous effort, conducted under Contract E(11–1)–2823, that resulted in the test of a 1700°F heat receiver of 10-kW (thermal) capacity. Successful testing of the 250-kW_{th} receiver will verify the potential of this technology for application to large-scale solar power generation using open-cycle Brayton systems.

Approach:

Project tasks under the present phase include:

a. Design of a 250-kW (thermal air-cooled receiver, operating at atmospheric pressure and having a thermal efficiency of 84 percent at 2000°F.
b. Experiments and analyses to evaluate the potential loss of heat by convection from the receiver.
c. Analysis to verify that the receiver design and performance will be capable of further scaling to commercial power generation levels.
d. Fabrication of the 250-kW receiver, together with fixtures and accessories required for testing at the DOE/ Georgia Institute of Technology (GIT) 400-kW_{ht} Test Facility.
e. Laboratory testing of the completed receiver for at least 10 cycles to temperatures in excess of 1000°F, using heated air.
f. Preparation of a test plan for the receiver in concentrated sunlight at GIT facility.
g. Shipping the receiver to the GIT facility.

Status:

Sanders Associates, Inc. has initiated preliminary design of the Brayton heat receiver and the experiment to evaluate heat loss by convection.

Future Efforts:

Depending on the results of the performance test, consideration will be given to thermal cycling testing of the heat receiver.

Refer to the photograph on the following page (Figure 17).

Figure 17. Mock Up of ¼ MW_t Heat Receiver Under Convective Loss Test.

TITLE	ORGANIZATION
Heat Pipe for Central Solar Receiver	Dynatherm Corporation One Industry Lane Cockeysville, MD 21030
AMOUNT	PRINCIPAL INVESTIGATOR
$313,142 (FY 76 Funds)	Walter B. Bienert (301) 666-9151

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Cockeysville, MD	24 months—February 1, 1976	E(11–1)–2839

PROJECT SUMMARY:

Objective:

This contract provides for the investigation of heat pipes as extended surfaces for a gas heat exchanger for application to a central solar receiver.

Approach:

This project requires four tasks:

a. Evaluate various heat exchanger concepts with respect with to the performance in conjunction with a typical generation cycle.
b. Extend the existing heat pipe technology to meet the requirements of a solar-to-gas heat exchanger.
c. Select a reference design heat exchanger and generate sufficient design detail to enable costing the unit.
d. Lay out, analyze, and cost a solar-gas system and compare its enegry costs with those of the reference central receiver plants.

Status:

Heat pipes of the size and type required have been successfully built and tested, and tests of prototype heat pipes are underway. An economic analysis, a development plan, and a definition of heat pipe manufacturing techniques are being initiated. A conceptual design of a receiver with definition of aperture fluxes and intensities is also being created.

Future Efforts:

A follow-on program is being proposed: design, fabricate, and test a 250-kW_{th} receiver; perform life tests and manufacturing development of liquid metal heat pipes; and design a 1-MWe pilot plant.

TITLE	ORGANIZATION
Development of Converter Heat Exchangers for Solar Thermo-Chemical Energy Collectors	Naval Research Laboratory Space Science Division Washington, D.C. 20375
AMOUNT	**PRINCIPAL INVESTIGATOR**
$120,000	Dr. Talbott A. Chubb

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Washington, DC	12 months—September 15, 1977	EG–77A–29–1105

PROJECT SUMMARY:

Objective:

The Naval Research Laboratory (NRL) has developed a solar thermal heat receiver design for decomposing SO_3 based on ceramic honeycomb extrusion technology. This technology may be used for chemical energy storage of solar thermal energy.

Approach:

Task 1 is to evaluate the honeycomb extrusion design and manufacturing capabilities of one or more industrial firms. Task 2 provides the engineering design and thermal analysis of the heat receivers for use on parabolic dish solar collectors.

The subtasks include:

a. Establishing an advisory committee to examine existing receiver designs.
b. Preparing performance specifications for the design of a test receiver.
c. Providing a list of candidate contractors capable of designing a receiver.
d. Selecting a contractor for evaluation, design, and analysis by competitive bidding.

Task 3. NRL is to subcontract to New Mexico State University (NMU) the task of designing facilities to test the performance of an experimental receiver.

Status:

Under task 1, the means for altering honeycomb extrusion designs is being explored and ceramic pieces and assemblies are being procured to explore production capabilities.

Future Efforts:

If results of the current effort are promising, the receiver will be built and tested.

Refer to the photograph on the following page (Figure 18).

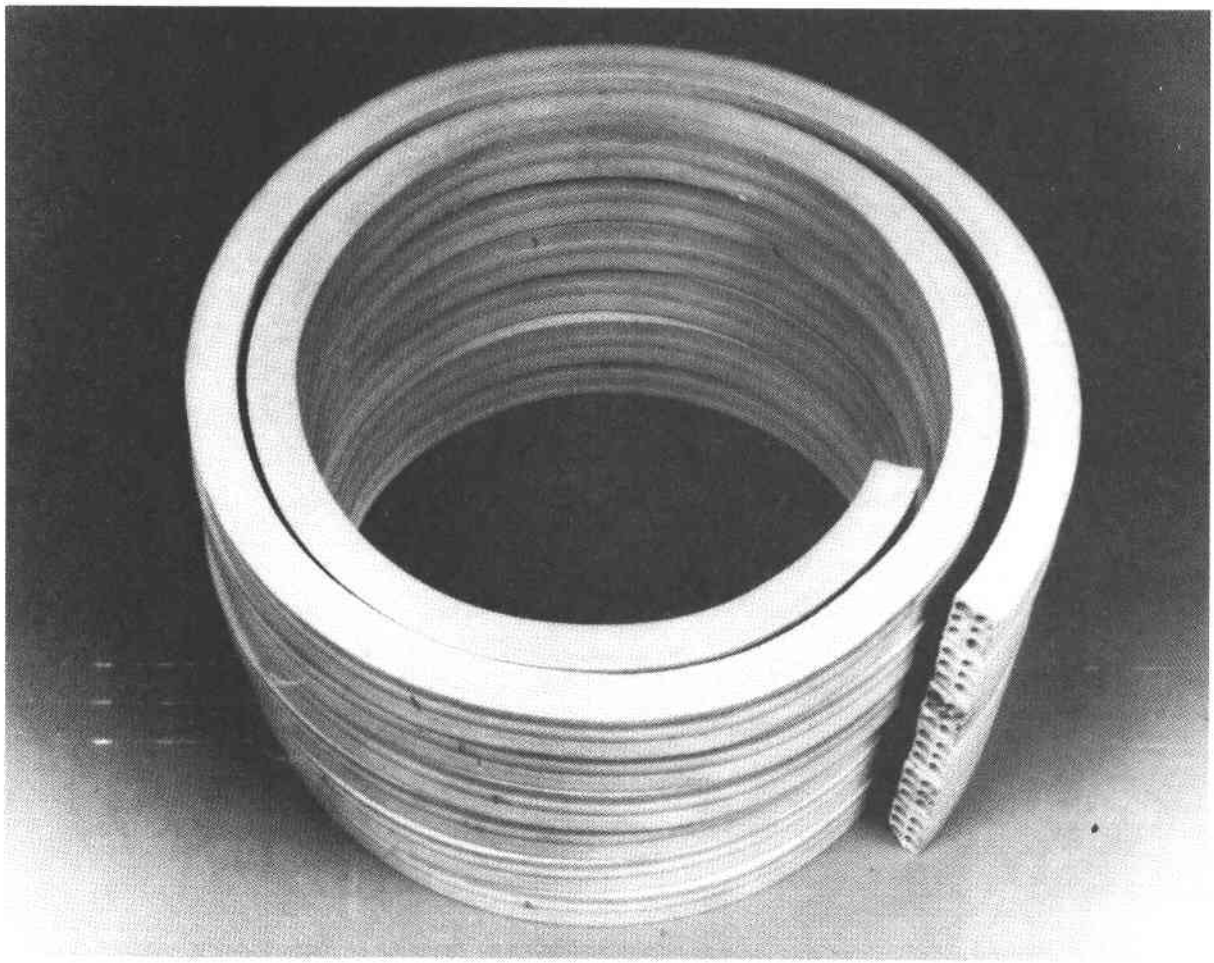


Figure 18. NRL—Ceramic Heat Exchanger.

TITLE	ORGANIZATION
Compound Parabolic Concentrator for Solar Thermal Energy Conversion	Argonne National Laboratory 9700 South Cass Avenue Argonne, IL 60439
AMOUNT	PRINCIPAL INVESTIGATOR
$450,000	W. W. Schertz, R. G. Matlock

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Argonne, IL	12 months—October 1, 1976	W–31–109–ENG–38

PROJECT SUMMARY:

Objective:

The objective of the Argonne Program is to develop solar collectors for power generation in the temperature range of 400° to 600°F (204° to 316°C).

Approach:

During 1977, approximately 100 ft² of 3X Compound Parabolic Concentrators (CPC) have been fabricated and testing initiated. The purpose of the testing is to compare the performance of lightweight plastic reflectors with aluminum reflectors in a side-by-side environment. Daily-cycle operation is being undertaken to provide data for comparison with computer model predictions. The in-house development of collector components is being augmented by subcontracts to industrial firms.

Status:

Design and fabrication of a pre-prototype 5X CPC have been completed. Analysis has indicated that an "advanced technology" version of the 5X CPC is capable of operation at 300°C with an efficiency of 55 percent. A subcontract to A.D. Little resulted in the conceptual design of a 2000 ft² 5X CPC system for demonstration at the Total Energy Test Facility. In addition, a preliminary energy cost analysis of an installed 5X CPC power plant has been performed using standard insolation data and NASA/JPL-furnished subsystem parameters.

Future Efforts:

This project has been transferred to the R&D Branch, Conservation and Solar Applications. Further work in the development of the CPC collectors by Argonne will be given consideration by that Branch.

TITLE	ORGANIZATION	
Solar Powered Steam Generator Heliostat	Brookhaven National Laboratory Associated Universities, Inc. Upton, NY 11973	
AMOUNT $190,000	PRINCIPAL INVESTIGATOR J. G. Cottingham	
WORK LOCATION Upton, NY	DURATION-AWARD DATE December 1, 1976	CONTRACT NO. E(30–1)–0016

PROJECT SUMMARY:

Objective:

The objective of this program is to develop a low-cost heliostat for a solar energy collector system designed to produce process steam which can compete economically with fossil fuel in areas where fossil fuel is the most expensive (northeast).

Success depends primarily on the development of a low-cost heliostat. The Brookhaven design is a lightweight, low profile helisotat using an aluminized plastic film reflector bonded to a metal/styrofoam support structure.

Approach:

Specific tasks under the Brookhaven project entail:

a. Heliostat Development: includes design, prototype fabrication, thermal performance measurements, and production cost analysis.
b. Reflector Surface Materials: survey of existing materials, evaluation, and test, etc.
c. Wind Study: correlation of wind speed and insolation; development of heliostat operational criteria.
d. Motor Control: motor test with simulated load, computer/motor electronics interface design.
e. Analyses: study of off-axis optical distortion and effect on heliostat size.
f. Market Analysis: study of process steam markets both new and retrofit, with emphasis on the Northeast U.S.

Status:

Two prototype heliostats are being built and tested. In parallel with the helisotat design, performance characteristics and requirements are being studied to minimize heliostat material cost per unit of solar energy collected. A study of the steam energy market is being made to identify the application best suited for early development. Production cost estimates will be made.

Future Efforts:

Consideration will be given to extending the Brookhaven effort depending on results of the test of the heliostat and the market analysis.

TITLE	ORGANIZATION
PARAVAC Solar Collector	Sun Power Corporation 3 High Point Road Westport, CT 06880
AMOUNT	PRINCIPAL INVESTIGATOR
$91,200	Carl Whiteford (203) 259-6266

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Westport, CT	10 months—August 16, 1977	EG–77–C–01–4031

PROJECT SUMMARY:

Objective:

The objective of this new program is to demonstrate the feasibility of constructing a "parabolic trough" concentrator employing Fresnel reflectors on a vacuum-formed cylinder. This technique has the potential for lowering typical collector costs for both energy and irrigation applications.

Approach:

The project task entails lining an accurate cylindrical trough with a preformed metallic reflecting plastic "Fresnel" sheet calculated to provide the optical equivalent of a parabolic trough. The success of this concept depends on how accurately a cylindrical cross-section backing for the Fresnel sheet is formed and how accurately the relatively small correction Fresnel reflector may be extruded. To achieve an accurate cylindrical contour a partial vacuum is used to pull the Fresnel sheet into an accurate circular cross section. To test the feasibility of this construction technique, three reflector assemblies are being built. A test program on the completed units will be undertaken to establish optical performance under conditions of wind loading and thermal expansion.

Status:

A prototype collector has been designed and built. A stress analysis of the structure has been performed indicating survival in winds up to ca. 100 miles/hour. The Fresnel sheet lens has been designed and it's optical performance confirmed analytically. The Fresnel lens die has been designed and is being fabricated.

Future Effort:

The Sandia Laboratories, Albuquerque, New Mexico, may, at the request of SOLAR, permit the Sun Power personnel to use the Sandia single collector test facility in evaluating the collector performance. The required retrofit of the collector to the test facility will be provided by Sun Power. Testing is to be performed by Sandia Laboratories.

TITLE	ORGANIZATION
Non-Imaging Concentrators for Wide-Angle Collection of Solar Energy	University of Chicago The Enrico Fermi Institute 5801 South Ellis Avenue Chicago, IL
AMOUNT	PRINCIPAL INVESTIGATOR
$300,000	R. Winston, J. O'Gallagher

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Chicago, IL	12 months—July 1, 1977	E(11–1)–2446

PROJECT SUMMARY:

Objective:

The three program objectives are:

1) Demonstrate the potential of non-imaging (CPC) concentrators for Solar Thermal power generation by fabricating a 5X collector and a prototype 16X lens-mirror collector,
2) Provide a 3X CPC instrumented installation to provide heat and hot water for an Indian school at Bread Springs, New Mexico.
3) Perform R&D in areas of novel CPC design, and non-specular reflective elements for CPC collectors.

The previous program of CPC support at ANL differs from the present U/Chicago program primarily in that the ANL program was directed towards final development of systems emphasizing active industrial participation. The present U/Chicago effort emphasizes more research oriented areas of CPC development.

Approach:

The roof-top prototype development entails the construction of approximately 15 square feet of 5X Compound Parabolic Concentrators (CPC) and conducting optical and thermal tests. The potential for this nontracking system is 600°F (315°C) at an efficiency of 42 percent. A roof-top test station is to be expanded to include a high-temperature test loop, solar/weather station, and data acquisition system. Advanced concepts for lens/mirror combinations using Fresnel lenses are to be studied. A 10 square foot 16X lens-mirror module is to be constructed and tested. (Potential 700°F and 40 percent efficiency.) Research is being conducted to reduce CPC reflector costs, write specifications of reflector tolerances versus concentration, and develop a simulation program for daily/yearly energy collection.

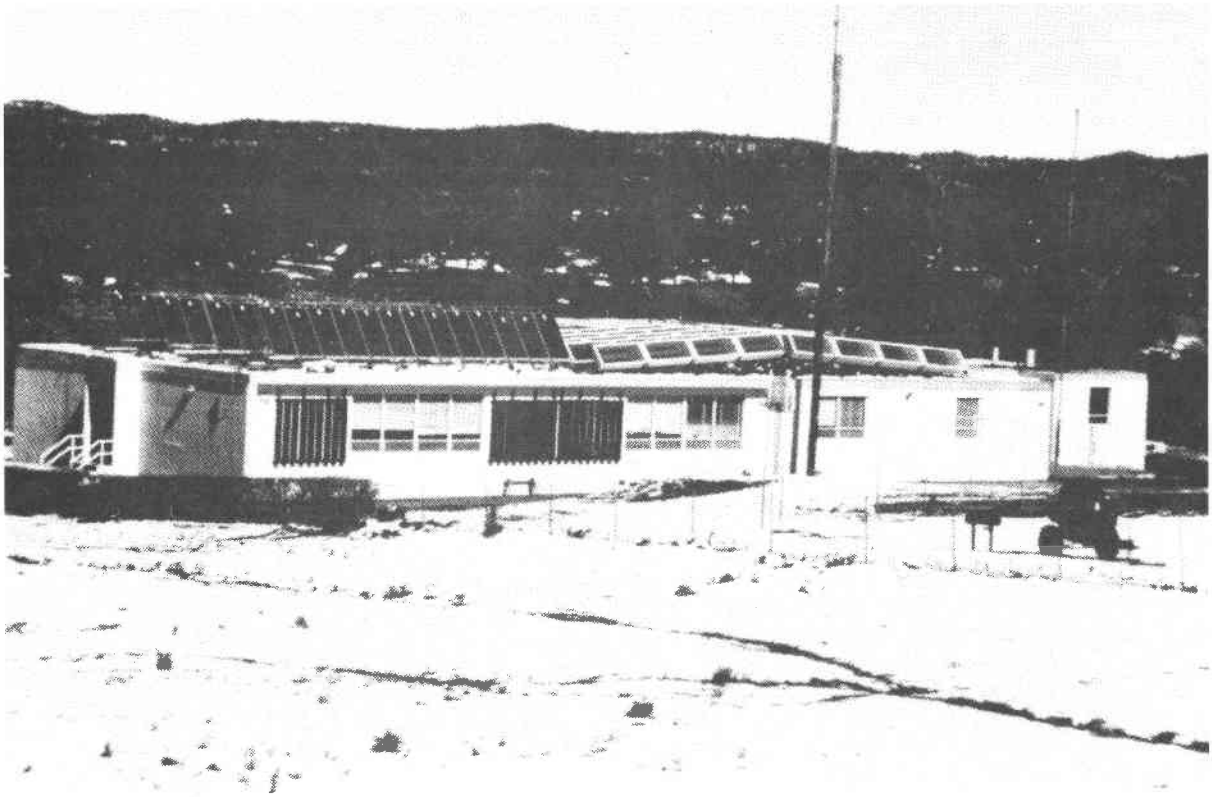
Status:

Low temperature testing of prototype 5X CPC collector has been completed. The 3X CPC installation at the Bread Springs, NM, Indian School is functioning and is providing heat. Concentrator performance simulation programs have been prepared.

Future Efforts:

Upon completion of high temperature test loop, performance will be compared with predicted results. The 16X lens-mirror CPC will be completed and tested. Instrumentation will be installed to monitor performance of the Bread Springs school. At present, no further support is planned for this effort beyond June 30, 1978.

Refer to the photograph on the following page (Figure 19).



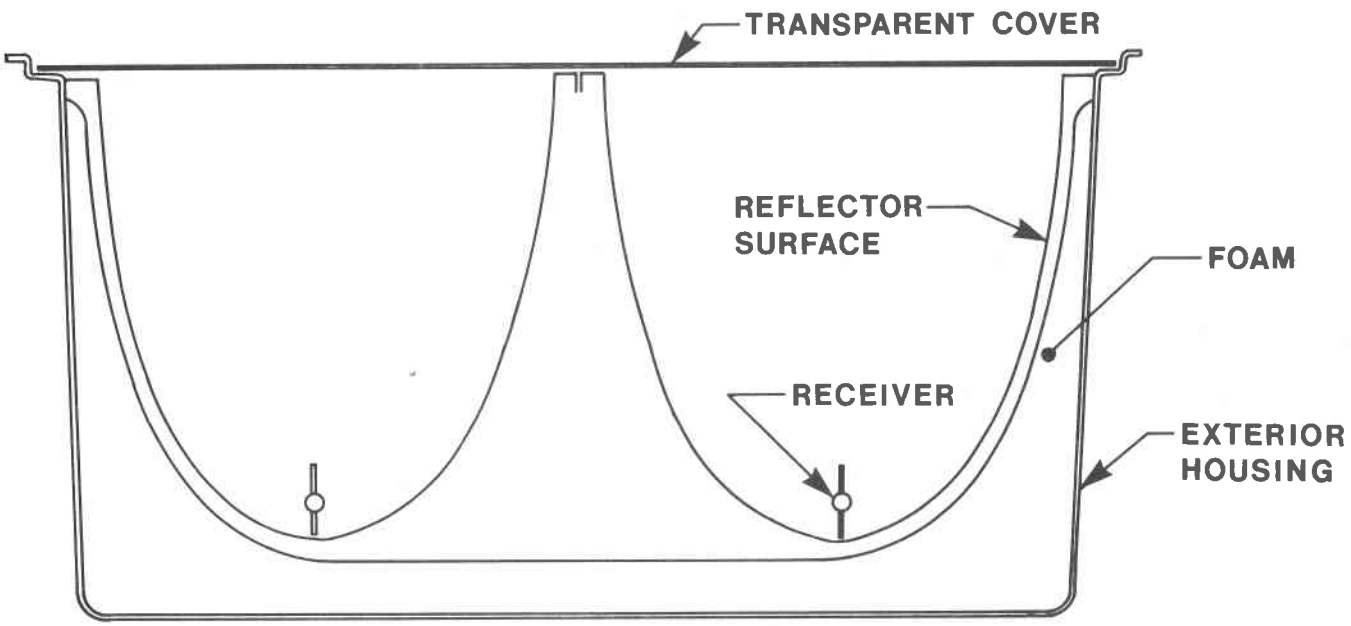


Figure 19. Top: Bread Springs Indian School with Compound Parabolic Reflectors (3 Times Concentration) (on right) and flat plate collectors (on left) installed on roof.
Bottom: Cross Section of the Bread Springs Project 3X CPC Collector.

TITLE	ORGANIZATION
Evaluation of a Two-Phase Turbine System for Solar Electric Power Generation	BiPhase Engines, Inc. 2907 Ocean Park Boulevard Santa Monica, CA 90406
AMOUNT	PRINCIPAL INVESTIGATOR
$94,000	Robert Spies

WORK LOCATION	DURATION–AWARD DATE	CONTRACT NO.
Santa Monica, CA	16 months—June 1, 1976	E(04–3)–1255

PROJECT SUMMARY:

Objective:

The objective of this program is to analyze, design, fabricate, test, and evaluate a two-phase turbine for operation at 600°F.

Approach:

The specific design chosen was based on the operating conditions and parameters of the Total Energy Test Facility at the Sandia Laboratories, Albuquerque, New Mexico

The program is to result in delivery of a trailer-mounted engine to a DOE selected site. In addition, cost and performance estimates for low (600°F), medium (1000°F), and high (1600°F) temperature versions will be provided.

Status:

Biphase Engines, Inc., has designed the turbine and has fabricated all parts. The turbine is to be assembled and tested shortly. Biphase Engines, Inc. is analyzing the potential of their turbine concept for application to a range of solar thermal systems.

Future Effort:

Continued development of the two-phase turbine will depend on results of tests of the turbine at conditions approximating the Total Energy Test Facility.

Refer to the photograph on the following page (Figure 20).

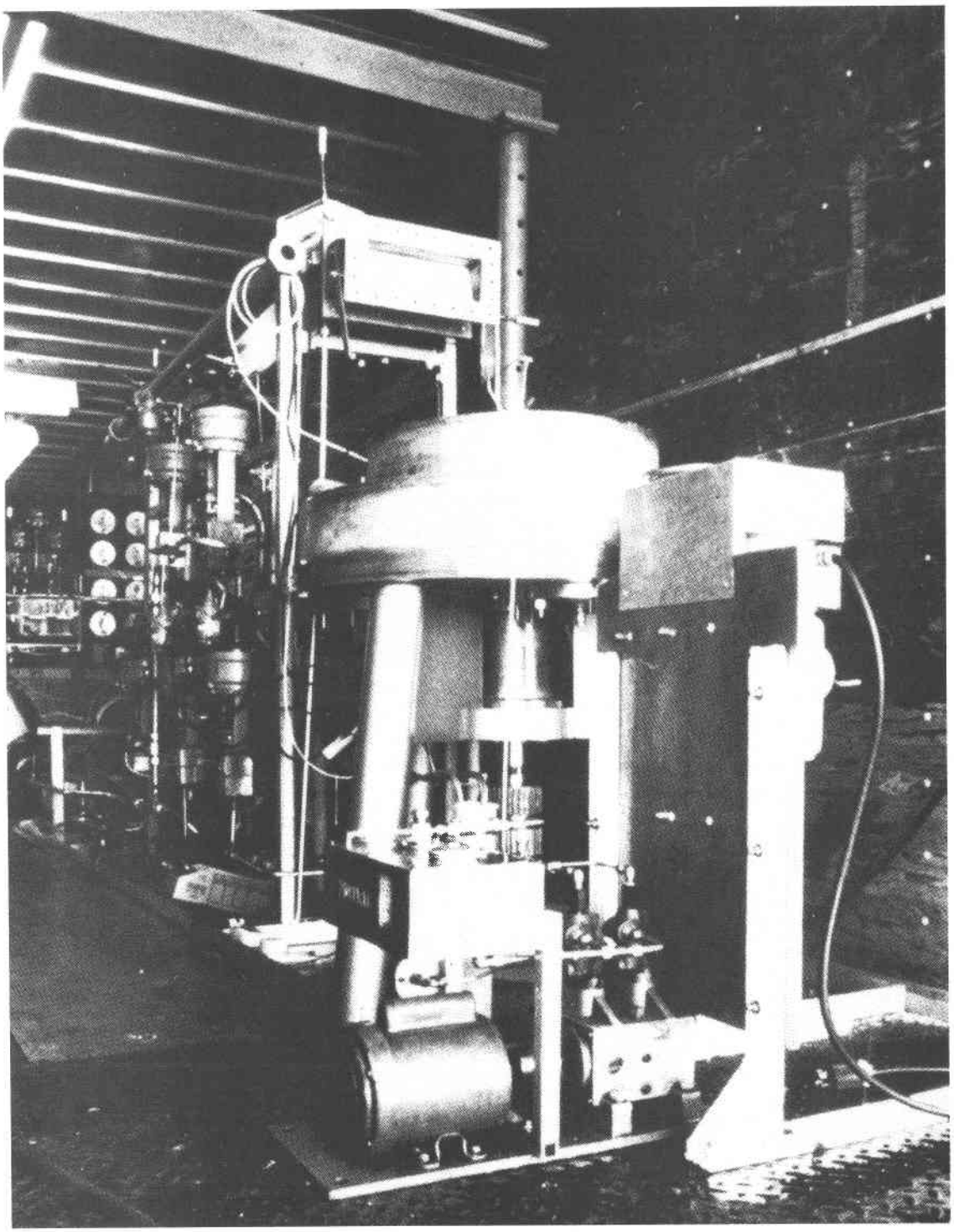


Figure 20. Biphase Engine Test Set-Up Installation: Two Phase Turbine and Regenerator.

TITLE	ORGANIZATION	
Technical Support and Advanced Concepts Development	Oak Ridge National Laboratory (ORNL) P.O. Box X Oak Ridge, TN 37830	
AMOUNT $120,000	PRINCIPAL INVESTIGATOR S. E. Beall, Jr.	
WORK LOCATION Oak Ridge, TN	DURATION-AWARD DATE 17 months—May 19, 1977	CONTRACT NO. 05 ENG 26

PROJECT SUMMARY:

Objective:

The project objectives are to assess the feasibility of the near-ground-level central receiver through a conceptual design study and to provide DOE Headquarters with technical assistance in the assessment of materials, chemistry, and thermal storage technology.

Approach:

Using an optical design developed under subcontract to ORNL by the University of Arizona Optical Sciences Laboratory, ORNL is assessing the feasibility of near-ground-level central receivers.

Status:

The University of Arizona has completed work on the subcontract awarded by ORNL. ORNL is evaluating the economic feasibility of the near-ground-level central receiver.

Future Effort:

If the concept proves to be feasible, detailed engineering and economic feasibility studies will be conducted in FY 78.

TITLE	ORGANIZATION
Optical Design of a Near-Ground-Level Central Receiver	University of Arizona Optical Sciences Laboratory Tucson, AZ 85721
AMOUNT	PRINCIPAL INVESTIGATOR
$54,000	S. E. Beall, Jr.

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO. Subcontract to
Tucson, AZ	4 months—June 1, 1977	05 ENG 26

PROJECT SUMMARY:

Objective:

The optical feasibility of a near-ground-level receiver is being studied in support of the Oak Ridge effort for Advanced Concepts Development.

Approach:

Several concepts of tower reflectors with additional concentration at the receiver are being examined. High reflectivity machined metal mirrors, such as Oak Ridge is fabricating for the laser program, are being considered in the design.

Status:

Currently, the near-ground-level receiver does appear feasible but complex and costly.

Future Effort:

No further extension of this work is contemplated after completion of the study.

TITLE	ORGANIZATION
Study of a 25 to 500 kWe Shallow Solar Pond System for Producing Shaft Power	Lawrence Livermore Laboratory University of California P.O. Box 808 Livermore, CA 94550
AMOUNT $65,000	PRINCIPAL INVESTIGATOR W. C. Dickerson

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Livermore, CA	15 months—October 1, 1976	W–7405–ENG–48

PROJECT SUMMARY:

Objective:

This effort is a conceptual design study to identify the applications potential for shallow solar ponds to provide power for small communities or for irrigation pumping on large farms in the arid Southwest.

Approach:

Lawrence Livermore Laboratory has undertaken a conceptual design study of a shallow solar pond power plant. The main elements of this study are: to modify present shallow solar pond designs for electric power and irrigation applications (subcontract to Barber-Nichols to define power conversion cycle for $11K); to design a water control and ducting system; to design a hot water storage reservoir; to determine the availability and cost of components; to consider alternative water-conserving methods for heat rejection from the Rankine cycle; to identify areas for further research and development; and to perform parametric performance and cost analysis for both prototype and demonstration size plants.

Status:

Prototype development is underway on a 4-inch deep modular pond that is made up of two 8′ x 200′ black bottom plastic bags with a domed fiberglass greenhouse type cover.

Future Effort:

Extension of this study will depend on a comparison of economic performance of the shallow solar pond system with other solar thermal power systems.

Refer to the photograph on the following page (Figure 21).

Figure 21. Lawrence Livermore Laboratory—Shallow Solar Pond Prototype Near Grants, NM.

TITLE	ORGANIZATION	
Hydrogen Production Process Development	Westinghouse Electric Corporation Advanced Energy Systems Division P.O. Box 10864 Pittsburgh, PA 15236	
AMOUNT $121,000	PRINCIPAL INVESTIGATOR G. H. Farbman	
WORK LOCATION Pittsburgh, PA	DURATION-AWARD DATE 8 months—May 17, 1977	CONTRACT NO. EG–77–C–02–4378

PROJECT SUMMARY:

Objective:

The overall project objective is to assess the technical and economic attractiveness of a hydrid electrochemical/thermochemical hydrogen production process called the Sulfur Cycle. This process provides the potential of using solar energy for the production of hydrogen.

Approach:

The project tasks entail screening candidate SO_3-decomposition catalysts, designing an SO_3-decomposition test loop, and testing candidate structural materials. This work is being coordinated with the Division of Energy Storage Systtems' activities in thermochemical production of hydrogen.

Status:

Several catalysts are being evaluated for activity and aging characteristics at temperatures to 1600°F in an existing low pressure test loop. The loop is being debugged and the catalysts tested.

All test work for decomposing SO_3 to date has been at atmospheric pressure. Since the ultimate process is expected to operate at pressures of perhaps 300 psi, a preliminary design of a pressurized SO_3 reduction test loop to test promising catalysts is to be conducted.

In addition, potential structural/heat transfer materials are to be tested in the presence of catalysts at temperatures to 1600°F, in a mixture of SO_3, SO_2, O_2, and steam. Test specimens have been procured and testing is to begin shortly.

Future Effort:

A continuation of the project tasks is expected during FY78.

Summary Statements

ADVANCED THERMAL TECHNOLOGY
PROGRAM ELEMENT
ADVANCED SYSTEMS
SUB-ELEMENT

TITLE	ORGANIZATION
Solar Thermal Power Systems Research and Development Management Project	National Aeronautics and Space Administration Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, CA 91103
AMOUNT	PRINCIPAL INVESTIGATOR
$1,365,000	V. Truscello, J. Becker

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Pasadena, CA	12 months—November 31, 1976	NAS7–100

PROJECT SUMMARY:

Objective:

The objective of this project is to support DOE in the management of the solar thermal electric advanced technology program. To implement this project, the Jet Propulsion Laboratory (JPL) has been designated as the coordinating center for this effort and works closely with DOE laboratories and with other NASA centers.

Approach:

The NASA Research and Development (R&D) project is divided into three task areas:

a. *Task I.* Project Management/Technical Overview/Coordination.
b. *Task II.* R&D Program Planning and Studies.
c. *Task III.* Technical Monitoring/Direction of R&D Contracts and Proposal Review.

Project plans, schedules, and reports/presentations to DOE are brought together under Task I. Task II includes the studies and analyses required to support the R&D program, and Task III includes the technical monitoring of 17 on-going DOE solar thermal contracts.

Status:

Program plans and recommendations for solar thermal R&D are prepared and submitted to DOE under Task I. Broad-based planning, drawing upon DOE, industry, NASA, NSF, universities and other sources, has been performed to identify key program areas and help the overall R&D effort. Under task II an advanced technology summary plan including intermediate and high temperature distributed receiver systems, as well as central receiver systems, is being developed. Studies to support various program plans include hybrid systems, absorber surface materials, heat engines, and distributed collector/central power station trade-offs. In addition to monitoring DOE's on-going contracts under Task III, JPL has reviewed approximately 100 unsolicited proposals for possible application to the R&D program. Approximately 10 percent of the reviews have resulted in contract packages prepared by NASA and submited to DOE for approval.

Future Effort:

The R&D management support activity is expected to be continued during FY 78. Studies will be initiated of advanced dispersed power systems, including dish-Stirling engine system concepts, as well as continuation of the work of the tasks described above.

Summary Statements

ADVANCED THERMAL TECHNOLOGY
PROGRAM ELEMENT
TECHNOLOGY ASSESSMENT
SUB-ELEMENT

TITLE	ORGANIZATION
High-Temperature Industrial Applications of Solar Thermal Energy	Oak Ridge National Laboratory (ORNL) P.O. Box X Oak Ridge, TN 37830
AMOUNT	PRINCIPAL INVESTIGATOR
$124,000	S. E. Beall, Jr., C. E. Bamberger

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Oak Ridge, TN	14 months—August 1, 1977	05 ENG 26

PROJECT SUMMARY:

Objective:

This project assesses the use of high-temperature (above 400°F) solar energy in fuels and chemicals manufacture.

Approach:

Candidate processes are being examined for engineering and economic feasibility, as well as possible impact on fossil energy consumption. The Institute of Gas Technology (IGT), under subcontract to ORNL, is assisting in this effort to assess the use of high-temperature solar energy.

Status:

The ORNL effort has recently begun. A survey has been undertaken to identify current processes having significant energy consumption. These processes will then be examined for possible application of solar thermal energy.

Future Effort:

These studies will continue in FY 78 and will result in a preliminary assessment of the role of solar thermal for application to fuels and chemicals manufacture.

TITLE	ORGANIZATION
Fuels and Chemicals from High Temperature Solar Energy	Institute of Gas Technology 3424 South State Street Chicago, IL 60616
AMOUNT	PRINCIPAL INVESTIGATOR
$31,336	Nicholas Biederman (312) 567-3650

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO. Subcontract to
Chicago, IL	6 months—September 1, 1977	05 ENG 26

PROJECT SUMMARY:

Objective:

The objective of this project is to assess the possibility of manufacturing fuels and chemicals by using high-temperature (above 400°F) solar energy.

Approach:

The Institute of Gas Technology (IGT), under contract to ORNL, is selecting several canditdate processes for the production of fuels or chemicals, using solar produced heat at temperatures of 400°F or greater.

Status:

The candidate processes are being assessed and rated for possible development or demonstration.

Future Effort:

The IGT efforts may be funded in FY 78 to further examine the applications of solar energy in the manufacturing of fuels and chemicals.

TITLE	ORGANIZATION
400 kWth Test Facility	Georgia Institute of Technology Engineering Experiment Station Atlanta, GA 30332
AMOUNT	PRINCIPAL INVESTIGATOR
$266,589	N. E. Poulos

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Atlanta, GA	17 months—August 1, 1977	E(40–1)5018

PROJECT SUMMARY:

Objective:

A 400 kWth Test Facility is being constructed on the Georgia Institute of Technology (GIT) campus. The purpose of the test facility is to provide a place for industry, universities, government, or qualified persons to evaluate experimental solar thermal components.

Approach:

The facility is to utilize 440 round mirrors, approximately 44 inches in diameter (111 cm) providing radiant heat fluxes from 25 to 200 W/cm² to a test area centrally located above the mirror field. A south tower with a movable platform is being considered to accommodate a wider variety of experiments.

Status:

The preparation of an experimenter's or user's manual is underway. The manual describes the facility operation and capabilities, and lists the available equipment, instrumentation, and the procedures to be followed in order to initiate an experiment.

The 400 kWth test facility was scheduled to go into operation in July, 1977. Because of weather and late delivery of components, the initial generation of steam and facility checkout was delayed until September, 1977. One external user of the test facility, Sanders Associates, has begun interfacing talks with GIT on the testing of an air-cooled Brayton heat receiver.

The 400 kWth facility has produced low temperature steam with about 10 percent of the mirrors installed. Subsequently, the remaining mirrors have been mounted and aligned and full power operation has been achieved.

Future Effort:

The 400 kWth test facility will initially be employed to test the Sanders Associates air-cooled receiver. Other components and experiments will be conducted subsequently.

Refer to the photograph on the following page (Figure 22).

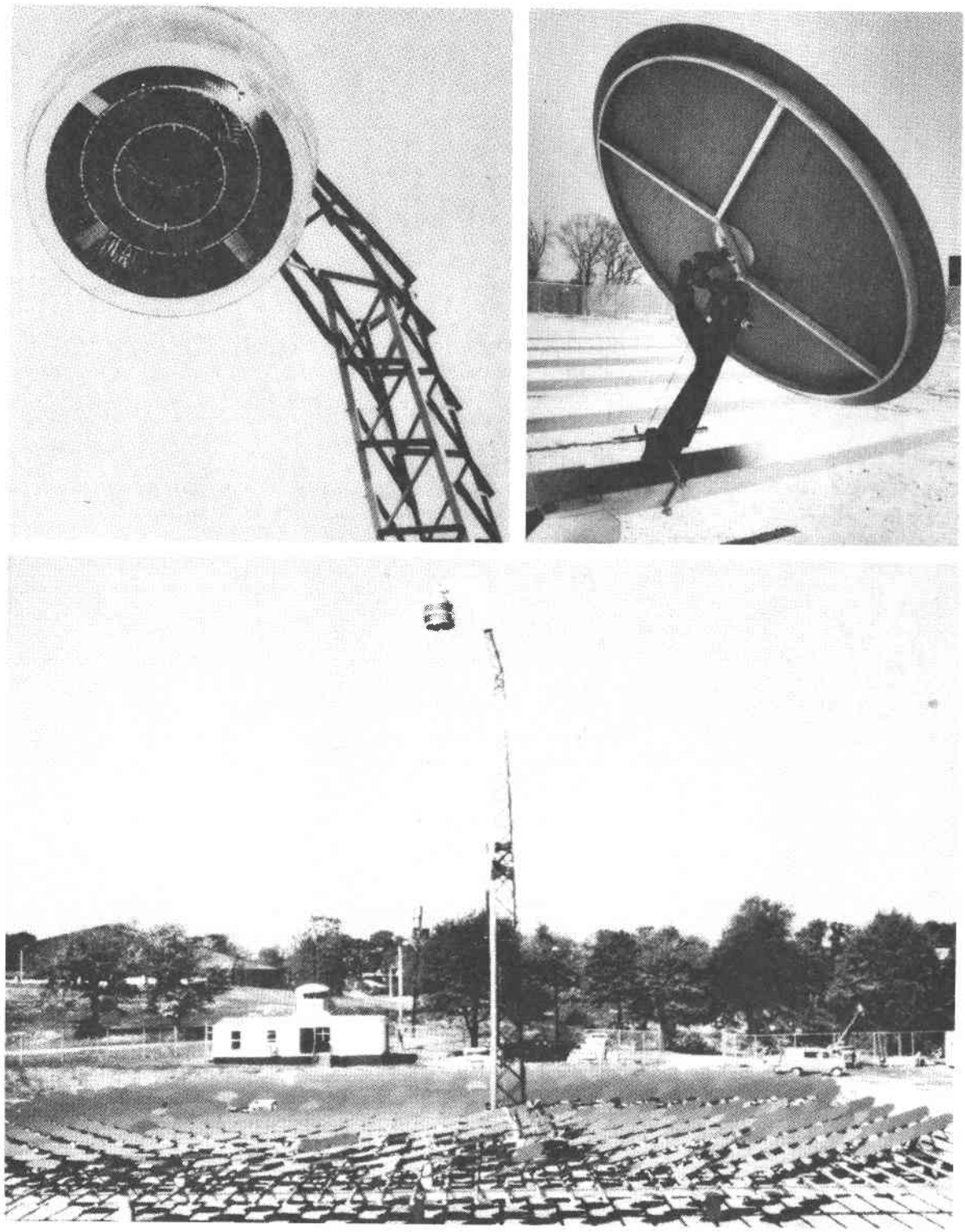


Figure 22. Georgia Institute of Technology—400 KW_{th} Test Facility (bottom); View looking into Tower—Installed Receiver (top left); Single Heliostat Mounted on Kinematic Motion Devices (top right).

TITLE	ORGANIZATION
Solar Thermal Test Facilities	STTF Users' Association University of Houston Houston, TX
AMOUNT	**PRINCIPAL INVESTIGATOR**
$169,489	A. F. Hildebrandt (505) 268-3994

WORK LOCATION	DURATION-AWARD DATE	CONTRACT NO.
Albuquerque, NM	24 months—November 1, 1976	EG–77–G–05–5308 EG–77–G–05–5484

PROJECT SUMMARY:

Objective:

The objective of this project is to encourage the use of the Solar Thermal Test Facilities by the scientific and engineering communities.

Approach:

The STTF User's Association informs scientists and engineers of the capabilities of the Solar Thermal Test Facilities by means of flyers, workshops, annual meetings, etc. The Association encourages the submission of proposals for solar and nonsolar related experiments in these facilities and provides the mechanisms for review and funding of these proposals. The STTF User's Association currently represents the Solar Thermal Test Facility at Albuquerque, NM and the 400 kWth test facility at the Georgia Institute of Technology, Atlanta, GA for non-programmatic experiments. It can arrange for experiments to be conducted at the Solar Furnace at White Sands, NM and the CNRS's Solar Furnace at Odeillo, France.

Status:

The first STTF User's Association workshop, that of High-Temperature Chemistry, was planned for late November 1977.

Future Effort:

Additional workshops and other meetings will be held pending the results of the first workshop. A newsletter of the STTF User's Association and membership drive are also being planned.

Refer to the photograph on the following page (Figure 23).

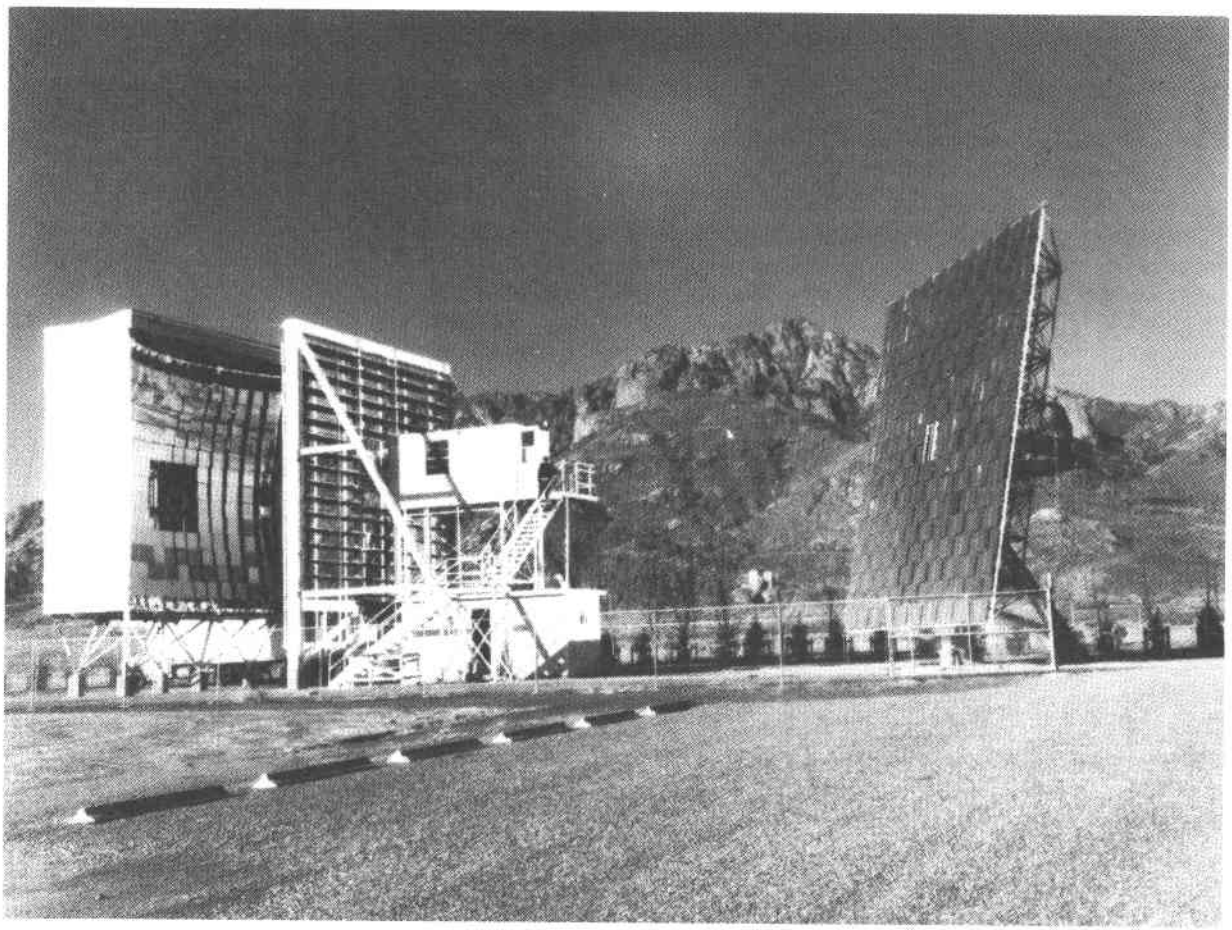


Figure 23. Solar Furnace at White Sands Proving Grounds, NM. One of the Test Facilities Coordinated by the STTF User's Association.

ALPHABETIC LIST OF CONTRACTORS FOR SOLAR THERMAL POWER SYSTEMS PROJECTS

APPENDIX ON UNSOLICITED PROPOSAL REQUIREMENTS

SOLAR recognizes that the unsolicited proposal is a valuable means by which unique or innovative methods or approaches can be made available in developing energy technology. Unsolicited proposals are offered in the hope that SOLAR will enter into a contract with the offeror for researching, developing, or providing services indicated within the proposal. These proposals should not be merely an advance proposal for a specific requirement which would normally be procured by competitive methods.

It is SOLAR's policy to encourage and foster the submission of unsolicited proposals. Since the preparation of an unsolicited proposal represents a substantial investment of time and effort by the offeror, organizations, or individuals who are interested in submitting an unsolicited proposal are encouraged to make preliminary inquiries relating to SOLAR's needs before expending extensive effort in preparing a detailed unsolicited proposal.

Favorable evaluation of an unsolicited proposal is not, in itself, sufficient justification for SOLAR to enter into contract with the offeror. Generally, any unsolicited proposal that (a) is available to the Government without restricion from another source, (b) closely resembles that of a pending competitive solicitation, or (c) is not sufficiently unique to justify acceptance, is unacceptable and must be rejected. Individuals and organizations may submit unsolicited proposals at any time to SOLAR. Proposals related to solar energy programs may be submitted to:

Office of Unsolicited Proposals
U.S. Department of Energy
Washington, D.C. 20545

Since unsolicited proposals may form the basis for technical evaluation or contract negotiations, each should contain detailed information on the purpose and objective of the proposed work; an indication of the offeror's background and previous experience; a concise statement of work; information relating to organization, facilities, and qualifications; other pertinent data; and a detailed cost estimate. Because of the great degree of interest in solar energy programs and the similarities among many proposed concepts and research and development ideas (which preclude funding them on an unsolicited basis), most projects are supported as a result of solicitations. Solicitation mechanisms used by SOLAR include:

a. *Requests for Proposals.* Requests for Proposals (RFP) are used to contract for a specific scope of work.
b. *Program Research and Development Announcements.* The Program Research and Development Announcements (PRDA) are used to solicit proposals where a specific need is not sufficiently definable to use the traditional RFP process.
c. *Program Opportunity Notices.* The Program Opportunity Notices (PON) are used for technological demonstrations where the objective is the acceleration of commercial application of new energy technologies and systems.

By their very nature, demonstration projects for solar energy technology do not lend themselves to consideration on an unsolicited basis. In addition, innovative concepts submitted on an unsolicited basis should promise a clear benefit to the solar energy program by offering a potential for improvement in cost or performance over other approaches.

☆U.S. GOVERNMENT PRINTING OFFICE: 1978 261-325/574 1-3