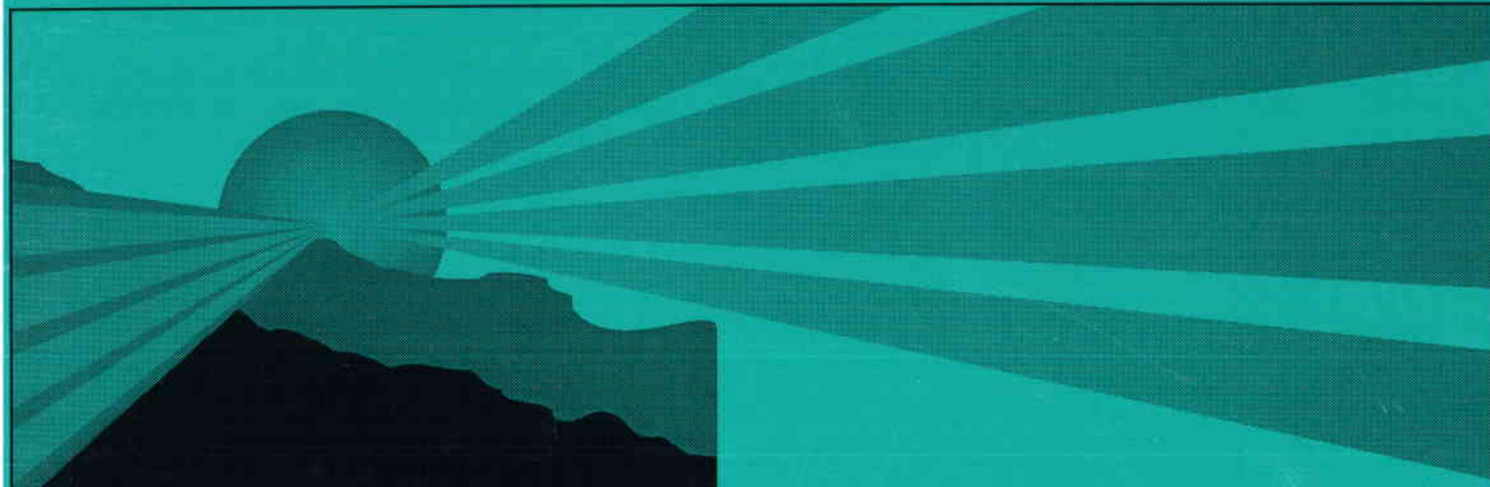

CONCENTRATING
SOLAR POWER
PROGRAM

Annual Operating Plan

Fiscal Year 2000

U.S. Department of Energy

CONCENTRATING · SOLAR · POWER

Sun·Lab

Sandia National Laboratories, Albuquerque, NM
National Renewable Energy Laboratory, Golden, CO

Operated for the United States Department of Energy

October 1999

Foreword

FY00 marks the beginning of our second year of operations guided by the April 1998 Five-Year Plan for the Department of Energy's Concentrating Solar Power Program. Areas of continuing emphasis include dish/engine reliability, dispatchable technology cost reduction, and advanced development. Key new activities include a significantly expanded trough technology development effort, small systems development, and evaluation of the potential for concentrating photovoltaics. We will formalize our quarterly tracking of milestones with a new web-based system. In an effort to reduce overhead costs, this year's Annual Operating Plan has been simplified and shortened.

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Introduction

Concentrating solar power (CSP) technologies (previously referred to as solar thermal electric technologies) use mirrors to concentrate the sun's energy up to 10,000 times to power conventional turbines or heat engines to generate electricity. This clean, secure, environmentally friendly power diversifies our domestic electricity production options and has the potential for major impacts in international markets. Energy from CSP systems is high-value renewable power because energy storage and hybrid designs allow it to be provided on-demand—even when the sun is not shining.

Future deployment of CSP technologies can substantially reduce greenhouse gas emissions. The rapid increases in annual production capacity achieved during the construction of existing plants (up to 80 MW/year) have demonstrated the capability of CSP production, with modest manufacturing capacity investment, to rapidly expand in order to provide huge quantities of power at prices that in the long term will compete directly with conventional fossil technologies. These technologies feature additional advantages of providing quality manufacturing jobs for local economies and export markets for key components.

Meeting our goals will be a challenge. We believe, however, that the combined capabilities of the Department of Energy (DOE), Sandia National Laboratories and the National Renewable Energy Laboratory (working together as Sun•Lab), and U.S. industry are up to that challenge, and hence that CSP can become a major source of clean, reliable, and secure power in the future.

Our Vision

Our vision for success of the Concentrating Solar Power Program is world leadership by U.S. industry in supplying 20 GW of concentrating solar power by 2020.

Our Mission

Our mission within the DOE's Concentrating Solar Power Program is to help provide for the energy, economic, and environmental security of the United States. We will fulfill our mission through technology research, development, and field validation required for CSP technologies to make a major contribution to clean global energy resources in the years to come.

Our Objective

Our objective is to develop and validate CSP technologies that meet the needs of the marketplace. Building on the success established to date, we expect to make significant progress in the next five years by focusing on the following three paths:

- Developing and demonstrating high-reliability distributed power systems;
- Reducing costs of dispatchable solar power; and
- Developing advanced components and systems.

Our Strategies

Our strategies for achieving our objective are to

- Focus on the reliability of dish/engine systems for emerging markets for distributed energy sources. Efforts in this area address the technology improvements needed to field more competitive next-generation systems. The efforts will result in orders of magnitude improvements in system reliability and also will achieve energy costs in the range of 9 to 11¢/kWh in about five years.
- Address the highest priority activities required to bring commercially proven trough and demonstrated power tower technologies to early dispatchable power markets. Accompanied by early demonstrations supported by both green power markets and multilateral organizations like the Global Environment Facility, this development effort will lead to a "next generation" of plant designs capable of producing dispatchable power for 6 to 8¢/kWh by 2003.
- Penetrate broad domestic and international megamarkets. Coupled with economies-of-scale emerging from continued expansion into high-value markets, the advanced technologies resulting from this path will allow CSP systems to compete in large-scale distributed and dispatchable markets priced at 4 to 6¢/kWh. At these prices, U.S. industry will ultimately be able to achieve our vision of 20 GW by 2020.
- Keep our technology efforts focused on the most critical needs of industry; ensure a technology capable of meeting market requirements; and support domestic and international information flow and policy decisions favorable to renewable energy.

Performance Measures: FY00

- Develop off-grid capability for remote CSP systems and begin testing at the National Solar Thermal Test Facility (NSTTF).
- Achieve 1,000 hours of autonomous field testing of a single dish/engine system.
- Initiate field testing of next-generation trough components.
- Complete final evaluation and documentation of the Solar Two Project.
- Initiate broad requests for proposals (RFPs) to engage universities and industry in development of advanced CSP components, including materials, drives, and small systems.

Milestones/Metrics

Individual activity milestones and metrics are listed with each activity. Program milestones and metrics (those by which the overall program is evaluated) are highlighted with shading. Others are specific to the individual teams' evaluations. Milestone summaries are included at the end of the document.

PATH 1: DISTRIBUTED POWER

1.1 SAIC Dish/Stirling O&M and Engineering Development

Background

This activity is a follow-on to the two-phase Utility-Scale Joint Venture Project subcontract, due to expire early in FY00. Two dish/Stirling systems are located at the Arizona Public Service Company's STAR Facility in Phoenix. A third system is located at the Pima-Maricopa Indian Reservation in Salt River Project territory near Phoenix. A fourth concentrator is located at NREL's mesa test facility. This activity will support continued operation and maintenance of these systems in addition to directed engineering development activities.

Objectives

- Achieve 200 hours of autonomous operation for each system without incident.
- Achieve 90% system availability for all three systems (more than 70% by mid-year).
- Collect reliability and operation and maintenance (O&M) cost and performance data for input to Sun♦Lab dish/engine reliability database.

Approach

A multiphase sole-source subcontract will be awarded to SAIC. The first phase of the subcontract will fund near-term engineering activities to correct design deficiencies related to the PCS (power conversion system, including actuator controller, combustion blower, and shutter/plug assembly) and the concentrator (focus control and alignment). These deficiencies contributed to most of the incidents hindering operation of the systems in FY99. In addition to these activities, SAIC will be funded to operate and maintain the three Arizona systems through the end of FY00. Reliability, O&M, and performance data will be delivered weekly and entered into the dish/engine reliability database.

On satisfactory completion of Phase 1 (as measured by SAIC's and its lower-tier subcontractor's success in meeting the project goals and deliverables), SAIC will be given permission to proceed to Phase 2 of the subcontract. Phase 2 will include continued operation and maintenance of the three Arizona systems in addition to longer-term engineering development activities focused on lowering cost and improving system reliability. These activities will be directed toward advanced drive development, additional focus control improvement, software and hardware upgrades, and ruggedization of the hybrid PCS.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
1.1.a	**Regularly update reliability database with SAIC operational data**	Mehos	Mar 00 and quarterly
1.1.b	**Achieve 70% availability for one month for one Arizona system**	Mehos	May 00
1.1.c	**Achieve 90% availability for one month for all three Arizona systems**	Mehos	Nov 00
1.1.d	**Document go/no-go decision for continuation of SAIC dish/Stirling project, depending on progress**	Mehos	Nov 00

1.2 25-kW Receiver Development

Background

Heat-pipe receivers have been identified and demonstrated to significantly improve the performance of dish/Stirling generation systems. A heat-pipe receiver can also greatly simplify system controls by adding thermal mass and transforming a non-uniform flux pattern into isothermal heat input. Heat-pipe receivers are seen as critically important to the Native American system. In addition, heat-pipe receivers greatly facilitate hybridization of the receiver, providing for solar augmentation with gas or other fuels.

Recent receiver efforts have concentrated on the development of long-lasting durable heat pipes, addressing structural and corrosion issues seen in prior versions. A promising candidate was initially tested last year. In addition, a bench-scale prototype of a low-cost hybrid approach has been tested, and the concept expanded to an integrated full-scale device design.

Objectives

The objective of this effort is to improve the durability and cost of heat-pipe systems to the point that our development partners incorporate heat pipes and hybrid heat pipes into their baseline systems. In FY00, we will test and improve the robustness of the perforated-metal heat pipe and will begin operation of a multi-device long-term durability bench test rig to help develop and prove cleaning methods and wick structure enhancements. We will complete fabrication and laboratory testing of a full-scale cost-effective hybrid heat-pipe receiver and will complete preparations for and begin on-sun testing.

Approach

The current heat-pipe approach, a felt wick supported by a perforated-metal exoskeleton, has been demonstrated successfully for 50 hours on sun, and more than 5,000 hours on a bench-scale device. We will continue to determine the operating characteristics of the full-scale version by subjecting a new receiver to harsh, real-world operating conditions. We will also continue laboratory development to improve the wick. Particular areas of concern are the wick-perforated metal bond and the viability of the cleaning procedures. To effectively investigate improvements, we need a facility for long-term testing of multiple devices that simulate a full-scale receiver. We have a capsule test array that can test 12 devices around the clock. However, the subtle differences in effects that appear after long exposure are not apparent on the small devices. A larger bench test device has successfully demonstrated full-scale effects, but the current test stand is capable of one test at a time. We will fabricate a new test rig to support four simultaneous unattended tests. We will begin testing devices to determine improvements in the bond and to determine if cleaning procedure simplifications affect system operation. We will also continue to operate and support existing capsule tests, including post-test metallurgy.

We have completed a full-scale hybrid receiver design based on the successful bench test. We have started fabrication, involving potential commercial vendors wherever possible. We will complete the fabrication of the device and development of control systems and approaches. We will initially test the hybrid heat pipe in the laboratory, in order to tune the control systems in a controlled environment. We will prepare the test bed concentrators for testing the hybrid heat pipe and begin on-sun testing.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
1.2.a	**Begin "real-world" testing of a perforated-metal heat-pipe receiver**	Andraka	Dec 99
1.2.b	**Begin operation of the multiple-device durability test rig**	Andraka	Mar 00
1.2.c	**Complete fabrication and test cell preparation for a full-scale hybrid heat-pipe receiver**	Moreno	Jun 00
1.2.d	**Complete on-ground testing of the full-scale hybrid heat-pipe receiver**	Moreno	Aug 00
1.2.e	**Complete preparations for and begin on-sun testing of hybrid heat-pipe receiver**	Moreno	Sep 00

1.3 Dish/Engine Critical Components Project

Background

The Boeing Dish/Engine Critical Components (DECC) Project started in April 1998, and a single dish/Stirling system has operated on-sun since July 1998. To date, this system has accumulated more than 3,100 hours of solar operation and generated more than 42,000 kWh of power. Boeing and its partner, Stirling Energy Systems (SES), have completed Phase 1 of the project. FY00 finds us preparing to start Phase 2 of the project.

Objectives

The objective of the Boeing DECC Project is to develop a solar dish/Stirling system for pre-commercial deployment in two to three years, using the former McDonnell Douglas dish/Stirling unit as the initial system prototype. Phase 1 focused on operating a refurbished dish/Stirling system, refurbishing 3 engines for test-cell and systems testing, and developing a plan for engine manufacturing. Phase 2 objectives (to be completed over a two-year time frame) are to phase in testing of up to 8 dish/Stirling systems (using 6 old concentrators and 2 new-generation designs) with 8 additional engines (3 old and 5 new designs) that will incorporate (to varying degrees) system upgrades for the cooling systems, generators, dish and engine controllers, and "key" engine components. Boeing's plan (a very ambitious one) is to deploy multiple pre-commercial systems after Phase 2 of the project—beginning in the fall of 2001.

Approach

We will work to get the DECC Phase 2 contract negotiated and placed as soon as possible. This will require coordinating program needs with the contractual requirements of the NREL Procurement Department. The project objectives for FY00 are to develop upgrades for the engine cooling system and the dish and engine controllers, to assemble and operate two more dish/Stirling systems (based on existing concentrators and engines) at the Boeing test site, and to develop an engine test facility at the Boeing test site. Our main focus in FY00 will be the system upgrades, the testing, and rolling up test data for the Sun♦Lab reliability database.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
1.3.a	**Start operation of second full dish/Stirling system** (The first system has been operational since Phase 1.)	Mancini	Feb 00
1.3.b	**Negotiate and place Phase 2 contract** All milestones are subject to contract negotiations.	Mancini	Mar 00
1.3.c	**Regularly update reliability database with Boeing operational data**	Mancini	Mar 00 and quarterly
1.3.d	**Start engine testing in Boeing test cell** "Stretch" in that sufficient dollars have not been provided to fully support this activity	Mancini	Jul 00
1.3.e	**Initiate bench testing of next-generation engine**	Mancini	Aug 00
1.3.f	**Start operation of third dish/Stirling system** "Stretch" in that sufficient dollars have not been provided to fully support this activity	Mancini	Aug 00

1.4 Native American System

Background

Remote applications provide an opportunity for high-value distributed power (50¢/kWh and higher for some remote applications) and many early opportunities for commercial deployment. In this project, we will develop a stand-alone 9-kW dish/Stirling system based on Sun♦Lab-developed structural facets, the proven SOLO 161 kinematic Stirling engine, and Cummins concentrator and controls technology.

Objectives

The Native American system objective is to fabricate, demonstrate, and field a fully integrated, stand-alone water-pumping dish/Stirling system for use at a Native American site in the southwest United States.

Approach

In FY99, we successfully designed, built, and initiated testing of a 9-kW dish/Stirling system in a grid-connected mode at the NSTTF in Albuquerque. Also, following a survey of Native American tribes in the southwestern United States, we initiated partnership discussions with four tribes—two each in Arizona and New Mexico. In FY00, we will continue technology development and integration and establish a working relationship with one or more Native American application partners. In the area of technology development, we will (1) continue operation, testing, and reliability improvement of the grid-connected system; (2) develop a next-generation system design, primarily to reduce cost and simplify installation; and (3) develop and test a stand-alone, water-pumping power-management system.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
1.4.a	**Complete a 50-hour, fault-free, reliability demonstration of the grid-connected system**	Diver	Nov 99
1.4.b	**Initiate unattended operation of the prototype grid-connected system**	Diver	Dec 99
1.4.c	**Initiate design of the second-generation dish/Stirling system**	Diver	Dec 99
1.4.d	**Sign agreement(s) with Native American application partner(s)**	Menicucci	Jan 00
1.4.e	**Regularly update reliability database with remote system operational data**	Diver	Mar 00 and quarterly
1.4.f	**Complete design of the second-generation dish/Stirling system**	Diver	Jun 00
1.4.g	**Demonstrate a non-grid-connected water-pumping system at the NSTTF**	Diver	Sep 00

1.5 Reliability Improvement

Background

Reliability of dish/engine systems has been identified as the major technical hurdle limiting commercialization of dish/engine systems. However, no methodology currently exists within Sun•Lab to evaluate the reliability of current projects or to provide a rationale for funding future projects. Even if such a methodology existed, no mechanism is in place to track or analyze the current or future reliability of CSP-funded systems. This activity will support the development of a reliability methodology, development of a reliability database, and Sun•Lab support for reliability growth of CSP-funded dish/engine commercialization activities.

Objectives

- Document standard definitions and methodology for tracking, analyzing, and reporting system reliability.
- Develop a web-based reliability database to track CSP-funded dish/engine projects and provide reliability reports at regular intervals (i.e., quarterly).
- Provide Sun•Lab technical support to SAIC and SES dish/engine activities.

Approach

Sandia reliability experts will support the development of a reliability methodology document that will form the basis for follow-on data collection and analysis efforts. The methodology will clearly define key measures of reliability (i.e., availability, mtbf, mttr, etc.) and define data collection requirements for current dish/engine projects. The methodology will be distributed for Sun•Lab and industry review prior to finalizing the document.

In parallel with development of the reliability methodology, staff will continue the development of a web-based database to track and analyze system performance and reliability. The database will be piloted on the current dish/engine projects (SAIC, SES, and Native American dish) with project leaders responsible for collecting the required data. Reliability and performance reports will be issued quarterly for each system.

Sun•Lab staff will continue to provide technical support to SAIC and SES dish/engine commercialization efforts. Technical assistance will occur on an as-needed basis but has historically consisted of support for facet alignment, infrared thermography, controls and data acquisition, hydrogen leak testing, optical characterization, and emissions testing. Where applicable, performance or reliability improvement resulting from these activities will be tracked within the reliability database.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
1.5.a	**Document reliability methodology**	Mehos	Dec 99
1.5.b	**Complete web-based database** Develop process by Feb 00, and ensure quarterly implementation status is current within 1 month	Mehos	Feb 00

PATH 2: DISPATCHABLE POWER

2.1 Trough Technology

2.1.1 Trough Receiver Reliability

Background

The long-term durability of the parabolic trough receiver, also known as the heat collection element (HCE), is the most important solar field reliability issue for both current and future trough plants. The HCEs installed at Solar Electric Generating Systems (SEGS) VIII and IX, located at Harper Lake, California, are experiencing large numbers of receiver failures that significantly reduce solar field performance and increase O&M costs. The current HCE design uses a cermet absorber coating and a glass envelope with an evacuated annulus; the current cermet material degrades when air is introduced into the envelope annulus. Developing a better fundamental understanding of the HCE degradation mechanisms and identifying methods of extending the lifetime of the HCE will have a significant beneficial economic impact on both current and future parabolic trough installations.

Objectives

The objectives of this activity are to determine the degradation mechanisms of the current HCEs and to identify methods of cost effectively improving the reliability of the HCE component. Possible factors that could contribute to the observed HCE degradation include the receiver design, the cermet coating materials, the manufacturing processes, the methods of installation, the collector design, and the operation practices of the solar fields at the current plants. Once the probable degradation mechanisms are identified, HCE modifications will be pursued that will address the issues. Sun•Lab will facilitate both the fabrication of new, modified HCEs and installation of the prototype HCEs in actual solar field conditions for improved reliability/lifetime validation.

Approach

The approach that will be used for this activity leverages the previous experiences gained with Sun•Lab's interaction with the SEGS plants and current activities by MWE Associates under a USA Trough subcontract. The subcontract results will provide HCE statistical information compiled at the SEGS plants and will be used to provide a broader view of current HCE failures. Sun•Lab will work with the SEGS O&M companies and SOLEL, the current HCE manufacturer, to develop an improved evacuated receiver design. The solar field installation procedures and the operational specifications will be examined to observe any correlation between current practices and premature HCE failures. Sun•Lab will also work with one or more of the O&M companies to procure a new HCE production run of a least 200 receiver tubes to perform in solar field validation testing. The new HCE's performance and reliability will be monitored for an extended period into the future.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.1.1.a	**Review and analyze MWE Associates' subcontract results on current HCE failures**	Mahoney	Dec 99
2.1.1.b	**Document collaboration with SEGS facilities to develop new and improved evacuated HCE by investigating materials, manufacturing methods, and other relevant issues**	Mahoney	Jun 00
2.1.1.c	**Procure new, modified HCEs (approximately 200 tubes) for solar field validation testing**	Mahoney	Aug 00

2.1.2 Trough Concentrator Performance

Background

The Luz LS-3 collector was used at the last commercial trough plants (SEGS VII through IX) and is considered to be the current state of the art in parabolic trough concentrators. A variation of the LS-3 that allows the collector to be tilted a few degrees is used for the direct-steam generation test at the Plataforma Solar de Almería in Spain. Although the operational experience of the LS-3 collector has been excellent (high tracking availability), the thermal performance and the maintainability (alignment) of the collector has not been equal to the earlier LS-2 design. For near-term projects, resolving the performance and maintainability issues of the LS-3 concentrator represent one of the most important opportunities for reducing the cost of trough power.

The EuroTrough torque box is a new concentrator concept that is thought to resolve many of the problems associated with the LS-3. Potential U.S. developers of future trough projects have expressed interest in the new torque box concentrator. However, current EuroTrough development plans will not complete sufficient testing on the torque-box design to allow it to be used in a commercial plant for four to five years.

Objectives

The objective of this project is to significantly speed up the testing and development of the torque-box concept that would allow it to be used in the next commercial parabolic trough project (within two years). This activity will test the torque box concentrator at an existing SEGS plant. Initially, a single torque box concentrator will be tested during FY00 and lead to a full loop test during FY01. The tests will change-out the existing LS-3 spaceframes (collector structure) on one LS-3 collector and later a full loop of collectors (8 collectors) at one of the operating trough plants and replace them with the torque-box design concentrator. This approach has a number of advantages. First, the collector will be tested in an operating commercial plant and will be used in normal operating service. This will significantly reduce the perceived financial risk for future plants. Second, by doing a full loop, direct performance comparisons can be made between the new concentrator and the earlier LS-2 and LS-3 collectors. Third, only the new concentrator structure will need to be purchased; all the mirrors, receiver tubes, foundations, and potentially the drives, electronics, and controls will be reused LS-3 parts. This significantly reduces the cost of the test. Finally, this activity provides U.S. industry an opportunity to get more first-hand experience with the torque-box trough design concept. U.S. industry could end up being better positioned to supply this trough concentrator design when the next trough plant is built. The EuroTrough consortium will provide licenses to any U.S. participants in the test.

Approach

Sun•Lab will work with the EuroTrough project team to finalize the torque-box design and develop the test plan for a prototype torque-box element and full collector loop. Sun•Lab will develop a testing-and-support memorandum of understanding (MOU) with one of the operating facilities to install and test the prototype loop at one of the operating SEGS plants. Sun•Lab will solicit U.S. industry partners through an MOU to participate in the installation and testing of the new collectors.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.1.2.a	**Implement MOU with operating company to host test**	Price	Jan 00
2.1.2.b	**Finalize initial torque-box concentrator design**	Price	Feb 00
2.1.2.c	**Deliver collector hardware to site for first collector**	Price	May 00
2.1.2.d	**Initiate operational testing of first collector**	Price	Jul 00
2.1.2.e	**Finalize torque-box collector design for loop**	Price	Sep 00
2.1.2.f	**Initiate operational testing of collector loop**	Price	FY01

2.1.3 USA Trough

Background

Based of the results of the recent CSP-sponsored parabolic trough technology roadmap, parabolic trough technology is viewed as an established technology with real near-term market opportunities and holds the potential for significant future advancement, more so than previously recognized. Because of the experience gained at the California SEGS projects, U.S. industry could be positioned to be key players in future trough development.

Objectives

The objectives of the USA Trough initiative are to

- Advance the state of the art of parabolic trough technology, integration, and services to improve the near-term (one to five years) competitiveness of the technology. Specific activities will reduce cost, improve performance, improve reliability, reduce commercial risk, or affect other factors to improve the competitiveness of trough technology.
- Increase U.S. scope and supply of future domestic and international trough projects (this includes all aspects of a project and not just hardware supply).

Approach

- Manage the five FY99 USA Trough activities.
- Issue competitive RFPs to (1) extend existing USA Trough research and development (R&D) activities and (2) generate new R&D activities. The goal is to have a minimum of two new or extension activities.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.1.3.a	**Place new (second phase) FY00 USA Trough contracts**	Price	Jun 00
2.1.3.b	**Place follow-on (to first phase) USA Trough contracts**	Price	Sep 00

2.1.4 O&M Cost Reduction

Background

The O&M experiences accrued through years of continuous operation and their associated financial impacts have resulted in performance improvements and reduced operating costs of parabolic trough plants. The benefits of O&M cost reduction have been demonstrated through the studies performed by Kramer Junction Company and the development of low-cost HCEs at Sunray Energy Inc. Additional understanding of the O&M issues and the current problems at the SEGS plants, their pragmatic solutions, and their performance and financial impacts will continue to provide vital information needed not only for future parabolic trough installations but also for other CSP technologies. Continued reduction in the O&M costs will further improve the sustainability of the current SEGS plants and will provide valuable lessons for the design and operation of future plants.

Objectives

The objective of this activity is to determine which O&M issues and solutions at the SEGS plants have performance and economic impacts for future parabolic trough plants. Some of these O&M issues that have future plant and CSP crosscutting impact were identified during the Trough Roadmapping exercises: mirror-wash methods and tools, parabolic trough concentrator alignment methods and tools, flexhose/ball joint replacements, and HCE performance assessment and replacement strategies. Other issues will be identified as this activity moves forward.

Approach

The approach that will be used for this activity leverages the previous experiences gained with Sun•Lab's interaction with the SEGS plants and the collaborative development of methods and solutions for understanding and solving the O&M issues. Initially, Sun•Lab will solicit the input from each of the SEGS facilities on their individual O&M issues and team with them to identify and prioritize Sun•Lab's efforts to have the most benefit to both current plant operations and future CSP installations. After identifying the O&M issues, Sun•Lab will focus our efforts on the issues that are most important and that have CSP crosscutting impact.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.1.4.a	**Identify O&M issues for each SEGS facility and prioritize and focus effort on those that are most important for future CSP plants**	Mahoney	Jan 00
2.1.4.b	**Complete report assessing performance, financial impact, and benefits to future CSP plant operations of selected O&M issues and solutions**	Mahoney	Sep 00

2.1.5 Design Team Coordination

Background

Often R&D activities are done in isolation. This activity will help foster communication between various trough R&D activities and between the laboratories and industry.

Objectives

- Coordination of activities to address a consistent set of goals and objectives.
- Improve communication between laboratories and industry.
- Improve responsiveness of laboratory teams.
- Encourage efficient use of resources.
- Provides tighter integration of goals and activities between laboratories and industry.

Approach

Sun•Lab will implement a trough design team to coordinate the various trough development activities being conducted. Periodic trough design team review meetings will be held to assess progress and coordinate between various activities. A quarterly newsletter will be generated to provide updates on activities to interested industry partners. A trough web page will be added to the CSP web site to provide general access to new and existing trough information and resources. In addition, Sun•Lab will implement MOUs with interested U.S. industry partners in the development and testing of trough technologies.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.1.5.a	**Distribute quarterly status newsletter**	Price	Jan 00 and quarterly
2.1.5.b	**Establish testing MOUs with SEGS operating companies**	Price	Mar 00

2.1.6 Baseline Data and Analysis

Background

In order to make decisions about what technologies to pursue, a clear understanding of the current state of the technology is necessary. Baseline design, cost, and performance data are needed for comparing technology alternatives. In addition, the tools necessary to evaluate that data and assess the cost/benefit of various alternatives are essential to the decision-making process.

Objectives

Our objective is to collect baseline performance and cost data on current trough plant designs and to assemble or develop computer tools and codes to model plant, receivers, and concentrator performance.

Approach

Use 30- and 80-MW SEGS plants as baselines for cost and performance.

- Work with existing O&M organizations to develop detailed O&M cost models and plant performance.
- Use R&D subcontracts to update cost and designs for domestic and international locations.

Use Sun•Lab expertise to develop performance models for receivers, concentrators, plants, and projects.

- Develop TRNSYS models for 30- and 80-MW SEGS plants, low- and high-impact integrated solar combined-cycle system plant designs.
- Update receiver (HCE) model, trough concentrator ray-trace model, and integrated cost/performance/finance model.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.1.6.a	**Complete validation of TRNSYS models for 30- and 80-MW SEGS plants**	Jones, S.	Jun 00
2.1.6.b	**Complete simplified trough plant spreadsheet model with integrated cost, performance, and finance modules for industry use with baseline data**	Price	Sep 00

2.2 Trough R&D

2.2.1 Near-Term Thermal Storage

Background

Economical and reliable near-term thermal storage is a necessary part of the development of trough technology. It will lead to dispatchable, solar-only trough plants and/or increased solar capacity factor. This, in turn, will expand strategic markets and reduce risk associated with the technology.

Objectives

The objective of this activity is to develop and demonstrate effective near-term thermal storage for trough systems, ultimately leading to full-scale testing at an existing SEGS plant in FY01.

Approach

This project examines storage solutions for trough technology and emphasizes near-term solutions. This will include component and system-level analysis of different thermal storage options. This analysis will be documented in a report that provides a comprehensive Sun•Lab assessment of thermal storage options for trough technology. A large portion of this project will be devoted to laboratory-scale testing of the molten-salt storage option in combination with high-temperature, heat-transfer oils. NREL and Sandia will collaborate on defining the system requirements and the experimental design. Unknowns that the experiment will need to address include behavior of lower-melting-point salts, dangers in case of hardware breach, and hardware design for efficient transitional states. The experiments will be conducted at Sandia.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.2.1.a	**Initiate laboratory-scale testing**	Pacheco	May 00
2.2.1.b	**Complete the near-term portion of the report documenting Sun•Lab assessment of thermal storage options for trough technology**	Hale	Jul 00
2.2.1.c	**Complete interim report on trough thermal storage testing**	Pacheco	Sep 00
2.2.1.d	**Complete thermal storage design specification for FY01 prototype field test**	Pacheco	Sep 00

2.2.2 Advanced Thermal Storage

Background

Significant improvements in thermal storage economics and operability are necessary for the continued successful development of trough technology. Although near-term storage options hold promise for increasing the value of the technology, successful advanced storage technologies will dramatically improve both the value and the economics of trough technology for the long term.

Objectives

Our objective is to identify three thermal storage options with potential for 50% cost reduction relative to near-term options. These options should have potential as direct storage to ensure ease of operability and simplicity of system design.

Approach

This project will begin with defining the generic cost and performance requirements for an advanced storage system. This process will involve a precursory systems-level analysis to examine what will be necessary levelized energy cost, operability, and performance requirements. Once these requirements have been specified, candidate storage materials will be identified and their potential evaluated through analysis and testing.

This project will assess different design and storage media options for advanced storage. Some options such as phase-change materials and chemical storage were considered in the 1980s but were never analyzed thoroughly. Some of these options may include modifications to current collector field or power plant designs. The purpose of this assessment is twofold: first, it will build our baseline level of expertise in advanced storage options; second, it will give us initial indications of which options hold the most promise to pursue in the future.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.2.2.a	**Define and document generic cost and performance goals for advanced thermal storage systems**	Hale	Apr 00
2.2.2.b	**Complete the advanced storage portion of the report documenting Sun•Lab assessment of thermal storage options for trough technology**	Blake	Sep 00

2.2.3 High-Temperature Selective Coating

Background

The current SOLEL HCE receiver tubes use a "cermet" (*cer*amic-*met*al) solar-selective absorber coating that is applied using vacuum deposition techniques. While this coating has demonstrated excellent thermal performance in evacuated HCE configurations, the coating has several drawbacks, which include high production costs and limited durability when exposed to air at parabolic trough operating temperatures. The high production costs of this coating contribute, in part, to the overall expense of new HCEs that range in cost from $800 to $1,000 each. The poor performance of this coating in air has resulted in the "fluorescent HCE" problem that plagues the solar field at SEGS VIII and IX. Currently, any loss of vacuum in the HCE or the breakage of the glass envelop typically results in the rapid degradation of the absorber coating and significantly impacts both solar field performance and O&M costs. Because the cost and durability of the absorber coating has significant impacts on both the current SEGS facilities and future parabolic trough plants, alternative approaches are needed to both reduce the production costs of the current or potential candidate solar-selective absorber coatings and improve the long term thermal stability of these coatings in air under parabolic trough service conditions. The development of a low-cost solar-selective coating that is stable in air at trough operating temperatures could facilitate a cost-reduction breakthrough toward significantly lower-cost receivers for both retrofit and new plant applications.

Objectives

We will pursue a multiple-path approach to assess the optical properties, thermal stability, and production costs of both current and potentially promising solar-selective absorber coating technologies. The overall objective is to lower the production cost of current and candidate solar-selective coatings that are used in parabolic trough applications and to improve the thermal stability of these coatings for long-term durability, in air, under parabolic trough operating conditions.

Approach

We will pursue a multiple-path approach to

- Assess the optical properties, the thermal stability, and the production costs of the current SOLEL cermet coating.
- Continue development of an improved thermally stable Black Crystal coating.
- Assess the potential of the Black Nickel coating available from Industrial Solar Technologies (IST) using Sun•Lab coating technologies to improve the thermal stability.
- Evaluate the potential of a new, C4 Technologies' proprietary, low-emittance coating.
- Develop a final optical design of a solar-selective absorber pigment.

Ultimately, we will develop and install low-cost prototype HCEs, using promising alternative solar-selective absorber coating(s), at the SEGS plants for in-field performance and durability evaluation. All of these efforts will leverage joint development between current and potential industry partners and Sun♦Lab.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.2.3.a	**Document evaluation of C4 Technologies' proprietary coatings for optical properties, thermal stability, and assess potential for parabolic trough applications**	Mahoney	Feb 00
2.2.3.b	**Document evaluation of IST Black Nickel coating, with Sun♦Lab improvements, at parabolic trough operating temperatures**	Mahoney	Jun 00
2.2.3.c	**Document surface protection efforts on Black Crystal coating, including evaluation of long-term thermal stability and assessment potential for parabolic trough applications**	Mahoney	Jun 00
2.2.3.d	**Develop and install prototype low-cost HCEs in SEGS solar fields**	Mahoney	Jul 00
2.2.3.e	**Document assessment of current cermet coating to determine probable degradation mechanisms, investigate methods of improving coating durability, if needed, and look for methods to reduce production costs.** This success of this task will depend upon the willingness of SOLEL to collaborate in this effort.	Mahoney	Sep 00
2.2.3.f	**Place contract with Surface Optics, Inc. to perform optical modeling to design a solar-selective absorber pigment with acceptable optical properties and thermal stability**	Mahoney	Sep 00

2.2.4 Low-Cost Receiver Development

Background

Currently, the only commercially available HCE is manufactured by SOLEL, in Israel. The current HCE design uses an evacuated receiver fabricated from stainless steel tubing, coated with a cermet absorber, a Pyrex® glass envelope coated with an anti-reflection coating, and a conventional glass-to-metal seal technology. The current purchase (first) cost of the SOLEL HCEs is between $800 and $1,000 each. System studies of trough technology indicate that the capital investment impact of the HCEs range from 8 to 12% of the total new plant cost. In order to achieve future trough technology cost targets, the first cost of the receiver needs to be reduced to about $250 each without significantly impacting the thermal performance of the HCE.

Objectives

The overall objective of this activity is to lower the purchase (first) cost of the current and/or alternative HCE. The initial objective is to establish the manufactured cost baseline for the current SOLEL HCE and to identify alternative manufacturing methods and/or design concepts that can significantly reduce the cost of manufacturing receiver tubes without significantly impacting the high thermal performance of current receivers (94 to 96% solar absorptance and 10 to 25% thermal emittance at 350°C). Building and testing of prototype HCEs would be needed to assess any new concepts and/or designs. There are two ultimate objectives of this task: (1) to develop, if appropriate, new low-cost HCEs, using promising alternative designs and materials and install prototype HCEs at the SEGS plants for in-field performance and durability evaluation during FY01 and (2) to establish U.S. supplier(s) of low-cost receivers during FY01.

Approach

The approach that will be used for this activity leverages the materials and manufacturing expertise of Sun•Lab to assess the current HCE design, manufacturing methods, and baseline costs. Based upon the economic baseline findings, we will either facilitate the improvement of the current HCE design through a design for manufacturing and assembly workshop or develop new, low-cost receiver concept(s) and/or design(s). If appropriate, we will build HCE subcomponents and/or HCE prototypes and perform preliminary tests to evaluate both thermal performance and preliminary durability. Based upon positive and promising findings, we will facilitate the involvement of potential U.S. HCE manufacturing capabilities through either competitive RFP or cooperative research and development agreement during FY01.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.2.4.a	**Review manufacturing methods and processes of current HCE and determine baseline costs**	Mahoney	Apr 00
2.2.4.b	**Determine the feasibility, manufacturability, and potential economic impacts of new low-cost receiver concepts and/or designs**	Mahoney	Jul 00
2.2.4.c	**Begin building, testing, and evaluating candidate prototype HCE designs**	Mahoney	Sep 00

2.3 Power Tower Technology

Background

Since the shut down of Solar Two, some very significant opportunities have developed for power tower technologies. There is considerable interest by our U.S. industry partners in pursuing potential international (e.g., Spanish Royal Decree) and domestic (state-mandated renewable energy portfolio) markets.

Objectives

The power tower technology project will focus on five major tasks this fiscal year: (1) capturing the knowledge we gained at Solar Two and wrapping up Solar Two evaluations and documentation; (2) completing the design basis document; (3) capturing the receiver lessons learned; (4) providing technical support to our industry partners for the next commercial power tower plant; and (5) developing an advanced heliostat with our industry partners.

Approach

In the first task, we plan to complete evaluations of operational and test data and write the final reports on Solar Two. The final outcome will be several documents, including test and evaluation final report, high-level summary, lessons learned, overall project report, DOE Golden final report, Solar Two SnapShot, and power tower roadmap. Also in this task, we will conduct and document metallurgical analysis of tank, steam generator, and receiver samples.

For the second and third tasks, we will contract with Bechtel to complete the design basis document and with Boeing to document lessons learned from the operation of the receiver. We will provide support to our industry partners by conducting systems analysis; addressing technical issues; relaying lessons learned in the design, construction, and operation and maintenance; and providing technical consultation as needed. To develop an advanced heliostat with our industry partners, we will first conduct a study to quantify the tradeoffs between large and small heliostats. We will develop and build a heliostat or key heliostat components (pending design decisions by our industry partners) and will be ready for full testing next fiscal year.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
2.3.a	**Complete study on optimum heliostat size**	Jones, S.	Dec 99
2.3.b	**Complete design basis document**	Pacheco	May 00
2.3.c	**Complete final Solar Two evaluations and documentation**	Pacheco	Sep 00

PATH 3: ADVANCED COMPONENTS AND SYSTEMS

3.1 Systems Analysis and Field Operations

3.1.1 Facilities Operations

Background

CSP facilities include the National Solar Thermal Test Facility (Sandia) and the High Flux Solar Furnace (NREL). These facilities provide the equipment and test capabilities needed by the program to meet our objectives. Operation and maintenance of these facilities is needed to conduct tests, while assuring compliance with environment, safety, and health (ES&H) requirements.

Objectives

We will define the hardware that needs to be developed and tested at the NSTTF to support the new project opportunities and perform O&M of the NSTTF to ensure the facility is available to support ongoing and new CSP projects.

Approach

Operations and maintenance of the facilities will be performed to ensure that the facility will be available to test components within ongoing and future projects. Specific testing costs will be borne by the projects. Facilities maintenance and overhead activities are covered in the activity.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
3.1.1.a	**Provide ES&H incidence-free facilities operation in support of CSP testing**	Kolb, W. and A. Lewandowski	On going

3.1.2 Eskom Technical Assistance

Background

Eskom is the national utility of South Africa, with 20 power stations and a nominal capacity of 38,000 MW. Eskom is interested in investigating CSP technologies for their potential to provide an alternative source of electricity both for domestic use and for possible export. The objectives of the Eskom CSP-Africa study are to

- Evaluate the leading solar thermal electric technology options with regards to their current and future potential for South Africa.
- Conduct a broad site assessment to identify the most attractive areas for potential plants.
- Identify preferred system(s) that could be economically feasible for Eskom to implement in the coming decade.
- Identify specific constraints that would need to be addressed to attain a sustainable deployment of solar thermal electric systems in South Africa.

Eskom has requested Sun♦Lab's technical assistance for this effort. Implementation of CSP technologies in South Africa would offer significant opportunities for U.S. industry.

Objectives

The objective of this effort is to cultivate Eskom's interest in becoming a user of CSP technologies. Our measure of success for this activity is Eskom management taking appropriate actions based on the recommendations of the CSP-Africa study.

Approach

Eskom is in the process of negotiating a Work for Others (WFO) agreement with NREL to cover project costs for the CSP-Africa study. DOE funding will be used to provide general support and training to Eskom in areas that are outside the scope of the WFO study. Our activities will include assisting Eskom in applying for Global Environment Facility (GEF) funding, interactions with World Bank and GEF staff on issues related to CSP technologies in South Africa, and conducting technical training to Eskom staff. Much of the effort will go into advising Eskom on CSP technologies most suitable to meet its objectives, which will help define the directions of the CSP-Africa study.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
3.1.2.a	**Complete first technical tours and training sessions for Eskom project manager**	Williams	Nov 99
3.1.2.b	**Complete written recommendations on technologies to evaluate in CSP-Africa study**	Williams	Mar 00
3.1.2.c	**Evaluate Eskom's interest in CSP through discussions with its management**	Williams	Sep 00

3.1.3 Technology Characterization Updates

Background

Systems analysis is needed to identify and nurture the development of new project opportunities for the Concentrating Solar Power Program. This activity will cover general systems analyses, including the updating of our technology characterization documents.

Objectives

In the systems analysis area, we will work to develop new CSP project opportunities of interest to U.S. industry and provide Sun•Lab technical assistance to U.S. industry and other project participants.

Approach

During FY99, we identified several new CSP power plant opportunities in cooperation with U.S. industry. Examples include a parabolic trough project near Mexicali, Mexico; power tower and dish projects in Spain; and a tower or trough project in South Africa. During FY00, systems analyses will be performed and discussed at workshops that include Sun•Lab and U.S. industry to determine the technical and economic feasibility of new potential projects. Technology characterization documents will be reviewed and, while the formal DOE/Electric Power Research Institute documents will not be modified, working versions will be kept current.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
3.1.3.a	**Complete systems analyses in support of the Spencer Management trough plant feasibility study in Mexico**	Kolb, G.	Mar 00
3.1.3.b	**Update systems analyses contained within DOE's trough and tower technology characterizations to reflect current status**	Kolb, G.	Sep 00

3.1.4 Dish/Engine Roadmap

Background

DOE funded a dish/engine technology roadmap workshop in June 1998. The workshop was well attended, with participants from the solar industry, Sun•Lab, DOE, utilities, and other interested stakeholders. Several products were generated following the workshop, including a workshop summary document and a viewgraph package describing recommendations developed during the course of the workshop. Since the workshop took place, commercialization activities have significantly changed. AlliedSignal discontinued its support for development of a 25-kW solarized gas turbine. Similarly, SAIC has significantly curtailed its corporate support for commercialization of a 25-kW dish/Stirling system. Late last year, a study conducted by A. D. Little stressed the need for improved reliability and alternative converter technologies. In parallel, a Sun•Lab investigation demonstrated the need to look beyond the development of 25-kW systems.

Objectives

Our objective is to develop a technology roadmap that will guide DOE-funded R&D activities related to the development of reliable, dish/engine systems. The roadmap "product" will consist of a spiral bound viewgraph package including supporting text.

Approach

Sun•Lab staff will develop a preliminary package and roadmap concept based on data generated from the initial dish/engine roadmap summary, the draft roadmap document generated by Bill Stine, the A. D. Little review of dish power systems, and the Sun•Lab remote market assessment.

The roadmap will identify products and requirements based on best information currently available. Based on these requirements, it will identify the most critical technology areas in need of development, list technology options and metrics (if available) for each option, and give recommendations for future R&D approaches and decision points for technology development activities.

The preliminary package will be updated based on reviews by Sun•Lab and DOE staff. A second draft of the document will then be distributed for review by a larger set of stakeholders, including industry. This review may be performed individually or by convening a group at NREL. A final version of the roadmap will be distributed following incorporation of issues raised and agreed upon during this review.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
3.1.4.a	**Complete final dish roadmap package**	Mehos	Apr 00

3.2 Concentrators

Background

Developing low-cost solar concentrators is key to commercializing CSP systems. The solar concentrator represents the "fuel" and accounts for 40 to 50% of the cost of a typical solar power plant. Structural mirror designs and low-cost drives are key to commercially viable CSP systems.

Objectives

We have four concentrator projects with a common objective of reducing the cost of CSP electricity. These projects include (1) structural facets, (2) a near-term drive, (3) advanced drives, and (4) Video Scanning Hartmann Optical Tester (VSHOT). The structural facet and the near-term drive activity are continuations from FY99. The advanced drive activity started in FY00 and is expected to continue into FY01. The VSHOT activity is a continuation from FY99.

The primary objective of the structural facet project is to manufacture replacement trough facets for the SEGS plants in California. With the manufacturing processes developed in this project, our goal is to be able to provide an American-made alternative replacement mirror to the SEGS operating companies at a cost of less than $\$70/m^2$. In addition, the structural facet project will support a wide range of potential applications of the structural facet approach to dishes, heliostats, and troughs. We will also support implementation of advanced optical materials.

The objective of the two drive activities is to reduce the cost of concentrator drives. In the near-term drive project, our goal is to reduce the cost of the Winsmith "low-cost" drive by more than 20% compared to the late 1980s study for low production levels. In the advanced drive design, we hope to identify drive designs that can reduce costs by an additional 25%.

The objective of the VSHOT activity is to maintain the system and keep it current with respect to hardware and software, thereby making it more robust and user-friendly.

Approach

In FY99, a cost-shared contract with Paneltec of Lafayette, Colorado, was placed to manufacture more than 200 facets to be field tested at the SEGS plants. All three SEGS operating companies are contributing to the cost share. Prototype facets were successfully manufactured and durability issues with the adhesive were addressed. In FY00, we expect to complete manufacture of the trough facets and install them at the SEGS power plants in California. The facets will then be monitored for durability. We will also support the Ft. Huachuca project with prototype fabrication and testing. As appropriate, advanced heliostat and trough activities and/or application of advanced optical materials will be supported.

In the near-term drive project in FY99, we contracted with Peerless-Winsmith to update the drawings and develop cost projections for the Winsmith low-cost drive. In FY00, we will work with Peerless-Winsmith and/or other manufacturing experts to develop approaches to reduce costs of drives, particularly at low and intermediate production levels. In the advanced drive area, DOE/Golden will solicit industry, university, and/or use DOE laboratory expertise for innovative drive concepts with the objective of significantly reducing drive costs compared to current alternatives. In FY00, we will place contracts for design, build, and test activities that will carryover into FY01.

The current control software for the VSHOT system was originally written three years ago in Visual Basic and will be updated to current Visual Basic software versions so that it can continue to be maintained easily. As for the control code itself, certain VSHOT subsystems have software bugs that will be fixed. Some software changes designed to extend the system's capability and make it easier to use will also be implemented. Certain hardware components will be upgraded including up-to-date Y2K compatible control computers and a new laser scanning system, which will allow shorter focal length concentrators to be tested. Lastly, we will start documenting the system and its operation so that it can be used by others not intimately familiar with the development of the system and its architecture.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
3.2.a	**Complete fabrication and evaluation of prototype structural facets for Ft. Huachuca**	Grossman	Nov 99
3.2.b	**Complete Phase 2 cost projections of the Winsmith "low-cost" drive**	Grossman	Dec 99
3.2.c	**Ship 200+ structural facets to SEGS**	Grossman	Mar 00
3.2.d	**Summarize VSHOT enhancements**	Wendelin	Jul 00
3.2.e	**Complete the Winsmith "low-cost" drive cost reduction study**	Grossman	Sep 00

3.3 Advanced Materials

Background

Development of solar mirrors having low cost and high durability is important because the success of CSP systems is strongly related to the optical durability and economic viability of the reflector materials. Low-cost, high-performance, and durable advanced optical materials that meet the demands of advanced system designs are necessary to achieve the cost and performance goals needed for commercialization of CSP technologies.

Objectives

The overall objective of this task is to develop, validate, and aid the commercialization of advanced reflector systems that can dramatically reduce the cost of concentrating solar power. The goal of the development activity is to identify a broad number of options for new reflector configurations and preparation processes for advanced reflector materials. The goal of the validation activity is to provide a means to screen candidate materials to objectively evaluate their potential for further consideration. The goal of the commercialization assistance activity is to help industry move materials that continue to offer promising optical durability through the manufacturing scale-up and field deployment stages of development so they can be handed off to industry for commercialization.

Approach

During FY00, our task will have three activities, each of which directly supports one element of the overall objective discussed above. The development of advanced reflector systems will be addressed by a new initiative that will involve university participation to provide guidance and R&D capabilities. To accomplish this we will convene a blue-ribbon panel of research experts. The panel will consist largely of professors from key universities that we would like to work with in the future plus a couple of participants from industry, a DOE participant, and an NREL participant. The panel will provide recommendations for program directions that will be used to generate a five-year plan for activities.

In support of the validation objective, a reliability testing activity will make use of our accelerated laboratory exposure chambers and our outdoor exposure testing sites to establish the durability of candidate advanced material constructions exposed to simulated and real-world environments. A regimen of qualification tests will be developed that will provide a metric to ascertain the promise of candidate advanced materials and to eliminate candidates that fail these screening tests from further consideration. One of our outdoor exposure testing sites (at Solar Two) will be decommissioned due to lack of on-site support and cost constraints associated with relocating the samples and equipment.

Regarding the commercialization objective, we currently have a very promising material that has been under subcontracted development for three years, namely, SAIC's (McLean, Virginia) "super-thin glass" mirror construction. To move this material closer to commercialization, we will have a manufacturing scale-up activity that will place another subcontract with SAIC to demonstrate its ability to produce super-thin glass mirrors in a roll-coated configuration. This will allow larger area test articles to be field-tested and increases the confidence and interest of prospective manufacturers in commercializing this technology. During FY00, SAIC will design, install, and optimize the operating conditions for a laboratory-scale roll-coater. In FY01, the roll-coater will be used to produce sufficient quantities of the super-thin glass material to use in production of structural facets for field deployment. The tests will be an important step forward in gaining further confidence in the use of this product.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
3.3.a	**Receive final report from university-led panel of experts on recommendations for conducting advanced materials development**	Jorgensen	Feb 00
3.3.b	**Design and implement reliability qualification tests to minimize early failures**	Jorgensen	Sep 00
3.3.c	**Complete testing of SAIC laboratory-scale roll-coater configuration**	Kennedy	Sep 00

3.4 Dish Component Development

Background

Significant technical advances in dish/engine components in the last few years are ready for demonstration applications in field systems for longer-term testing. The heat-pipe approach developed by Sun♦Lab is in need of long-term full-scale testing. This can be accomplished best on the automated Native American system with a SOLO engine. In addition, this greatly benefits the control and operation schemes envisioned for the non-grid-connected system.

The Ft. Huachuca system has many similarities to the Native American system, so reliability data collected on that system is applicable to the development of the Native American system. The system incorporates the advanced WG Associates control system, the SOLO Stirling engine, and the same drives. The mirror technology has failed at Ft. Huachuca. We have determined that the existing structure can support the next generation of structural facets, renewing the life of the system.

Objectives

We will complete at least 100 hours of integrated testing with an advanced heat pipe on the Native American system, demonstrating the performance and controls enhancements of this approach. We will complete at least 500 additional hours of operation at Ft. Huachuca. We will replace the membrane facets with structural facets, bringing the dish back to original specification operation of 7.5 kW.

Approach

We have a Thermacore-built heat pipe for the SOLO engine, which incorporates a Sun♦Lab-designed engine interface. We will initially adapt the current remote system to operate with this receiver by mounting the receiver on the spare engine and modifying the housing appropriately. After the Path 1 perforated-metal receiver test is completed, we will fabricate a perforated-metal receiver for the Native American system that incorporates the engine interface design (if successful) from the Thermacore heat pipe. The perforated-metal heat pipe will better fit the engine package, and will be used for long-term testing on the Native American system. This will enhance the performance of the system while accruing hours on a heat-pipe receiver.

We will continue to support the operation of the Ft. Huachuca system through technical advice, data reduction, and hands-on support as needed. We will implement our reliability database system (Path 1) to capture failures and repairs. We will work with WG Associates to incorporate the next-generation structural facets into the structure and provide hands-on engineering support to install, align, and tune the resulting system. Ft. Huachuca will provide $30,000 to fund the fabrication of the facets and other equipment. As appropriate, we will incorporate advanced reflective surfaces, such as SolarBrite, on some or all of the facets.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
3.4.a	**Begin integrated heat-pipe testing on the Native American system**	Andraka	Jan 00
3.4.b	**Regularly update reliability database with Ft. Huachuca operational data**	Diver	Mar 00 and quarterly
3.4.c	**Begin integrated perforated-felt heat-pipe testing with the Native American system** Depends on successful "real world" testing of the 75-kW perforated-felt heat pipe (Path 1) and successful testing of the Thermacore heat pipe (above) and availability of the system and engine.	Andraka	Apr 00
3.4.d	**Complete facet retrofit of Ft. Huachuca system**	Moss	Jun 00
3.4.e	**Complete 500 additional hours of testing on the Ft. Huachuca system**	Diver	Sep 00

3.5 Small Dish Systems

Background

An FY99 market assessment activity focused on identifying applications for remote CSP systems concluded that substantial market opportunities exist for systems with power outputs in the range of 0.5 to 3 kW. To date, all dish development activities have concentrated on systems ranging from 10 to 25 kW. This activity, a follow-on to the FY99 work, will focus on completing the conceptual design for a 5 to 10 m^2 dish and fabricating and testing critical components, such as drives and controls. The activity will be closely coordinated with the converter development activities with the intent of applying a converter to a second-generation small concentrator in FY01.

Objectives

- Complete the conceptual design of a proof-of-concept dish.
- Demonstrate the potential for the conceptual design to meet the cost target of $5/W system cost.
- Fabricate and test critical dish components.

Approach

Sun♦Lab staff will develop and document system specifications for a small dish concentrator based in part on data collected during the FY99 market requirement activity. The document will include all pertinent operational, performance, and safety specifications for the dish and will be used as the basis for completing an in-house conceptual design. Once the conceptual design has been completed, staff will proceed with fabrication and testing of critical design components.

Based on the system specification document and the conceptual design, staff will issue an RFP for the design and fabrication of small 5 to 10-m^2 dish/converter systems. The statement of work for the RFP will be coordinated with the converter development activity.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
3.5.a	**Complete system specifications document**	Mehos	Nov 99
3.5.b	**Complete system conceptual design for proof-of-concept dish**	Mehos	Feb 00

3.6 Concentrating PV

Background

Concentrating photovoltaic (CPV) converters have the potential to replace Stirling engines if a number of technical and economic issues can be solved. The cost issues can be partly mitigated by using cells capable of concentrations exceeding 500 suns. At these levels, the high unit cost of both current cell and anticipated new cell technologies become a reasonable part of the system cost. However, cooling the cells, particularly at concentrations greater than 500 suns, is a serious problem. New strategies based on semiconductor industry solutions can be studied to address this issue. Flux uniformity is also a serious issue that can significantly degrade array performance, in particular, for near-term cell options.

Objectives

The near-term objective of this effort is to demonstrate 15% solar-to-electric conversion efficiency for a currently available CPV prototype converter. A longer-term objective will be to demonstrate 25% efficiency for a small-scale system concept using advanced cell options.

This first-year effort in CPV technology will serve as a foundation for future collaborative development with the Photovoltaic Program. Initiation of an analytical effort will provide the opportunity to build on our CSP expertise and enhance our ability to move CPV forward rapidly. It is critical to the success of the effort to quickly move to experimental work in order to focus our understanding of the technical issues.

Approach

The Concentrating Solar Power Program will address these issues by conducting the following tasks:

- Develop a deeper understanding of both previous and current CPV projects and assess the near-term potential for new cell and concentrator technologies to address a range of market opportunities.
- Identify and analyze options for providing uniform flux to a CPV array over a range of concentrations (500 to 2,000), including fundamentally new concentrator designs and current designs with secondaries.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
3.6.a	**Complete report reviewing CPV history and status**	Menicucci	Mar 00
3.6.b	**Identify and select concepts to reduce flux variations to less than 5% over the cell array at intercept factors greater than 90%**	Lewandowski	Aug 00

3.7 Long-Term R&D

Background

The overall goal of long-term R&D within the program is to maintain avenues for introduction and exploration of new component and system concepts for use in CSP technologies. For the near term, this effort will continue the investigation of alternative converters (defined as anything but 25-kW kinematic Stirling) as options for both small-scale and larger-scale dish systems.

Objectives

Additional engine/converter options are needed to ensure future technical success of CSP dish concentrator technologies, including both small-scale and 25-kW systems. CSP will support the on-sun testing at the High-Flux Solar Furnace of converters from CFIC (thermoacoustic) and Edtek (thermophotovoltaic) by continuing FY99 subcontracted efforts. The Concentrating Solar Power Program will also assist the Golden Field Office in preparing a university solicitation for new conversion concepts.

Approach

The Concentrating Solar Power Program will address these issues by conducting the following tasks:

- Continue testing support of small-scale converters (CFIC and Edtek) and demonstrate 15% solar-to-electric conversion efficiency for at least one prototype.
- NREL will issue an RFP, directed to industry, for new and innovative converter concepts. This RFP will be coordinated with the small dish system activity.
- Assist the Golden Field Office as necessary in preparing RFP for university solicitation.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
3.7.a	**Issue industry RFP for converter development**	Lewandowski	Jan 00
3.7.b	**Complete on-sun testing of Edtek thermophotovoltaic converter**	Lewandowski	Mar 00
3.7.c	**Complete on-sun testing of CFIC thermoacoustic engine**	Lewandowski	Apr 00
3.7.d	**Document go/no-go decision on follow-on activities for long-term R&D contracts**	Lewandowski	Jun 00

H. HEADQUARTERS PROGRAM SUPPORT

H.1 CSPEAC

Background

The Concentrating Solar Power Program is interested in establishing an ongoing set of external peer reviews for the operation of the program. The Concentrating Solar Power Executive Advisory Committee (CSPEAC) or similar group (depending on applicable regulations) will provide a fresh perspective on program operations that will aid Sun•Lab in providing the highest quality technical service for the DOE.

Objectives

The objective of CSPEAC is to provide alternative perspectives on key issues, tapping into expertise and insights that don't exist within the program. Such feedback will be useful in management and operations of laboratory activities and in developing new strategic thrusts.

Approach

To carry out its mission, CSPEAC will be exposed to a broad array of high-level interactions on the Concentrating Solar Power Program. CSPEAC will act as "friendly critics" for the program, questioning and raising debates on key program issues, but maintaining confidentiality on problem areas until they are resolved. Specific activities of CSPEAC will vary depending on program needs but generally include the following:

- Provide independent review and critique of CSP strategy, goals, balance and directions.
- Review recommended innovative research directions and potential partners.
- Evaluate program progress toward meeting goals by laboratories and industry partners.
- Assess the strength and value of the program to DOE and the nation and provide recommendations for improving these characteristics.
- Identify promising opportunities for CSP research, development, and deployment.
- Assess program management practices and provide recommendations for improvement.
- Assist in identifying and evaluating opportunities for strategic partnerships.

CSPEAC is a peer-review body. It will make recommendations and observations but has no governing authority with respect to the DOE program or Sun•Lab. Sun•Lab staff will provide assistance to DOE as needed in the formation and operation of CSPEAC.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
H.1.a	**Complete draft charter and identify CSPEAC candidates**	Williams	Nov 99

H.2 SolarPACES

Background

The International Energy Agency's CSP working group, SolarPACES, is a mechanism for international information-, task-, and cost-sharing of CSP technologies and projects among its 13 member countries. It has been a mechanism for leveraging our CSP investments internationally for many years.

Objectives

Our objectives within SolarPACES are to keep abreast of advances in CSP technologies and opportunities for major CSP projects worldwide; and to share tasks and costs of major CSP activities on a mutually beneficial basis with other SolarPACES-member CSP programs.

Approach

We will participate in SolarPACES activities by

- Leading key SolarPACES activities (as operating agents and sector leaders) to ensure beneficial direction of key activities;
- Supporting SolarPACES START missions and related activities to potential market countries; and
- Implementing cooperative projects (remote dish, engine exchange, etc.) that meet our program objectives and leverage our resources.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
H.2.a	**Complete SolarPACES Task I Program of Work and Annual Report Input**	Tyner	Feb 00

H.3 Communications

Background

The Communications team transmits and assists technical staff in transmitting information about CSP to the solar community, to our DOE sponsor, to industry, and to the general public. Sun♦Lab staff routinely participates in technical conferences and publishes technical reports and papers, and the Communications team assists with this effort. The team maintains an active and detailed site on the Internet, including a photo database and library of publications. In addition, the team prepares communication products to promote and increase awareness of the possibilities that CSP brings to the energy supply of the nation and the world.

Objectives

The major objective for the Sun♦Lab Communications team is to create effective communication products for the Concentrating Solar Power Program, such as publications, exhibits, and Internet pages. The team works with Sun♦Lab management and staff to create these products to provide information about the mission, policy, technologies, and research of the program. The team includes industry partners as appropriate in creating these materials.

Approach

We will create, produce, and update SnapShots and other printed materials about technical accomplishments, market assessments, and goals and successes of the Concentrating Solar Power Program, develop and produce exhibits and supporting materials, and study effective means to release information on the Internet in a timely fashion as needs arise. We will not only supply requested communication products and support for management and staff, but also will suggest effective ways to approach those needs. The team will take an active role in publicizing CSP through the media and will supply supporting materials to those seeking to make CSP well known. For FY00, the CSP Management team agreed to eliminate production of the quarterly progress report to cut costs. A web-based milestone tracking activity will be implemented instead.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
H.3.a	**Initiate web-based milestone review system and assess progress quarterly**	Tyner	Jan 00 and quarterly
H.3.b	**Update CSP electronic document database to include both abstracts and (unless unavailable) full papers**	Van Arsdall	Mar 00 for FY99; Sep 00 for FY98-95

H.4 Earth Day 2000

Background

April 22, 2000, will be the 30th Anniversary of Earth Day—the annual event that celebrates and promotes, among other things, sustainability, ecology, and renewable energy. The event will be held in Washington, D.C., and is expected to be a more-encompassing event than in previous years.

Objectives

This is an excellent opportunity for the Concentrating Solar Power Program to provide information to the public, policy makers, and industry about CSP technology. In the past, we have identified a few events, such as this, each year at which to exhibit and explain the technology.

Approach

We will negotiate a contract with Kramer Junction Company to ship and exhibit its LS-trough display at Earth Day 2000. This activity will also be supported with a booth exhibit and interactive, educational displays.

Milestones/Metrics

Activity	Milestone Description	Responsible Individual	Expected Completion
H.4.a	**Provide high-visibility CSP display at Earth Day 2000 in Washington, D.C.**	Lowrey	Apr 00

Milestones/Metrics Summary (by date)

Activity	Milestone Description	Responsible Individual	Expected Completion
3.1.1.a	Provide ES&H incidence-free facilities operation in support of CSP testing	Kolb, W. and A. Lewandowski	On going
1.4.a	Complete a 50-hour, fault-free, reliability demonstration of the grid-connected system	Diver	Nov 99
3.1.2.a	Complete first technical tours and training sessions for Eskom project manager	Williams	Nov 99
3.2.a	Complete fabrication and evaluation of prototype structural facets for Ft. Huachuca	Grossman	Nov 99
3.5.a	Complete system specifications document	Mehos	Nov 99
H.1.a	Complete draft charter and identify CSPEAC candidates	Williams	Nov 99
1.2.a	Begin "real-world" testing of a perforated-metal heat-pipe receiver	Andraka	Dec 99
1.4.b	Initiate unattended operation of the prototype grid-connected system	Diver	Dec 99
1.4.c	Initiate design of the second-generation dish/Stirling system	Diver	Dec 99
1.5.a	Document reliability methodology	Mehos	Dec 99
2.1.1.a	Review and analyze MWE Associates' subcontract results on current HCE failures	Mahoney	Dec 99
2.3.a	Complete study on optimum heliostat size	Jones, S.	Dec 99
3.2.b	Complete Phase 2 cost projections of the Winsmith "low-cost" drive	Grossman	Dec 99
1.4.d	Sign agreement(s) with Native American application partner(s)	Menicucci	Jan 00
2.1.2.a	Implement MOU with operating company to host test	Price	Jan 00
2.1.4.a	Identify O&M issues for each SEGS facility and prioritize and focus effort on those that are most important for future CSP plants	Mahoney	Jan 00
2.1.5.a	Distribute quarterly status newsletter	Price	Jan 00 and quarterly
3.4.a	Begin integrated heat-pipe testing on the Native American system	Andraka	Jan 00
3.7.a	Issue industry RFP for converter development	Lewandowski	Jan 00
H.3.a	Initiate web-based milestone review system and assess progress quarterly	Tyner	Jan 00 and quarterly
1.3.a	Start operation of second full dish/Stirling system	Mancini	Feb 00
1.5.b	Complete web-based database	Mehos	Feb 00
2.1.2.b	Finalize initial torque-box concentrator design	Price	Feb 00
2.2.3.a	Document evaluation of C4 Technologies' proprietary coatings for optical properties, thermal stability, and assess potential for parabolic trough applications	Mahoney	Feb 00
3.3.a	Receive final report from university-led panel of experts on recommendations for conducting advanced materials development	Jorgensen	Feb 00
3.5.b	Complete system conceptual design for proof-of-concept dish	Mehos	Feb 00
H.2.a	Complete SolarPACES Task I Program of Work and Annual Report Input	Tyner	Feb 00

Activity	Milestone Description	Responsible Individual	Expected Completion
H.3.b	**Update CSP electronic document database to include both abstracts and (unless unavailable) full papers**	Van Arsdall	Mar 00 for FY99; Sep 00 for FY98-95
1.1.a	**Regularly update reliability database with SAIC operational data**	Mehos	Mar 00 and quarterly
1.2.b	**Begin operation of the multiple-device durability test rig**	Andraka	Mar 00
1.3.b	**Negotiate and place Phase 2 contract**	Mancini	Mar 00
1.3.c	**Regularly update reliability database with Boeing operational data**	Mancini	Mar 00 and quarterly
1.4.e	**Regularly update reliability database with remote system operational data**	Diver	Mar 00 and quarterly
2.1.5.b	**Establish testing MOUs with SEGS operating companies**	Price	Mar 00
3.1.2.b	**Complete written recommendations on technologies to evaluate in CSP-Africa study**	Williams	Mar 00
3.1.3.a	**Complete systems analyses in support of the Spencer Management trough plant feasibility study in Mexico**	Kolb, G.	Mar 00
3.2.c	**Ship 200+ structural facets to SEGS**	Grossman	Mar 00
3.4.b	**Regularly update reliability database with Ft. Huachuca incident data**	Diver	Mar 00 and quarterly
3.6.a	**Complete report reviewing CPV history and status**	Menicucci	Mar 00
3.7.b	**Complete on-sun testing of Edtek thermophotovoltaic converter**	Lewandowski	Mar 00
2.2.2.a	**Define and document generic cost and performance goals for advanced thermal storage systems**	Hale	Apr 00
2.2.4.a	**Review manufacturing methods and processes of current HCE and determine baseline costs**	Mahoney	Apr 00
3.1.4.a	**Complete final dish roadmap package**	Mehos	Apr 00
3.4.c	**Begin integrated perforated-felt heat-pipe testing with the Native American system**	Andraka	Apr 00
3.7.c	**Complete on-sun testing of CFIC thermoacoustic engine**	Lewandowski	Apr 00
H.4.a	**Provide high-visibility CSP display at Earth Day 2000 in Washington, D.C.**	Lowrey	Apr 00
1.1.b	**Achieve 70% availability for one month for one Arizona system**	Mehos	May 00
2.1.2.c	**Deliver collector hardware to site for first collector**	Price	May 00
2.2.1.a	**Initiate laboratory-scale testing**	Pacheco	May 00
2.3.b	**Complete design basis document**	Pacheco	May 00
1.2.c	**Complete fabrication and test cell preparation for a full-scale hybrid heat-pipe receiver**	Moreno	Jun 00
1.4.f	**Complete design of the second-generation dish/Stirling system**	Diver	Jun 00
2.1.1.b	**Document collaboration with SEGS facilities to develop new and improved evacuated HCE by investigating materials, manufacturing methods, and other relevant issues**	Mahoney	Jun 00
2.1.3.a	**Place new (second phase) FY00 USA Trough contracts**	Price	Jun 00
2.1.6.a	**Complete validation of TRNSYS models for 30- and 80-MW SEGS plants**	Jones, S.	Jun 00

Activity	Milestone Description	Responsible Individual	Expected Completion
2.2.3.b	**Document evaluation of IST Black Nickel coating, with Sun•Lab improvements, at parabolic trough operating temperatures**	Mahoney	Jun 00
2.2.3.c	**Document surface protection efforts on Black Crystal coating, including evaluation of long term thermal stability and assessment potential for parabolic trough applications**	Mahoney	Jun 00
3.4.d	**Complete facet retrofit of Ft. Huachuca system**	Moss	Jun 00
3.7.d	**Document go/no-go decision on follow-on activities for long-term R&D contracts**	Lewandowski	Jun 00
1.3.d	**Start engine testing in Boeing test cell**	Mancini	Jul 00
2.1.2.d	**Initiate operational testing of first collector**	Price	Jul 00
2.2.1.b	**Complete the near term portion of the report documenting Sun•Lab assessment of thermal storage options for trough technology**	Hale	Jul 00
2.2.3.d	**Develop and install prototype low-cost HCEs in SEGS solar fields**	Mahoney	Jul 00
2.2.4.b	**Determine the feasibility, manufacturability, and potential economic impacts of new low-cost receiver concepts and/or designs**	Mahoney	Jul 00
3.2.d	**Summarize VSHOT enhancements**	Wendelin	Jul 00
1.2.d	**Complete on-ground testing of the full-scale hybrid heat-pipe receiver**	Moreno	Aug 00
1.3.e	**Initiate bench testing of next-generation engine**	Mancini	Aug 00
1.3.f	**Start operation of third dish/Stirling system**	Mancini	Aug 00
2.1.1.c	**Procure new, modified HCEs (approximately 200 tubes) for solar field validation testing**	Mahoney	Aug 00
3.6.b	**Identify and select concepts to reduce flux variations to less than 5% over the cell array at intercept factors greater than 90%**	Lewandowski	Aug 00
1.2.e	**Complete preparations for and begin on-sun testing of hybrid heat-pipe receiver**	Moreno	Sep 00
1.4.g	**Demonstrate a non-grid-connected water-pumping system at the NSTTF**	Diver	Sep 00
2.1.2.e	**Finalize torque-box collector design for loop**	Price	Sep 00
2.1.3.b	**Place follow-on (to first phase) USA Trough contracts**	Price	Sep 00
2.1.4.b	**Complete report assessing performance, financial impact, and benefits to future CSP plant operations of selected O&M issues and solutions**	Mahoney	Sep 00
2.1.6.b	**Complete simplified trough plant spreadsheet model with integrated cost, performance, and finance modules for industry use with baseline data**	Price	Sep 00
2.2.1.c	**Complete interim report on trough thermal storage testing**	Pacheco	Sep 00
2.2.1.d	**Complete thermal storage design specification for FY01 prototype field test**	Pacheco	Sep 00
2.2.2.b	**Complete the advanced storage portion of the report documenting Sun•Lab assessment of thermal storage options for trough technology**	Blake	Sep 00

Activity	Milestone Description	Responsible Individual	Expected Completion
2.2.3.e	**Document assessment of current cermet coating to determine probable degradation mechanisms, investigate methods of improving coating durability, if needed, and look for methods to reduce production costs**	Mahoney	Sep 00
2.2.3.f	**Place contract with Surface Optics, Inc. to perform optical modeling to design a solar-selective absorber pigment with acceptable optical properties and thermal stability**	Mahoney	Sep 00
2.3.c	**Complete final Solar Two evaluations and documentation**	Pacheco	Sep 00
2.2.4.c	**Begin building, testing, and evaluating candidate prototype HCE designs**	Mahoney	Sep 00
3.1.2.c	**Evaluate Eskom's interest in CSP through discussions with its management**	Williams	Sep 00
3.1.3.b	**Update systems analyses contained within DOE's trough and tower technology characterizations to reflect current status**	Kolb, G.	Sep 00
3.2.e	**Complete the Winsmith "low-cost" drive cost reduction study**	Grossman	Sep 00
3.3.b	**Design and implement reliability qualification tests to minimize early failures**	Jorgensen	Sep 00
3.3.c	**Complete testing of SAIC laboratory-scale roll-coater configuration**	Kennedy	Sep 00
3.4.e	**Complete 500 additional hours of testing on the Ft. Huachuca system**	Diver	Sep 00
1.1.c	**Achieve 90% availability for one month for all three Arizona systems**	Mehos	Nov 00
1.1.d	**Document go/no-go decision for continuation of SAIC dish/Stirling project, depending on progress**	Mehos	Nov 00
2.1.2.f	**Initiate operational testing of collector loop**	Price	FY01

Program Milestones/Metrics Summary

Activity	Milestone Description	Responsible Individual	Expected Completion
1.1.c	Achieve 90% availability for one month for all three Arizona systems	Mehos	Nov 00
1.2.a	Begin “real-world” testing of a perforated-metal heat-pipe receiver	Andraka	Dec 99
1.2.d	Complete on-ground testing of the full-scale hybrid heat-pipe receiver	Moreno	Aug 00
1.3.a	Start operation of second full dish/Stirling system	Mancini	Feb 00
1.4.a	Complete a 50-hour, fault-free, reliability demonstration of the grid-connected system	Diver	Nov 99
1.4.b	Initiate unattended operation of the prototype grid-connected system	Diver	Dec 99
1.4.g	Demonstrate a non-grid-connected water-pumping system at the NSTTF	Diver	Sep 00
1.5.b	Complete web-based database	Mehos	Feb 00
2.1.1.c	Procure new, modified HCEs (approximately 200 tubes) for solar field validation testing	Mahoney	Aug 00
2.1.2.d	Initiate operational testing of first collector	Price	Jul 00
2.1.4.b	Complete report assessing performance, financial impact, and benefits to future CSP plant operations of selected O&M issues and solutions	Mahoney	Sep 00
2.1.6.b	Complete simplified trough plant spreadsheet model with integrated cost, performance, and finance modules for industry use with baseline data	Price	Sep 00
2.2.1.b	Complete the near term portion of the report documenting Sun•Lab assessment of thermal storage options for trough technology	Hale	Jul 00
2.2.1.d	Complete thermal storage design specification for FY01 prototype field test	Pacheco	Sep 00
2.2.2.b	Complete the advanced storage portion of the report documenting Sun•Lab assessment of thermal storage options for trough technology	Blake	Sep 00
2.2.3.d	Develop and install prototype low-cost HCEs in SEGS solar fields.	Mahoney	Jul 00
2.3.c	Complete final Solar Two evaluations and documentation	Pacheco	Sep 00
3.1.2.b	Complete written recommendations on technologies to evaluate in CSP-Africa study	Williams	Mar 00
3.1.3.b	Update systems analyses contained within DOE’s trough and tower technology characterizations to reflect current status	Kolb, G.	Sep 00
3.1.4.a	Complete final dish roadmap package	Mehos	Apr 00
3.2.c	Ship 200+ structural facets to SEGS	Grossman	Mar 00
3.3.c	Complete testing of SAIC laboratory-scale roll-coater configuration	Kennedy	Sep 00
3.4.a	Begin integrated heat-pipe testing on the Native American system	Andraka	Jan 00
3.4.e	Complete 500 additional hours of testing on the Ft. Huachuca system	Diver	Sep 00
3.5.b	Complete system conceptual design for proof-of-concept dish	Mehos	Feb 00
H.3.a	Initiate web-based milestone review system and assess progress quarterly	Tyner	Jan 00 and quarterly

FY00 CSP Budget Summary

FY00 Budget

12/09/99 Final for AOP

	WBS	Sandia FTE$	Sandia Purchases	Sandia R&D Contr	Sandia Total	NREL FTE$	NREL Purchases	NREL R&D Contr	NREL Total	DOE Org	DOE Total	CSP FTE$	CSP Purchases	CSP R&D Contr	CSP Total
Concentrating Solar Power Total		**4452**	**2065**	**370**	**6886**	**2090**	**438**	**4896**	**7424**		**1100**	**6542**	**2503**	**6366**	**15410**
Path 1. Distributed Power		**1646**	**320**	**80**	**2046**	**267**	**21**	**2700**	**2988**		**0**	**1913**	**341**	**2780**	**5034**
SAIC O&M and Eng Development	1.1	35	6	0	41	90	6	1850	1946		0	125	12	1850	1987
25kW Receiver R&D	1.2	850	150	0	1000	10	0	75	85		0	860	150	75	1085
DECC Activities	1.3	60	0	0	60	35	0	775	810		0	95	0	775	870
Native American System	1.4	563	149	80	792	0	0	0	0		0	563	149	80	792
Reliability Improvement	1.5	138	15	0	153	132	15	0	147		0	270	30	0	300
Path 2. Dispatchable Power		**1967**	**881**	**155**	**3003**	**940**	**207**	**1436**	**2583**		**0**	**2907**	**1088**	**1591**	**5586**
Trough Technology	2.1	375	110	125	610	567	190	1176	1933		0	942	300	1301	2543
Trough R&D	2.2	675	581	0	1256	264	10	260	534		0	939	591	260	1790
Power Tower Technology	2.3	917	190	30	1137	109	7	0	116		0	1026	197	30	1253
Path 3. Adv Components/Systems		**724**	**749**	**135**	**1607**	**828**	**175**	**695**	**1698**		**500**	**1552**	**924**	**1330**	**3805**
System Analysis & Field Operations	3.1	293	582	0	875	120	55	25	200		0	413	637	25	1075
Concentrators	3.2	221	70	125	416	55	15	25	95		200	276	85	350	711
Advanced Materials	3.3	0	0	0	0	276	70	190	536		0	276	70	190	536
Dish Component Development	3.4	124	87	10	220	9	0	0	9		0	133	87	10	229
Small Dish Systems	3.5	40	5	0	45	205	25	260	490		100	245	30	360	635
Concentrating PV	3.6	46	5	0	51	105	10	95	210		0	151	15	95	261
Long-Term R&D	3.7	0	0	0	0	58	0	100	158		200	58	0	300	358
HQ Holdback		**115**	**115**	**0**	**230**	**55**	**35**	**65**	**155**		**600**	**170**	**150**	**665**	**985**
Front Office		0	0	0	0	0	0	0	0	HQ	600	0	0	600	600
Program		115	115	0	230	55	35	65	155		0	170	150	65	385

SPECIFIED DISSEMINATION ONLY

DOE/EE

G. Burch

T. Rueckert

G. Strahs

J. Kern

DOE/AL

D. Sanchez

DOE/GO

F. Stewart

R. Martin

NREL

S. Bull

B. Garrett

R. Hulstrom

C. Warner

T. Williams (20)

Sandia

S. Varnado

M. Tatro

C. Cameron

J. Gee

J. Chavez

J. Tillerson (12)

C. Tyner (50)