

BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Subcommittee On Energy ~~GAO/RCED-83-120~~

Development And Applications 12/1/85

Committee On Science And Technology

House Of Representatives

**Prospects For Continued Operation Of DOE's
Solar Test Facilities And Selected Aspects Of Its
Solar Project Closeouts**

The Department of Energy (DOE) has constructed and operated several solar test facilities and projects aimed at advancing the development of solar energy. The subcommittee requested GAO to examine the prospects for DOE's continued operation of five of these solar test facilities and to determine the extent to which DOE will recover its investment and complete data collection activities associated with solar energy projects it is now closing out.

GAO found that:

- DOE will continue operating the test facilities in fiscal year 1983 and that funding for four of these facilities is anticipated for fiscal year 1984.
- DOE is taking steps to protect the Federal investment in solar projects being closed out. Little, if any, funds are expected to be recovered, but data collection activities will be completed for most projects.





UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION

B-211141

The Honorable Don Fuqua, Chairman
Subcommittee on Energy Development
and Applications
Committee on Science and Technology
House of Representatives

The Honorable Hamilton Fish, Jr.
Ranking Minority Member
Subcommittee on Energy Development
and Applications
Committee on Science and Technology
House of Representatives

In response to your letter dated June 7, 1982, we examined the Department of Energy's (DOE's) plans for continuing Federal solar test facilities and for closing out projects supported under its solar energy program. As expressed in your letter and further clarified in discussions with your office, the subcommittee was concerned that congressional options on the funding of solar energy research and development may be foreclosed if solar test facilities are shut down. Also, the subcommittee was concerned whether DOE was adequately protecting the Government's financial and data collection interests in the solar energy projects it is closing out.

As agreed with your office, we limited our work to the solar photovoltaic, solar thermal, and wind energy technology areas.¹ examining 5 test facilities and 39 projects in these

¹The solar photovoltaic (conversion of sunlight directly into electricity), solar thermal (conversion of sunlight into thermal energy to produce heat or electricity), and wind energy (conversion of wind, an indirect form of solar energy, into electricity or mechanical energy) technology areas constitute the major portion of DOE's solar program.

technology areas,² and to providing information on the following questions:

--What are the prospects for continued operation of the test facilities through fiscal year 1983?

--To what extent does DOE expect to recover the Federal funds expended and complete the data collection activities associated with the solar energy projects that are being closed out?

We found that the five test facilities will continue operations through fiscal year 1983, and DOE plans to fund operation of all facilities except the Parabolic Dish Test Site in fiscal year 1984. For the solar projects being closed out by DOE, little of the expended funds are expected to be recovered, but completion of data collection activities is expected for most projects.

A brief summary of the results of our review is discussed below. Appendix I contains our objectives, scope, and methodology. The details of our review are in appendix II. Appendix III provides the description and mission of the solar test facilities reviewed. Appendix IV contains a detailed listing of the solar projects covered, their cost, disposal status, and data collection plans.

DOE has constructed and operated several solar energy test facilities and numerous projects to advance the objectives of its solar energy program. The test facilities carry out experiments in a laboratory environment using new designs and concepts to test hardware, solve technological problems, and to verify performance of subsystems and components. The solar projects show the technical feasibility of various solar systems in actual residential, commercial, and industrial applications, and, more importantly, serve as a mechanism for obtaining performance, reliability, and other data, which can be used to guide Federal and private sector research efforts.

²The test facilities we were requested to examine are the Central Receiver Test Facility in Albuquerque, New Mexico; the Advanced Components Test Facility in Atlanta, Georgia; the Parabolic Dish Test Site at Edwards Air Force Base, California; the MOD-0 Wind Turbine in Sandusky, Ohio; and the Small Wind Systems Test Center at Rocky Flats, Colorado. These test facilities relate to the solar thermal and wind energy technology areas. The 39 projects we examined relate to all three technology areas.

Recently, however, DOE has been redirecting its program and level of research and development (R&D) efforts in all solar technology areas, including the operation of its test facilities and projects. The current administration believes that the Federal Government's emphasis should be on long-term, high-risk R&D activities with high-payoff potential and away from demonstration and commercialization activities. DOE's test facilities and solar projects deal primarily with testing and research activities relating to existing technologies as opposed to long-term, high-risk R&D activities. Therefore, DOE did not specify any funding for the continued operation of its various solar test facilities in its fiscal year 1983 budget request, and DOE has initiated an effort to closeout its solar energy projects.

Although DOE did not specify any funding in its fiscal year 1983 budget request for the continued operation of its solar test facilities, funding for all five test facilities is now being provided in fiscal year 1983. DOE had originally intended to provide fiscal year 1983 R&D funding to only two of these facilities. However, due to the recently passed continuing resolution for fiscal year 1983, the funding of all five facilities is now being continued. Further, DOE now plans to continue funding four of these five test facilities in fiscal year 1984. Funding for the Parabolic Dish Test Site, however, is not included in DOE's fiscal year 1984 budget request and DOE expects to terminate this facility's operation after the end of fiscal year 1983.

Regarding the solar energy projects, DOE is now closing out these projects and has established a task force to expedite this process. In this closeout effort, DOE expects to recover little, if any, of the related Federal investment. Of the 39 projects examined, DOE is precluded from recovering funds on 25 projects because (1) on 19 projects, DOE does not have title to the solar energy system, and therefore no potential for the recovery of funds invested exists; (2) in three instances, DOE undertook the projects with another Federal agency, and under Federal Property Management Regulations, agency-to-agency property transfers are accomplished at no cost; and (3) on three other projects DOE closed out, it found that no funds were recoverable because the projects had little or no commercial value. Of the remaining 14 projects, DOE does not expect to recover any funds because the projects have little commercial value, and any salvage value would be offset by the cost to dismantle the systems' equipment and components and restore the project sites to their original condition. Consequently, when applicable, DOE is attempting to reduce its costs by transferring project title to the participants involved in the projects, thereby permitting the projects to continue operating and, in turn, freeing DOE from the costs of restoring the project sites.

DOE's closeout of its solar energy projects will not adversely affect planned data collection activities on most projects. Over 85 percent of the projects we reviewed have either completed or are expected to complete their planned data collection activities or, in a few cases, the projects have been ended early for reasons not related to the project closeout activities. However, on two projects--the Central Receiver Pilot Plant and the MOD-2 wind machines--DOE may reduce its data collection activities, and on three other projects--the Georgetown University and Sacramento Municipal Utility District photovoltaic projects and the Small Community Solar Thermal Power Experiment--DOE has no funding or specific plans for data collection. Although some data may ultimately be obtained on each of these five projects through limited DOE and/or contractor efforts, the full completion of planned data collection activities on these projects remains uncertain.

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We did not obtain agency comments on this report. However, we did discuss its contents with the principal Deputy Assistant Secretary for Conservation and Renewable Energy and with officials in charge of DOE's solar photovoltaic, solar thermal, and wind energy technology areas. We incorporated their comments where appropriate. We are sending copies of this report to the Chairmen, House Committee on Energy and Commerce and the House and Senate Committees on Appropriations; the Secretary of Energy; and other interested parties. We will also make copies available to others upon request.

J. Dexter Peach
J. Dexter Peach
Director

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ABBREVIATIONS

DOE	Department of Energy
GAO	General Accounting Office
R&D	research and development

OBJECTIVES, SCOPE, AND METHODOLOGY

The objectives of our review were to examine DOE's activities and plans relating to its solar test facilities and projects and provide information on the issues of concern to the Chairman and Ranking Minority Member of the Subcommittee on Energy Development and Applications, House Committee on Science and Technology. We focused our review on determining DOE's current plans for continued operation of its solar test facilities in fiscal year 1983 and on assessing the extent to which expended Federal funds will be recovered and planned project data collection activities completed for those solar projects that are being closed out.

To accomplish these objectives, we obtained information on the test facilities and projects related to DOE's photovoltaic, solar thermal, and wind energy technology areas, as well as the status of, and the rationale for, its current project closeout activities. We limited our work to these three technology areas, which account for over two-thirds of DOE's past solar program funding, at the request of the subcommittee. We conducted our work primarily at DOE headquarters in Washington, D.C., and at DOE's Operations Office in Albuquerque, New Mexico. We interviewed DOE headquarters officials responsible for carrying out work in the photovoltaic, solar thermal, and wind energy areas, and officials serving on DOE's project closeout task force. Additionally, we discussed project disposal activities with officials from DOE's Office of Project and Facilities Management and Office of Policy who are responsible for the disposition of real and personal property acquired in the conduct of DOE activities. We also interviewed those officials of DOE's Albuquerque Operations Office responsible for the development and implementation of the majority of the solar project closeout plans and for the operation of DOE solar test facilities. We obtained and examined past and current budgets, program plans, and other DOE documents relating to the various solar energy programs and their objectives.

In addition, we visited each of the five test facilities we were asked to examine. These facilities are the Central Receiver Test Facility in Albuquerque, New Mexico; the Advanced Components Test Facility in Atlanta, Georgia; the Parabolic Dish Test Site at Edwards Air Force Base, California; the MOD-0 Wind Turbine in Sandusky, Ohio; and the Small Wind Systems Test Center at Rocky Flats, Colorado. We discussed with officials at each facility the purpose and past activities of the facility, their fiscal year 1983 plans and anticipated funding levels, the impact of the anticipated funding levels on their ability to conduct testing activities, and their long-range expectations for the facility. We obtained and reviewed relevant documents

on the facilities' objectives, achievements, and relationships to the overall DOE solar program.

Further, we selected and examined DOE records on 39 of the 56 photovoltaic, solar thermal, and wind energy projects being closed out by DOE.³ We selected these projects in June 1982, concentrating our work on those with the highest Federal cost. The Federal funding for the projects examined totaled \$367 million, or 93 percent of the total amount spent or authorized for all 56 projects in the three solar energy technology areas. We examined the records to determine DOE's plans for closeout of the projects, and the projects' planned and expected data gathering activities. We also visited 9 of the 39 projects and 2 DOE contractors responsible for 3 other projects to confirm information obtained from DOE and to determine the affects of the project closeouts. The projects visited were selected based on (1) known DOE closeout plans, which provided a point of reference for our visit and discussions with project representatives; (2) ease of geographic accessibility to our staffs in Washington, D.C., and Albuquerque, New Mexico; and (3) the technology used in order to ensure coverage of the three solar technologies included in our review. Our review was performed in accordance with generally accepted government audit standards.

³There are many ways to count DOE's solar projects. DOE lists 38 projects in its records, yet there are over 300 separate locations for these projects. For our purposes, we have counted each solar application in a group of related solar applications, with an average cost of \$1 million or more, as separate projects (e.g. the four MOD-OA wind turbines, costing \$15 million, are counted as four separate projects, whereas DOE counts this as one project).

PROSPECTS FOR CONTINUED OPERATION
OF DOE'S SOLAR TEST FACILITIES AND
SELECTED ASPECTS OF ITS SOLAR PROJECT CLOSEOUTS

DOE had conducted numerous R&D efforts in the development of solar photovoltaic, solar thermal, and wind energy technologies. These efforts were undertaken to improve the performance, reduce the costs, and remove other barriers impeding the commercial use of these technologies. DOE's eventual goal was to develop technologies that were economical and ready for widespread use.

Included in these R&D efforts were the construction and operation of several solar test facilities and the funding of solar energy projects. According to DOE solar program officials, these test facilities and projects fill a crucial role in the solar energy development process by performing the following missions:

- Solar test facilities carry out experiments in a laboratory environment using new designs and concepts to improve existing technology. These facilities perform research activities, test hardware, identify and solve technological problems, and verify the performance of subsystems and components.
- Solar projects show the technical feasibility of various solar technologies in actual residential, commercial, and industrial applications. These projects follow the testing activities, and although they are not intended to be economical, they provide a mechanism for giving solar technology public visibility and for obtaining performance, reliability, and other data.

Recently, DOE has changed its approach toward the development of solar energy technologies. Under past administrations, DOE supported solar energy development activities through the commercialization stage. However, with the current administration's philosophy that the Government's emphasis should be on long-term, high-risk R&D activities with high-potential payoff and away from near-term research, demonstration, and commercialization activities, DOE has been reducing its funding and level of R&D efforts in all solar technology areas. Overall, solar funding has dropped from \$472 million appropriated in fiscal year 1981 to \$257 million appropriated in fiscal year 1982. DOE's fiscal year 1983 budget request contained \$72 million for solar energy R&D, reflecting DOE's intention to further reduce solar energy funding. However, DOE has recently been appropriated \$202 million for solar energy R&D in fiscal year 1983.

In response to the administration's philosophy regarding Federal support of R&D and the resulting reduced budgets for solar energy development, DOE had been redirecting its program away from the construction and operation of test facilities and projects to funding activities related primarily to long-term research. DOE's fiscal year 1983 budget request did not specify any direct funding for the operation of its various solar test facilities. Additionally, DOE has initiated an effort to close-out its solar energy projects and has established a task force to expedite the closeout process.

SOLAR TEST FACILITIES: OPERATIONS
TO CONTINUE THROUGH FISCAL YEAR 1983

Although DOE was planning to limit its fiscal year 1983 funding to two of the five solar energy test facilities, the five facilities are now to continue operating with fiscal year 1983 funds. Under the terms of the continuing resolution that provides DOE's appropriation for fiscal year 1983, funding is being provided to all five test facilities. Beyond fiscal year 1983, DOE is planning to continue funding four of the five facilities. Funding for the Parabolic Dish Test Site is expected to be terminated at the end of fiscal year 1983.

The five test facilities have conducted a wide range of testing and research experiments, and according to the directors of DOE's solar thermal and wind energy technology areas, these five facilities represent DOE's major test efforts in their respective areas. These facilities and their missions are

- the Central Receiver Test Facility in Albuquerque, New Mexico, which primarily tests and evaluates central receiver⁴ components and systems;
- the Advanced Components Test Facility in Atlanta, Georgia, which is used to test new solar thermal concepts and technologies;
- the Parabolic Dish Test Site at Edwards Air Force Base, California, which is used to test high-temperature parabolic dish⁵ concentrator systems and components;

⁴A type of concentrating solar thermal power system in which a single, tower-mounted receiver is heated by the solar rays reflected from a field of independent tracking mirrors.

⁵A type of solar thermal power system in which a receiver is heated by solar rays reflected from a concentrating collector in the shape of a dish.

--the MOD-0 Wind Turbine in Sandusky, Ohio, which is used to provide operation and performance data on large wind turbines and components; and

--the Small Wind Systems Test Center at Rocky Flats, Colorado, which is used to test small wind system components and prototypes as well as commercially available machines.

A detailed description of each facility and its activities is included in appendix III.

Prior to fiscal year 1983, DOE had planned to reduce its financial support for these test facilities. DOE's fiscal year 1983 budget request did not specify any direct funding for these facilities, and according to DOE solar program officials and representatives of the test facilities, only the Advanced Components Test Facility and the MOD-0 Wind Turbine were to receive fiscal year 1983 R&D funds from DOE. The Central Receiver Test Facility and the Parabolic Dish Test Site were to be supported at a reduced level with fiscal year 1982 carryover funds (funds obligated, but not spent, in fiscal year 1982) and by sources outside the DOE solar program, and the Small Wind Systems Test Center was expected to have its activities terminated by DOE during the fiscal year.

However, the continuing resolution for fiscal year 1983 (P.L. 97-377, Dec. 21, 1982) appropriates funds for DOE to continue the programs and activities which it conducted in fiscal year 1982. Consequently, DOE is applying a portion of this funding to the continued operation of these test facilities. The following table shows each facility's funding for both fiscal years 1982 and 1983.

Estimated Funding For Selected
DOE Solar Test Facilities

	Fiscal year 1982			Fiscal year 1983		
	DOE funding	Outside sources (note a)	Total	DOE funding	Outside sources (note a)	Total
	(millions)					
Central Receiver Test Facility	\$ 2.3	\$ -	\$ 2.3	\$ 2.0	\$ 2.4	\$ 4.4
Advanced Components Test Facility	0.4	-	0.4	0.2	-	0.2
Parabolic Dish Test Site	1.8	0.1	1.9	0.6	0.1	0.9
MOD-0 Wind Turbine	1.1	-	1.1	1.1	-	1.1
Small Wind Systems Test Center	3.2	b/-	3.2	2.0	b/-	2.0

a/Outside sources consist of other Federal agencies and private industry.

b/The Small Wind System Test Center received about \$6,000 from private industry for test activities in fiscal year 1982. Approximately \$20,000 is expected from industry for fiscal year 1983 test activities.

Beyond fiscal year 1983, continued DOE funding is anticipated for most of these facilities. According to the directors of DOE's solar thermal and wind energy technology areas, the Advanced Components Test Facility, the MOD-0 Wind Turbine, and the Central Receiver Test Facility concentrate on high-risk research and testing activities and will be continued. They stated that, for fiscal year 1984, DOE plans to fund a number of R&D activities at each of these facilities, and that DOE may likely continue its support for a number of years.

The Small Wind Systems Test Center is also planned by DOE for continued operation beyond fiscal year 1983. DOE funding for this test facility in fiscal year 1984 will be to maintain its capability for performing industry-funded testing and research activities. According to DOE officials, this facility does not have a long-term, high-risk R&D role in DOE's program, and they expect that 1984 is the last fiscal year DOE will support the facility.

The Parabolic Dish Test Site, however, is not expected to receive any additional funding beyond fiscal year 1983. DOE's fiscal year 1984 budget request does not provide funding for this facility. According to the director of DOE's solar thermal technology area, the Parabolic Dish Test Site may continue operations during part of fiscal year 1984 on carryover funds, but it will be closed down during that year. He stated that DOE will no longer be developing parabolic dish technology, and that this facility therefore has no role in DOE's solar program. The DOE official added that the test site's concentrators may be used for other purposes, but that decisions on its future use will not be made until the fiscal year 1984 budget is finalized.

SOLAR PROJECTS: RECOVERY OF FUNDS
UNLIKELY BUT MOST DATA COLLECTION
ACTIVITIES TO BE COMPLETED

DOE's past solar program efforts involved the construction and operation of various solar energy projects in order to give the associated technologies public visibility and to obtain information on the respective solar energy systems' performance. DOE's current policy, however, is to closeout these projects in order to redirect program activities toward long-term, high-risk research efforts and to save Federal funds which would have been expended on operating these projects. In doing so, DOE has recognized that the Government has a substantial investment in such projects that needs to be protected. In this regard, DOE has taken steps to review projects for possible recovery of Federal funds and to complete planned data collection activities on the projects. Despite these steps, little, if any, funds will likely be recovered. However, completion of planned data collection activities on most projects is expected.

Establishment of DOE's project
closeout activities

On February 4, 1982, the Assistant Secretary for Conservation and Renewable Energy established a task force to review all solar projects funded by DOE to determine project costs, informational value, relationship to private sector activities, and contractual mechanisms needed to effect project completion, termination, or cancellation. Subsequently, the Assistant Secretary established as a policy the completion or termination of these projects. In a March 11, 1982, memorandum, the Assistant Secretary stated:

"It is CE [Conservation and Renewable Energy] policy that we should disengage from completed market test demonstration/experiment type projects as quickly as possible. A guideline to follow is that a project should be terminated once we have gotten what we paid

for including the results needed for guidance in planning long range future research efforts. Generally, there is no need to continue a project beyond its "final design" completion (detailed construction drawings with detailed cost estimates) and/or after six months of data collection following full scale operation."

Based on documents provided by the task force, a total of 56 separate projects costing \$395.8 million were ongoing under DOE's photovoltaic, solar thermal, and wind energy technology areas and were subject to closeout in accordance with the Assistant Secretary's memorandum, as follows:

Number of Ongoing DOE Solar Projects

<u>Technology area</u>	<u>Number of projects</u>	<u>DOE cost (note a)</u>
		(millions)
Photovoltaic	22	\$ 72.7
Solar thermal	25	225.6
Wind energy	<u>9</u>	<u>97.5</u>
Total	<u>56</u>	<u>\$395.8</u>
	—	—

a/DOE cost includes authorized expenditures for ongoing projects as of July 1982, and the estimated cost to complete projects currently under design or construction.

The principal Deputy Assistant Secretary for Conservation and Renewable Energy, who is in charge of the closeout activities, and a member of the project closeout task force told us there were three reasons for the establishment and implementation of the project closeout policy. These officials told us:

--The closing of solar energy projects takes DOE "out of the demonstration business" and puts it more in line with the administration's philosophy of concentrating on long-term, high-risk R&D with high potential payoff, leaving near-term R&D and commercialization to industry to perform.

--DOE has shown an inability to closeout projects after they have been completed and achieved their objectives. Very few projects DOE has undertaken in solar energy have been closed out, and projects which were started as early

as 1975 are still operating. Although these projects have provided valuable information on the operation of various solar energy systems, they have outlived their usefulness to DOE's program.

--DOE could save funds by closing out these projects. DOE spends approximately \$750,000 monthly to operate and monitor projects in the photovoltaic, solar thermal, and wind energy areas. While possible savings could not be determined, it would be a considerable portion of this amount.

Little, if any, funds recoverable
from project closeouts

DOE has spent a substantial amount on its solar energy projects and is taking action to protect this expenditure during the project closeout process; however, there is little likelihood that it will recover any funds. DOE is instead trying to minimize its losses and at the same time benefit solar energy development by transferring the project title to other project participants wherever possible.

DOE has invested about \$400 million in its various solar energy projects. This investment has purchased a considerable amount of equipment which may be of commercial value. DOE is aware of this and has directed that its property management officials review the project dispositions for possible recovery of expended funds. As stated in the Assistant Secretary for Conservation and Renewable Energy's March 11, 1982, memorandum:

"* * * the Assistant Secretary for Management and Administration advises me that no commitments regarding disposition of real property may be made until his office has reviewed and approved the disposition proposal."

This approval by the Assistant Secretary for Management and Administration is incorporated into the termination procedure established in the memorandum, and the task force on project closeouts has been directed to handle the disposition for DOE's solar program. Officials of the task force and in the Office of the Assistant Secretary for Management and Administration stated that review and approval are being made prior to the disposal of both real and personal property at the project sites. They said that they are looking for the most financially advantageous method for disposing of these projects, considering the commercial value of the projects as energy producers, the salvage value of the projects if dismantled and sold, and the cost to the Government for restoring the sites of projects closed out.

Although DOE is examining projects for possible recovery of funds, our examination of documents and discussions with DOE officials about the 39 projects we reviewed indicated that there is little likelihood any funds will be recovered from disposal of such projects. The disposal status for 25 projects could be determined, and no funds are recoverable from these projects for the following reasons:

- On 19 of the projects, project title does not belong to DOE. In accordance with the applicable contracts or grants on these projects, the title to the projects' systems were transferred to other project participants. In these cases, DOE has no ownership rights to the projects' assets, and therefore no potential for recovery of funds invested exists.
- Three projects were conducted with other Federal agencies, and transfer of project ownership to these participants will have no effect on recovery of funds previously spent. Under Federal Property Management Regulations, agency-to-agency transfers of this type are to be accomplished at no cost.
- Three projects had been closed out, and DOE found that no funds were recoverable. In each instance, the project had little or no commercial value. Two of these three projects--the Coolidge Deepwell Solar Irrigation Project in Coolidge, Arizona, and the Small Wind Machine Field Evaluation Projects in various locations--were turned over at no cost to other project participants. The other project--the MOD-OA wind turbine in Clayton, New Mexico--was dismantled. Analyses done for DOE showed that these projects had little or no commercial value as energy producers, and that removal costs were greater than salvage values.

The remaining 14 projects are currently under negotiation with the project participants for disposal, but DOE solar program and management and administration officials believe that there is little likelihood that any funds from these projects will be recovered, since these are research projects and are not economical to operate. Consequently, the projects would not have any commercial value. These officials added that removal of these projects is expected to cost more than the salvage value. The disposal status of the projects is shown in appendix IV.

DOE officials on the task force and in the Office of the Assistant Secretary for Management and Administration stated that they will continue to look for any possible cost recovery on projects that have yet to be closed out. However, if none is

available, DOE's goal will be to transfer ownership to project participants capable of continuing the projects. According to these officials, this transfer will provide a twofold benefit. First, transferring title to the other project participants will relieve DOE of its obligation to dismantle the projects and restore the project sites, which could be expensive. For example, the estimate obtained by DOE on the cost to remove the Coolidge Neerwell Solar Irrigation Project and restore the site was approximately \$200,000 greater than the projected salvage value. These officials therefore believe that transferring title and leaving projects such as Coolidge in place will save Federal funds. Second, such transfers will enable the projects to be continued, which would benefit the development and use of solar energy technology. While these officials stated that the projects have outlived their usefulness to DOE's program, they believe the continued operation of the projects by other participants can still benefit solar energy development through their visibility and the "hands-on" experience the projects can provide.

Data collection activities to
be completed on most projects,
but uncertain for others

DOE's funding of solar energy projects serves a number of purposes, such as assistance to the solar industry and generation of public acceptance of these technologies through their visibility. However, according to DOE program officials, the most important reason for DOE's participation in solar energy projects has been the collection of data on the operation of the various solar energy systems. The data available from these projects can be used to determine how well the systems worked, which components of the systems did or did not work well, whether the systems interfaced properly with conventional energy sources, and how appropriate the systems were for particular applications. This information can then be used to guide Federal and private sector research efforts to improve the performance of solar energy systems.

In DOE's current effort to close out its solar energy projects, data collection activities on most projects will not be affected. Our examination indicates that on 34 of 39 projects (87 percent), DOE's closeout efforts are not expected to have an effect on completion of planned data collection activities. Specifically:

--Sixteen projects have completed their planned operational and data collection periods, or in cases where no specified data collection period existed, they have been judged by DOE to have run a sufficient length of time to provide needed performance data.

--Thirteen ongoing projects are still scheduled to complete data collection activities with DOE funding.

--One project, the Agricultural Wind Experiment, is being continued by the Department of Agriculture, and the data collection is expected to be completed.

--Four projects will not complete their planned data collection for reasons not related to the project closeout activities.⁶

We found five projects on which full data collection is uncertain. Two of these projects are currently operational and may have their DOE-sponsored data collection activities reduced. The other three projects, which are now under design or construction, do not have planned and funded data collection activities. These projects are discussed below:

--The 10-megawatt⁷ Central Receiver Pilot Plant in Barstow, California, which began operations in July 1982, was originally scheduled for a 5-year test and operational period. DOE solar program officials stated that they now expect to fund only a 2-year test period in which to obtain performance data and end project funding by September 1984.

--The MOD-2 wind machines in Goldendale, Washington, which began test operations in June 1982, were originally planned for a 5-year test and operational period. In response to the solar project closeout effort, DOE had decided to end its funding of this project by October 1982, after about 1/2 year of operation. The project has since experienced technical problems, necessitating its shutdown, and DOE is now continuing its funding in order to repair the machines. However, DOE officials stated that they are uncertain if funding for the planned data collection activities will be continued once the wind machines are repaired.

⁶Three photovoltaic projects, the BDM Office Building in Albuquerque, New Mexico; the G.N. Wilcox Hospital in Kauai, Hawaii; and the Mississippi County Community College in Blytheville, Arkansas; had their data collection periods reduced because of technical problems and obsolete technology. A fourth photovoltaic project, the Northwest Mississippi Junior College in Senatobia, Mississippi, was never completed.

⁷A megawatt is a power unit equal to 1 million watts or 1 thousand kilowatts.

--The photovoltaic projects at Georgetown University in Washington, D.C., and the Sacramento Municipal Utility District in Rancho Seco, California, and the Small Community Solar Thermal Power Experiment in Osage City, Kansas, are under design or construction and will not be operational until late fiscal year 1984 at the earliest. DOE documents show preliminary intent to collect data on the projects' operation, but at this time DOE has not provided funding for data collection activities or developed specific data collection plans.

A detailed listing of the planned data collection periods and the current status of the 39 projects is contained in appendix IV.

DOE solar program officials agree that completion of data collection efforts on the above five projects is uncertain. They stated that if DOE does not complete planned data collection activities on the Central Receiver Pilot Plant and the MOD-2 wind turbines, they are hopeful that the data collection efforts would be continued and completed by the other project participants and would result in the full collection of performance data.

However, current indications from the project participants are that full data collection on these two projects would not be completed. Representatives of organizations involved in the Central Receiver Pilot Plant and the MOD-2 wind turbines stated that they cannot fully undertake the operation and data collection expense without DOE support, and that they would not complete all the planned activities if DOE withdraws from these projects. Representatives of the Central Receiver Pilot Plant stated that the high cost of operating this project (which they estimated to be approximately \$3.5 million per year) effectively prohibits their funding of the operation and data collection activities and that they consequently would not complete the 5-year planned operation and data collection period without DOE funding. A representative of the MOD-2 wind turbines was more optimistic, and he stated that the project would continue to operate with funding from private industry and internal sources. However, he stated that their activities would not be as extensive as those originally planned for the project by DOE, and that some previously planned activities, such as determining the effects of wind machine clusters on the performance of individual machines, would not be performed.

On the three projects that do not have planned and funded data collection activities, DOE solar program officials stated that they planned to request funding for data collection activities on these projects in future annual budget submissions. DOE

officials stated that they believe that the collection of data from these projects is important, and they will make efforts to obtain the data. However, the officials pointed out that with the reductions in solar energy activities and the redirection of DOE activities toward long-term R&D, data collection activities associated with these projects may not be funded. In that event, the data collection activities would be left up to the contractor or industry to perform.

DESCRIPTION AND MISSION OF
SOLAR TEST FACILITIES REVIEWED

CENTRAL RECEIVER TEST FACILITY

The Central Receiver Test Facility is a 5-megawatt central receiver tower located within the Kirtland Air Force Base in Albuquerque, New Mexico. This facility, which began full operations in 1978, is operated for DOE by the Sandia National Laboratories. The facility cost over \$22 million to design and construct and has now been operating for 4 years. DOE provided \$2.3 million for the operation of the facility in fiscal year 1982.

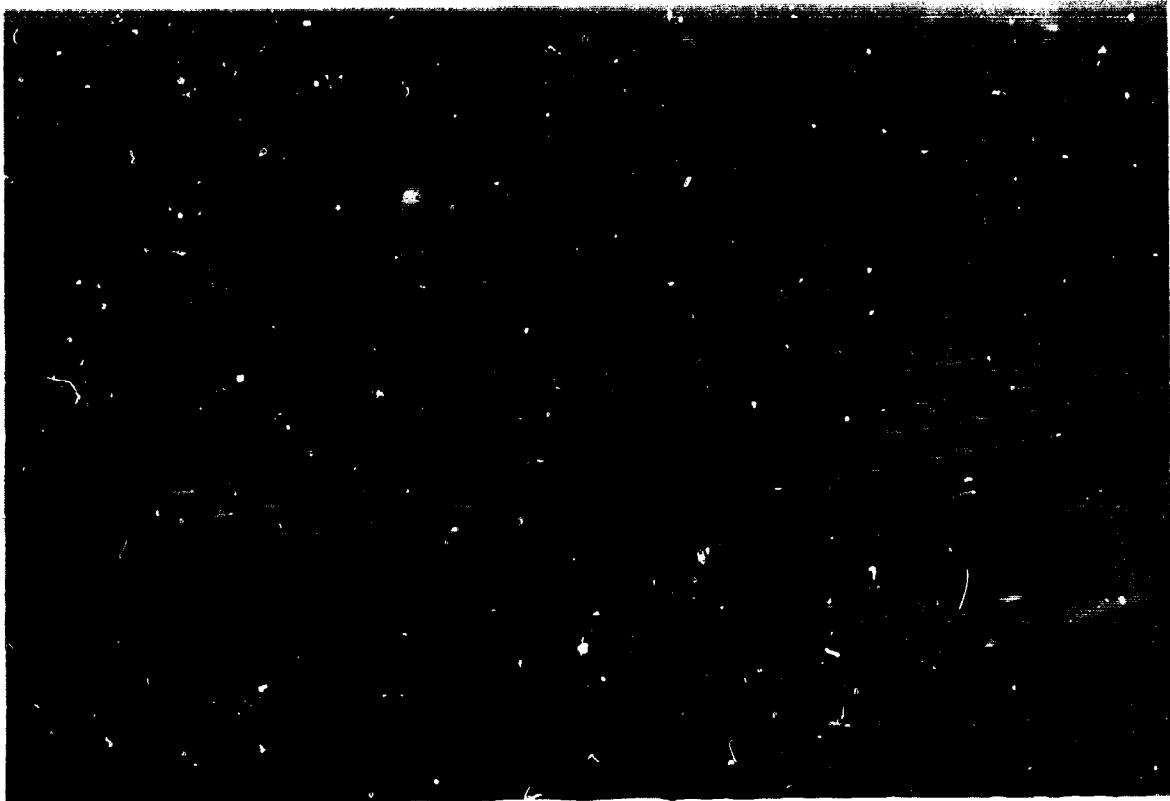
The mission of the Central Receiver Test Facility is to serve DOE's solar thermal program as a platform for testing and evaluating prototype components and subsystems for central receiver electric power or industrial process heat⁸ plants. The facility consists of a tower upon which various central receiver designs can be tested and 222 heliostats (mirrors) that focus sunlight onto the tower or receiver.⁹ The facility can produce a concentration of sunlight equal to 2,250 suns and a temperature of 2,327 degrees Celsius (4,220 degrees Fahrenheit) and has been used to

- analyze solar receivers using water, gas, molten salts, and sodium as heat exchange mediums;
- investigate new prototype heliostat designs;
- evaluate instrumentation systems; and
- train personnel and potential users on how to operate solar facilities of this type.

The Central Receiver Test Facility has also been used for research not connected with the solar thermal program, such as testing the heating effects on missile covers, determining the potential for using heliostat fields for astronomical study, and simulating the effects of nuclear blasts on soil.

⁸Thermal energy used in the preparation and treatment of goods produced by manufacturing processes.

⁹A device located at the focal point of a concentrator that converts solar rays into heat.



Central Receiver Test Facility

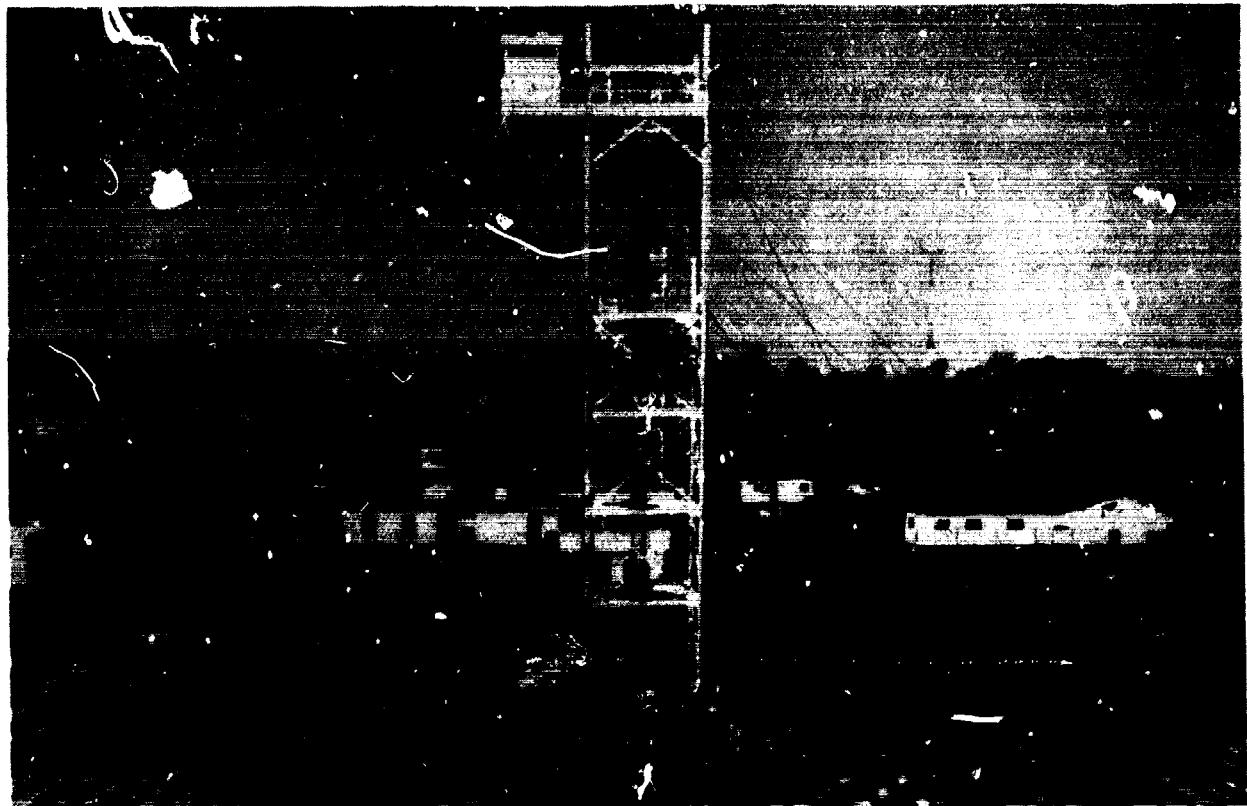
ADVANCED COMPONENTS TEST FACILITY

The Advanced Components Test Facility, located in Atlanta, Georgia, and operated by the Georgia Institute of Technology, is a 325-kilowatt high-temperature central receiver test facility. The facility consists of a test tower and 550 heliostats capable of producing heat up to 2,133 degrees Celisus (3,871 degrees Fahrenheit) from sunlight. Originally, the facility was a high-temperature, high-pressure solar steamplant which began operations in September 1977 but was modified in early 1978 to make it more adaptable to a testing role, which began in August 1978. The facility cost approximately \$1.6 million to design and construct. DOE funding for the operation of this facility totaled \$400,000 in fiscal year 1982.

The Advanced Components Test Facility's mission is to maintain an intermediate-sized capability to test solar thermal concepts and technologies that hold promise for scale-up and use in DOE's solar thermal program. In this regard, the facility is able to test

--central receiver components and subsystems,
--high-temperature insulation and structural materials,
--direct energy conversion components and subsystems, and
--chemical reactor components and subsystems.

According to DOE officials in the solar thermal technology area, the Advanced Components Test Facility's mission and efforts complement those of the Central Receiver Test Facility. DOE officials stated that this facility does research that is of a more long-term, high-risk nature and on a scale one-tenth the size of the Central Receiver Test Facility. Consequently, ideas and components that have been shown to have viability by the Advanced Components Test Facility can be scaled-up for testing on the larger Central Receiver Test Facility.

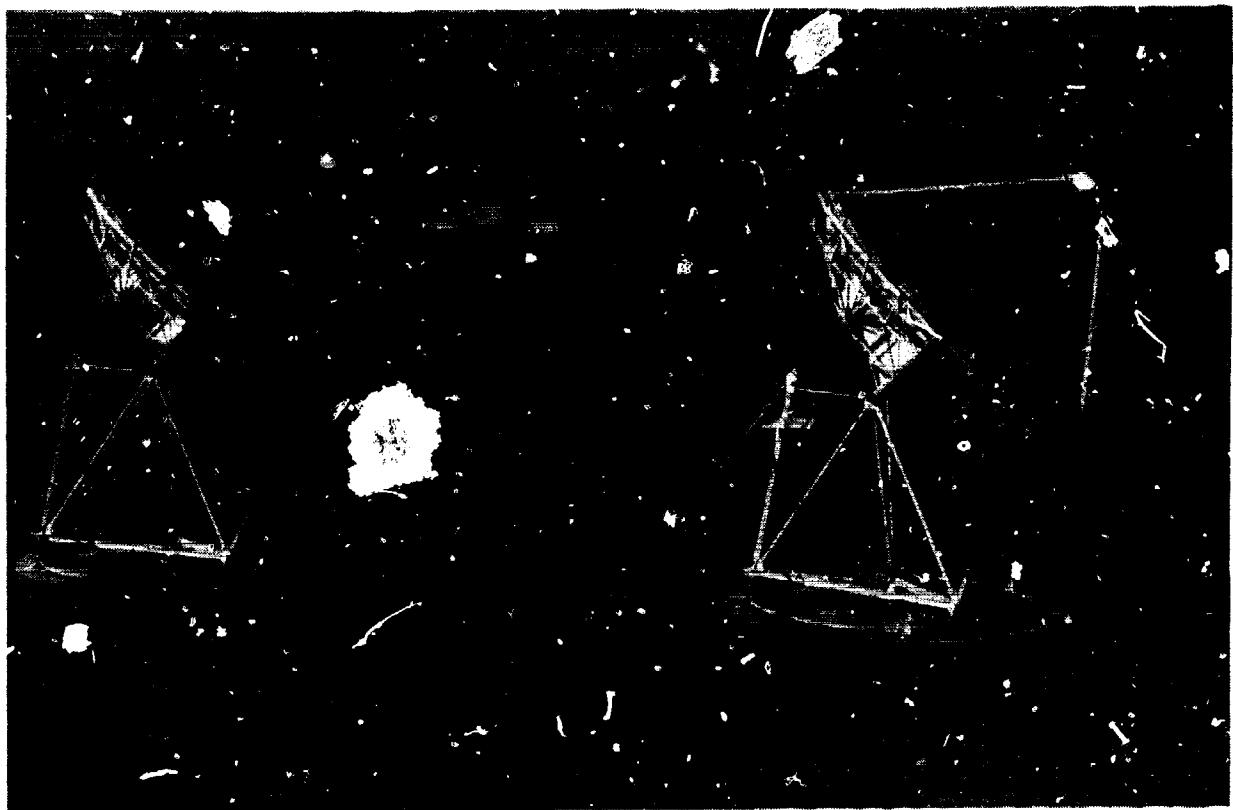


Advanced Components Test Facility

PARABOLIC DISH TEST SITE

The Parabolic Dish Test Site is a high-temperature, point-focusing solar thermal test facility. The site is located on Edwards Air Force Base in California and is operated for DOE by the Jet Propulsion Laboratory. The facility consists of two 11-meter parabolic dish concentrators, which are curved structures with a reflective surface that follow the movement of the sun and direct solar radiation onto a receiver positioned at the focal point of the dish. The cost of constructing the two concentrators, which have been in use since 1980, is \$689,000. The facility was funded \$1.8 million by DOE for operations in fiscal year 1982.

The Parabolic Dish Test Site is used by DOE's solar thermal program to test high-temperature, point-focusing solar concentrator systems and components. The present concentrators are capable of achieving concentrated solar beams that can produce temperatures of up to 3,327 degrees Celsius (6,020 degrees Fahrenheit). The concentrators are used to test point focusing receivers (which transform solar energy into thermal energy), power conversion subsystems, hybrid systems (which use both fossil and solar energy), and instrumentation. Like the other solar thermal test facilities (the Central Receiver Test Facility and the Advanced Components Test Facility), the Parabolic Dish Test Site performs experiments that are primarily DOE funded; however, it does perform experiments, on a cost-reimbursable basis, for other organizations with DOE approval. The facility received \$100,000 from industry in fiscal year 1982 for cost-reimbursable experiments.



Parabolic Dish Test Site

MOD-0 WIND TURBINE

The MOD-0 Wind Turbine (MOD is a DOE abbreviation for model) is a 100-kilowatt machine located in Sandusky, Ohio. The MOD-0 Wind Turbine is operated by the National Aeronautics and Space Administration's Lewis Research Center and was designed and built as a large wind machine experimental test-bed, which began operation in September 1975. A first-generation large wind machine, the MOD-0 turbine has a three-bladed, 125-foot diameter rotor and is mounted on a tower 100 feet above the ground. The cost to construct and modify the MOD-0 Wind Turbine has totaled \$1.9 million. DOE provided the facility \$1.1 million for operations in fiscal year 1982.

The purpose of the MOD-0 Wind Turbine is to provide operation and performance test data on large wind turbines and components for DOE's wind energy program. The MOD-0 is used for verifying wind system designs and has provided the test and operating data needed to develop DOE's 200-kilowatt MOD-0A wind machines and its larger, 2-megawatt MOD-1 machine. The MOD-0 was modified and used for testing second generation technology

needed for the 2.5-megawatt MOD-2 wind turbines and has undergone subsequent modification for testing of more advanced rotors, towers, and other components.



MOD-0 Wind Turbine

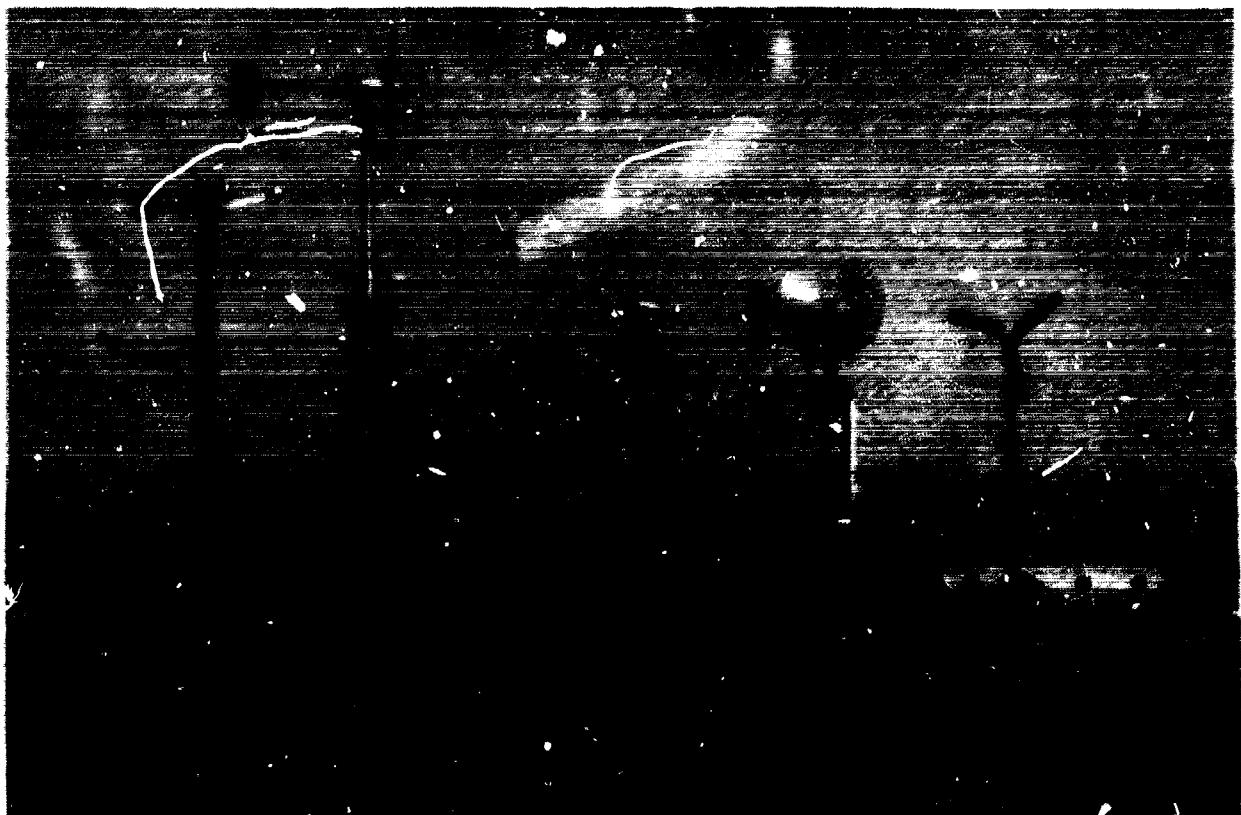
SMALL WIND SYSTEMS TEST CENTER

Located at DOE's Rocky Flats weapons plant near Golden, Colorado, the Rocky Flats Small Wind Systems Test Center has been the focal point of the DOE wind energy program's research efforts on small wind systems (less than 100 kilowatts). The Test Center, which is managed by Rockwell International for DOE, consists of 32 test pads upon which it can test various small wind machines and components and a building to house the test center operations. The Rocky Flats Test Center has cost approximately \$2.4 million to construct. The Test Center was funded \$3.2 million by DOE during fiscal year 1982.

According to DOE wind energy program officials, the Rocky Flats Test Center has four major uses:

- Testing commercially available machines purchased from manufacturers.
- R&D on new small wind system concepts and components.
- Testing new prototypes developed by DOE.
- Testing small wind machines at manufacturer's expense.

The Test Center has also been involved in other aspects of DOE's small wind energy systems program. The Test Center supported technological advancements in small wind energy systems through subcontracted efforts and provided technical assistance to industry in the development of reliable small wind energy systems. The Test Center also managed DOE's now-terminated Field Evaluation Program, which was intended to place small machines in each State and U.S. territory in order to identify and reduce technical and economical barriers to their use.



Small Wind Systems Test Center

COST, DISPOSAL STATUS, AND DATA COLLECTION PLANS
FOR SOLAR ENERGY PROJECTS REVIEWED

<u>Project</u>	<u>DOE cost</u> (in millions)	<u>Disposal status</u>	<u>Data collection status</u>
<u>Solar photovoltaic projects</u>			
DOE Office Building Albuquerque, NM (note a)	\$2.19	Project title transferred to contractor per contract.	2 year planned data collection period reduced to 1/2 year and ended 12/82 due to technical problems.
Beverly High School Beverly, MA	3.79	Project title transferred to contractor per contract.	2 year planned data collection period funded through completion in 11/83.
Dallas/Forth Worth Airport Dallas, TX (note a)	1.95	Project title transferred to contractor per contract.	2 year planned data collection period funded through completion in 8/84.
G.W. Wilcox Hospital Kauai, HI	2.78	Project title transferred to contractor per contract.	2 year planned data collection period reduced to 1 year and ended 12/82 due to technical problems.
Lovington Square Shopping Center Lovington, NM	3.43	Project title transferred to contractor per contract.	2 year planned data collection period funded through completion in 5/83.
Newman Power Station El Paso, TX	.96	Project title transferred to contractor per contract.	2 year planned data collection period funded through completion in 6/83.
Oklahoma Science and Arts Center Oklahoma City, OK	3.18	Project title transferred to contractor per contract.	2 year planned data collection period funded through completion in 4/84.
San Bernardino Community Development Center San Bernardino, CA	1.54	Project title transferred to contractor per contract.	1 year planned data collection period funded through completion in 5/83.
Sky Harbor Airport Phoenix, AZ (note a)	7.50	Project title transferred to contractor per contract.	2 year planned data collection period funded through completion in 6/84.
Nead Irrigation Project Nead, NE	2.19	Transfer of title to University of Nebraska pending.	No specified data collection period. Project has operated since 7/77. Full data collection considered complete by DOE.

a/Projects we visited.

<u>Project</u>	<u>DOE cost</u>	<u>Disposal status</u>	<u>Data collection status</u>
(in millions)			
Natural Bridges National Monument Natural Bridges, UT	\$ 5.04	Project title transferred to U.S. Park Service.	1 year planned data collection period complete.
Radio Station WMMO Byron, OH	.78	Transfer of title to WMMO pending.	No specified data collection period. Project operational since 8/79. Full data collection considered complete by DOE.
Mt. Laguna Radar Station Pine Valley, CA	2.35	Project title transferred to U.S. Army.	No specified data collection period. Project operational since 12/78. Full data collection considered complete by DOE.
Mississippi County Community College Blytheville, AR	7.73	Project title transferred to College per grant.	5 year planned data collection period reduced to 2 years and ending 9/83 due to mechanical problems and obsolescence.
Northwest Mississippi Junior College Senatobia, MS	7.80	Project title transferred to College per grant.	Grant expired prior to completion of photovoltaic system. Justice Department has initiated an investigation of irregularities.
Georgetown University National Photovoltaic Exemplar Facility Washington, DC	10.14	To be determined.	Project is currently under construction. DOE presently has no plans or funds to collect data on this project.
Sacramento Municipal Utility District Rancho Seco, CA	7.75	To be determined.	Project is currently being designed. DOE presently has no plans or funds to collect data on this project.
<u>Wind energy projects</u>			
NOD-OA 200-Kw Wind Machines (4)	15.0		2 year planned data collection period on each mach'ne.
Clayton, HI (note a)		DOE removed wind machine.	Planned data collection complete.
Culebra, PR		Under negotiation.	Planned data collection complete.
Block Island, RI		DOE to remove wind machine.	Planned data collection complete.
Oahu, HI		Under negotiation.	Planned data collection complete.

a/Projects we visited.

<u>Project</u>	<u>DOE cost</u> (in millions)	<u>Disposal status</u>	<u>Data collection status</u>
MOD-1 2-Mwe Wind Machine Boone, NC	\$ 29.0	Current DOE plans are to dismantle the machine, but negotiations for title transfer are underway.	2 year planned data collection period complete.
MOD-2 2.5-Mwe Wind Machines Goldendale, WA	42.3	Transfer of title to Bonneville Power Administration under negotiation.	2 year planned data collection period. Operational date 6/82. Due to technical problems, DOE continuing to fund repair of wind machines, but funding of data collection activities after repair uncertain.
Field Evaluation Projects Miscellaneous Locations (note a)	6.9	Project title transferred to various property owners.	1 to 2 years planned data gathering periods on machines. Although some data gathering ending early, all relevant data gathering considered complete by DOE.
New England Wind Projects Martha's Vineyard, MA (note a)	.4	Project title transferred to Sandia National Laboratories.	1 year planned data gathering period complete.
Agricultural Wind Experiment Bushland, TX (note b)	3.9	Project title transferred to U.S. Department of Agriculture.	1 to 2 years planned data gathering period on three separate projects. Projects now becoming operational. DOE funding one year of data collection. Department of Agriculture expected to fund additional data collection.
<u>Solar thermal projects</u>			
Central Receiver Pilot Plant Barstow, CA (note b)	143.9	Under negotiation.	5 year planned data collection period. Project operational date 7/82. DOE currently intends to end its involvement in project in 1984 after only 2 years of data collection.
Solar Total Energy Project Shenandoah, GA (note a)	27.5	Under negotiation.	2 year planned data collection period funded through completion in 7/84.

a/DOE contractors responsible for projects visited by GAO.

b/projects we visited.

APPENDIX IV

APPENDIX IV

<u>Project</u>	<u>DOE cost</u> (in millions)	<u>Disposal status</u>	<u>Data collection status</u>
Small Community Solar Thermal Power Experiment Osage City, KS	\$ 4.6	To be determined.	1 year data collection period anticipated. Project expected to be operational in 1986. No plans or funding for data collection activities yet provided.
Coolidge Deepwell Solar Irrigation Project Coolidge, AZ	6.6	Project title transferred to property owner.	No specified data collection period. Project operational since 1/79. Full data collection considered complete by DOE.
Capital Concrete Dish Project Topeka, KS	.50	Under negotiation.	1 year planned data collection period funded through completion in 7/83.
Home Laundry Co. Pasadena, CA (note a)	1.70	Project title transferred to contractor per contract.	1 year planned data collection period funded through completion in 9/83.
Caterpillar Tractor Company San Leandro, CA (note a)	3.5	Project title transferred to contractor per contract.	25 month planned data collection period funded through completion in 10/84.
Lone Star Brewery San Antonio, TX (note b)	1.0	Project title transferred to contractor per contract.	1 year planned data collection period complete.
U.S. Steel-Chemicals Haverhill, OH	2.7	Project title transferred to contractor per contract.	2 year planned data collection period funded through completion in 9/84.
Dow Chemical Company Dalton, GA	1.4	Project title transferred to contractor per contract.	1 year planned data collection period complete.
Southern Union Refinery Lovington, NM	1.5	Project title transferred to contractor per contract.	1 year planned data collection period complete.
Ore-Ida Foods Ontario, OR	1.8	Project title transferred to contractor per contract.	1 year planned data collection period complete.
Riegel Textiles LaFrance, SC	1.9	Project title transferred to contractor per contract.	This project is an upgrade of an existing project. DOE plans to gather data on the performance of the upgraded system through an existing arrangement with the Sandia National Laboratories.

a/Projects we visited.b/DOE contractor responsible for project visited by GAO.

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