DOE/EDP-0035

ENVIRONMENTAL DEVELOPMENT PLAN
SOLAR THERMAL POWER SYSTEMS

August 1979

U.S. Department of Energy
Assistant Secretary for Energy Technology
Assistant Secretary for Environment

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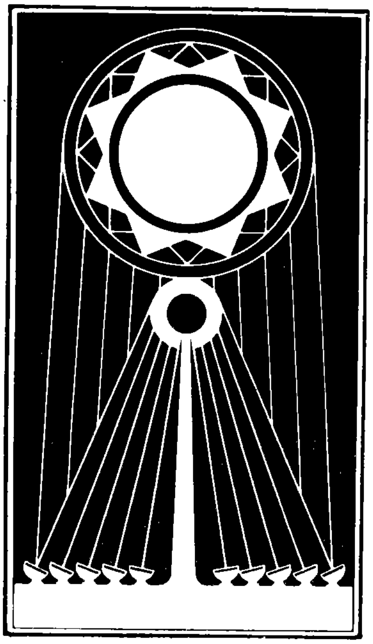

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U.S. Department of Energy
Assistant Secretary for Energy Technology
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FOREWORD

Environmental Development Plans (EDPs) are prepared by the Department of Energy (DOE) to help fulfill the Department's responsibility for the development of environmentally acceptable energy technologies. The EDP provides a common basis for planning, managing, and reviewing all environmental aspects of the energy programs under DOE's jurisdiction.

The EDP is timed to precede key technology program decisions as the technology moves from the exploratory development stage to an engineering development or technology demonstration phase. To ensure that environmental, health, and safety (EH&S) considerations will be addressed adequately in the technology decisionmaking process, the EDP (1) identifies and evaluates EH&S concerns; (2) defines EH&S research and related assessments to examine or resolve the concerns; (3) provides a coordinated schedule with the technology program for required EH&S research and development; and (4) indicates the timing for Environmental Assessments, Environmental Impact Statements, Environmental Readiness Documents, and Safety Analysis Reports.

The initial EDP for Solar Thermal Power Systems (DOE/EDP-0004) was published in March 1978. This EDP provides a substantial updating of the 1978 document. It draws on analysis contained in the Environmental Readiness Document (ERD) for Solar Thermal Power Systems (DOE/ERD-0019). ERDs are assessments prepared independently by the Office of Environment to provide a critical review of the environmental readiness of a technology.

This revised EDP on the Solar Thermal Power Program is being released under authority of DOE Order 5420.1 dated August 10, 1978. It was prepared jointly by the Division of Planning and Technology Transfer (ET), the Division of Central Solar Technology (ET), and the Technology Assessments Division (EV), with assistance from the research and support divisions of the Office of Environment.

This EDP is now being distributed so that everyone having interests and responsibilities with respect to Solar Thermal Power Systems may have the opportunity to review and provide suggested changes for future updates.

Ruth C. Clusen
Assistant Secretary
for Environment

Donald M. Kerr
Acting Assistant Secretary
for Energy Technology

ENVIRONMENTAL DEVELOPMENT PLAN

FOR

SOLAR THERMAL POWER SYSTEMS

1979

Department of Energy
Washington, D.C. 20545

Technology Program Office:	Office of Energy Technology
Technology Program:	Solar, Geothermal, Electric, and Storage Systems
Energy Technology:	Solar Thermal Power Systems
Program Coordination:	Ronald Loose Division of Planning and Technology Transfer Gregory D'Alessio Technology Assessments Division Office of Environment

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I. SUMMARY

The Environmental Development Plan (EDP) system is designed to provide a common basis for planning, managing, and reviewing the environmental aspects of the varous energy technology programs under the Department of Energy's (DOE) jurisdiction. For a specified technology development program, an EDP performs the following functions:

- Governs the nature and content of the Environmental Issues and Control Technology annex to the Energy System Acquisition Project Plan, which is the basic management document for DOE project activities;*

- Summarizes the environmental concerns associated with technology development, demonstration, and commercialization identified and evaluated in the previous EDP and the Environmental Readiness Document (ERD)** if one has been prepared;

- Defines general requirements for environmental, health, and safety research and impact assessments to resolve these concerns and defines an implementation strategy;

- Provides a coordinated schedule for required environmental research and development (R&D), technology program activities, and decision points; and

- Indicates approximate timing for documents required in the National Environmental Policy Act (NEPA) process, ERDs, and safety analyses where appropriate.

The publication of an EDP is generally timed to precede key technology program decisions that result in program shifts from an exploratory development into the technology development, engineering development, demonstration, or commercialization phase. The time frame covered by an EDP generally encompasses all significant decision points relating to the technology program. Projects or subprograms that are likely to result in a demonstration or commercialization within the near term are presented in detail. Projects that will need to be considered in greater detail in the next EDP update are identified.

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*"Program and Project Management System for DOE Outlay Programs," memorandum from Dale D. Myers, Under Secretary, Department of Energy, May 31, 1978.

**The ERD is an independent evaluation by the Office of Environment which analyzes a technology's environmental acceptability.

This EDP for the DOE Solar Thermal Power Systems Program* briefly describes the goals of the program and identifies potential environmental, health, safety, and socioeconomic impacts relevant to solar thermal power systems (STPS), particularly those sited in the Southwest. These impacts are screened for "key issues," i.e., those issues considered to be the most serious in nature, that have near-term importance to the program, and for which current knowledge of effects and control is inadequate. A management plan is then presented for conducting and coordinating environmental research in concert with the technology development effort to ensure that identified environmental issues are resolved prior to significant public deployment of the technology.

Two main categories of STPS are under development: the small, dispersed power system and the large, central power applications. Small power systems are to be used in 10-kilowatt electric (kWe) to 10-megawatt electric (MWe) applications, powering irrigation systems or as components in total energy systems. Large power systems, which include the central receiver "power tower" as a major program element, may provide power up to 500 MWe. Significant progress was made in 1978 toward demonstrating both small and large applications.

During 1978, small power applications activity continued on the total energy system experiments at Ft. Hood, Texas, and Shenandoah, Georgia. The preliminary design effort on the Ft. Hood experiment was completed. Continuation of this experiment is under review. Detailed system engineering design efforts for the Shenandoah total energy system experiment were completed in the spring of 1979. Procurement of major components and construction will be initiated, with the hardware procurement being finalized during 1980 for the Shenandoah project.

Another component of the small power application are the two developmental solar irrigation projects 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 operational system is currently providing significant operational performance data, which will be used in defining requirements for future experiments.

A second experiment, a larger 200-horsepower 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.

In the case of the large power applications, a site near Barstow, California, was selected in 1977 for the 10-MWe central receiver pilot plant. The plant will adapt a high-temperature solar heat collection subsystem to supply steam to a turbine plant provided by a public utility. In support of

*This is the first update of DOE/EDP-0004, Solar Thermal Power Systems, March 1978.

this effort, the Albuquerque Central Receiver Test Facility (CRTF) initiated full power operation early in 1978. This facility provides a capability for testing at power levels exceeding 5 thermal megawatts and for testing and evaluating all major central receiver subsystems and components, including receivers, heliostats, and high-temperature thermal storage. The 1978 program effort also included 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 CRTF.

Key environmental concerns associated with the development and deployment of STPS have been identified by the March 1978 STPS EDP in the following subject areas:

- Site selection (including the question of water availability),
- Ecological and microclimatic effects,
- Working fluid handling and release modes, and
- Misdirected solar radiation.

By the time a scale-up and commercialization decision must be made on solar thermal power applications, most of the required research on environmental problems should be completed or underway as a result of the R&D planned in this EDP. Therefore, the program for the development of STPS should not be delayed by lack of environmental information.

II. TECHNOLOGY PROGRAM

A. PROGRAM SCOPE AND GOALS

Responsibility for the Thermal Power Systems Program resides with the Chief, Thermal Power Systems Branch, Division of Central Solar Technology. Management emphasis is on decentralization of the management of major program elements from Headquarters to the field offices (Denver, Albuquerque, and San Francisco) and to major national laboratories. In addition, TPS coordinates with Conservation and Solar Application (C&SA) to facilitate commercialization and for joint sponsorship of specific application demonstrations. Coordination on subsystem technology development includes Division of Energy Storage Systems, Transportation Energy Conversion, Division of Power Systems, and Office of Energy Research.

The overall objective of the Thermal Power Systems Program is to establish the technical readiness of cost-competitive solar thermal power systems for both small (under 10 MWe) and large (over 10 MWe) energy production applications. Central receiver and distributed receiver technologies are being demonstrated in the context of large and small power applications, respectively. The technical readiness of a system is determined by its ability to perform reliably at required output levels with predictable durability. When a technically ready system approaches cost-competitiveness, activities coordinated with the C&SA Resource Manager aimed at commercialization will be initiated. Initial commercial implementation goals are as follows:

- For small power applications, early 1980s;
- For large power applications, mid-1980s; and
- For high-temperature processing of fuels and chemicals from nonrenewable feedstocks, 1990.

To meet these goals, the following technology developments are stressed in the program:

- Reduction of heliostat costs for large power systems,
- Reduction of trough and dish collector costs for small power systems,
- Development of complete systems packages for small power systems, and
- Increased performance and reduced cost of subsystems other than collectors for advanced technology.

The program will lead toward reduction of dependence on foreign oil in the near term and a renewable and inexhaustible source of energy in the long term (Ref. 1).

B. TECHNOLOGY DESCRIPTION AND PROGRAM MILESTONES

1. Solar Thermal Energy Technology Description

Solar thermal systems collect and concentrate the Sun's radiant energy to heat or vaporize a working fluid at high temperatures. The thermal energy thus produced can be applied to industrial processes directly or converted into electrical or mechanical power. Two generic methods presently exist for the utilization of solar thermal energy: the central receiver system and the distributed collector system.

In the central receiver configuration, a field of dual-axis tracking mirrors (heliostats) intercept and redirect solar radiation toward a single large receiver mounted atop a tower. The redirected radiation strikes the receiver and heats the internally circulating working fluid. Working fluids under consideration include high-pressure water, superheated steam, hydrocarbon oils, molten salts, and liquid metals. It has been estimated that first generation central receiver systems, with working fluid temperatures of 540°C, can satisfy 16 percent of the temperature requirements of the industrial process heat market and can provide steam conditions compatible with many existing electric power plants. Central receiver systems under development with temperatures up to 930°C could meet 75 percent of the current bulk electric market. A 10-MWe demonstration plant is under construction near Barstow, California, and should begin operation in 1981. Central receiver systems that repower conventional fossil fuel plants may be in operation by 1984 (Refs. 1, 2, 3, and 4).

The distributed collector system concentrates sunlight and converts it to heat at individual collector modules using parabolic troughs and dishes or hemispherical bowls. These mirrors redirect and concentrate the Sun's rays onto a receiver/absorber unit located at the focus of the mirror. The internally circulating working fluid is heated and then pumped through an interconnected pipe network to a boiler or heat exchanger. The overall conversion efficiencies of these systems are expected to range from 12 to about 30 percent. It has been suggested that the greatest potential application for a system using parabolic troughs is in the process heat and total energy sectors (0.5- to 10-MWe range); for parabolic dishes, in small electric power plants (1- to 10-MWe range); and for bowls, in remote applications such as irrigation pumping (Refs. 1 and 5).

Both the central receiver and the distributed collector systems require thermal storage subsystems using various media warmed by surplus heat while the receiver is operating. This stored heat is then used to warm the working fluid during dark or cloudy periods. Auxiliary power systems may also be needed either at the site or elsewhere on the utility grid.

2. Solar Thermal Power Systems Program Elements

The Solar Thermal Power Systems Program is structured around two key subprograms: Small Thermal Power Systems (including advanced technology) and Large Thermal Power Systems. There is also a Project Advisor for construction projects. Program technology milestones are shown in Figure 2-1.

The Small Solar Thermal Power Systems Subprogram is concerned with development and application demonstrations of solar thermal systems under 10 MWe. These systems are characterized by close geographic proximity to the point of energy use. Major elements of this subprogram are

- Small power systems industrial applications, which focuses on industrial process heat markets;

- Total energy applications, which involves systems delivering both electrical (or mechanical) and thermal power for industrial or institutional uses (spaceheating, domestic water heating), applications for which will be in the 0.1- to 10-MWe range;

- Small community applications, which focuses on systems in the 1- to 10-MWe range, likely to be used in municipally owned power systems. Point-focusing subsystems are primarily being considered;

- Remote applications, which addresses small power systems (10-kWe to 250-kWe range) for irrigation and other small isolated electric process heat or shaft horsepower requirements; and

- Distributed receiver subsystems and components, which involves developing and testing of small systems components.

In addition, the advanced technology element was established to identify new, economically attractive systems to meet the long-term requirements of the Solar Thermal Power Systems Program. This element will also demonstrate the technical feasibility of key subsystems and components of these systems and conduct generic research in areas such as coatings, reflective surfaces, and materials. The major objective is the development of advanced subsystems, components, and manufacturing process technology and the coordination of test facilities.

The Large Solar Thermal Power Systems Subprogram is concerned with solar thermal plants of 10-MWe or greater capacity designed for use in utility networks or large process heat applications. Major elements of the subprogram are

- Repowering-retrofit systems, which involves repowering/retrofit of existing fossil-fueled applications with solar thermal technology;

- Solar storage-coupled systems, which are characterized by the use of energy storage subsystems to extend the operating hours of a

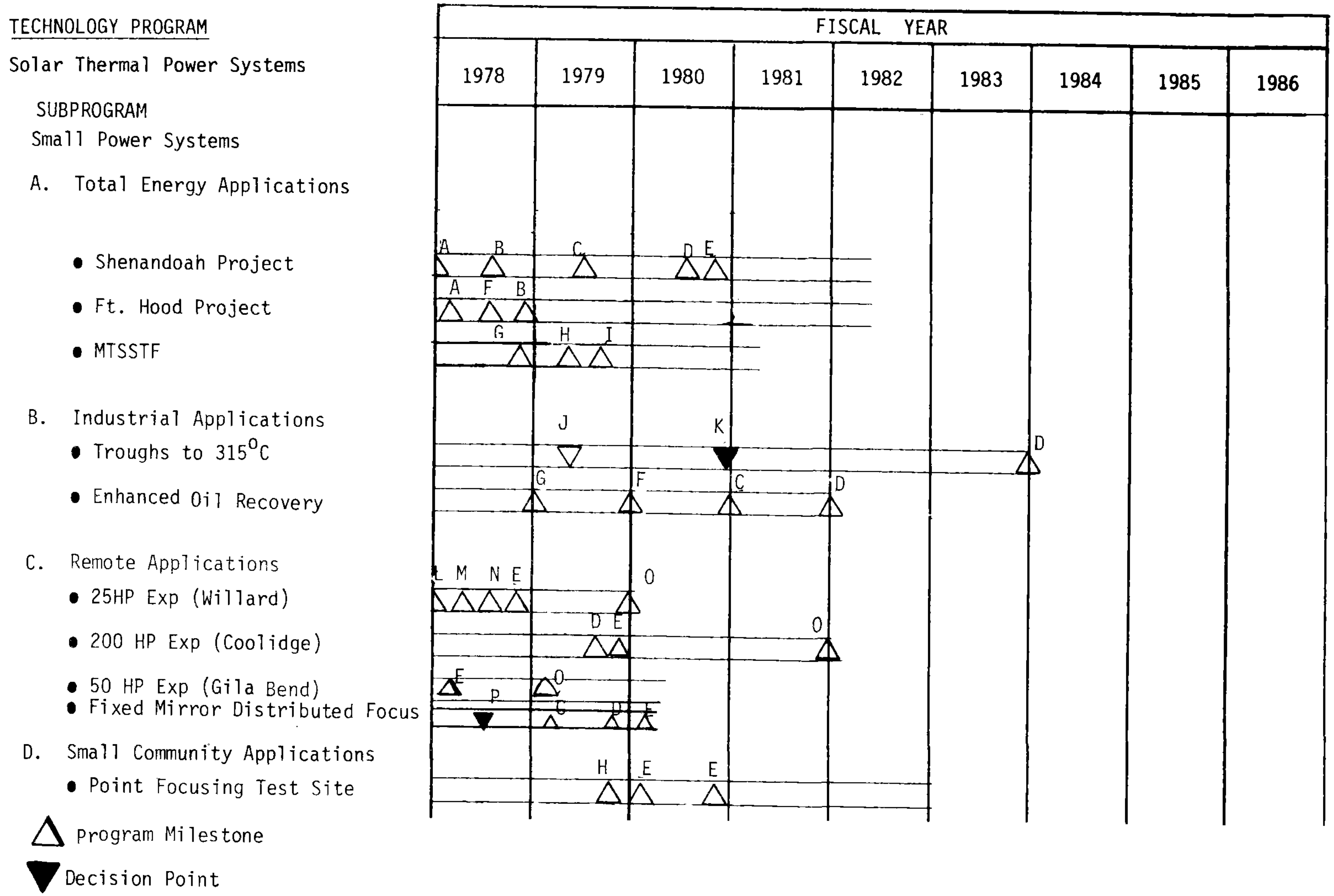
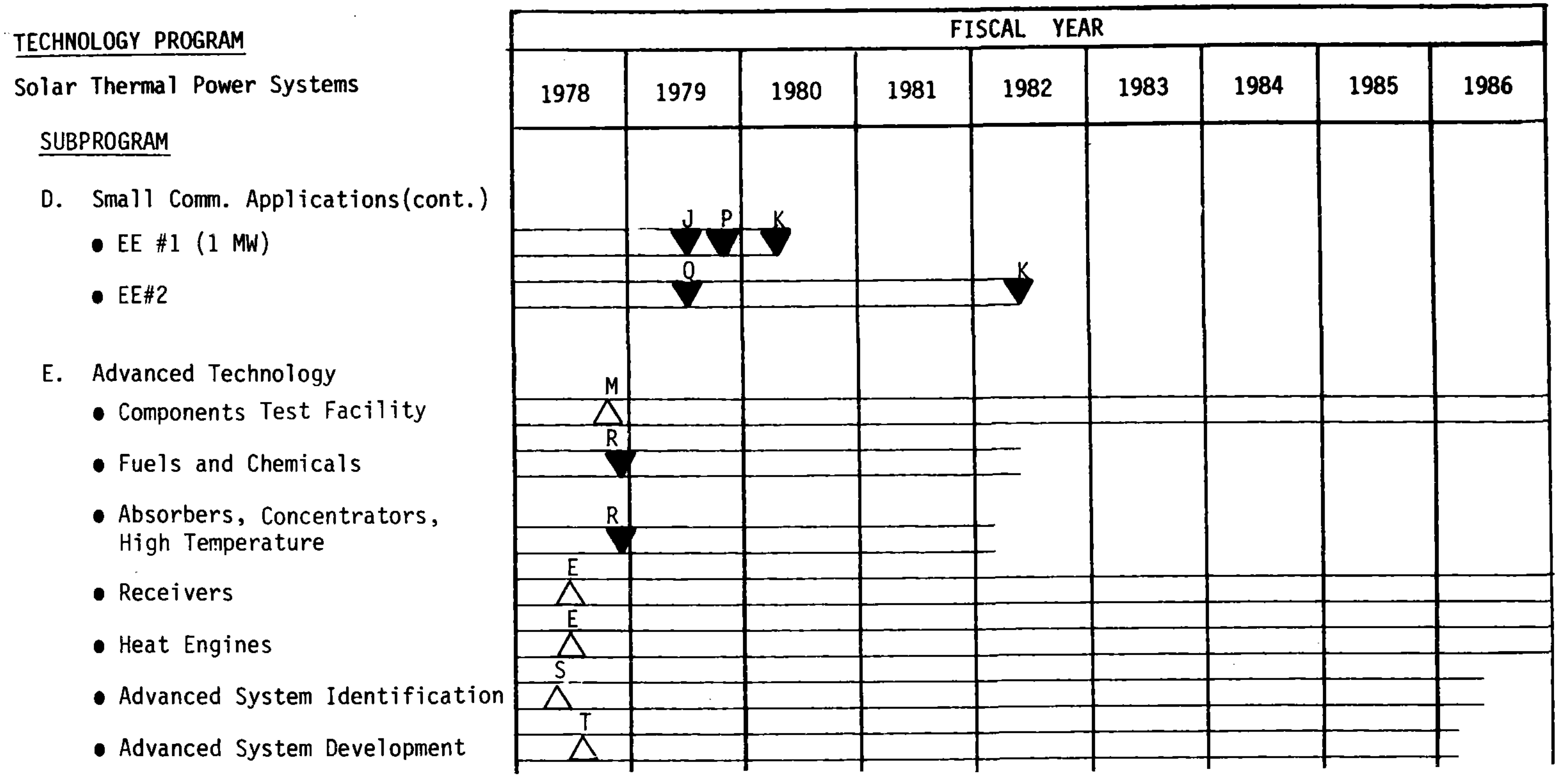


Figure 2-1. Technology Program Milestones And Decision Points



△ Program Milestone

▼ Decision Point

SMALL POWER SYSTEMS

A. Concept design completed
B. Preliminary design completed
C. Design completed
D. Construction completed
E. Start operations/testing
F. Preliminary design started
G. RFP
H. Upgrade facility
I. Begin dish testing (GE)
J. Technology system selected
K. Go-No Go
L. Installation & testing completed
M. Initial operation completed
N. Upgrade completed
O. Complete DOE involvement
P. Site selection
Q. Continuation decision
R. Program definition
S. Advanced dispersed system identification
T. Advanced system testing

Figure 2-1. Technology Program Milestones And Decision Points (Continued)

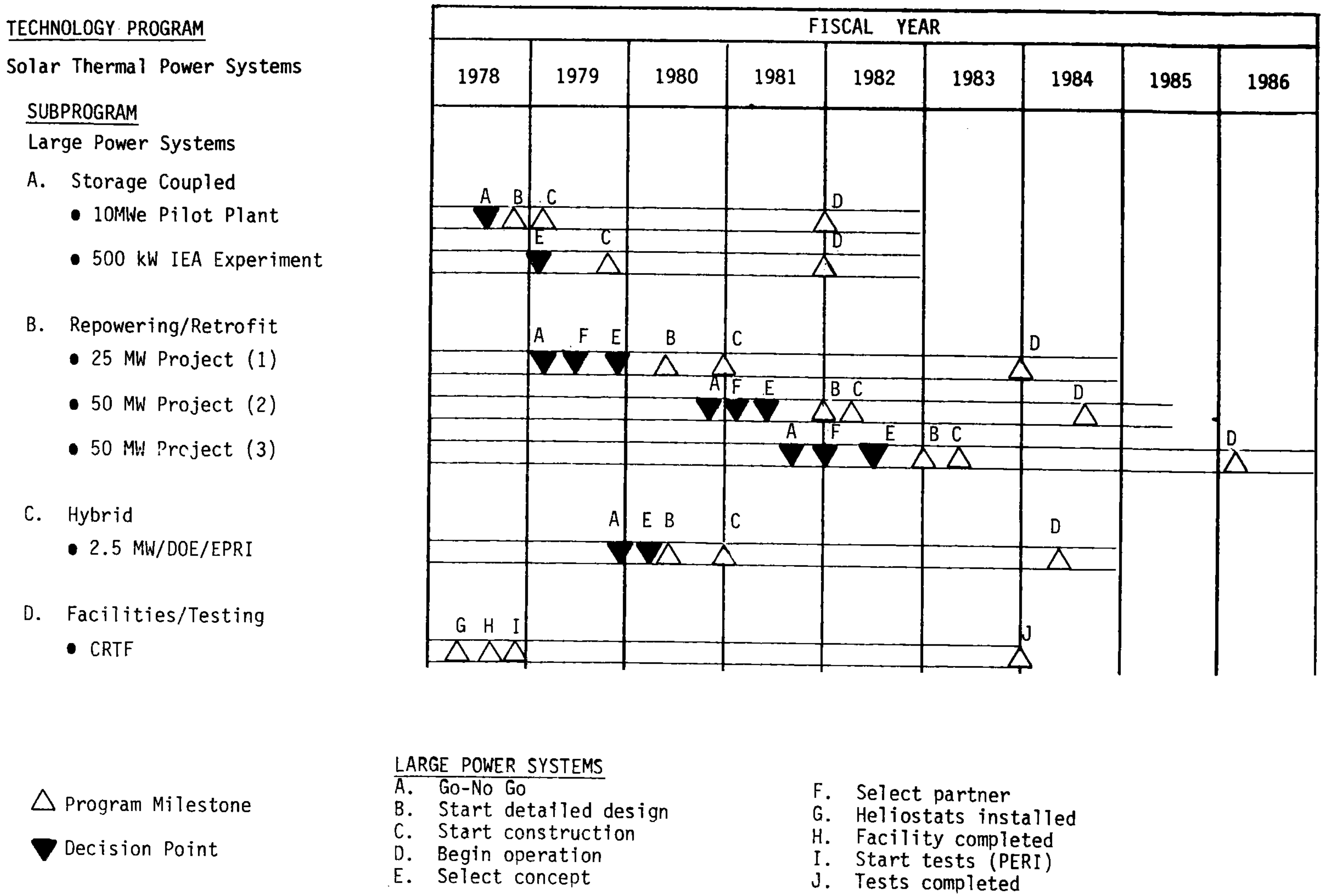


Figure 2-1. Technology Program Milestones And Decision Points (Continued)

solar thermal power plant. Options being developed are a central receiver using steam conversion (the baseline system), using very high temperature gas, molten salt, or sodium receiver.

- Solar/fossil hybrid applications, which involves the combined use of solar thermal and fossil fuel technology in new power plants; and
- Central receiver subsystems and components, which has the responsibility of developing and testing heliostats and central receivers.

3. Current Status and Planned Projects

a. Small Solar Power Systems

(1) Total Energy Systems

During 1978, the solar total energy system activity continued on two total energy system experiments at Shenandoah, Georgia, and Ft. Hood, Texas. These large-scale experiments represent specific applications of the total energy concept to industrial 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 total energy system industrial application is tailored to satisfy energy requirements for a knitwear manufacturing facility in Shenandoah, Georgia. The General Electric Company was 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, was selected to complete a preliminary design during 1978. The Ft. Hood project is currently under review.

The Mid-Temperature Solar System Test Facility (MSSTF) in Albuquerque, New Mexico, began initial operations in 1976. When completed, it will consist of an 800-square-meter collector field made up of four different concentrator concepts. Three line focusing concentrators are operational; the fourth concentrator, a 7-meter-diameter parabolic dish for the Shenandoah experiment, is being installed. The facility includes a power conversion subsystem, thermal storage subsystems, and heat exhangers, which provide a capability to test a completely integrated total energy system. The

Collector Module Test Facility (CMTF) in Albuquerque, New Mexico, completed testing on nine intermediate temperature collector concepts for small power systems in FY 1978. The test results on collectors tested at CMTF were published and widely distributed in 1978. Planning in support of dispersed high-temperature thermal applications and alternative total energy concepts is underway.

MSSTF will continue to provide basic engineering performance data for the subsystems to be employed in the intermediate temperature range. Continuing experiments at MSSTF will offer the opportunity to prove the feasibility of concepts at relativley low cost without the need for full-scale demonstration systems. CMTF provided performance data for mid-temperature concentrating collector concepts during FY 1978, which will be used to characterize collector concepts and to screen candidates for intermediate temperature small power applications.

(2) Small Community Power and Remote Systems

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, initially began operating in July 1977. The system has now been upgraded to a 1400-square-meter collector field capable of operating a 50-horsepower organic Rankine engine, an irrigation pump, controls, and a thermal storage sybsystem 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 pumping and is also providing significant operational performance data, which will be used in defining requirements for future experiments.

The second experiment, a larger 200-horsepower 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 in 1979. Lower system costs through higher operating temperatures and higher efficiencies are sought in this experiment. Both experiments are intended to provide realistic performance and cost information on solar irrigation pumping applications.

The design for the Small Communities Engineering Experiment No. 1 was initiated in 1978. Three contractors (Ford-Aerospace, McDonnell Douglas Astronautics, and General Electric) were selected to develop design concepts from which one will be selected for development and construction. The selection of the design will be made in 1979. The selection of a site for the Small Communities Engineering Experiment No. 1 will be made in 1979.

(3) Advanced Thermal Power Technology

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, 1500°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 and for a 2000°F air-cooled ceramic receiver for Brayton cycle applications. Construction of a 400-kW test facility at the Georgia Institute of Technology was completed, and successful initial operation was achieved. This facility was used to test an advanced solar Brayton receiver in 1978.

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 and 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.

b. Large Power Systems

(1) 10-MWe Central Receiver Pilot Plant

Preliminary designs and subsystem experiments for a 10-MWe pilot plant were completed in 1977. The selection of a site near Barstow, California, for the pilot plant preceded completion of this 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 the final engineering design of the plant and for preparations associated with construction. Before initiating the final design, 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 1978 to join with DOE in the implementation of this pilot plant effort. The plant will utilize a high-temperature solar heat collection subsystem to deliver steam to a turbine plant supplied by the utility partners.

A number of critical subsystem and component tests were completed during 1977 including the testing of five heliostats, three receivers, and energy storage subsystems. Heliostat array control and tracking experience was obtained through testing at the new Central Receiver Test Facility.

Studies initiated during 1977 are intended to identify promising alternative large-scale system concepts for utility or industrial applications. Three alternatives include fossil hybrids instead 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 are being evaluated for possible demonstration.

In the coming year, the repowering of existing oil- and gas-fired electric power plants and the retrofit of industrial process heat applications 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. DOE management and support of the 10-MWe 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 performance data and cost information suitable for decisionmaking. In addition, data applicable to solar repowering with the central receiver will be obtained.

(2) Central Receiver Subsystems and Components

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 (18 square meters) and a cavity-type line central receiver has also been completed.

CRTF initiated full power operation early in 1978. The facility provides a capability for testing at capacities exceeding 5 thermal megawatts. At present, it will provide the capability for testing and evaluating all major central receiver subsystems and components, including receivers and heliostats. Receiver testing was emphasized during 1978, and tests were conducted to verify the receiver design for the 10-MWe Barstow pilot plant. CRTF will also be used to test receivers developed through private funding from the Electric Power Research Institute. The 1978 program effort provided for the development of additional alternative low-cost heliostat designs and water/steam receivers. Designs of these components will be tested and evaluated during 1979 at CRTF.

4. Environmental Acceptability

STPS projects are structured to achieve specific technology objectives; however, the projects are also utilized to achieve environmental objectives. For example, the 10-MWe Central Receiver Pilot Plant near Barstow, California, is both a demonstration of technology development and a test facility for evaluating environmental acceptability and for acquiring environmental data applicable to future central and distributed power plants.

III. ENVIRONMENTAL CONCERNS AND REQUIREMENTS

A. INTRODUCTION

All possible impacts must be identified and screened to ensure that an EDP reflects the full range of environmental issues associated with a proposed program. The generic impact areas of air and water quality, land use, ecology, health and safety, aesthetics, resource requirements, and social/institutional concerns were examined for each key phase of STPS development to identify these issues.

The environmental, health, and safety issues were identified through a review of existing research data, STPS experience, and projections of probable concerns associated with the technology. Once the issues were identified, a preliminary screening occurred whereby key issues were isolated. The essential screening criteria were as follows:

- Nature and magnitude (severity) of environmental impact,
- Extent (scope of impact),
- Current knowledge,
- Concern of other groups and Federal agencies, and
- Irreversibility and cumulative nature of impact.

None of these criteria were used alone to screen for key environmental issues. Taken together, however, they formed the basis for a comprehensive screening. Considerations given to the setting of priorities on required research are described in Appendix A.

Although the primary emphasis of this year's research was on the key issues, work is proceeding on certain secondary concerns. Periodic updating of this EDP facilitates reassessment of issue status and addition of previously unidentified issues in light of current knowledge and program development.

B. AREAS OF CONCERN

The two major applications of STPS technologies are (a) large-scale, central receiver and (b) smaller scale, distributed receiver applications for either or both electric power generation and heat production. Environmental concerns vary significantly with the application and site.

Large-scale, electric power generation systems are land, capital, and in some cases, water intensive. Sites for early development will probably be in remote areas of southwestern deserts. The primary environmental concern will be worker safety onsite and ecological impacts offsite. The primary siting constraints will be the availability of water and land.

Smaller scale, distributed receiver STPS are likely to be located near areas already developed for agriculture or industry. The primary environmental concern will be public safety and protection of property. The primary siting constraint will be institutional barriers such as land use, zoning, and utility interfaces.

Key environmental concerns associated with the development and deployment of STPS have been identified in the following general areas:

- Site selection (including the question of water availability),
- Ecological and microclimatic effects,
- Handling and disposal of system fluids and wastes, and
- Misdirected solar radiation.

C. DISCUSSION OF CONCERNS AND REQUIREMENTS

Concerns, the current state of knowledge, research needed to resolve the concerns, other requirements, and the expected output of that research (end item) are listed in Table 3-1. Some concerns identified in the table are generic in nature and include elements common to both large and small power systems, such as fluid management and misdirected reflections from collectors. Other concerns are specific to centralized receiver systems, such as the effects of the technology on desert ecosystems and the possible production of atmospheric pollution at the receiver.

A listing of completed, current, and planned research is provided in Appendix B, which details the relationship between the key concerns and requirements and specific projects. Because solar thermal power applications, particularly total energy systems, have elements similar to solar heating and cooling systems, some of the projects listed in Appendix B were designed primarily for the Solar Heating and Cooling of Buildings Program. Due to the potential applicability of many projects, data results will be reviewed as they become available. The following assessment of the STPS concerns draws from the results of previous assessments and information gained from completed studies listed in Appendix B (Refs. 4 and 6 through 10).

1. Site Selection

Solar thermal power systems are land intensive. Large solar collection systems can require large tracts of land, thereby displacing other current or projected land uses. Although solar dispersed power system experiments and prototype large power systems scheduled for near-term initiation require relatively small amounts of land, early investigation of this issue is important to ensure that the socioeconomic impacts associated with long-term, cumulative land utilization are understood before deployment of large-scale solar thermal facilities.

Table 3-1. Environmental, Health, And Safety Concerns And Requirements For Solar Thermal Power Systems

Program Element, Decision Point, and Date	EH&S Impact Area	EH&S Concern	EH&S Research Area	EH&S Requirements	Status of EH&S Requirements	Requirement End Item and Time
Construction of 50MW Repowering Project, 1982	Land, Socioeconomic, Ecology	STPS-1 Site Selection Integrating STPS technology into the social and institutional structures requires resolution of such issues as land use, sun rights, zoning, and consumer/utility interfaces. Issues, alternatives, and consequences of policy decisions need to be identified for local governments anticipating STPS development.	Socioeconomic Effects	STPS-1.1 Technological impact assessment to identify issues raised by STPS, as well as alternatives and consequences of policy decisions.	Ongoing	Report 2 years 1981
		Land requirements are probably larger than early estimation of 1 or 2 sq. mi/100MWe, if a large exclusion area is included to reduce fugitive dust from other activites. Convenient large tracts of land may not be in the public domain (see: BLM Desert Management Plan, DOD Military reservation requirements, status of Indian lands, and Railroad rights of way).	Ecology & Socioeconomic Effects	STPS-1.2 Assess land requirements for individual sites, total land requirements, land availability, competition for land use, and legal/institutional barriers constraining the acquisition of land. Develop criteria for site selection. Develop plan for dealing with factors (particularly institutional factors) that constrain land use.	Planned	Guidelines and plans 2 years 1981
		Generic locations for early development of central STPS will probably be in southwestern deserts. The technology is land and water intensive. Availability of water may severly restrict site selection either because of alternative water demands or cost of delivery.	Water Resources	STPS-1.3 Assess water requirements for individual sites, total water requirements, water availability (from point of view of both quantity and proximity to probable sites), competition for water use, and legal/institutional barriers to water use. Develop plan for dealing with institutional and other factors that constrain water use.	Planned	Site specific reports 2 years 1981
		Transmission corridors and access roads may represent a greater threat to desert environment than the site proper.	Ecological Effects	STPS-1.4 Assess needs, land availability, and adverse impacts associated with the construction of transmission corridors and access roads. Identify and characterize major needs and impacts. Develop plan for mitigating constraints and impacts.	Planned	Plans 1-2 years 1981
Operation of 10MW Baseline Project, 1981	Ecology	STPS-2 Ecological and Microclimatic Effects The generic location for early development of central STPS will probably be in southwestern deserts. Desert ecosystems are poorly understood. What is known indicates that they are fragile, and it is certain that disruption of such ecosystems will either be irreparable or very long lasting. For this reason, many of the impacts of supporting systems to STPS, which are understood in their current applications, should be reassessed for desert installations.	Ecological Effects	STPS-2.1 Fundamental Research on desert ecosystems.	Ongoing	Reports 1-2 years 1981
			Ecological Effects	STPS-2.2 Ecological and microclimatic effects of different solar collector systems.	Ongoing and Planned	Reports 1-2 years 1981
Begin 50MW Repowering Study, 1979			Ecological Effects	STPS-2.3 Ecological characterization and monitoring of the 10MWe SSTF at Barstow, California.	Ongoing	Reports 1-2 years 1981
			Ecological Effects	STPS-2.4 Vegetation management and recovery studies at sites disturbed for STPS development.	Planned	Report 1981
			Ecological Effects	STPS-2.5 Ecological characterization and monitoring of candidate STPS sites.	Planned	Reports 1½ yr/site 1981

Table 3-1. Environmental, Health, And Safety Concerns And Requirements For Solar Thermal Power Systems (Continued)

Program Element, Decision Point, and Date	EH&S Impact Area	EH&S Concern	EH&S Research Area	EH&S Requirements	Status of EH&S Requirements	Requirement End Item and Time
Plan Additional Microclimate Simulations, 1980	Ecology	Large central STPS will cause local changes in patterns of absorption of solar radiation and thermal albedo. These will probably be accompanied by changes in air flow which will be further modified by the heliostat arrays. The magnitude of these changes will be closely coupled to the facility design and the management strategy applied to the ground surface in the heliostat field. These variables plus disturbances caused by construction activities, such as fugitive dust, may have significant effects on adjacent ecosystems.	Ecological Effects	STPS-2.6 Microclimatic effects are worthy of special note. However, they are considered as one aspect of ecological study. The subject is addressed in items STPS-2.2 and STPS-2.3 currently in progress.	See STPS-2.2 and STPS-2.3	N/A
Plan Additional Field Tests on Molten Sodium, 1979	**Water Quality, Ecology, Safety, and Health**	STPS-3 Handling and Disposal of Fluids and Wastes Candidate working/storage fluids for STPS include liquid sodium, sodium hydroxide, hydrocarbon oils, and eutectic salts. In addition undefined cleaning solutions may be used routinely to clean heliostat surfaces. Accidental or emergency release of the fluids could cause fire, explosions, contamination of surface and groundwater, and impact both aquatic and terrestrial ecosystems. Normal system flushing represents similar threats and introduces a problem of waste disposal. The fluids of concern and the consequence of their release is dependent on whether the facility is centralized or dispersed, and the nature of the ecosystem impacted.	Health and Safety	STPS-3.1 Assess potential on-site fluid release from centralized STPS facilities and potential worker health and safety problems. Develop safety guidelines as required, and identify liquid waste disposal requirements.	Planned	Handling and disposal guidelines 1 year 1980
			Health Effects	STPS-3.2 Using tiered-testing system, characterize toxicity of working fluids.	Ongoing	Toxicity report 3 years 1982
			Ecological Effects	STPS-3.3 Assess potential effects of working/storage fluid wastes or spills from centralized STPS facilities on desert ecosystems.	Ongoing	Ecological effects report 1 year 1980
			Ecological Effects	STPS-3.4 Assess potential for chemical contamination of soils and groundwater by fluid release from dispersed STPS.	Planned	Reports 2 years 1981
			Environmental Control Technology	STPS-3.5 Assessment of control and containment systems and waste disposal systems.	Planned	Reports 2 years 1984
Plan Additional Heliostat Hazard Studies, 1980	Health and Safety	STPS-4 Misdirected Solar Radiation Misalignment of heliostats during operation, or accidental reflections of solar radiation from heliostats during installation, are serious hazards to workers in centralized STPS. A lesser but significant hazard is also associated with dispersed STPS. Consequences of misdirected solar radiation range from fire, to bodily harm, to glare in off-site areas.	Occupational Health and Safety	STPS-4.1 Assessment of potential hazards and development of guidelines and standards for solar collector manufacture, transport, and installation.	Ongoing and Planned	Guidelines 1 year 1979 Effects reports 1982
			Occupational Health and Safety	STPS-4.2 Monitor installation of heliostat field at 10MWe STPS for compliance with guidelines. Modify guidelines and standards as required.	Planned	Revised guidelines 1 year 1980
			Environmental Control Technology	STPS-4.3 Assess control techniques and systems.	Planned	Report 1 year 1984

To the extent that sites for early large-scale, centralized systems are presently limited to southwestern deserts, site selection must be acknowledged as a potential problem that may impact both rate and cost of exploitation. Land requirements may be larger than the 2 square miles (5.2 million square meters) per 100-MWe capacity currently envisaged. A larger exclusion area may be required to reduce production of fugitive dust or to reduce risk to the public from misdirected solar radiation.

STPS require 30 to 50 percent more cooling water than fossil fuel plants of comparable size. Many convenient large tracts of land with usable water may not be available. The Bureau of Land Management is currently developing a desert management plan, which includes identification of areas for protection under the National Wilderness Protection Act. Military reservations, Indian lands, and railroad right-of-ways further partition the apparent continuous desert expanses. It should be noted particularly that easily accessible water is currently allocated to other purposes and that present water delivery costs are underpriced. Purchase of small parcels of land may be necessary to either secure water rights or complete a tract.

Size and distribution of large-scale solar thermal power systems in deserts of the southwest is likely to be restricted by available water. Management strategies for the optimum use of available water resources on a regional basis will be needed when the commercialization phase is initiated. This requirement is not unique to STPS but is particularly acute in the Southwest. Significant delays in exploiting STPS can be anticipated if water-right questions are not addressed early in program development.

Small solar power systems will be deployed in residential communities or commercial/industrial areas. These applications may involve the displacement of commercially valuable land and significant modification of community land use plans. The use of solar collector fields may require low-profile zoning of adjacent sites, changing current zoning regulations and displacing existing activities. Dispersed solar power plants are industrial facilities and would potentially be restricted to sites zoned for industrial uses. These are generally located far from residential and commercial zones where the end product of the solar plant is required. The use of these plants for residential and commercial applications may necessitate zoning modification. Cooperative systems involving collection or shared storage, such as community-owned total energy systems, may violate restrictions on property use. Additional land use impacts are ecological in nature and are discussed in Ecological Effects.

The land use research will be conducted in two phases: an initial impact assessment by mid-FY 1980, and an updated study by mid-FY 1986. Initiation of this study is scheduled for 1979, which will allow sufficient time to assess any impacts associated with land displacement and use. The development of planning methodologies will also be conducted in two phases: A preliminary methodology will be formulated by early FY 1982, in time for planning the three total energy system prototype modules. Based on the operating experience from these systems, the planning methodology will be updated by mid-FY 1986.

2. Ecological Effects

a. Environmental Impacts

The environmental impacts of the supporting subsystems for STPS that are common to other power generation technologies, such as cooling towers, transmission line corridors, access and service roads, and construction towers, are acute in desert environments where disruptions are likely to be either irreparable or very long lasting. For example, recreational use of service roads for access to remote areas characteristically has impacted areas many times the size of the site the road was intended to service.

Construction and maintenance of heliostat fields could significantly modify native plant and animal communities and impact surface water and groundwater conditions. The nature of these effects will depend on the details of the heliostat field. Some designs require paving or chemically treating the field to control dust or vegetation, which interferes with heliostat operation. Other designs might require initial denudation of the field followed by regrowth of vegetation under the mirrors. Paving the field could significantly impact desert wash areas and groundwater conditions by increasing runoff from rains and snow, thereby increasing potential for flash flooding, and removing wash areas as watering areas for desert animals. Herbicides or chemical dust suppressors applied to the field could contaminate groundwater and, ultimately, drinking water supplies.

This EDP schedules a study which will quantitatively assess the adverse ecological and environmental effects and subsequently develop any necessary control measures. One aspect of the study will involve research at the Central Receiver Test Facility. Local hydrology patterns will be monitored to detect any significant changes in groundwater flow or wash area formation. Using standard community analysis techniques, flora and fauna will be characterized at the facility site. The results of this analysis will then be compared to the results of an analysis for an adjacent, "similar" site. This will indicate the degree of ecological disturbance resulting from the facility heliostat field, as well as the characteristics of the replacement community.

Simulated heliostat fields of various proposed solar central power systems will be built and sampled. Again, any shifts in local hydrology and biota will be measured, and methods will be developed to alleviate detrimental hydrological and ecological impacts of the heliostat field. Identification of possible beneficial ecological consequences of building extensive land-covering structures such as heliostat fields will be examined. This might require some type of microtopographic manipulation. Completion of the study is planned for FY 1981, which ensures the availability of adequate control technologies to be used in the design of the 50-MWe repowering project, the 10-MWe alternative system experiment, and the hybrid system experiment.

b. Alteration of the Microclimate

Alteration of the microclimate by solar central power system operations may adversely affect indigenous wildlife and vegetation. Although for a single facility the extent of these effects will probably be limited, microclimate impacts are presently a key concern due to the novelty of the issue and the lack of adequate observational data. The importance now attached to this concern is less than in the previous EDP (Ref. 4), based on some preliminary modeling of microclimate changes. An accurate assessment of these alterations and the concomitant effects requires onsite monitoring or simulation of onsite conditions. This EDP plans three studies which will yield the necessary informaiton. Initially, power plant operating conditions will be simulated using appropriate computer, laboratory, and field models. Environmental and ecological changes will be tested and sampled in these simulated systems.

Desert ecosystem impacts will then be assessed. If this assessment indicates the need for control strategies, various techniques will be investigated, such as planting the heliostat field with vegetation of varying reflecting powers. The simulation study, ecosystem analysis, and mitigation research will be completed in FY 1981, which will allow adequate time to incorporate any necessary control methods into the design of the 100-MWe baseline prototype module.

Monitoring activities are also scheduled. When the 10-MWe baseline system experiment begins operations, various climatological parameters will be measured at the facility, including air and surface temperatures, wind speeds, and net reflectivity. Onsite ecosystem impacts will be studied, and further investigations of mitigation strategies will be conducted if necessary. The results of this research will be available in early FY 1986 and may be used in designing future system experiments and prototype modules. Additionally, these results can serve as a data base for assessing the effects of widespread solar power system deployment on regional climate.

3. Handling and Disposal of System Fluids and Wastes

Accidental or emergency release or flushing of working and storage fluids such as liquid sodium, sodium hydroxide, hydrocarbon oils, and eutectic salts composed of sodium or potassium nitrates/nitrites could cause fires and explosions, contaminate drinking water supplies, increase soil salinity, impact terrestrial and aquatic communities, and reduce the effectiveness of sewage treatment systems. Resolution of these issues is important so that serious safety and pollution problems can be avoided during operation of solar thermal system experiments and prototype modules.

As a first step, it is necessary that candidate working/storage fluids be identified and characterized in terms of flammability, explosive nature, reactivity, etc. Studies of the potential pathways for fluid release into working and residential areas are necessary to pinpoint specific danger areas. Strategies for mitigation and control of occupational and public safety hazards need to be examined to ensure system safety.

To date, research has concentrated on health and safety hazards (Ref. 8). A handbook entitled "Hazardous Properties and Environmental

Effects of Materials Used in Solar Heating and Cooling Technologies: Interim Handbook," was issued in December 1978; a final version is scheduled for publication in FY 1980. Data from these sources should be applicable to the Solar Thermal Power Systems Program. Research on the characteristics and effects of liquid metals has been conducted for nonsolar power plants. In addition, strategies already exist or are being developed for mitigating occupational and public health exposure to working fluids. Some of these have been developed for nonsolar systems, in which case their applicability to solar power plants must be assessed. The system safety criteria formulated for the 10-MWe baseline system experiment also contain relevant control methods. Definitive performance criteria currently being developed for residential solar heating and cooling systems will yield mitigation and control strategies applicable to solar total energy systems.

Applicable solar heating and cooling research will provide useful data by early FY 1979, in time for incorporation of mitigation and control strategies into total energy system experiments and prototype modules. The necessary studies of occupational impacts and their control have already been completed for the 10-MWe baseline system experiment, which will serve as a data source for planned environmental studies. All the studies outlined above will complete a major phase in late FY 1980. This will allow for incorporation of mitigation and control strategies into the 50-MWe repowering project, the 10-MWe alternative system experiment, the hybrid system experiment, and the dispersed small power system experiments and prototype modules.

Since 1977, scientists at the Los Alamos Scientific Laboratories have been studying environmental effects that could be expected from spills and disposal of state-of-the-art heat transfer fluids on soils, vegetation, and water quality. Thus far, silicones, glycols, and hydrocarbons have been investigated in test chambers with data validated in field comparisons. Data from these continuing studies will provide a scientific basis for mitigation and control strategies.

4. Misdirected Solar Radiation

Heliostat reflections have the potential to cause severe burns, eye injury, and fires, as well as to create dangerous conditions for nearby ground and air traffic during all phases of heliostat fabrication and use. Because numerous heliostats may be used in STPS (both central and dispersed), it is important to address and resolve this issue to ensure that safe procedures are used during heliostat manufacture and installation and that any necessary control strategies are incorporated into system design and operation procedures. Occupational and public safety hazards can thus be reduced or obviated. The dangers associated with misaligned or even properly aligned heliostats are a very real concern; in the limited heliostat experience to date, a worker has been severely burned and a small fire started (Ref. 6).

To assess the severity of potential impacts, evaluations of light intensities and hazardous ranges of single and multiple coincident heliostat beams are needed. Such studies are necessary for heliostat manufacture, transport, installation, and operation. Analytical models can be formulated to determine the intensity of reflected and misdirected beams under key normal and abnormal operational modes and to assess the effects of these beams on humans, vehicles, and combustible materials. To mitigate any safety hazards identified by these studies, control measures (hardware and/or operational) need to be investigated.

Much of this research has already been completed. An optical hazard study has been conducted at the Central Receiver Test Facility, and resulting collector system safety criteria have been developed for the 10-MWe baseline system experiment. In addition, the Electric Power Research Institute has studied the potential effects of heliostat reflection on combustibles, traffic, and personnel. However, all the research to date has focused on potential hazards during system operations. This EDP plans a two-phase study to (a) analyze the safety hazards potentially encountered during heliostat manufacture, transport, and installation and (b) develop control procedures as needed.

The result of the above efforts will be the development of adequate mitigation and control methods. Safety criteria have already been proposed for a 10-MWe baseline system experiment, so the heliostat operational procedures adopted will demonstrate their efficacy. These procedures can also be used in solar dispersed power experiments and prototype modules that utilize heliostats. Control strategies for heliostat manufacture and installation will be formulated during FY 1979, in time for incorporation into the heliostat manufacturing test facility.

5. Other Concerns

Utility-consumer interface has been identified as a secondary concern. Several projects address this issue and it is identified in Table 3-1 under STPS-1 Site Selection; however, additional discussion is warranted. Widespread deployment of solar dispersed power systems can impact utility capacity factors and load demands and may result in significant changes in utility rate schedules. The use of solar power systems, particularly total energy systems, could reduce utility revenues and exert heavy peak load demands. These effects could create serious financial and load management problems for utilities.

It is therefore important to better understand the effects that widespread solar thermal power use will have on electricity demand and utility financial requirements. This information is necessary to develop alternative pricing mechanisms that ensure utility financial soundness but do not place undue burdens on solar users. Otherwise, utility-supplied auxiliary power may become prohibitively expensive. The price of electricity may also increase if utilities are required to purchase excess electricity produced by solar dispersed power systems. Studies are necessary to assess the impacts of excess electricity generation on utility load management and finances and to determine equitable rate schedules for purchasing this excess power.

A number of studies addressing this issue have been completed or are underway. Several of these are specific to STPS; one completed DOE research project has evaluated the impact of solar total energy systems on electric utility design practice. In addition, two studies designed for residential solar heating and cooling systems are applicable to solar dispersed power systems: a completed study (sponsored by the National Science Foundation) that addressed the effects of solar heating and cooling use on electric utilities and a similar current study sponsored by the Electric Power Research Institute that entails a demonstration program and is designed to develop solar systems compatible with utility supply and demand requirements. The results of this study will be available in 1979 and can be used in the development of governmental regulatory options. Identified methods also can be demonstrated in system experiments and prototype modules for total energy systems and small power systems.

The information gained from the above studies will also be used as input to a study proposed by this EDP. This research project will assess the impacts on utility load management and rate schedules resulting from the generation of excess electricity by solar dispersed power systems. The research will be conducted in two phases: an initial impact analysis by the end of FY 1983, based on operating experience from total energy system experiments, and an updated assessment by the end of FY 1986. Alternative pricing mechanisms proposed by this study can be demonstrated in solar dispersed power prototype modules.

Solar energy systems are material intensive, and a clear understanding of the amounts of residuals associated with manufacturing these systems is needed. Initial studies indicate that this is not a major or unique problem; however, DOE is performing a detailed nationwide analysis of this and other indirect impacts of solar energy development. The results of this Technology Assessment of Solar Energy (TASE) will be available in mid-1980.

IV. ENVIRONMENTAL PROGRAM STRATEGY AND MANAGEMENT

A. PROGRAM GOAL

The goal of the DOE Environmental Program is to ensure that energy technologies developed, demonstrated, and brought to the commercialization phase by DOE are environmentally acceptable. In particular, ensuring environmental acceptability refers not only to meeting the present, immediate requirements of the law but also to identifying environmental problems and taking measures that will avoid or mitigate adverse effects of widespread and long-term use of these technologies.

Section III enumerates and discusses the various environmental concerns and the R&D required. This section describes the implementation strategy developed to address these needs.

B. PROGRAM STRATEGY

To accomplish the above-stated goal, DOE conducts a number of assessments to determine the environmental, health, and safety (EH&S) implications of energy technology development and utilization. The results of these assessments provide the basis for the DOE program addressing the concerns and requirements described in Table 3-1. The current program is designed to

- Produce information that will define the nature and scope of potential EH&S impacts,
- Provide an information base for the establishment of EH&S standards and regulations,
- Ensure that environmental considerations are taken into account in the program decisionmaking process,
- Define mitigation measures and develop appropriate control technology to minimize impacts and meet environmental standards at reasonable cost, and
- Assist in program decisions or in defining mitigation measures.

The EH&S program consists of numerous projects, which are generally grouped as follows:

- Baseline characterizations to identify potential impacts and to establish the environmental conditions before significant development takes place;
- Operational site measurements and monitoring to assess environmental conditions during resource development and energy production operations;

- Effects studies to evaluate the ecological, health, safety, social, and economic impacts of solar developments and to develop the capability to predict long-term consequences;

- Integrated assessment and evaluation of our knowledge concerning the issues;

- Environmental control and abatement research to limit emissions and reduce impacts to prescribed or acceptable levels; and

- Development of EH&S guidelines and performance criteria.

The current and planned research and assessment program is summarized in Appendix B. The projects listed have been developed, planned, and implemented in coordination with the Office of Energy Technology and the Office of Environment to address the concerns and requirements of Table 3-1.

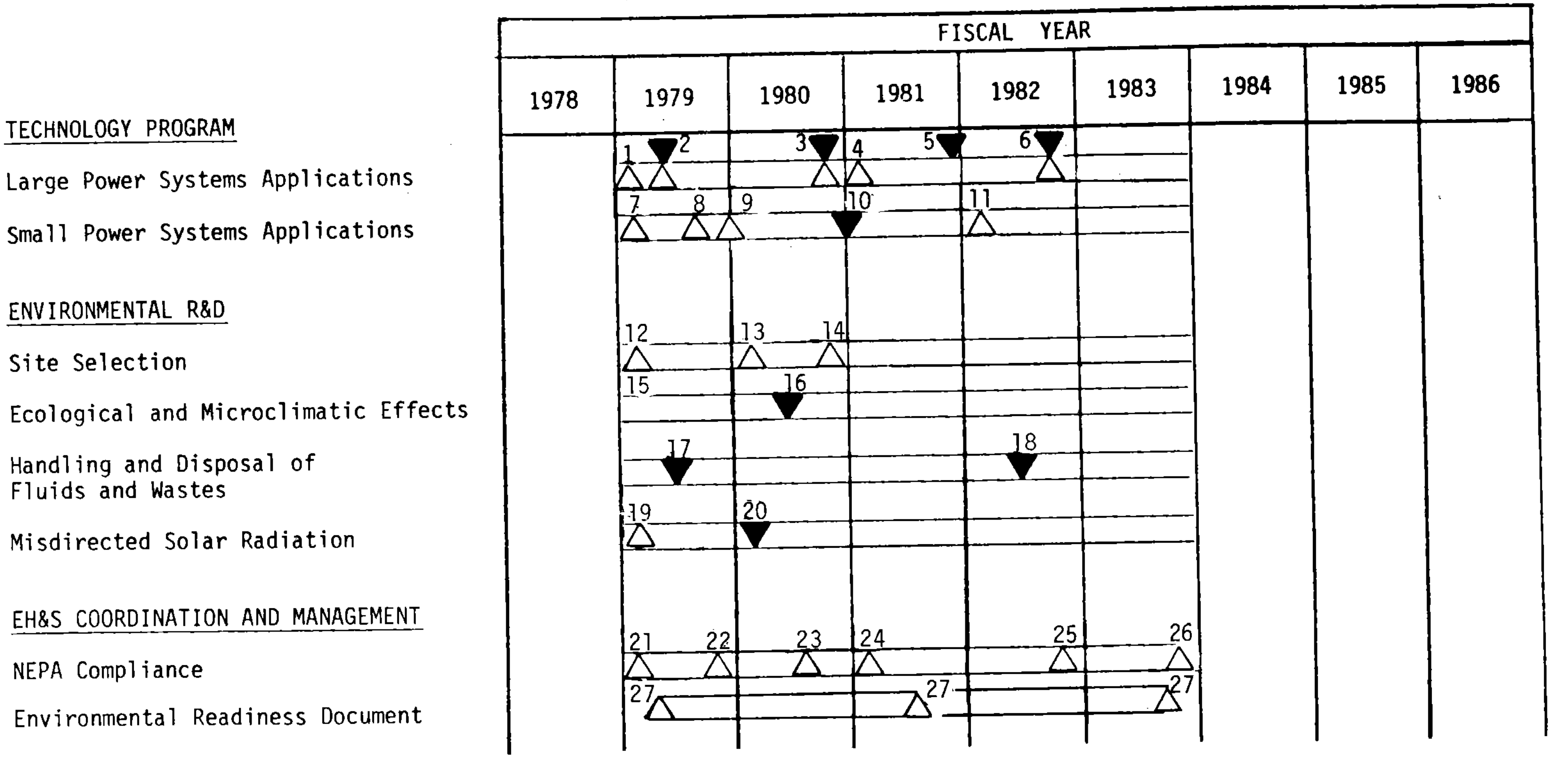
Figure 4-1 presents the schedule for environmental R&D efforts and compliance activities, coordinated with the schedule of the Solar Thermal Power Systems Program. The upper section of the figure summarizes the STPS program (Figure 2-1) and establishes a time frame for the completion of projects and demonstrations. Research on potential environmental impacts associated with these stages of development is scheduled to precede completion of major projects or demonstrations. Preparation of Environmental Assessments (EAs)/Environmental Impact Statements (EISs) and EDPs is scheduled in the NEPA compliance section. The programmatic EA is scheduled to be completed in FY 1979; EAs and, if necessary, EISs will be prepared for each of the STPS test sites. Revisions to the EAs/EISs will be scheduled in the updated EDP.

C. PROGRAM MANAGEMENT

1. Responsibility

The Office of the Assistant Secretary for Environment (ASEV) and the Office of the Assistant Secretary for Energy Technology/Energy Technology, Solar (ETS) are responsible for preparing, reviewing, approving, and coordinating implementation of this EDP. The Office of Environment (EV)/Division of Technology Assessment will coordinate with ETS/Division of Planning and Technology Transfer in identifying and determining the priorities of major health and environmental issues and reviewing research and assessment activities for relevance and timeliness.

The primary responsibility for performing the environmental research and assessment activities related to solar technology development will be shared by ETS and EV. Each program office will initiate, fund, and manage its health and environmental research and assessment programs in support of high-priority needs enumerated in the EDP. Projects implemented will be coordinated and reviewed through the Solar Environmental Coordinating Committee (SECC) and its subcommittees described below.



△ Program Milestone

▼ Decision Point

1. Start Construction of 10MW Baseline Project
2. Begin 50MW Repowering Study
3. Begin 50-300MW Solar Hybrid Studies
4. Construction of 25MW Repowering Project
5. Operation of 10MW Baseline Project
6. Construction of 50MW Repowering Project
7. Operation of Irrigation Experiment
8. Small Community Application
9. Construction of Total Energy Systems
10. Industry Demonstration Projects Begin
11. Industry Demonstration Projects Continue
12. Land Requirements Quantification
13. Planning Methodology
14. Water Availability
15. Continued Ecological Monitoring
16. Microclimate Simulations
17. Field Tests on Molten Sodium
18. Complete First Phase, Short-term Toxicology Study
19. Monitor NO_x Production if Assessment Indicates Significant Levels
20. Assess Heliostat Standards
21. Monitor Heliostat Installation
22. Programmatic EA (Solar Thermal Power Systems)
23. Repowering/Retrofit Large Power Systems, EA
24. Enhanced Oil Recovery, Small Power Systems, EA
25. Updated Programmatic EA (Solar Thermal Power Systems)
26. 10MWe Pilot Plant, Large Power Systems, EA
27. Complete ERD

Figure 4-1. Solar Thermal Power System Program Coordination Technology And Environmental Milestones

EV will concentrate on environmental and biological effects research and national impact assessments resulting from particular commercialization scenarios and assessment of control options; ETS will concentrate on resource assessment and development of environmental control technologies. ETS will identify the need for and prepare appropriate NEPA documents at the earliest possible date to meet the intent of NEPA. EV will assist in determining the need for and the timing and will provide overall review and approval of the documents. EV and ETS will coordinate the activities of offices in DOE and other Government agencies to ensure that resources are employed optimally for solar-related environmental research and assessment.

2. Coordination

The Solar Environmental Coordinating Committee is a special group constituted under authority of DOE Order 5420.1, composed of representatives of various DOE offices to assist in the implementation of the DOE Environmental Development Plan System. The primary function of SECC is to monitor and overview the status of environmental R&D programs, to ensure that the intent of the EDPs is achieved, and to promote regular information exchanges and coordination between offices responsible for environmental R&D. Specifically, SECC, through appropriate subcommittees,

- Participates in the preparation and review of EDPs and identifies the need for and recommends revisions in EDPs;
- Maintains a collective awareness of the content, status, and results of environmental R&D efforts and apprises management periodically of status and issues;
- Advises management of gaps, redundancies, and potential conflicts in the R&D efforts and recommends corrective options for management considerations; and
- Coordinates between performing offices those necessary physical and institutional arrangements required for the conduct of respective research efforts.

3. Management Documents

In addition to EDPs, certain EH&S documents are prepared to assist management in conducting DOE's environmental program. The most significant of these are briefly described below.

Environmental Readiness Document - The ERD is an independent assessment report prepared by ASEV with the full cognizance of technology program line managers. It provides a state-of-the-art assessment of the environmental status of a technology at the phase of development being considered for management decisions, usually at the key decision points of the management system. The ERD presents the results of a critical review and analysis of environmental R&D results carried on in the preceding phase and provides further definition of concerns and research needs for the ensuing period. The ERD provides the basis for the ASEV position on the environmental readiness of a DOE technology at each key decision point.

Environmental Assessment/Environmental Impact Statement - The National Environmental Policy Act of 1969 establishes the statutory requirements for EISs. For all programs and projects which may require EISs, an EA may first be prepared. An EA is a statement that provides the information on which to base a determination of the necessity for an EIS or a finding of no significant environmental impact. EAs may be prepared for any action and at any time to assist Departmental planning and decision-making. EAs and EISs are prepared by program offices according to DOE procedures and are reviewed by the Office of Environment and the Office of the General Counsel.

Safety Analysis - A safety analysis is prepared by program managers according to DOE procedures (Uniform Independent Safety Review System), early in the design phase of a proposed facility that DOE intends to procure and operate. The use of a safety analysis to identify hazards, eliminate and control identified hazards, assess residual risk, and document management authorization of a DOE operation applies equally to technology base activities and energy system acquisition projects. The purpose is to limit risks to the health and safety of the public and employees and adequately protect property and the environment.

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APPENDIX A

SETTING RESEARCH PRIORITIES FOR SOLAR THERMAL POWER SYSTEMS

The economic and technical aspects of many technologies are strongly dependent on the degree of environmental control required; consequently, the scheduled environmental research must be assigned priorities and integrated with technology program goals. Previous screening criteria discussed in Section III.A both identify environmental concerns and implicitly aid in setting research priorities. In addition, three major factors require consideration in defining, assigning priorities to, and scheduling environmental research. Each is discussed below.

A. REGULATORY IMPETUS

When Federal, State, or local regulations or standards exist explicitly for new technologies, or implicitly through general regulation of some of the potential emissions, a ranking of possible impacts has already been performed by the regulating agency. Research directed toward determining the potential for compliance with existing or imminent regulations must be placed high on the priority list. Generally, when adequate regulations and standards exist, research is directed more toward producing cost-effective compliance options (control technology) than determining impacts of alternative levels of control. Federal regulations concerning air and water emissions and their resulting environmental effects, solid waste disposal, toxic material handling, and occupational safety and health matters applicable to phases of solar thermal power system technology include the following:

- National Environmental Policy Act,
- Nonnuclear Energy Research and Development Act,
- Clean Air Act,
- Federal Water Pollution Control Act (as amended by Clean Water Act),
- Safe Drinking Water Act,
- Occupational Safety and Health Act,
- Resource Conservation and Recovery Act,
- Fish and Wildlife Conservation Act,
- Endangered Species Act,
- Toxic Substances Control Act, and
- Federal Hazardous Substances Act.

B. ENVIRONMENTAL RESOLUTION TIME VERSUS PUBLIC UTILIZATION TIME

A primary consideration for determining research needs is the schedule of utiiization for the particular technologies. The objective of the Environmental Development Plan (EDP) is to plan environmental research so that issues are resolved before a technology is made available to the public. Therefore, whenever it is estimated that the time required to resolve an environmental issue (environmental resolution time) through R&D is greater than or equal to the time before the technology is available to the public (utilization time), that issue is a priority.

C. COST-EFFECTIVENESS

Another approach to determining priorities is to look at the commonality of problem overlap among diverse technologies. Researching the problems of a particular technology may resolve similar problems involving other technologies. Such an approach could be viewed as cost-effective, and ranked accordingly.

APPENDIX B

SUMMARY OF COMPLETED, CURRENT, AND PLANNED ENVIRONMENTAL RESEARCH PROJECTS

The following is a summary of research that is directly applicable to the effects of solar thermal power system development. The projects described here address both key concerns as identified in Table 3-1 and concerns now considered to be secondary.

Appendix B. Completed, Current, And Planned Research Projects

Projects Listed Are Keyed to Concerns and Requirements in Table 3-1

CONCERN	REQUIREMENT NUMBER	SPONSORING AGENCY/OFFICE* PROJECT TITLE	PERFORMING ORGANIZATION*	STATUS	START DATE+	COMPL. DATE+
STPS-1 Site Selection	1.1, 1.2	Electric Power Research Institute Solar Energy Impact on Utilities and Consumers	Arthur D. Little Company	Ongoing		1979
	1.1	National Science Foundation Implications of Residential Solar Space Conditioning on Electric Utilities	Franklin Institute	Completed		1976
	1.1	DOE/ET/Solar Solar Total Energy Impact on Utilities Studies	Electric Power Institute Texas A&M Research Foundation	Completed		1977
	1.1, 1.2, 1.3	Legal Barriers to Solar Heating and Cooling of Buildings	Environmental Law Institute	Completed		1976
	1.1, 1.2, 1.3	Solar Thermal Program Support Systems Engineering and Mission Analysis (Small Communities Project)	The Aerospace Corporation	Completed		1976
	1.1, 1.2, 1.3 1.4	DOE/EV/OHER Planning Studies - Community Utilization of Dispersed STPS	University of California, Los Angeles	Planned	1981	1981
STPS-2 Ecological and Micro-climatic Effects	2.1, 2.2	Electric Power Research Institute Environmental Assessment of Solar Thermal Power Plants	Black and Veatch Consulting Engineers	Completed		1978

+Fiscal Year

Appendix B. Completed, Current, And Planned Research Projects

Projects Listed Are Keyed to Concerns and Requirements in Table 3-1 (Continued)

CONCERN	REQUIREMENT NUMBER	SPONSORING AGENCY/OFFICE* PROJECT TITLE	PERFORMING ORGANIZATION*	STATUS	START DATE+	COMPL. DATE+
STPS-2 Ecological and Micro-climatic Effects (cont'd)	2.1, 2.2	DOE/ET/Solar Solar Energy Conversion: An Analysis of Impacts on Desert Ecosystems	Arizona State	Completed		1978
	2.3	Characterize Barstow 10MWe STPS Site and Monitoring Plan	University of California, Los Angeles	Ongoing	1978	1981
	2.2, 2.5	DOE/EV/OHER Assess Potential Pollutant Production In Atmosphere Around Receivers	University of California, Los Angeles	Planned	1981	1981
	2.1,2.2,2.6	Ecological Microclimate Effects of Different Collection Systems	Arizona State University (subcontractor to University of California, Los Angeles	Ongoing	1978	1980
	2.4, 2.5	Baseline Analysis - Monitoring Plan for Potential STPS Sites	University of California, Los Angeles	Planned	1981	1981
	2.2	DOE/EV/TAD The Central Receiver Power Plant: An Environmental, Ecological, and Socioeconomic Analysis	Lawrence Berkely Labs	Completed		1977
STPS-3 Handling and Disposal of Fluids and Works	3.1, 3.3, 3.4	Electric Power Research Institute Environmental Assessment of Solar Thermal Power Plants	Black and Veatch Consulting Engineers	Completed		1978
	3.1, 3.2	DOE/ET/Solar Toxicological Evaluation of Liquids Proposed for Use in Direct Contact Liquid-Liquid Heat Exchanger for Solar Heated and Cooled Buildings	Colorado State University	Completed		1976
	3.1,3.3,3.4	System Safety Program Requirements for Solar Thermal Power Systems	Martin Marietta Corporation	Completed		1977

+Fiscal Year

Appendix B. Completed, Current, And Planned Research Projects

Projects Listed Are Keyed to Concerns and Requirements in Table 3-1 (Continued)

CONCERN	REQUIREMENT NUMBER	SPONSORING AGENCY/OFFICE* PROJECT TITLE	PERFORMING ORGANIZATION*	STATUS	START DATE+	COMPL. DATE+
STPS-3 Handling and Disposal of Fluids and Works (cont'd)	3.2	Environmental Controls: Double Wall Approach for Solar Hot Water Systems: Flame and Toxic Gas Barriers For Collector Insulation	National Aeronautics and Space Administration	Ongoing		1979
	3.3	Interim Performance Criteria For Solar Heating and Cooling Systems in Commercial Buildings	National Bureau of Standards	Completed		1977
		DOE/EV/OHER				
	3.1	Identification and Assessment of Potential Occupational or Public Health and Safety Issues Unique to STPS Technology	University of California, Los Angeles	Planned	1979	1980
	3.1	Assessment of Potential Fluid Release from Solar Thermal Power System Facilities and Possible Worker Health and Safety Problems	University of California, Los Angeles	Planned	1979	1980
	3.2	Health Effects of Materials Used in Solar Heating and Cooling Systems: Assessment Using Experimental Biological Systems	Lovelace Biomedical and Environmental Research Laboratories	Ongoing	1977	1982
	3.2	Toxicology of Sodium and Lithium	Battelle Pacific Northwest Laboratories	Ongoing	1977	1981
	3.3	Transport of Toxic Solar Energy Working Fluids Released to the Atmosphere: Information Requirement	Los Alamos Scientific Laboratory	Completed		1978

+Fiscal Year

Appendix B. Completed, Current, And Planned Research Projects

Projects Listed Are Keyed to Concerns and Requirements in Table 3-1 (Continued)

CONCERN	REQUIREMENT NUMBER	SPONSORING AGENCY/OFFICE* PROJECT TITLE	PERFORMING ORGANIZATION*	STATUS	START DATE[+]	COMPL. DATE[+]
STPS-3 Handling and Disposal of Fluids and Works (cont'd)	3.3	Potential Effects of Solar System Working Fluids as Ecosystem Contaminates	Los Alamos Scientific Laboratory	Ongoing	1977	1982
	3.3	Assess Potential Ecological Effects of Fluid Release from Central Power Systems	University of California, Los Angeles	Planned	1980	1980
	3.3, 3.4	Assess Potential Chemical Contaminated Soils and Groundwater by Fluid Release From Dispersed Power Systems	University of California, Los Angeles	Planned	1980	1980
	3.1, 3.3, 3.4	DOE/EV/ECT The Environmental Issues Associated With Solar Heating and Cooling of Residential Buildings	Sandia Laboratories	Completed		1976
	3.1	Environmental and Fire Hazards of Materials Used for Solar Heating and Cooling	Sandia Laboratories	Ongoing	1978	1979
	3.5	Assessment of Environmental Controls for Solar Thermal Power Systems	Undetermined	Planned	1982	1984
	3.3, 3.4	DOE/OES Disposal and Recycle of Hazardous Chemicals From Solar Heating and Cooling Systems	Sandia Laboratories	Completed		1978

+Fiscal Year

Appendix B. Completed, Current, And Planned Research Projects

Projects Listed Are Keyed to Concerns and Requirements in Table 3-1 (Continued)

CONCERN	REQUIREMENT NUMBER	SPONSORING AGENCY/OFFICE* PROJECT TITLE	PERFORMING ORGANIZATION*	STATUS	START DATE+	COMPL. DATE+
STPS-4 Misdirected Solar Radiation	4.1	Electric Power Research Institute A Study of Optical Radiation Hazards Associated With a Control Receiver Solar Thermal Power Facility	Black and Veatch Consulting Engineers	Completed		1977
	4.1	Environmental Assessment of Solar Thermal Power Plants	Black and Veatch Consulting Engineers	Completed		1978
	4.1	DOE/ET/Solar System Safety Program Requirements for Solar Thermal Power Systems	Martin Marietta Corporation	Completed		1977
	4.1	Eye Hazard and Glint Evaluation for the 5MWt Solar Thermal Test Facility	Sandia Laboratories	Completed		1977
	4.2	Characterize Barstow 10MWe STPS Site and Monitoring Plan	University of California, Los Angeles	Ongoing	1978	1981
	4.1	DOE/EV/OHER Identification and Assessment of Potential Occupational or Public Health and Safety Issues	University of California,	Ongoing	1978	1979
	4.1	Preparation of Safety Procedure Guidelines for Fabrication, Transportation, Installation and Operation of Heliostats	Sandia Laboratories (subcontracter to University of California, Los Angeles	Planned	1979	1979

+Fiscal Year

Appendix B. Completed, Current, And Planned Research Projects

Projects Listed Are Keyed to Concerns and Requirements in Table 3-1 (Continued)

CONCERN	REQUIREMENT NUMBER	SPONSORING AGENCY/OFFICE* PROJECT TITLE	PERFORMING ORGANIZATION*	STATUS	START DATE+	COMPL. DATE+
STPS-4						
Misdirected Solar Radiation (cont'd)	4.1	Damage to Mammalian Cells by Solar Radiation	Lawrence Berkeley Labs	Planned	1979	1982
	4.2	DOE/EV/OHER Monitoring for Compliance and Modification of Guidelines as Necessary During Installation of Heliostats	Sandia Laboratories (subcontractor to University of California, Los Angeles)	Planned	1980	1980
	4.3	DOE/EV/ECT Assessment of Environmental Control for Solar Thermal Power Systems	Undetermined	Planned	1982	1984
STPS-All	GENERAL	DOE/ET/Solar Preliminary Solar Program Technology Assessment	Standard Research Institute	Completed		1977
		Solar Program Assessment: Environmental Factors, Solar Thermal Electric	Energy and Environmental Analysis, Inc.	Completed	1976	1977
		Solar Program Assessment: Environmental Factors, Solar Heating and Cooling of Buildings	Energy and Environmental Analysis, Inc.	Completed		1977
		DOE/EV/TAD Technology Assessment of Solar Energy	National Labs	Ongoing	1977	1980
		EPA Preliminary Environmental Assessment of Solar Energy Systems	Lockheed Missiles and Space Company	Completed		1976

GLOSSARY

ASEV	Assistant Secretary for Environment
CMTF	Collector Module Test Facility
CRTF	Central Receiver Test Facility
DOE	Department of Energy
EA	Environmental Assessment
ECT	Division of Environmental Control Technology
EDP	Environmental Development Plan
EH&S	environmental, health, and safety
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ERD	Environmental Readiness Document
ET	Office of Energy Technology
ETS	Office of Energy Technology Solar, Geothermal, Electric, and Storage Systems
EV	Office of Environment
MSSTF	Mid-Temperature Solar System Test Facility
NEPA	National Environmental Policy Act
NSF	National Science Foundation
OES	Office of Environmental Safety
OHER	Office of Health and Environmental Research
R&D	research and development
SECC	Solar Environmental Coordinating Committee
Solar	Division of Solar Energy
STPS	Solar Thermal Power Systems
TAD	Technology Assessments Division
TPS	Chief, Thermal Power Systems Branch

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