ENERGY AND MINERALS
DIVISION

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

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B-178205

The Honorable Robert C. Seamans
Administrator, Energy Research
and Development Administration

Dear Dr. Seamans:

We have surveyed the Energy Research and Development Administration's (ERDA) solar energy research, development, and demonstration program to assess the adequacy of the planning process established to meet program goals. Although ERDA has initiated program plans and will periodically update them as the solar technologies develop, we noted some opportunities for improving the planning process. Specifically, ERDA should:

--Establish a formal system for setting priorities for allocating resources among different solar technologies to provide Congress and others with better visibility concerning program needs.

--Expedite the development of measurable cost and performance objectives for all solar technologies.

--Establish a system of decision points for use in evaluating the progress of the program.

We conducted our survey at ERDA Headquarters in Washington, D.C. and at other selected Federal agencies and non-Government entities involved in solar energy research and development.

BACKGROUND

Under the Energy Reorganization Act of 1974 (P.L. 93-438), responsibility for solar energy research and development, previously scattered in several agencies, was centralized in ERDA. This act, combined with the Solar Heating and Cooling Demonstration Act of 1974 (P.L. 93-409), the Solar Energy Research, Development, and Demonstration Act of 1974 (P.L. 93-473), and the Federal Nonnuclear Energy Research and Development Act of 1974

(P.L. 93-577), gave ERDA general authority to conduct a wide range of activities intended to ensure that economically competitive and environmentally acceptable solar technologies are available as soon as possible so that solar energy can become a major energy source.

In support of this new mission, the Congress dramatically increased appropriations over previous levels. In fiscal year 1974--prior to the enactment of these laws--funding for solar energy research and development had been about $11 million. Appropriations quadrupled to more than $50 million in fiscal year 1975, totaled nearly $115 million in fiscal year 1976, and are expected to be about $290 million in fiscal year 1977. On the whole, the Federal budget for solar energy has become one of the fastest growing budgets in the agency.

Solar energy research and development and planning

ERDA is developing the following seven major technologies for harnassing solar energy:

--solar heating and cooling in residential and commercial buildings,

--agricultural and industrial process heat applications,

--production of fuels from biomass,

--photovoltaic conversion systems,

--wind energy systems,

--solar thermal conversion systems, and

--ocean thermal energy conversion systems.

Although each of these technologies are considered to be technically feasible and generally non-polluting, research and development are needed to make them commercially competitive with alternative fuel sources.

In developing these seven solar technologies, ERDA has issued a number of program plans, including a June 1975 plan for the solar research and development demonstration program and an October 1975 plan for the solar heating and cooling program. It also has issued national energy plans in 1975 and 1976, which included ERDA's solar energy efforts. These

efforts are being carried out by ERDA national laboratories, private industry, universities, and other Federal agencies.

In conjunction with these plans, ERDA initiated a Program Approval System in November 1975. The Program Approval Documents produced under this system describe the major resources to be committed to each research and development program, and the schedules and milestones for evaluating results.

The Program Approval Document for the solar program, which was issued in March 1976, contained the estimated potential impacts of the seven solar technologies. According to the estimates, solar energy's contribution would equal about one quad 1/ or one percent of the Nation's energy demand in 1985 and about 16 quads or 10 percent of the demand in the year 2000. Thus, ERDA's plans indicate solar energy will not make a major near-term contribution to meeting the Nation's energy needs.

OPPORTUNITIES FOR IMPROVING SOLAR RESEARCH AND DEVELOPMENT PLANNING

To carry out its responsibility to research, develop, and demonstrate economically competitive and environmentally acceptable solar technologies, ERDA is seeking to lower costs and improve reliability to the point where natural economic forces will expedite commercialization. In pursuing this strategy, ERDA has given priority to certain solar technologies that it considered to be most advanced and may provide the greatest impact on the Nation's energy needs in the shortest period of time. We found, however, that ERDA did not establish a formal priority system to provide visibility as to the basis for its allocation of resources to each of the solar technologies. We also noted that ERDA has not established cost and performance objectives for some solar technologies being studied so that progress toward meeting program goals could be measured and decision points established for reevaluating the relative priorities given to the technologies.

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1/One quad equals 10^{15} Btu.

ERDA funding of solar program

Although the Congress appropriated amounts in excess of those contained in the President's budget submission for solar energy research and development work in fiscal year 1976 and is expected to do so in fiscal year 1977, these increases have generally followed funding priorities established by ERDA. ERDA's funding for research and development work in the solar technologies for fiscal years 1975-1977 are shown below.

Solar technology	Amounts funded		
	FY 1975	FY 1976 (note a)	FY 1977 (note b)
	(millions)		
Heating and cooling of buildings	$10.9	$ 40.1	$ 86.5
Agricultural and industrial process heat	1.6	4.7	7.8
Solar photovoltaic	5.1	21.7	64.0
Wind energy	5.3	14.8	21.6
Solar thermal energy	14.6	15.6	75.8
Ocean thermal energy	1.9	6.1	13.5
Fuels from biomass	.6	3.6	9.7
Technology support and utilization (note c)	.1	3.9	11.5
Total (note d)	$40.0	$110.6	$290.4

a/Does not include transition quarter.

b/Estimated ERDA appropriation.

c/Amounts commonly applicable to the seven solar technologies.

d/Totals may not add due to rounding.

Some energy experts have questioned the emphasis ERDA has placed on certain solar technologies in funding its research and development work. For example, the Office of Technology Assessment questioned, in a May 1976 report, what is believed was an overemphasis on the development of electric power systems relative to the solar heating and cooling technology. University and private industry officials told us that they too were concerned about the funding priorities given to other solar technologies.

Priority system needed to assure program effectiveness

To effectively use available funds, ERDA's research and development efforts should be directed towards the solar technologies and projects that have the greatest potential to meet the program's goals. ERDA emphasized certain solar technologies, but did not make formal evaluations comparing the alternative solar technologies.

In February 1976, ERDA told the House Committee on Science and Technology that its solar energy priorities were based on an assessment of

--pay-off times (commercialization);

--technology readiness for advancement to demonstration;

--impact of demonstrated systems as a function of time;

--economic projections of energy costs and cost/benefit analyses;

--interest and capability of industry to implement demonstrated systems;

--resource location and use of energy or power produced; and

--environmental, social, and legal factors.

Division of Solar Energy officials said that these factors were subjectively considered in determining solar energy priorities and they did not document how or the extent to which these factors were considered in establishing priorities. Thus, without such information we could not determine the weights assigned or the relative importance given to each factor.

Within some solar technologies ERDA has made comparative studies of alternative approaches to determine priorities. For example, ERDA studied several alternative approaches for the solar thermal conversion technology and determined that the central receiver system approach should be emphasized. Similar studies were made or underway of the alternative approaches within the wind and photovoltaic technologies.

Hence, ERDA, in some cases, has determined program priorities within a specific technology based on comparative studies of the various approaches, but has not extended such studies comparing the various solar technologies to each other.

Cost and performance objectives needed to evaluate progress

The relative priorities assigned to each of the solar technologies need to be reevaluated as research and development work progresses in these technologies. To measure progress toward ERDA's goal of making solar energy economically competitive with alternative fuel sources in the shortest time frame, program plans should establish target costs, including target dates for achieving these costs, and identify tasks which are clearly related toward achieving cost and performance objectives.

As of April 1976, we found that ERDA had developed such plans with specific cost and performance criteria for only one of the seven solar technologies. ERDA considers manufacturing costs of solar panels as the principal barrier to the commercial feasibility of photovoltaic conversion. The program's activities are, therefore, geared toward reducing the manufacturing costs so that the costs of photovoltaic cells will reach $500 per peak kilowatt by 1985 and $100 to $300 by 2000. ERDA has also established specific milestones for measuring the program's progress by setting interim cost specifications of $5,000 per kilowatt by 1979 and $2,000 by 1982.

None of ERDA's program plans for the six other solar technologies had established performance criteria for commercial acceptability, or cost and performance milestones for measuring progress towards achieving that goal. For example, the plans for the solar thermal conversion program established target dates for constructing facilities, pilot plants, and demonstrations but did not establish any cost

or performance objectives. Without cost and performance goals and milestones, the target dates presently established do not provide visibility as to whether the solar technologies will evolve into economically competitive solar energy systems.

In subsequent discussions of this matter with ERDA officials they said cost milestones have been developed, as of August 1976, for three of the six remaining solar technologies, i.e., wind, ocean thermal, and solar thermal. However, these milestones were not finalized but were contained in an internal working draft and, according to ERDA officials, are utilized in fiscal year 1978 budget preparation.

CONCLUSIONS

We recognize that the urgency of the Nation's energy needs and the problems inherent in the recent reorganization of solar energy responsibilities may have necessitated ERDA to initially expand its solar energy program based on subjective judgments of the priorities. However, we believe that a formal evaluation of the available solar technologies to assure that funds are more effectively used to meet the program's goals should be added to ERDA's plans at this time.

A formal system of priorities, based in part on such evaluations, would provide the Congress better visibility over the basis for ERDA's solar program budget request and would give the Congress a better basis for evaluating the adequacy of requested funding levels of the solar program or for funding alternative approaches. In addition, such a system could place other Federal and State agencies and private industry in a better position to initiate proposals to meet program needs.

We believe also that cost and performance objectives should be extended to all solar technologies to measure the progress achieved so that decision points may be established for reevaluating the priorities. As research and development work progresses, additional data may show that certain technologies should be given greater emphasis or that some technologies may not be economically feasible in the foreseeable future. In such cases, cost and performance progress measurements could provide indications when a change in emphasis should be made.

To achieve the goals of the solar energy program in the shortest possible time frame, proper planning, including

a well conceived and executed system for setting priorities, is essential. While several solar technologies may ultimately be commercialized, all solar technologies should be thoroughly evaluated and compared to ensure that those technologies and approaches with the most promise of attaining program goals are commercialized at the earliest feasible time.

RECOMMENDATIONS TO THE ADMINISTRATOR

We recommend that you:

--Establish a formal system for setting priorities to allocate limited resources among different solar technologies and among alternative approaches within each technology. To make visible the bases for establishing priorities, this system should be supported by comparative studies based on a set of predetermined criteria, ranked or weighted according to their importance in meeting program goals.

--Expedite the development of measurable cost and performance objectives for all solar technologies. These objectives should specify target costs, performance criteria for environmental acceptability and operating reliability, and dates by which those targets are expected to be met. A companion schedule of research, development, and demonstration activities designed to further those objectives should also be developed. In addition, major cost and performance milestones should be made visible in ERDA's National energy plans.

--Establish a system of decision points for evaluating the success of the program in meeting established cost and performance objectives. Priorities for the solar technologies can then be reassessed and changed as appropriate based on the success towards meeting the objectives.

A draft of this report was furnished to ERDA officials responsible for the solar energy program. Their comments were considered in finalizing this report and changes made where appropriate.

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We are sending copies of this report to the Director, Office of Management and Budget; the Chairmen, House and Senate Appropriations and Government Operations Committees; the Chairmen, House and Senate Subcommittees on Public Works; and the Chairmen, Senate Committee on Interior and Insular Affairs and House Committee on Science and Technology.

As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the House and Senate Committees on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We appreciate the courtesy and cooperation extended to our staff during the survey and would appreciate being informed of the actions you take on our recommendations.

Sincerely yours,

Monte Canfield, Jr.
Director