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Report to Sen. Frank Church, Chairman, Senate Committee on Energy and Natural Resources: Energy Research and Development Subcommittee; by Robert F. Keller, Acting Comptroller General.

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Management and funding aspects of three nonnuclear energy research, development, and demonstration subprograms under the Energy Research and Development Administration were examined. The three subprograms were: photovoltaic energy of the solar energy program; direct combustion of the coal program; and hydrothermal technology application of the geothermal energy development program. Findings/Conclusions: The extent to which research, development, and demonstration funds were used for management support services among the three subprograms varied. The amounts used for planning and managing were: $1.8 million (5.3%) for solar photovoltaic energy; $5.4 million (9%) for coal direct combustion; and $0.2 million (1.1%) for hydrothermal technology applications. The management support services included: planning subprogram activities, reviewing and evaluating research proposals, and contract and administrative support. Amounts of research, development, and demonstration funds used for planning and management services were not disclosed in the agency's budget justification documents or accounting records. Recommendations: ERDA should separately identify in the budget and accounting records each subprogram's research, development, and demonstration funds used for management support services and make the amount of such funds visible in the agency's annual budget submission to the Congress. (RRS)

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-186105

February 25, 1977

The Honorable Frank Church
Chairman, Subcommittee on Energy
Research and Water Resources
Committee on Energy and Natural
Resources
United States Senate

Dear Mr. Chairman:

In response to your October 27, 1976, letter and subsequent discussions with your office, we reviewed certain management and funding aspects of three nonnuclear energy research, development, and demonstration subprograms under the Energy Research and Development Administration. These subprograms were: photovoltaic energy of the solar energy development program; direct combustion of the coal program; and hydrothermal technology applications of the geothermal energy development program.

As agreed with your office, we reviewed the

--funds available and obligated for fiscal years 1975-76, and the transition quarter;

--types of organizations receiving subprogram funds;

--percent of funds awarded by competitive solicitation versus sole source;

--funding used for planning and/or managing purposes, paper studies, research and development, and test and demonstration; and

--funds managed by personnel outside agency headquarters.

We are recommending that the Administrator, Energy Research and Development Administration, separately identify in the budgeting and accounting records each subprogram's research, development, and demonstration funds used for management support services and make the amount of such funds visible in the agency's annual budget submission to the Congress. In this regard, we observed that the extent to which these funds were being used for such services varied

among the three subprograms, amounting to: $1.8 million, or 5.3 percent obligated for solar photovoltaic energy; $5.4 million, or 9 percent, obligated for coal direct combustion; and $0.2 million, or 1.1 percent, obligated for hydrothermal technology applications. These management support services included: planning subprogram activities; reviewing and evaluating research proposals; and, contract and administrative support.

The amounts of research, development, and demonstration funds used for planning and management services were not disclosed in the agency's budget justification documents and accounting records which we reviewed. In our opinion, the disclosure of this information would be helpful to the Congress in carrying out its funding and oversight responsibilities for each of the research, development, and demonstration subprograms.

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.

Copies of this report will be sent to the Energy Research and Development Administration so that the requirements of section 236 can be set in motion.

Our review was conducted at the Energy Research and Development Administration headquarters in Washington, D.C. and was limited to interviewing officials involved in the specific funding and management aspects of the three subprograms, analyzing financial information provided by agency officials, and reviewing eight selected contracts. The results of our review are enclosed.

We have discussed the matters presented with agency officials and have considered their comments in the preparation of the report. We did not, however, obtain formal

agency comments because of the tight reporting deadline established by the Subcommittee.

Sincerely yours,

ACTING Comptroller General
of the United States

Enclosure

COMMENTS ON CERTAIN MANAGEMENT AND FUNDING ASPECTS OF SELECTED NONNUCLEAR ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION SUBPROGRAMS

BACKGROUND

The Energy Research and Development Administration (ERDA) was created by the Energy Reorganization Act of 1974 (Public Law 93-438, October 11, 1974) and was established in January 1975. The act authorized ERDA to bring together and direct Federal activities relating to the research and development of various sources of energy and to carry out several other functions. ERDA's responsibilities include

--exercising central responsibility for policy, coordination, support, and management of all energy research and development programs;

--encouraging and conducting research and development, including demonstrating commercial feasibility and practical applications related to the development and use of various energy sources; and

--participating in and supporting cooperative research and development projects which may involve contributions of financial or other resources to the work done by public or private persons or agencies.

ERDA was established by integrating several energy research and development programs which were scattered among several Federal agencies. In the fossil energy areas, the Department of the Interior's Office of Coal Research, and part of the Bureau of Mines were integrated into ERDA's fossil energy programs. Solar and geothermal energy conversion programs were transferred to ERDA from the National Science Foundation.

There are roughly three phases which a technology must pass before it becomes commercial. The first phase is exploratory research. In the 1960s and 1970s, the National Science Foundation and the Office of Coal Research began funding laboratory research in solar, geothermal, and coal technologies. ERDA is presently continuing these efforts and, in certain activities, is moving on to the next phase--the

pilot plant phase. In this phase, technical feasibility is demonstrated on a small scale with the use of pilot plants. These plants are built to demonstrate that the energy systems can operate continuously for hours, days, or even years. Since ERDA's formation many tests and/or small scale demonstrations have been initiated in the solar, geothermal, and coal energy areas.

If these pilot plants prove successful, demonstration plants will be built to prove technical feasibility on a large scale and/or economic viability. Commercialization, which is sometimes considered the final phase because Government support may still be necessary, is the end product of extensive and costly research and development efforts.

To accelerate the movement of technologies through their various phases, the Congress has greatly increased the funding available to ERDA for energy research and development. For example, solar energy research and development appropriations rose from about $50 million in fiscal year 1975 under the National Science Foundation to about $114 million in fiscal year 1976 under ERDA. ERDA's fiscal year 1977 budget includes about $290 million for solar energy research and development. Large increases have also occurred in other nonnuclear energy research and development programs. Such increases require a more extensive management effort. To meet its expanded management responsibilities, ERDA has assigned some managerial responsibilities to other Federal agencies, ERDA laboratories, ERDA operations offices, and private industry.

On October 27, 1976, the Chairman, Subcommittee on Energy Research and Water Resources, Senate Committee on Energy and Natural Resources, asked the General Accounting Office to develop information on three ERDA subprograms. These subprograms were coal direct combustion within the Division of Coal Conversion and Utilization, photovoltaic energy within the Division of Solar Energy, and hydrothermal technology applications within the Division of Geothermal Energy.

We focused our review on the research, development, and demonstration funds appropriated for each subprogram. Indirect costs for salaries paid to ERDA headquarters and field operations offices personnel were not included as part of our review. These costs are separately funded through appropriations for the program support line item in ERDA's budget and are not identified by subprogram in ERDA's accounting and budgeting records.

For each subprogram we obtained information showing (1) program funding, (2) fund recipients, (3) method of

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awards, (4) use of funds, and (5) program management. Except for selected contracts, we did not verify in detail the information provided by ERDA officials.

With respect to the information on fund recipients, the Chairman requested a breakout of small and large businesses which we obtained by using information ERDA provided. According to ERDA, this determination is made by each contractor based on the following guidance which ERDA provides to its prospective contractors:

> "A small business concern for the purpose of Government procurement is a concern, including its affiliates, which is independently owned and operated, is not dominant in the field of operations in which it is quoting on Government contracts, and can further qualify under the criteria concerning number of employees, average annual receipts, or other criteria, as prescribed by the Small Business Administration."

In determining fund uses, we broke out funding for management support, paper studies, research and development, and test and demonstration. We identified management support costs as those research, development, and demonstration funds used for such functions as: developing management plans; coordinating activities among contractors and other Federal agencies; monitoring the success of programs; reviewing and evaluating research proposals; and contract and administrative support services. We considered paper studies to include technical evaluations, state-of-the-art studies, systems analysis work, and feasibility and design studies associated with facilities.

SOLAR PHOTOVOLTAIC ENERGY

Solar photovoltaic energy is one of seven technologies currently being developed within ERDA's solar energy program. This program is administered by the Division of Solar Energy under the ERDA Assistant Administrator for Solar, Geothermal, and Advanced Energy Systems.

Photovoltaic energy is a process which converts sunlight falling on a photo-sensitive material (solar cells) directly into electrical energy. The overall goal of the solar photovoltaic energy subprogram is to develop low-cost, reliable photovoltaic systems and to encourage the creation of a viable industrial and commercial capability to produce and distribute these systems in widespread residential and commercial use.

Photovoltaic energy principles are widely understood, primarily through experience gained with its use in the space program. In addition, photovoltaic technology has provided energy for transistor radios, buoy lights, and highway emergency call systems. Most solar cells, however, are currently made from silicon, and are very expensive. ERDA is seeking to develop less expensive solar cells which would make photovoltaic energy an economically competitive source of renewable energy.

Program funding

From January 1975 through the transition quarter, a total of $190.5 million in appropriated funds was made available to ERDA for the seven technologies being developed under the solar energy program. Of this amount, $33.9 million was made available for the photovoltaic energy subprogram, as shown in the table below.

Photovoltaic energy funding

	Fiscal year		
	1975	1976 (note a)	Total
	(000 omitted)		
Appropriations allotted	b/$5,051	$28,859	$33,910
Obligations	5,051	28,414	33,465
Unobligated balance	$ 0	$ 445	$ 445

a/Includes transition quarter.

b/Appropriations transferred from the National Science Foundation in January 1975.

The $0.4 million unobligated balance was carried over from the transition quarter to fiscal year 1977.

Fund recipients

In determining the types of organizations receiving subprogram funds, we obtained data from agency program and financial records and through discussions with agency officials. This data indicated that ERDA obligated a significant portion of the $33.5 million for work being carried out by other

Federal agencies and ERDA laboratories, as shown in the following table.

Type of organization receiving funds	Amount obligated (note a)	Percent of total
	(000 omitted)	
Small business	$ 18	.1
Large business	4,621	13.8
Universities	2,245	6.7
Federal agencies	23,108	69.0
ERDA laboratories	3,473	10.4
Total	$33,465	100.0

a/Obligations from January 19, 1975, through the transition quarter.

We selected for review the three projects for which ERDA obligated the largest amounts of funds. These projects account for $25.4 million, or about 76 percent of the subprograms' total obligations.

--A total of $18.8 million was for a project being carried out by the National Aeronautics and Space Administration's (NASA's) Jet Propulsion Laboratory, Pasadena, California, to develop low-cost silicon solar arrays.

--About $3.3 million was for a project with the NASA Lewis Research Center, Cleveland, Ohio, to test the operating characteristics of various photovoltaic systems to determine their usefulness.

--About $3.3 million was for work being carried out by Sandia Laboratories (Sandia), one of ERDA's Government-owned, contractor-operated, multiprogram laboratories. Sandia is responsible for conducting detailed systems analysis and developing subsystems which incorporate sunlight tracking and/or concentration techniques to improve overall systems performance.

ERDA officials said they make extensive use of these laboratories because of

--their unique capabilities and experience in specific photovoltaic research efforts. NASA, for example, has the experience gained from photovoltaic cell research within the space program;

--their responsiveness to ERDA headquarters' direction and control;

--the urgency of these efforts which did not permit sufficient time to involve new entities in a significant way; and

--their willingness to conduct their projects primarily through the use of outside contractors.

Although the preceding table indicated that only a relatively small percentage of obligations was incurred for private industry work, our review of the projects being carried out by the Sandia and NASA laboratories showed that a significant portion of such projects was being subcontracted to private industry. Based on information provided to us by officials at these laboratories, about $13.4 million, or 52.8 percent of the $25.4 million obligated for work by these laboratories, was subcontracted with private firms and universities. This information indicated that about 74 percent of the $13.4 million was subcontracted with large businesses, 20 percent with small businesses, and 6 percent with universities.

Method of award

In our analysis of the $33.4 million obligated for the photovoltaic energy subprogram, ERDA provided us with information on the methods used for awarding funds to recipients. This information indicated that such awards were made primarily on a noncompetitive basis, as shown in the following table.

Method of award	Amount obligated (note a)	Percent
	(000 omitted)	
Competitive	$ 4,605	13.8
Noncompetitive (note b)	28,860	86.2
Total	$33,465	100.0

a/Obligations from January 19, 1975, through the transition quarter.

b/Includes $723 thousand for projects initiated by the National Science Foundation and transferred to ERDA.

Our review showed that of the $28.9 million awarded noncompetitively, a total of about $26.6 million, or 92 percent, was awarded to other Federal agencies and ERDA laboratories. ERDA's justification for such noncompetitive awards was similar to its rationale for funding ERDA and NASA laboratories as discussed in the preceding section, that is, the unique capabilities of the performing organizations and the urgency of the tasks to be performed.

Although ERDA awarded funds to other Federal agencies and ERDA laboratories noncompetitively, the Sandia and NASA laboratories subsequently made predominantly competitive awards to their subcontractors. Information provided by ERDA and NASA officials indicated that these organizations awarded $10.4 million, or about 78 percent of the $13.4 million subcontracted, competitively from January 1975 through the transition quarter. Thus, the Sandia and NASA laboratories' efforts to subcontract through competitive awards indicate that a significant portion of the funding under the photovoltaic subprogram was awarded competitively.

Use of program funds

As part of our review, we tried to determine how much of the subprogram funds were being used for management support, paper studies, research and development, and test and demonstration. We noted, however, that ERDA's program and financial records did not provide a sufficient breakout of this information. Accordingly, through our detailed analysis of these records and through discussions with ERDA and laboratory officials, we were able to develop estimates showing the purposes for which the $33.4 million was obligated. Our categorization of such information indicated that ERDA's

principal efforts are in line with the subprogram objective to research and develop low-cost solar cells and alternative systems, as shown below.

Use of photovoltaic funds by type of function

Function	Amount obligated (note a)	Percent of total
	(000 omitted)	
Management support	$ 1,759	5.3
Paper studies	3,314	9.9
Research and development	23,992	71.7
Test and demonstration	4,400	13.1
Total	$33,465	100.0

a/Obligations from January 19, 1975, through the transition quarter.

The nearly $1.8 million obligated for management support was primarily associated with managing the ongoing projects at the NASA and Sandia laboratories. These organizations also accounted for about one-third of the $3.3 million obligated for paper studies, with the remainder attributable to private businesses. These studies, for the most part, were for analysis work on systems using alternative photo-sensitive materials. The test and demonstration obligations were primarily for the photovoltaic systems test facility at the NASA Lewis Research Center.

Program management

The degree to which ERDA retains day-to-day management of the photovoltaic energy subprogram varies depending on the activities involved. These activities include: systems analysis and engineering, low-cost silicon solar array development, concentrator system development, test and applications, and research and development on advanced systems. For example, ERDA has designated two organizations as project managers responsible for planning and managing specific subprogram activities: NASA's Jet Propulsion Laboratory, which has responsibility for the low-cost silicon solar array development; and, Sandia Laboratories which has responsibilities for both the systems analysis and engineering and the concentrator development activities. In addition, the NASA Lewis Research

Center has been given managerial responsibilities for the major portion of the test and applications subprogram activity. ERDA headquarters has retained day-to-day management over the advanced research and development activity.

In sharing managerial responsibility with Sandia and NASA laboratories, ERDA headquarters has retained overall programmatic responsibility for the conduct and direction of the various subprogram activities. This responsibility includes developing a national photovoltaic program, coordinating activities among contractor and other Federal agencies, and monitoring the success of the programs. Managerial responsibilities assigned to NASA and Sandia laboratories include

--planning and defining the scope and objectives of their respective subprogram activities and projects;

--soliciting, evaluating, and selecting specific projects to be conducted under their respective activities;

--providing technical and administrative guidance for technical work conducted under their respective activities and/or projects.

In short, ERDA headquarters maintains overall responsibility over the subprogram but has delegated day-to-day management to Sandia and NASA laboratories for much of the solar photovoltaic subprogram.

NASA and ERDA officials estimated that the costs associated with such day-to-day management amounted to $1.5 million. These costs were charged directly to subprogram research, development, and demonstration funds during the period covered by our review.

ERDA officials said they delegated certain project management responsibilities primarily because they did not have sufficient staff available at ERDA headquarters. Although they expect the headquarters staff for this subprogram to double during fiscal year 1977 from the present three professionals, they pointed out that such an increase would not be sufficient to allow headquarters to perform the day-to-day management of all subprogram activities. Thus, project management through the above research organizations is expected to continue.

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COAL DIRECT COMBUSTION

ERDA's Assistant Administrator for Fossil Energy administers three major fossil programs--coal, petroleum and natural gas, and in-situ technology. Direct combustion from coal is one of eight subprograms within the coal program.

The primary objectives of the coal direct combustion subprogram are to develop methods for burning coal cleanly and to increase the economy of converting coal to electricity. Specific areas of research and development include:

--Fluidized-bed combustion, atmospheric and pressurized, with particular attention to achieving high combustion efficiency, acceptable component durability, minimum emission of particulates and sulfur and nitrogen oxides, and reliable operation of combined cycle systems.

--Combustion and heat transfer characteristics of chars, coal oil slurries, solvent refined coal and coal-derived liquid fuels when burned in conventional furnaces, and the application of such data to improved combustor design.

--Causes of adherent slag and ash deposits, and development of methods for minimizing these efficiency degrading problems.

--Identification and control of toxic elements released during the direct combustion of coal.

Program funding

From January 19, 1975, through the transition quarter, over $630 million in appropriated funds was made available to ERDA for carrying out activities under the coal program. Of this amount, $91.1 million was made available for the direct combustion subprogram, as shown in the following table.

Direct combustion funding

	Fiscal year		
	1975	1976 (note a)	Total
	(000 omitted)		
Appropriations allotted	b/$31,476	$59,596	$91,072
Obligations	4,270	56,322	60,592
Unobligated balance	$27,206	c/$ 3,274	c/$30,480

a/Includes transition quarter.

b/Amounts transferred from Department of the Interior.

c/Includes $8 million of unobligated funds which were transferred to the coal magnetohydrodynamics subprogram.

In addition to the amounts shown above, ERDA conducts some coal direct combustion research work in other subprograms. For example, in the coal advanced research and supporting technology subprogram, ERDA obligated about $3.7 million in fiscal year 1976, including the transition quarter, for exploratory direct combustion research.

An ERDA official said that most of the unobligated balance at the end of the transition quarter was reserved for contracts under negotiation by ERDA's Procurement Division. This official added that these contracts are expected to be executed during the first half of fiscal year 1977.

Fund recipients

Our analysis of data obtained from agency program and financial records and through discussions with agency officials indicated that ERDA obligated a significant portion of the $60.6 million for work being carried out by private industry, as shown in the following table.

Type of organization receiving funds

Type of organization	Amount obligated (note a)	Percent of total
	(000 omitted)	
Small business	$ 7,641	12.6
Large business	45,130	74.5
Non-profit institutions	398	0.7
Universities	2,984	4.9
Federal agencies	750	1.2
Foreign governments	302	0.5
ERDA laboratories and energy research centers	3,387	5.6
Total	$60,592	100.0

a/Obligations from January 19, 1975, through the transition quarter.

In the coal direct combustion subprogram, industrial sites are being used for pilot demonstration plants to facilitate and encourage industrial participation in the design, fabrication, erection, and operation of fluidized bed combustion systems. This work is aimed at fostering industry involvement to assist in solving institutional and technological problems.

An ERDA official responsible for this subprogram said that most contracts were awarded to large business firms because small business entities have difficulty in meeting the cost sharing targets set by ERDA. ERDA's target for cooperative joint funding is one-third private and two-thirds Federal for pilot plants and is 50-50 sharing for demonstration plants. About half of the funds obligated for this subprogram from January 1975 through the transition quarter was for cost-sharing contracts.

We selected for review the three contracts with the largest amounts obligated from January 19, 1975, through the transition quarter. These contracts were:

--A $22 million contract with Pope, Evans, and Robbins, Inc., a large business, to design, construct, and test a multicell fluidized bed boiler. The Department of the Interior awarded this contract in October 1972 and it was

transferred to ERDA in January 1975. From January 1975 through the transition quarter, ERDA obligated about $7.6 million for this contract.

--A $27.5 million cost-sharing contract awarded on March 1, 1976, to Curtis-Wright Corporation, a large business, to engineer, design, construct, test, and evaluate a pressurized, fluidized-bed pilot plant. As of September 30, 1976, ERDA had obligated $7.6 million for this contract.

--A $6.3 million contract awarded on September 30, 1976, to City Public Service Board, a small business, to design, engineer, construct, operate, maintain, test, and evaluate a coal-oil slurry system. ERDA obligated the entire $6.3 million of this contract as of September 30, 1976.

Under the two selected contracts with large businesses, for which ERDA obligated about $15.2 million, these contractors subcontracted about $8.2 million to other private firms from January 1975 through the transition quarter. Information was not readily available to determine whether each of these subcontractors were small or large businesses, but we noted that some small businesses were used. Under the third contract, for which ERDA had obligated $6.3 million, the contractor had not awarded any subcontracts as of September 30, 1976.

Method of award

In our analysis of the $60.6 million obligated for the direct combustion subprogram, ERDA provided us with information on the methods used for awarding funds to recipients. This information is provided below.

Method of award	Amount obligated (note a)	Percent
	(000 omitted)	
Competitive	$23,967	39.6
Noncompetitive	36,625	60.4
Total	$60,592	100.0

a/Obligations from January 19, 1975, through the transition quarter.

An ERDA official said that most of the noncompetitive awards were for projects originally under contract with the Department of the Interior prior to their being transferred to ERDA. According to this official, the Department of the Interior awarded sole-source contracts for these projects, but ERDA has awarded most of its contracts competitively for projects it initiated in this subprogram.

Two of the three contracts we reviewed in detail were competitively awarded by ERDA. The third contract was originally awarded on a noncompetitive basis in 1972 by the Department of the Interior. ERDA justified its continuation of this project on a noncompetitive basis for the following reasons:

--The need to provide continuity of operation.

--The selection of another contractor would result in a duplication of effort at additional Government expense.

--The time span to commercialization for this technology is short and the present contractor's experience and familiarity with the project would expedite its completion.

Of the $8.2 million subcontracted under the Pope, Evans, and Robbins, Inc., and Curtis-Wright Corporation contracts, about 98 percent was subcontracted competitively. This indicates that if subcontracts were considered in the above table, the proportion of funds awarded competitively may increase.

Use of program funds

From our analysis of ERDA program and financial records and through discussions with ERDA officials, we determined that a significant portion of the $60.6 million obligated for the direct combustion subprogram was for research, development, test, and demonstration activities as shown in the following table.

Use of direct combustion funds
by type of function

Function	Amount obligated (note a)	Percent of total
	(000 omitted)	
Management support	$ 5,429	9.0
Paper studies	2,374	3.9
Research and development	24,262	40.0
Test and demonstration	28,527	47.1
	$60,592	100.0

a/Obligations from January 19, 1975, through the transition quarter.

The $5.4 million for management support services was primarily associated with seven contracts totaling about $4.6 million. These contracts were awarded to private industry for the performance of various technical and management support tasks. The balance, about $0.8 million, was largely for contract and administrative support services from ERDA laboratories and energy research centers and for computer services from universities.

The nearly $2.4 million in obligations for paper studies, for the most part, were for design studies relating to direct combustion facilities, evaluation of coal gasification research and development, and state-of-the-art studies on coal chemistry and technology. These studies were performed under eight contracts with industrial firms, one nonprofit institution, one university, and a foreign government.

Program management

ERDA has retained overall control and management responsibilities for the direct combustion subprogram. In this regard, ERDA headquarters exercises approval authority over each contract awarded under this subprogram. Of the $5.4 million in obligations for management support services shown in the preceding table, $4.6 million was for planning, technical, and other staff functions provided by contractors to headquarters.

In response to our inquiry concerning ERDA's need for such contracted services, an official within the Division of Coal Conversion and Utilization explained that his

division's workload was heavy and that it, therefore, needed assistance to adequately carry out its duties. He added that this situation developed as a result of the rapid expansion of the direct combustion subprogram. This required that the division develop planning and budgeting information within short time frames and furnish data for ERDA's national energy plan, with essentially the same staff that was transferred from the Department of the Interior.

HYDROTHERMAL TECHNOLOGY APPLICATIONS

Hydrothermal technology applications is one of six subprograms within ERDA's geothermal energy development program. This program is administered by the Division of Geothermal Energy under the ERDA Assistant Administrator for Solar, Geothermal, and Advanced Energy Systems.

Geothermal energy uses the heat stored in the earth's core and is a large potential domestic energy source. However, ERDA estimates only a fraction of this resource to be extractable over the next 25 years, primarily from hydrothermal technology applications.

These applications include using fluids from the vapor-dominated reservoirs at the geysers in California and various liquid-dominated reservoirs. The vapor-dominated hydrothermal resource has been economically exploited in the United States, but is rare and represents only a small fraction of the total potential of geothermal resources. The liquid-dominated hydrothermal resource is more extensively found, but has not been exploited to any degree for power production in the United States. This resource represents the principal geothermal energy resource available for near-term exploitation.

The objective of the hydrothermal technology applications subprogram is to establish the technical feasibility of using liquid-dominated geothermal resources for both electric power generation and nonelectric uses. Development efforts are to progress systematically from the testing of components through subsystems and processes in field test facilities, to the scaled testing of integrated energy conversion or utilization systems in pilot plants.

Program funding

Of the $71 million of appropriations available to the geothermal energy program from January 1975 through the transition quarter, about $17 million, or 24 percent, was

made available to the hydrothermal technology applications subprogram, as shown below.

Hydrothermal technology applications funding

	Fiscal year		
	1975	1976 (note a)	Total
	(000 omitted)		
Appropriations allotted	b/$5,886	$11,150	$17,036
Obligations	5,886	11,011	16,897
Unobligated balance	$ 0	c/$ 139	c/$ 139

a/Includes transition quarter.

b/Amounts transferred from the National Science Foundation.

c/Includes $98,000 of unobligated funds which were transferred to other subprograms in the geothermal program.

In addition to the amounts shown in the above table, projects supporting the hydrothermal technology applications subprogram are funded under other geothermal subprograms, such as the engineering research and development and resource exploration and assessment subprograms.

Fund recipients

Based on our review of agency program and financial records and through discussions with agency officials, we obtained data indicating the types of organizations receiving hydrothermal technology applications subprogram funds. This data indicated that ERDA obligated a significant portion of the $16.9 million for work being carried out by ERDA laboratories, as shown in the following table.

Type of organization receiving funds

Type of organization	Amount obligated (note a)	Percent of total
	(000 omitted)	
Small business	$ 341	2.0
Large business	4,176	24.7
Universities	2,313	13.7
Federal agencies	1,040	6.2
ERDA laboratories	8,937	52.9
State agencies	90	0.5
	$16,897	100.0

a/Obligations from January 19, 1975, through the transition quarter.

We selected for detailed review two projects for which the largest amounts were obligated. These two projects account for about 52 percent of this subprogram's total obligations.

--About $5.5 million was obligated for a project with ERDA's Idaho National Engineering Laboratory, a Government-owned, contractor-operated laboratory, to improve energy extraction and conversion technologies to provide for the economic production of electricity from a moderate temperature hydrothermal resource. About 68.1 percent of the research was conducted by the operating contractor. The remaining research was subcontracted to large corporations (30.3 percent), universities (1.5 percent), and small businesses (.1 percent).

--A total of $3.3 million was obligated for a project with the San Diego Gas and Electric Company to determine the technical and economic feasibility of using high-temperature, high-salinity geothermal reservoirs and to gain information on the extent and characteristics of such reservoirs. The San Diego Gas and Electric Company began this project in 1971 and, in August 1975, ERDA contracted to provide funds for a large

portion of the project's capital cost and 50 percent of the operating cost. Total estimated cost of the project is about $7.6 million through June 1978. Information provided by ERDA officials indicated that about 40 percent of the amounts obligated were for subcontracts to private industry.

Method of award

In our analysis of the $16.9 million obligated for the hydrothermal technology applications subprogram, ERDA provided us with information on the methods used for awarding funds to recipients. This information indicated that such awards were made primarily on a noncompetitive basis as shown below.

Method of award	Amount obligated (note a)	Percent
	(000 omitted)	
Competitive	$ 1,025	6.1
Noncompetitive (note b)	15,872	93.9
Total	$16,897	100.0

a/Obligations from January 19, 1975, through the transition quarter.

b/Includes $2.4 million obligated for projects transferred from the National Science Foundation.

No competitive awards were made within this subprogram until the transition quarter. ERDA officials justified the noncompetitive awards primarily because of the limited geographical locations available for hydrothermal research, the special expertise required, and the urgency to initiate certain projects. ERDA officials pointed out that competitive awards did occur in the transition quarter and will increase in future years as research efforts are expanded and private industry gains more interest.

ERDA officials provided us information on subcontracts awarded by the Idaho National Engineering Laboratory. The vast majority, 99 percent of projects subcontracted, were awarded noncompetitively for reasons similar to those noted above.

Use of program funds

From our analysis of ERDA program and financial records and through discussions with agency officials, we determined the hydrothermal technology applications subprogram functions for which the $16.9 million was obligated. The largest amount of funds was obligated for research and development efforts under this subprogram, as shown in the following table.

Use of hydrothermal funds by type of function

Function	Amount obligated (note a)	Percent of total
	(000 omitted)	
Management support	$ 194	1.1
Paper studies	2,507	14.9
Research and development	9,856	58.3
Test	4,340	25.7
Total	$16,897	100.0

a/Obligations from January 19, 1975, through the transition quarter.

The $194,000 obligated for management support was for technical services provided by ERDA's Lawrence Berkeley Laboratory for the design and construction of a test facility in the Imperial Valley of California. In addition, ERDA headquarters has delegated day-to-day project management responsibilities to two of its operations offices; however, the related management costs are not charged to subprogram funds. These costs are applied against a separate program support line item in the ERDA budget.

The $2.5 million obligated for paper studies was primarily for design and feasibility studies relating to geothermal systems. Such studies were conducted by private industry, an ERDA laboratory, universities and a State agency.

During the period covered by our review, no demonstrations of hydrothermal technology applications were funded under this subprogram or under the demonstration subprogram of the geothermal program.

Program management

ERDA headquarters has retained overall program management of all projects within the hydrothermal subprogram. However, for certain projects, ERDA has delegated day-to-day managerial responsibilities to its Idaho Falls and San Francisco operations offices. The responsibilities of these operations offices include monitoring performance of the contractors, recommending program and project changes, and assisting in program planning. Geothermal Division officials plan to extend this management assistance policy to more operations offices. Presently they are preparing a Technical Management Assistance Agreement which will delineate the respective roles of ERDA headquarters and ERDA operations offices in managing the geothermal program.

Officials within ERDA's Division of Geothermal Energy told us that they delegated some managerial responsibilities primarily because they believe onsite project management would be more effective through providing closer contact with the actual research. In addition, they pointed out that personnel ceilings and travel fund restrictions have threatened to reduce the effectiveness of project management from headquarters.

CONCLUSIONS

From January 19, 1975, through the transition quarter, ERDA obligated a total of $111 million for the three subprograms reviewed. ERDA awarded a large portion of the funds on a noncompetitive basis to private industry and other Federal agencies. We noted that significant amounts of the solar photovoltaic and coal direct combustion subprograms operating funds were used for management support functions. ERDA headquarters also obtained management support from its field operations offices, but the costs of such support were included in ERDA's program support budget.

ERDA has sought to minimize the extent of public financial commitment by pressing for the highest possible levels of industry cooperation and involvement. In awarding funds, ERDA considered each organization's expertise and experience. As a result, private industry's involvement varied among the subprograms depending largely on its capabilities and experience. ERDA justified awarding funds noncompetitively principally because of time constraints and the unique capabilities and experience of selected organizations.

The functions for which research and development funds are used depend largely on the phase of development of a subprogram. Hence, in the solar photovoltaic and hydrothermal subprograms, where program activities are primarily in the exploratory research and process development phases, funds were predominantly used for research and development and only small amounts for testing and demonstration. On the other hand, a major portion of the coal direct combustion subprogram funds was used for the construction and testing of pilot demonstration facilities.

In each subprogram reviewed, ERDA primarily used different types of organizations in obtaining some management support.

--Solar photovoltaic energy project management responsibilities were given to NASA and ERDA laboratories. Management support services accounted for 5.3 percent of the subprogram funds obligated.

--Coal direct combustion management support and planning tasks were contracted to private industry. Management support services accounted for 9.0 percent of the subprogram funds obligated.

--Hydrothermal technology applications project management responsibilities were given to ERDA field operations offices. Costs of services provided by such offices are funded from ERDA's program support budget. Management support services provided by other organizations accounted for 1.1 percent of the subprogram funds obligated.

These amounts of subprogram research, development, and demonstration funds used for management support services were neither disclosed in the agency's budget justification documents nor accounting records.

In a September 21, 1976, report to the Chairman, Subcommittee on Energy Research, Development, and Demonstration (Fossil Fuels), House Committee on Science and Technology (EMD-76-11), we similarly noted that management support costs incurred under certain Fossil Energy contracts with private industry were not being specifically identified in the ERDA budget request as support services. We recommended that ERDA disclose such costs in a separate line item in Fossil Energy's budget to the Congress. Pursuant to the reporting requirements under section 236 of the Legislative Reorganization Act of 1970, ERDA subsequently advised the

House and Senate Committees on Government Operations that it disagreed with our recommendation. ERDA said, in part:

> "To show a separate line item in the Fossil Energy budget for management and technical support would run counter to the basic logic of our budget structure and presentation and would distract from the decision-level focus upon programmatic accomplishment. However, our budget back-up material will contain data pertaining to such contracts."

We continue to believe, however, that research, development, and demonstration program funds used for management support services should be disclosed to the Congress. Such disclosure should help the Congress in carrying out its oversight responsibilities for each of the research, development, and demonstration subprograms and in providing it with greater insight for assessing the reasonableness of each subprogram's objectives and funding requirements. By disclosing amounts for management support services separately from amounts for research, development, and demonstration, the Congress would have a better opportunity to assess the degree to which ERDA is relying on outside management support services in conducting its subprograms.

We believe ERDA should reduce its reliance on outside management and technical support contracts because such reliance tends to dilute the agency's ability to retain essential control over the conduct of its programs and to assure the Congress that its programs are being carried out in an efficient and economical manner.

RECOMMENDATION TO THE ADMINISTRATOR

We recommend that the Administrator, ERDA, separately identify in the budgeting and accounting records each subprogram's research, development, and demonstration funds used for management support services and make the amount of such funds visible in the agency's budget submission to the Congress.