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Report to the Chairman, Subcommittee on Energy and Water Development, Committee on Appropriations, House of Representatives

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DEPARTMENT OF ENERGY

Solar and Renewable Resources Technologies Program

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GAO

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Resources, Community, and
Economic Development Division

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July 11, 1997

The Honorable Joseph M. McDade
Chairman, Subcommittee on Energy
and Water Development
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

The Department of Energy's (DOE) fiscal year 1998 budget request for the Solar and Renewable Resources Technologies Program is $330 million,[1] an increase of almost $79 million from fiscal year 1997 appropriations. The program is managed primarily by the Office of Utility Technologies to advance clean, reliable, and affordable power through cost-shared research partnerships with industry and laboratories.[2] As agreed with your office, this report provides program information on (1) the level of funding committed to research and development (R&D) and other activities in fiscal year 1998, (2) the extent to which DOE's costs have been shared with private industry and the type of cost-share arrangements, and (3) the extent to which the funds have been competitively awarded.

We categorized R&D activities as basic research, applied research and exploratory development, advanced development/engineering development, and operational tests/field validations. Appendix I provides the definitions used in this report for these R&D phases.

Results in Brief

In fiscal year 1998, DOE proposes to spend $311 million of the $345 million Solar and Renewable Resources Technologies Program's budget for solar and renewable energy R&D projects and $34 million for non-R&D activities.[3] The R&D projects range from experiments for increasing knowledge and understanding to full-scale engineering development. Because many of the renewable energy technologies already exist and are being improved to increase their efficiency and reduce cost, $55 million will be spent for operational tests/field validations—the phase of R&D that is closest to commercialization. Almost $16 million of the non-R&D funds will be used

[1]In fiscal year 1998, DOE also proposes using $15 million in funds carried over from fiscal year 1997 for a total of $345 million.

[2]DOE's Office of Transportation Technologies manages the Biofuels Energy Systems activity.

[3]Comprehensive data by R&D activity for actual fiscal year 1996 and estimated fiscal years 1997 and 1998 funding are included in appendix II.

for program direction, including salaries, travel, and administrative services. The remaining non-R&D activities include information dissemination, incentive payments to public power entities, and laboratory maintenance and construction.

DOE leverages federal funds and encourages commercialization of renewable energy technologies by requiring industry and other partners to share the R&D costs. During fiscal years 1996 and 1997, private industry and other groups' cost-sharing ranged between 3 and 84 percent of the cost of the research projects, depending on the renewable energy subprogram, the size of the firms involved, and the phase of R&D. The cost-shares were in the form of cash or in-kind contributions, such as salary or equipment costs or a combination of both.

Most of the funding agreements entered into by the Solar and Renewable Resources Technologies Program were awarded on a competitive basis during fiscal years 1996 and 1997.[4] The percentage of competitive awards ranged from none for some subprogram activities to 100 percent for others. Most of the subprograms awarded at least 50 percent of the funds competitively. According to DOE program officials, the contract funds awarded noncompetitively met allowable exceptions to competition.

Background

Renewable energy technologies generate electricity, fuels, and/or heat through the use of resources that are continually replenished, such as sunlight (photovoltaics), heat from the sun (solar thermal), wind, naturally occurring underground steam and heat (geothermal), plant and animal waste (biomass), and water (hydropower). The Solar and Renewable Resources Technologies Program funds research on renewable energy for utilities, transportation systems, industry, and buildings and for advanced utility system technologies. In addition, the program provides support for solar and renewable energy technologies in domestic and international markets through incentive programs to public power entities and through mechanisms established to increase commercial financing resources for major foreign purchases of U.S. technologies.

Most new product and process development is not initiated by new science but instead is an attempt to meet perceived market needs by drawing on existing technologies and on the pool of scientific knowledge. R&D can proceed sequentially from basic research to the operational

[4]Funding agreements include contracts, subcontracts, grants, cooperative agreements, and cooperative research and development agreements.

tests/field validations phase. These various phases can proceed sequentially in that basic research serves as the source of innovation. In these situations, new scientific knowledge initiates a chain of events culminating in the development and sale of a new product, process, or service. In other situations, the activities may not proceed in such a linear fashion, as changes to existing products often arise from the recognition of new market opportunities, advances in manufacturing capabilities, or advances in technology independent of progress in the underlying science.

Commercialization is an attempt by a firm to profit by incorporating new technology into products, processes, and services used or sold in the marketplace. For many new technologies, commercialization implies scaling up from prototype to volume manufacturing and committing greater resources to marketing and sales activities. Research projects in the operational tests/field validations phase are closest to the marketplace in terms of commercialization. An October 1995 report by the Office of Technology Assessment found that many factors other than scientific understanding strongly influence commercial success: the nature and composition of markets; competition from older technologies; choices of design and implementation; the availability of financing, standards, and complementary assets or infrastructure; and the ability to link with strategic partners.[5]

In DOE's fiscal year 1998 congressional budget request, the term "deployment" is used in different ways. At times, deployment is used in the context of deploying an emerging technology in a field validation or operational test, which is a precommercialization activity. At other times, deployment is used in the context of the deployment of commercial products in cost-effective applications. An example would be the state energy grant programs, which facilitate the implementation of energy efficiency measures and renewable energy systems.

Proposed Fiscal Year 1998 Funding for DOE's Solar and Renewable Resources Technologies

In fiscal year 1998, DOE plans to spend 90 percent of its solar and renewable energy program funds on R&D to promote the commercial viability of renewable energy technologies. The remaining funds will be spent on non-R&D activities for program direction, such as salaries, travel, and administrative services and to support the deployment of solar and renewable energy technologies into domestic and international markets.

[5]Innovation and Commercialization of Emerging Technologies, Office of Technology Assessment (Oct. 1995).

Fiscal Year 1998 Funding for R&D Projects

For fiscal year 1998, DOE proposes to spend $311 million (or 90 percent) of the Solar and Renewable Resources Technologies Program budget for R&D projects. Most of the research conducted will be in the applied research phase. (See table 1.) About $55 million (or 18 percent) of those funds will be spent for operational tests and field validations of integrated technologies in a realistic operating environment. Projects in this phase are closest to the marketplace in terms of eventual commercialization. Activities include concept development, market and technical feasibility studies, prototype construction, and scale-up demonstrations.

Table 1: Proposed Funding by Research Phase for Solar and Renewable Energy Subprograms, Fiscal Year 1998

Dollars in thousands

Subprogram	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Solar Building Technology	0	$1,350	$1,125	$1,525
Photovoltaic Energy Systems	$11,000	28,000	28,400	9,600
Solar Thermal Energy Systems	0	4,260	8,790	6,750
Biopower/ Biofuels Energy Systems	0	27,805	17,272	31,463
Wind Energy Systems	0	13,400	29,458	0
Geothermal	2,600	15,482	9,418	2,500
Hydrogen	0	5,958	6,114	2,928
Hydropower	0	1,000	0	0
Electric Energy Systems & Storage[a]	15,620	25,230	3,130	520
Totals	**$29,220**	**$122,485**	**$103,707**	**$55,286**

[a]The Electric Energy Systems and Storage subprogram figures do not include the Climate Challenge (see table 2 for description of this activity), which has been categorized by DOE as non-R&D.

Source: Developed by GAO from DOE's data.

According to DOE officials in the Office of Utility Technologies, none of these projects fund the commercialization of the technologies. However,

some of these technologies may already be commercially viable in specific niche applications or geographical regions. And with additional R&D, these technologies may have further commercial potential in a larger range of markets and applications and at less cost. For example, the mission of the wind energy subprogram is to establish wind energy as a regionally diversified, cost-effective power generation technology. To date, wind turbine technology development in the United States has been viable only at sites with high average wind speeds.[6] However, wind may have commercial potential as an energy source in areas of the country where winds are of moderate velocity, such as the midwestern United States from the Canadian border to Mexico. The additional applied research is needed to develop a next generation wind turbine that will be competitive at lower average wind speeds.

In other cases, DOE is supporting the test and demonstration of first-of-a-kind technologies. For example, the biofuels energy systems activity is funding the development of cost-competitive processes to produce ethanol from low-cost agricultural and forestry wastes, such as rice straw and sawdust. According to a DOE official in the Office of Fuels Development, the technology to produce ethanol from such wastes has not been demonstrated anywhere in the world. The program strategy is to demonstrate the technology in an industry-owned facility and share the cost.

According to DOE program officials, without DOE's assistance, the technologies might not reach commercialization. If the technologies have not been demonstrated to be cost-competitive, industry may not be willing to invest the funds needed to achieve market penetration. To reduce the perceived risk, DOE is helping to test and document the performance because performance cannot always be accurately predicted through modeling. For example, a technology close to commercialization is the geothermal heat pump. In fiscal year 1998, DOE plans to work with an industry consortium to further test and document the performance of this technology to accelerate widespread consumer acceptance. To date, DOE has invested $17 million in this program. In fiscal year 1998, the budget request was reduced by almost one-half compared with fiscal year 1997 by eliminating the funding for new large demonstration projects.

Appendix II has a comprehensive listing of R&D funding by phase of research for each solar and renewable energy subprogram and activity for fiscal years 1996 through 1998.

[6]Wind turbines are machines that generate electricity by using the kinetic energy of the wind.

Fiscal Year 1998 Funding for Non-R&D Activities

DOE plans to use the remaining $34 million of the proposed budget to fund non-R&D initiatives and activities that support the deployment of solar and renewable energy technologies into domestic and international markets. (See table 2.) The amount represents over an 80-percent increase from the fiscal year 1997 appropriation for non-R&D activities. Almost one-half of the non-R&D funds in the fiscal year 1998 budget will be used for program direction. Program direction includes funding for federal salaries and benefits, travel, administrative services, and other related activities. From the $34 million, $5 million will be spent on maintenance and expansion of the National Renewable Energy Laboratory. Other non-R&D funds will be used to provide incentives for renewable energy production to new facilities owned by public power entities as provided by section 1212 of the Energy Policy Act of 1992; provide support for voluntary actions by electric utilities to reduce, avoid, or sequester greenhouse gas emissions; and disseminate information on renewable energy technologies. A description of each of the non-R&D activities is included in appendix III.

Table 2: Proposed Funding for Solar and Renewable Energy Non-R&D Programs, Fiscal Year 1998

Dollars in thousands

Subprogram	Fiscal year 1998
Program Direction	$15,642
National Renewable Energy Laboratory	5,000
Renewable Energy Production Incentive	4,000
Committee on Renewable Energy Commerce and Trade	2,000
The America's 21st Century Program	2,500
The U.S. Initiative on Joint Implementation	2,500
Solar Technology Transfer	1,360
Climate Challenge[a]	1,000
Totals	**$34,002**

[a]Climate Challenge is an activity in the Electric Energy Systems and Storage subprogram.

Source: Developed by GAO from DOE's data.

DOE's Research Is Cost-Shared With Private Industry and Other Partners

DOE uses cost-sharing of renewable energy projects to leverage federal funds. Through partnerships with DOE, partners from private industry and other groups provide cost-share amounts that range from as little as 3 percent to as much as 84 percent of the research costs for renewable energy projects. DOE program officials told us that cost-sharing from

industry and other partners ensures effective use of federal funds and helps to expedite the development and eventual commercialization of technologies because the partners have a vested interest in them.

According to DOE officials from the Office of Utility Technologies and the Office of Transportation Technologies, the cost-share contributions by partners from private industry are generally higher for projects in the later phases of R&D. For example, the industry's cost-share percentages for the photovoltaic program are 24 percent for the basic and applied R&D phases and 92 percent for technology development.

The cost-share requirements for specific projects are generally established during the initial solicitation for partners and are met by cash, in-kind contributions, or a combination of both. In-kind contributions may consist of employees' time and salary costs, use of partners' facilities and equipment, and/or the cost of purchasing facilities or equipment.

DOE provided us with information on typical cost-share percentages for each of its renewable energy subprograms by activity. The information shows that the cost-share contributed by private sector partners and other partners varies by subprogram and activities. The range of cost-share percentages by subprogram and the type of partners, which include utilities, universities, industry, and trade associations, is summarized in table 3.

Table 3: Range of Typical Cost-Share Percentages, Typical Types of Partners, and Primary Types of Contributions by Renewable Energy Subprograms

Subprogram	Cost-share percentages[a]	Typical partners	Primary types of cost-share contribution[b]		
			Cash	In-kind	Mixed
Solar Building Technology	15-40	Industry, utilities, universities, and trade groups	[b]	x	[b]
Photovoltaic Energy Systems	13-70	Industry, utilities, universities, and trade groups	x	[b]	[b]
Solar Thermal Energy Systems	3-80	Industry and utilities	x	[b]	[b]
Biopower/ Biofuels Energy Systems	24-80	Industry, utilities, and universities	[b]	x	[b]
Wind Energy Systems	21-30	Industry and universities	x	[b]	[b]
Geothermal	15-84	Industry and utilities	[b]	[b]	x
Hydrogen	5-50	Industry and trade groups	[b]	[b]	x
Hydropower	30-62	Industry	x	[b]	[b]
Electric Energy Systems and Storage[c]	15-50	Industry	x	[b]	[b]

[a]Some of DOE's R&D projects such as those performed by some national laboratories and some universities are not cost-shared. The cost-share percentages represent those projects that are cost-shared.

[b]Cost-share requirements may have been met by cash, in-kind contributions, or a combination of both. This table presents the primary type of contribution.

[c]The Electric Energy Systems and Storage subprogram figures do not include the Climate Challenge activity, which has been categorized by DOE as non-R&D.

Source: Developed by GAO from DOE's data.

See appendix IV for detailed information on typical cost-shares for specific renewable energy activities. Appendix V has information on DOE's funding to trade associations.

Most Renewable Energy R&D Funds Are Awarded Competitively

Of the funds awarded through funding agreements, five of the nine subprograms awarded at least 50 percent of their funds on a competitive basis. However, the extent of competition varied by subprogram. Some subprogram activities awarded none of the funds competitively; some awarded 100 percent of the funds competitively. Table 4 shows the range of competition by subprogram.

DOE awards contracts, subcontracts, grants, cooperative agreements, and cooperative research and development agreements (CRADA) through its laboratories, field offices, and headquarters. All contract awards are subject to the requirements of the Competition in Contracting Act and the Federal Acquisition Regulation. The grant and cooperative agreement awards are subject to DOE's Financial Assistance Regulations.

Some of the funding agreements were awarded without competition. According to program officials, the noncompetitively awarded contracts met allowable exceptions to procurement rules. The federal rules require specific written justification for contract awards made without competition. Allowable exceptions include awards made in the public's interest or to a unique source.

Detailed information on the extent of competition by budget subprogram and activity is shown in appendix VI.

Table 4: Range of Competitive Awards for Renewable Energy Subprograms

Subprogram	Primary procurement mechanism	Percent of competition
Solar Building Technology	Grant	50-100
Photovoltaic Energy Systems	Subcontract	79-100
Solar Thermal Energy Systems	Subcontract	18-100
Biopower/Biofuels Energy Systems	Contract, cooperative agreement, and subcontract	34-100
Wind Energy Systems	Subcontract	0-100
Geothermal	Grant and contract	0-95
Hydrogen	Contract	85-100
Hydropower	Contract	84-97
Electric Energy Systems & Storage[a]	Contract, grant, CRADA, and cooperative agreement	75-100

[a]The Electric Energy Systems and Storage subprogram figures do not include the Climate Challenge activity, which has been categorized by DOE as non-R&D.

Source: Developed by GAO from DOE's data.

Agency Comments

We provided copies of a draft of this report to DOE for review and comment. We discussed the draft with DOE officials, including the Acting Assistant Secretary for Energy Efficiency and Renewable Energy, who agreed with the report's findings. DOE provided us with technical corrections and clarifications that we incorporated where appropriate.

Scope and Methodology

To determine the level of funding committed to R&D and other activities, we obtained data from DOE for each solar and renewable energy subprogram and activity by R&D phase. We obtained actual funding data for fiscal year 1996 and projected funding for fiscal years 1997 and 1998. We used DOE's definitions for the R&D phases. To determine the extent that project costs are shared with private industry, we obtained information on typical cost-sharing arrangements for each subprogram and activity for projects that were funded during fiscal years 1996 and 1997 and specific funding data for trade associations. To identify the extent to which funds are competitively awarded, we obtained DOE's estimate of the percentage of competitive awards for each subprogram and activity. Our analyses were based on data provided by DOE. We did not independently verify or validate the data provided to us.

We reviewed DOE's fiscal year 1998 budget request, our prior reports, and various DOE program documents. We also discussed the renewable energy programs, the fiscal year 1998 budget request, cost-sharing, and competition with officials in DOE's Office of Utility Technologies and Office of Transportation Technologies. Our review was performed from May through June 1997 in accordance with generally accepted government auditing standards.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies to the Secretary of Energy and make copies available to others on request.

Please call me at (202) 512-3841 if you or your staff have any questions about this report. Major contributors to this report include Susan Kladiva, Robin Nazzaro, and Carrie Stevens.

Sincerely yours,

Victor S. Rezendes
Director, Energy, Resources,
and Science Issues

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Abbreviations

DOE	Department of Energy
R&D	research and development
CRADA	cooperative research and development agreement

Research and Development Definitions

The following definitions for the phases of research and development (R&D) are based on definitions used by the Department of Defense. The definitions have been modified by the Department of Energy to reflect non-Defense R&D efforts.

Basic Research includes all scientific effort and experimentation directed toward increasing knowledge and understanding in those fields of physical, engineering, environmental, social, and life sciences related to long-term national needs. It requires fundamental knowledge ultimately required for the solutions of social, economic, political, physical, or military problems. It forms a part of the base for subsequent applied research and exploratory and advanced development in the various disciplines and new or improved functional capabilities.

Applied Research and Exploratory Development includes all effort directed toward the solution of specific problems, short of major development projects. This type of effort may vary from fairly fundamental applied research to quite sophisticated bread-board hardware, study, programming, and planning efforts. It would thus include investigations and minor development effort. The dominant characteristic of this category of effort is that it be pointed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions and determining their parameters.

Advanced Development/Engineering Development includes all effort directed toward projects which have moved into the development of hardware for field experiments and tests. This category includes proof of technological feasibility and assessment of operability and producibility. It also includes engineering and manufacturing technology development.

Operational tests/field validations include the evaluation of integrated technologies in a realistic operating environment to assess the performance or cost reduction potential of advanced technology. Multiple validations may be required to assess different applications for different regions. This phase helps to expedite the technology transition from the laboratory to operational use.

Solar and Renewable Energy Research and Development Funding, Fiscal Years 1996 Through 1998

Table II.1: Solar Buildings Technology Activity Funding, Fiscal Year 1996

Dollars in thousands

Solar buildings activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Quality Assurance	0	0	$475	0
Technology Deployment	0	0	0	$425
Technology Development	0	$1,025	0	0
Totals	**0**	**$1,025**	**$475**	**$425**

Table II.2: Solar Buildings Technology Activity Funding, Fiscal Year 1997

Dollars in thousands

Solar buildings activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Quality Assurance	0	0	$350	0
Technology Deployment	0	0	0	$1,050
Technology Development	0	$1,100	0	0
Totals	**0**	**$1,100**	**$350**	**$1,050**

Table II.3: Solar Buildings Technology Activity Funding, Fiscal Year 1998

Solar buildings activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Quality Assurance	0	0	$325	0
Technology Deployment	0	0	0	$1,525
Technology Development	0	$1,350	800	0
Totals	**0**	**$1,350**	**$1,125**	**$1,525**

Table II.4: Photovoltaic Energy Systems Activity Funding, Fiscal Year 1996

Dollars in thousands

Photovoltaic activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Fundamental Research				
Measurement & Characterization	$4,945	0	0	0
Basic Research/ University Programs	5,000	0	0	0
Advanced Materials & Devices				
Thin Film Partnerships	0	$15,866	0	0
Crystalline Silicon/High Efficiency Devices	0	8,000	0	0
Collector Research & Systems Development				
Manufacturing R&D (PVMaT)	0	0	$8,200	0
System Engineering & Reliability	0	0	12,900	0
PV Integrated Building Opportunities (PV:BONUS)	0	0	1,648	0
Climate Change Action Plan (PV-COMPACT)	0	0	0	$5,000
Totals	**$9,945**	**$23,866**	**$22,748**	**$5,000**

Table II.5: Photovoltaic Energy Systems Activity Funding, Fiscal Year 1997

Dollars in thousands

Photovoltaic activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Fundamental Research				
Measurement & Characterization	$5,000	0	0	0
Basic Research/ University Programs	5,000	0	0	0
Advanced Materials & Devices				
Thin Film Partnerships	0	$16,000	0	0
Crystalline Silicon/High Efficiency Devices	0	8,000	0	0
Collector Research & Systems Development				
Manufacturing R&D (PVMaT)	0	0	$9,600	0
Systems Engineering & Reliability	0	0	12,400	0
PV Integrated Building Opportunities (PV:BONUS)	0	0	1,000	0
Climate Change Action Plan (PV-COMPACT)	0	0	0	$3,000
Totals	**$10,000**	**$24,000**	**$23,000**	**$3,000**

Table II.6: Photovoltaic Energy Systems Activity Funding, Fiscal Year 1998

Dollars in thousands

Photovoltaic activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Fundamental Research				
Measurement & Characterization	$5,500	0	0	0
Basic Research/University Programs	5,500	0	0	0
Advanced Materials & Devices				
Thin Film Partnerships	0	$20,000	0	0
Crystalline Silicon/High Efficiency Devices	0	8,000	0	0
Collector Research & Systems Development				
Manufacturing R&D (PVMaT)	0	0	$10,000	0
System Engineering & Reliability	0	0	14,400	0
PV Integrated Building Opportunities (PV:BONUS)	0	0	4,000	0
Climate Change Action Plan - (PV-COMPACT)	0	0	0	$9,600
Totals	**$11,000**	**$28,000**	**$28,400**	**$9,600**

Table II.7: Solar Thermal Energy Systems Activity Funding, Fiscal Year 1996

Dollars in thousands

Solar thermal R&D activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Thermal Systems Research/Thermal Systems Research	0	$3,159	$3,500	0
Power Applications Research/Dish/ Engine Development	0	0	2,500	$2,768
Power Applications Research/Power Tower Development	0	0	0	4,640
Power Applications Research/SolMaT Initiative	0	0	1,520	0
Power Applications Research/Systems & Industrial Assistance	0	450	450	0
Totals	**0**	**$3,609**	**$7,970**	**$7,408**

Table II.8: Solar Thermal Energy Systems Activity Funding, Fiscal Year 1997

Dollars in thousands

Solar thermal R&D activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Thermal Systems Research/Thermal Systems Research	0	$3,800	$4,650	0
Power Applications Research/Dish/ Engine Development	0	0	1,100	$3,200
Power Applications Research/Power Tower Development	0	0	0	4,520
Power Applications Research/SolMaT Initiative	0	0	1,930	0
Power Applications Research/Systems & Industrial Assistance	0	1,050	2,000	0
Totals	**0**	**$4,850**	**$9,680**	**$7,720**

Table II.9: Solar Thermal Energy Systems Activity Funding, Fiscal Year 1998

Dollars in thousands

Solar thermal R&D activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Thermal Systems Research/Thermal Systems Research	0	$3,560	$4,360	0
Power Applications Research/Dish/ Engine Development	0	0	1,820	$2,000
Power Applications Research/Power Tower Development	0	0	0	4,550
Power Applications Research/SolMaT Initiative	0	0	1,880	0
Power Applications Research/Systems & Industrial Assistance	0	700	730	200
Totals	**0**	**$4,260**	**$8,790**	**$6,750**

Table II.10: Biopower/Biofuels Energy Systems Activity Funding, Fiscal Year 1996

Dollars in thousands

Biopower/biofuels energy systems R&D activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Biofuels Energy Systems/Ethanol Production	0	$15,944	$2,500	$650
Biofuels Energy Systems/Biodiesel Production	0	300	0	0
Biofuels Energy Systems/Feedstock Production	0	5,005	0	0
Biofuels Energy Systems/Regional Biomass Energy Program	0	3,806	0	0
Biofuels Energy Systems/ Thermochemical Conversion	0	1,775	0	0
Biopower Energy Systems/Utility/ Thermochemical Conversion	0	2,101	0	0
Systems Development	0	0	3,465	14,762
Biomass for Cogeneration	0	0	1,130	0
Municipal Solid Waste	0	0	0	1,760
Totals	**0**	**$28,931**	**$7,095**	**$17,172**

Table II.11: Biopower/Biofuels Energy Systems Activity Funding, Fiscal Year 1997

Dollars in thousands

Biopower/biofuels energy systems R&D activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Biofuels Energy Systems/ Ethanol Production	0	$16,320	$1,430	$5,000
Biofuels Energy Systems/Biodiesel Production	0	750	0	0
Biofuels Energy Systems/Feedstock Production	0	2,500	0	0
Biofuels Energy Systems/Regional Biomass Energy Program	0	1,650	0	0
Biofuels Energy Systems/ Thermochemical Conversion	0	0	0	0
Biopower Energy Systems/Utility/ Thermochemical Conversion	0	1,435	0	0
Systems Development	0	0	4,096	14,444
Biomass for Cogeneration	0	0	4,000	0
Feedstock Production	0	0	2,100	0
Regional Program	0	0	0	1,575
Totals	**0**	**$22,655**	**$11,626**	**$21,019**

Table II.12: Biopower/Biofuels Energy Systems Activity Funding, Fiscal Year 1998

Dollars in thousands

Biopower/biofuels energy systems R&D activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Biofuels Energy Systems/Ethanol Production	0	$18,040	$1,000	$11,000
Biofuels Energy Systems/Biodiesel Production	0	1,000	0	0
Biofuels Energy Systems/Feedstock Production	0	4,300	1,700	0
Biofuels Energy Systems/Regional Biomass Energy Program	0	1,650	1,350	0
Biofuels Energy Systems/ Thermochemical Conversion	0	0	0	0
Biopower Energy Systems/ Utility/Thermochemical Conversion	0	2,815	0	0
Systems Development	0	0	10,222	20,463
Biomass for Cogeneration	0	0	3,000	0
Totals	**0**	**$27,805**	**$17,272**	**$31,463**

Table II.13: Wind Energy Systems Activity Funding, Fiscal Year 1996

Dollars in thousands

Wind program R&D activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Applied Research/ Core Research	0	$5,850	0	0
Applied Research/ University Research	0	1,800	0	0
Applied Research/ Wind Hybrid Systems	0	400	$350	0
Applied Research/ Avian Research	0	1,500	0	0
Turbine Research/ Near Term Research and Testing	0	0	1,000	0
Turbine Research/ Next Generation Turbine Project	0	0	5,840	0
Turbine Research/ Small Wind Turbine Project	0	0	0	0
Turbine Research/ Supporting Research, Testing, and Management	0	0	8,480	0
Cooperative Research and Testing/Industry Support	0	0	3,050	0
Cooperative Research and Testing/Certification and Standards	0	0	700	0
Cooperative Research and Testing/ Utility Analysis	0	0	1,200	0
Cooperative Research and Testing/ National Wind Technology Center Operations	0	400	850	0
Totals	**0**	**$9,950**	**$21,470**	**0**

Table II.14: Wind Energy Systems Activity Funding, Fiscal Year 1997

Dollars in thousands

Wind program R&D activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Applied Research/ Core Research	0	$9,340	0	0
Applied Research/ University Research	0	1,200	0	0
Applied Research/ Wind Hybrid Systems	0	590	$500	0
Applied Research/ Avian Research	0	570	0	0
Turbine Research/ Near Term Research and Testing	0	0	0	0
Turbine Research/ Next Generation Turbine Project	0	0	0	0
Turbine Research/ Small Wind Turbine Project	0	0	0	0
Turbine Research/ Supporting Research, Testing, and Management	0	0	8,500	0
Cooperative Research and Testing/Industry Support	0	0	3,850	0
Cooperative Research and Testing/Certification and Standards	0	0	1,500	0
Cooperative Research and Testing/Utility Analysis	0	0	1,450	0
Cooperative Research and Testing/National Wind Technology Center Operations	0	500	1,000	0
Total	**0**	**$12,200**	**$16,800**	**0**

Table II.15: Wind Energy Systems Activity Funding, Fiscal Year 1998

Dollars in thousands

Wind program R&D activity	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Applied Research/ Core Research	0	$10,000	0	0
Applied Research/ University Research	0	1,600	0	0
Applied Research/ Wind Hybrid Systems	0	1,000	$1,000	0
Applied Research/ Avian Research	0	500	0	0
Turbine Research/ Near Term Research and Testing	0	0	4,000	0
Turbine Research/ Next Generation Turbine Project	0	0	9,000	0
Turbine Research/ Small Wind Turbine Project	0	0	1,460	0
Turbine Research/ Supporting Research, Testing, and Management	0	0	5,240	0
Cooperative Research and Testing/Industry Support	0	0	4,358	0
Cooperative Research and Testing/Certification and Standards	0	0	2,000	0
Cooperative Research and Testing/Utility Analysis	0	0	1,400	0
Cooperative Research and Testing/National Wind Technology Center Operations	0	300	1,000	0
Totals	**0**	**$13,400**	**$29,458**	**0**

Table II.16: Geothermal Activity Funding, Fiscal Year 1996

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Geothermal Electric				
Exploration/ Production Technology	$1,200	$4,800	$2,700	0
Drilling Technology	300	3,500	2,099	0
Hot Dry Rock Fenton Hill Experimental Site	0	700	1,200	0
Energy Conversion Technology	300	2,700	2,200	0
Site Development Activities	0	400	0	$2,000
Geothermal Heat Pumps	200	300	1,000	3,800
Totals	**$2,000**	**$12,400**	**$9,199**	**$5,800**

Table II.17: Geothermal Activity Funding, Fiscal Year 1997

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Geothermal Electric				
Exploration/ Production Technology	$1,500	$5,200	$2,700	0
Drilling Technology	300	3,818	2,200	0
Hot Dry Rock Fenton Hill Experimental Site	0	400	0	0
Energy Conversion Technology	300	2,700	2,400	0
Site Development Activities	0	0	0	$2,000
Geothermal Heat Pumps	200	482	1,000	4,800
Totals	**$2,300**	**$12,600**	**$8,300**	**$6,800**

Table II.18: Geothermal Activity Funding, Fiscal Year 1998

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Geothermal Electric				
Exploration/ Production Technology	$1,800	$6,200	$3,200	0
Drilling Technology	300	5,000	3,018	0
Hot Dry Rock Fenton Hill Experimental Site	0	0	0	0
Energy Conversion Technology	300	4,000	2,700	0
Site Development Activities	0	0	0	0
Geothermal Heat Pumps	200	282	500	$2,500
Totals	**$2,600**	**$15,482**	**$9,418**	**$2,500**

Table II.19: Hydrogen Activity Funding, Fiscal Year 1996

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Research and Development				
Production	0	$2,587	$1,907	0
Storage	0	1,333	760	0
Utilization	0	895	1,079	0
Systems Analysis	0	0	3,409	0
Technology Validation	0	0	0	$2,361
Totals	**0**	**$4,815**	**$7,155**	**$2,361**

Table II.20: Hydrogen Activity Funding, Fiscal Year 1997

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Research and Development				
Production	0	$3,713	$1,411	0
Storage	0	1,557	485	0
Utilization	0	688	1,814	0
Systems Analysis	0	0	2,404	0
Technology Validation	0	0	0	$2,928
Totals	**0**	**$5,958**	**$6,114**	**$2,928**

Table II.21: Hydrogen Activity Funding, Fiscal Year 1998

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Research and Development				
Production	0	$3,712	$1,411	0
Storage	0	1,558	485	0
Utilization	0	688	1,814	0
Systems Analysis	0	0	2,404	0
Technology Validation	0	0	0	$2,928
Totals	**0**	**$5,958**	**$6,114**	**$2,928**

Table II.22: Hydropower Activity Funding, Fiscal Year 1996

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Hydropower Development	0	$1,483	0	0
Totals	**0**	**$1,483**	**0**	**0**

Table II.23: Hydropower Activity Funding, Fiscal Year 1997

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Hydropower development	0	$1,000	0	0
Totals	**0**	**$1,000**	**0**	**0**

Table II.24: Hydropower Activity Funding, Fiscal Year 1998

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
Hydropower Development	0	$1,000	0	0
Totals	**0**	**$1,000**	**0**	**0**

Table II.25: Electric Energy Systems and Storage Activity Funding, Fiscal Year 1996

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
High-Temperature Superconductivity Research & Development				
Superconductivity Partnership Initiative	0	$8,000	0	0
2nd Generation Wire Initiative	$4,000	0	0	0
Strategic Research	8,000	2,280	0	0
Energy Storage Research & Development				
Integration	0	312	$220	$225
Components	65	290	365	0
Analysis	0	500	0	0
Electric & Magnetic Fields Research & Development	0	9,487	0	0
Totals	**$12,065**	**$20,869**	**$585**	**$225**

Table II.26: Electric Energy Systems and Storage Activity Funding, Fiscal Year 1997

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
High-Temperature Superconductivity Research & Development				
Superconductivity Partnership Initiative	0	$9,500	0	0
2nd Generation Wire Initiative	$5,000	0	0	0
Strategic Research	4,000	1,250	0	0
Energy Storage Research & Development				
Integration	0	680	$385	$385
Components	0	570	430	0
Analysis	0	1,550	0	0
Electric & Magnetic Fields Research & Development	0	8,000	0	0
Totals	**$9,000**	**$21,550**	**$815**	**$385**

Table II.27: Electric Energy Systems and Storage Activity Funding, Fiscal Year 1998

Dollars in thousands

Budget category/ subcategory	Basic research	Applied research/ exploratory development	Advanced development/ engineering development	Operational tests/field validations
High-Temperature Superconductivity Research & Development				
Superconductivity Partnership Initiative	0	$12,500	$2,000	0
2nd Generation Wire Initiative	$8,000	0	0	0
Strategic Research	7,500	2,500	0	0
Energy Storage Research & Development				
Integration	0	1,020	520	$520
Components	120	710	610	0
Analysis	0	500	0	0
Electric & Magnetic Fields Research & Development	0	8,000	0	0
Totals	**$15,620**	**$25,230**	**$3,130**	**$520**

Note: The tables in this appendix were developed by GAO from data provided by DOE.

DOE's Description of Non-R&D Solar and Renewable Energy Programs

Non-R&D programs pay for federal salaries and benefits, federal travel, the working capital fund for administrative services, and other related expenses.

National Renewable Energy Laboratory (NREL): facility maintenance and the third and last phase of construction to modify the Field Test Laboratory Building.

Renewable Energy Production Incentive (REPI): authorized by section 1212 of the Energy Policy Act of 1992 to provide incentive payments, subject to the availability of appropriations, for electricity produced by new renewable energy facilities that are owned by public power entities. The incentive is intended to provide comparability with tax incentives that are available to private sector entities.

Solar International: Committee on Renewable Energy Commerce and Trade (CORECT) is authorized by the Energy Policy and Cooperation Act, as amended by the Energy Policy Act of 1992, to reduce the barriers to the export of U.S. renewable energy technologies.

The Americas' 21st Century Program implements CORECT export strategies in Latin America and the Asia-Pacific regions to facilitate the use and incorporation of U.S. renewable energy technologies in grid and off-grid applications.

The U.S. Initiative on Joint Implementation supports voluntary projects between two or more countries, leading to the implementation of projects that reduce, avoid, or sequester greenhouse gas emissions.

Solar Tech Transfer: the Energy Efficiency and Renewable Energy Clearinghouse (EREC) and the Energy Efficiency and Renewable Energy Network (EREN) disseminate information to the general public and the business community through a toll free telephone service and the Internet.

Climate Challenge: facilitates voluntary actions by electric utilities to reduce, avoid, or sequester greenhouse gas emissions.

Typical Cost-Share Partnerships for the Solar and Renewable Energy Program, Fiscal Years 1996 and 1997

Table IV.1: Solar Buildings Technology Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Quality Assurance	0/100	65/35	Cash	Solar Rating & Certification Corp.
Technology Deployment	50/50	70/30	In-kind	Sacramento Municipal Utility District
Technology Development	60/40	80/20	In-kind	National Renewable Energy Laboratory, University of Wisconsin

Table IV.2: Solar Buildings Technology Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Quality Assurance	45/55	85/15	Cash	Solar Rating & Certification Corp.
Technology Deployment	25/75	60/40	In-kind	National Association of Homebuilders Research Center
Technology Development	55/45	80/20	In-kind	Energy Laboratory, Inc.

Table IV.3: Photovoltaic Energy Systems Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Fundamental Research				
Measurement and Characterization	100/0	100/0	[a]	National Renewable Energy Laboratory
Basic Research University Programs	60/40	100/0	[a]	University of Utah
Advanced Materials and Devices				
Thin Film Partnerships	36/64	70/30	Cash	Siemens Solar Industries
Crystalline Silicon/High Efficiency Devices	63/37	100/0	[a]	Research Triangle Institute
Collector Research and Systems Development				
Manufacturing R&D (PVMaT)	8/92	57/43	Cash	ASE Americas
System Engineering and Reliability	68/32	87/13	Cash	Southwest Technology Development Institute
PV Integrated Building Opportunities (PV: BONUS)	0/100	50/50	Cash	Energy Conversion Devices, Inc.
Climate Change Action Plan (PV-COMPACT)	0/100	50/50	Cash	Utility Photovoltaic Group

[a]This activity was not cost-shared.

Table IV.4: Photovoltaic Energy Systems Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Fundamental Research				
Measurement and Characterization	100/0	100/0	[a]	National Renewable Energy Laboratory
Basic Research University Programs	60/40	100/0	[a]	Johns Hopkins University
Advanced Materials & Devices				
Thin Film Partnerships	35/65	70/30	Cash	Solarex Corporation
Crystalline Silicon/High Efficiency Devices	60/40	100/0	[a]	California Institute of Technology
Collector Research and Systems Development				
Manufacturing R&D (PVMaT)	7/93	57/43	Cash	AstroPower, Inc.
System Engineering and Reliability	68/32	90/10	Cash	New Mexico State University
PV Integrated Building Opportunities (PV: BONUS)	0/100	50/50	Cash	Solar Design Associates
Climate Change Action Plan (PV-COMPACT)	0/100	30/70	Cash	Interstate Renewable Energy Council

[a]This activity was not cost-shared.

Table IV.5: Solar Thermal Energy Systems Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Thermal Systems Research/ Thermal Systems Research	68/32	97/3	In-kind	3M, ELI
Power Applications Research/ Dish/Engine Development	9/91	50/50	Cash	SAIC, Stirling Thermal Motors, Arizona Public Service
Power Applications Research/ Power Tower Development	18/82	50/50	Cash	Southern California Edison, Bechtel, Rockwell
Power Applications Research/ SolMaT Initiative	12/88	20/80	Cash	SAIC, Rockwell, McDonnell Douglas
Power Applications Research/ Systems and Industrial Assistance	71/29	40/60	Cash	Kramer Junction, Harper Lake, Daggett Leasing

Table IV.6: Solar Thermal Energy Systems Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Thermal Systems Research/ Thermal Systems Research	63/37	97/3	[a]	3M, ELI
Power Applications Research/Dish/Engine Development	11/89	50/50	Cash	SAIC, Stirling Thermal Motors, Arizona Public Service
Power Applications Research/ Power Tower Development	30/70	50/50	Cash	Southern California Edison, Bechtel, Rockwell
Power Applications Research/ SolMaT Initiative	17/83	25/75	Cash	SAIC, Rockwell, McDonnell Douglas
Power Applications Research/ Systems and Industrial Assistance	61/39	40/60	Cash	Kramer Junction, Harper Lake, Daggett Leasing

[a]DOE did not identify the type of cost-share.

Table IV.7: Biopower/Biofuels Energy Systems Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Biofuels Energy Systems/Ethanol Production	67/33	76/24	In-kind	Arkenol
Biofuels Energy Systems/ Biodiesel Production	34/66	69/31	Cash	USDA Office of Energy
Biofuels Energy Systems/Feedstock Production	65/35	67/33	In-kind	Oklahoma State University
Biofuels Energy Systems/ Regional Biomass Energy Program	1/99	30/70	Cash	Shirel Lumber Company
Biofuels Energy Systems/ Thermochemical Conversion	100/0	Closeout of program	[a]	[a]
Thermochemical Conversion	89/11	100/0	[a]	[a]
Systems Development	7/93	56/44	Cash	Westinghouse, Hawaii Cane &Sugar, Niagra Mohawk, Minnesota Valley Alfalfa Producers
Biomass for Cogeneration	OIT project	[b] [b]		[b]
Municipal Solid Waste	OIT project	[b] [b]		[b]

[a]This activity was not cost-shared.

[b]Office of Industrial Technologies project. DOE did not provide any cost-share information.

Table IV.8: Biopower/Biofuels Energy Systems Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Biofuels Energy Systems/ Ethanol Production	60/40	24/76	In-kind	BC International
Biofuels Energy Systems/ Biodiesel Production	14/86	25/75	In-kind	Columbus Food, National Biodiesel Board, American Sightseeing Company, Fats & Proteins Research Institute
Biofuels Energy Systems/ Feedstock Production	50/50	50/50	In-kind	U.S. Forest Service, Northcentral Forest Experiment Station
Biofuels Energy Systems/ Regional Biomass Energy Program	1/99	20/80	In-kind	Applied Agricultural Technologies
Thermochemical Conversion	100/0	100/0	[a]	[a]
Systems Development	9/91	45/55	Cash	Westinghouse, Niagra Mohawk, Minnesota Valley Alfalfa Producers, Iowa Electric
Biomass for Cogeneration	OIT program	[b]	[b]	[b]
Feedstock Production	OTT program	[c]	[c]	[c]
Regional Program	OTT program	[c]	[c]	[c]

[a]This activity was not cost-shared.

[b]Office of Industrial Technologies. DOE did not provide any cost-share information.

[c]Office of Transportation Technologies. DOE did not provide any cost-share information.

Table IV.9: Wind Energy Systems Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Applied Research/ Core Research	74/26	100/0	[a]	AWS Scientific, Embedded Systems, Airfoils Inc.
Applied Research/ University Research	43/57	100/0	[a]	North Carolina A&T, Georgia Tech University, University of Illinois
Applied Research/ Wind Hybrid Systems	93/7	100/0	[a]	University of Massachusetts
Applied Research/ Avian Research	30/70	100/0	[a]	University of California, WEST, Inc.
Turbine Research/ Near Term Research and Testing	0/100	77/23	Cash	CannonWind Eagle, Zond, R Lynette
Turbine Research/ Next Generation Turbine Project	0/100	70/30	Cash	Wind Turbine Co., Zond
Turbine Research/ Small Wind Turbine Project	0/100	79/21	Cash	Windlite, CannonWind Eagle, World Power Tech, Bergey Windpower
Turbine Research/ Supporting Research, Testing, and Management	97/3	100/0	[a]	Ohio State
Cooperative Research and Testing/Industry Support	36/64	100/0	[a]	American Wind Energy Association
Cooperative Research and Testing/Certification and Standards	100/0	100/0	[a]	[a]
Cooperative Research and Testing/Utility Analysis	57/43	100/0	[a]	Princeton Economic Research Incorporated, Electrotek, AWS Scientific (U*WRAP)[b]
Cooperative Research and Testing/National Wind Technology Center Operations	67/33	100/0	[a]	Mountain Valley Energy

[a]This activity was not cost-shared.

[b]Utility Wind Resource Assessment Program (U*WRAP).

Table IV.10: Wind Energy Systems Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Applied Research/ Core Research	53/47	100/0	[a]	AWS Scientific, NASA, Ames, Mech Dynamics, Dynamic Designs
Applied Research/ University Research	24/76	100/0	[a]	North Carolina A&T
Applied Research/ Wind Hybrid Systems	63/37	100/0	[a]	University of Massachusetts
Applied Research/ Avian Research	58/42	100/0	[a]	Boise State University
Turbine Research/ Near Term Research and Testing	[b]	[b]	[b]	[b]
Turbine Research/ Next Generation Turbine Project	[b]	[b]	[b]	[b]
Turbine Research/ Small Wind Turbine Project	[b]	[b]	[b]	[b]
Turbine Research/ Supporting Research, Testing, and Management	85/15	100/0	[a]	McNiff Light Industry
Cooperative Research and Testing/Industry Support	63/37	100/0	[a]	American Wind Energy Association
Cooperative Research and Testing/Certification and Standards	71/29	100/0	[a]	Underwriters Laboratory, American Wind Energy Association
Cooperative Research and Testing/Utility Analysis	37/63	100/0	[a]	Princeton Economic Research Incorporated, Utility Wind Interest Group
Cooperative Research and Testing/National Wind Technology Center Operations	85/15	100/0	[a]	Mountain Valley Energy

[a]This activity was not cost-shared.

[b]DOE did not provide data for turbine research subcontracts funded from uncosted obligations balances in fiscal year 1997.

Table IV.11: Geothermal Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Geothermal Electric				
Exploration Production Technology	80/20	70/30	Both	Oxbow, CalEnergy, Caithness, Far West, Unocal
Drilling Technology	75/25	75/25	Both	Halliburtton, AZ Grant, Baker Hughes, INTEQ, Security Diamond Products, Hughes Christensen, Unocal, Tonto, Schlumberger, International Logging
Hot Dry Rock Fenton Hill Experimental Site	35/65	100/0	[a]	Project in closeout mode
Energy Conversion Technology	80/20	85/15	Both	CalEnergy, Pacific Gas & Electric, Unocal, Douglas Energy
Site Development Activities	0/100	16/84	Cash	Unocal, Calpine Corp., Northern California Power Agency, Pacific Gas & Electric
Geothermal Heat Pumps	15/85	33/67	Cash	Geothermal Heat Pump Consortium— over 100 member companies, consisting of utilities and service and equipment companies, Oklahoma State University

[a]This activity was not cost-shared.

Table IV.12: Geothermal Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Geothermal Electric				
Exploration Production Technology	80/20	75/25	Both	Oxbow, CalEnergy, Caithness, Far West, Unocal
Drilling Technology	70/30	70/30	Both	Halliburtton, AZ Grant, Baker Hughes INTEQ, Security Diamond Products, Hughes Christensen, Unocal, Tonto, Schlumberger, International Logging
Hot Dry Rock Fenton Hill Experimental Site	100/0	100/0	[a]	[a]
Energy Conversion Technology	80/20	85/15	Both	CalEnergy, Pacific Gas & Electric, Unocal, Douglas Energy
Site Development Activities	0/100	16/84	Cash	Unocal, Calpine Corp., Northern California Power Agency, Pacific Gas & Electric
Geothermal Heat Pumps	10/90	33/67	Cash	Geothermal Heat Pump Consortium— over 100 member companies, consisting of utilities and service and equipment companies, Oklahoma State University

[a]Project is being closed out.

Table IV.13: Hydrogen Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Research and Development				
Production	66/34	65/35	Cash	Texaco, Air Products, SRT Inc., Praxair
Storage	68.5/31.5	65/35	In-kind and cash	A.D. Little, Energy Conversion Devices, Inc., Materials & Electrochemical Research Corp., Praxair
Utilization	61/39	50/50	In-kind	International Fuel Cells Corp., DCH Technology, Inc.
Systems Analysis	32.6/67.4	75/25	Cash and in-kind	National Hydrogen Association, Sentech, Hydrogen Fuel Cell Letter, Directed Technologies, 122 West Longitude
Technology Validation	38.5/61.5	50/50	Cash	City of Palm Desert, Dupont, Bluebird

Table IV.14: Hydrogen Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Research and Development				
Production	55/45	65/35	In-kind	Texaco, Air Products, SRT Group Inc., Praxair
Storage	53/47	65/35	In-kind and cash	Energy Conversion Devices, Inc., A.D. Little, Materials & Electrochemical Research Corp., Praxair
Utilization	47/53	95/5	In-kind	International Fuel Cell Corp., DCH Technology, Inc.
Systems Analysis	30/70	75/25	In-kind	National Hydrogen Association, Sentech, Hydrogen Fuel Cell Letter, Directed Technologies
Technology Validation	25/75	50/50	Cash and in-kind	Teledyne Brown, International Fuel Cell Corp., MC Power, Energy Conversion Devices, Inc.

Table IV.15: Hydropower Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Hydropower Development	67/33	38/62	Cash	Voith Hydro, Inc.

Table IV.16: Hydropower Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
Hydropower Development	45/55	70/30	Cash	Alden Research Laboratory

Table IV.17: Electric Energy Systems & Storage Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
High-Temperature Superconductivity Research & Development				
Superconductivity Partnership Initiative	100/0	50/50	Cash	Electric Power Research Institute, Reliance, Lockheed Martin
2nd Generation Wire Initiative	100/0	50/50	Cash	Midwest Superconductivity
Strategic Research	90/10	50/50	Cash	American Superconductor, Intermagnetics General, Southwire
Energy Storage Research & Development				
Integration	28/72	50/50	50 - cash and 50 - in-kind	GNB Technologies
Components	62/38	85/15	50 - cash and 50 - in-kind	JCI, ZBB
Analysis	69/31	100/0	[a]	Frost & Sullivan
Electric and Magnetic Fields Research & Development	56/44	73/27 (RAPID[b] is 50/50)	Cash	The member companies[c] of EEI, APPA, NRECA, and NEMA

[a]This activity was not cost-shared.

[b]Represents the cost-share ratio for the Research and Public Information Dissemination portion of this activity.

[c]Edison Electric Institute (EEI), American Public Power Association (APPA), National Rural Electric Cooperative Association (NRECA), and National Electrical Manufacturers Association (NEMA).

Table IV.18: Electric Energy Systems & Storage Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Cost-share: DOE/partners	Primary cost-share type	Typical partners (company names)
High-temperature Superconductivity Research & Development				
Superconductivity Partnership Initiative	100/0	50/50	Cash	Electric Power Research Institute, Reliance, Lockheed Martin
2nd Generation Wire Initiative	100/0	50/50	Cash	3M, Midwest Superconductivity
Strategic Research	95/5	50/50	Cash	American Superconductor, Intermagnetics General, Waukeshau Electric
Energy Storage Research & Development				
Integration	12/88	50/50	50 - cash and 50 - in kind	AC Battery Corp., Virginia Power
Components	29/71	85/15	50 - cash and 50 - in-kind	JCI, ZBB
Analysis	26/74	100/0	[a]	Energetics
Electric & Magnetic Fields Research & Development	48/52	67/33 (RAPID[b] is 50/50)	Cash	The member companies[c] of EEI, APPA, NRECA, and NEMA

Note: The tables in this appendix were developed by GAO from data provided by DOE.

[a]This activity was not cost-shared.

[b]Represents the cost-share ratio for the Research and Public Information Dissemination portion of this activity.

[c]Edison Electric Institute (EEI), American Public Power Association (APPA), National Rural Electric Cooperative Association (NRECA), and National Electrical Manufacturers Association (NEMA).

Solar Renewable Energy Funding to Trade Associations

Table V.1: Funding to Trade Associations, Fiscal Years 1996 and 1997

Dollars in thousands

Trade association	1996	1997	Subprogram	Purpose of funding
Solar Energy Industries Association	$844[a]	$856[a]	Solar Thermal and Photovoltaic Energy Systems	Sponsor conferences, print publications, promote use of photovoltaics, conduct market analyses, and coordinate industry activities.
Association of State Dam Safety Officials	0	39	Hydropower	Assist DOE in conduct of state hydropower resource assessments and coordinate with state agencies.
National Hydrogen Association	339	247	Hydrogen	Evaluate new technology and sponsor conferences on new processes and technology.
National Bioenergy Industries Association	238	275	Biopower/Biofuels Energy Systems[b]	Promote the deployment of biomass power technology.
United Bioenergy Commercialization Association	175	0	Biopower/Biofuels Energy Systems[b]	Encourage the development of biomass resources.
Biomass Energy Alliance	50	50	Biopower/ Biofuels Energy Systems[b]	Inform the public about biomass energy and disseminate information.
Geothermal Heat Pump Consortium	3,200	4,200	Geothermal	Provide deployment materials, limited R&D, data collection, and pilot demonstration grants for utilities.
Geothermal Energy Association	270	350	Geothermal	Foster communication, education, and training among companies of the U.S. geothermal industry and facilitate exports.
Geothermal Resources Council	147	155	Geothermal	Develop and convene special meetings, workshops, conferences, and courses pertaining to geothermal exploration, development, and utilization.
Energy Storage Association	0	40	Electric Energy Storage Systems	Prepare white papers on the use of energy storage in renewable systems.
American Wind Energy Association	656	661	Wind Energy Systems	Disseminate information to the wind industry and facilitate export of wind products and services.
Total	$5,919	$6,873		

[a]The fiscal year 1996 amount is comprised of $256,000 from Solar Thermal and $588,000 from Photovoltaics; the fiscal year 1997 amount is comprised of $256,000 from Solar Thermal and $600,000 from Photovoltaics.

[b]The services were performed for DOE's Biomass activity.

Source: Developed by GAO from DOE's data.

Competition for Solar and Renewable Energy Program Procurements, Fiscal Years 1996 and 1997

Table VI.1: Solar Buildings Technology Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory[a]	Laboratory inhouse/ outsourced[b]	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Quality Assurance[c]	0/100	Grant	50/50	Solar Rating & Certification Corp.
Technology Deployment[d]	50/50	Grant	50/50	Sacramento Municipal Utility District
Technology Development	60/40	Grant	100/0	National Renewable Energy Laboratory, University of Wisconsin

[a]Information in this table is typical of work performed and may be based on a typical project for each category. Outsourced includes interagency fund transfers, procurements through DOE entities, and laboratory subcontracts. Contracts with entities that operate the national laboratories are competitive and are shown in the competitive/noncompetitive column. Fiscal year 1996 data represent actual program implementation; fiscal year 1997 data represent a mix of implemented and planned, since some work is in the procurement process.

[b]Refers to funding agreements through contracts, subcontracts, grants, cooperative agreements, and CRADAs.

[c]Quality Assurance: Rationale for major noncompetitive procurement: The Solar Rating & Certification Corp. is a nonprofit organization established by the solar industry to develop standards by which solar water and solar pool heating systems can be rated. DOE has supported the development of tests by which the systems can be certified as meeting minimum standards of durability, reliability, safety, and operation. One task was the development of a computer model that simulated the testing of a solar water heating system; which involves determining the thermal efficiency, operating characteristics, and required electrical power to drive the system.

[d]Technology Deployment: Rationale for major noncompetitive procurement: The Sacramento Municipal Utility District initiated a program to sell solar water systems to their customers. DOE provided funds for technical assistance and instrumentation for a small number of those systems.

Table VI.2: Solar Buildings Technology Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Quality Assurance[a]	45/55	Grant	60/40	Solar Rating & Certification Corp.
Technology Deployment[b]	25/75	Request for proposals	70/30	National Association of Homebuilders Research Center
Technology Development[c]	55/45	Request for proposals, grants, and CRADAs	80/20	Energy Laboratory, Inc.

[a]Quality Assurance: Rationale for major noncompetitive procurement: The Solar Rating & Certification Corp. is a nonprofit organization established by the solar industry to develop a set of standards by which solar water and solar pool heating systems can be rated. DOE is supporting a task that will develop a methodology to determine the ability of solar water and solar pool heating systems installed on roofs to withstand hurricane winds.

[b]Technology Deployment: Rationale for major noncompetitive procurement: DOE is working with industry associations (e.g., the National Association of Homebuilders Research Center, National Spa and Pool Institute, and Solar Energy Industries Association) to hold workshops, conduct surveys, and develop materials that will educate homebuilders, pool builders, and utilities about the benefits of solar energy. This is expected to lead to cooperative projects with several builders and utilities. DOE would then provide technical information and instrumentation for selected field projects and share the costs of field validation projects.

[c]Technology Development: Rationale for major noncompetitive procurement: DOE has cooperative research and development agreements with companies developing a new selective-absorbing coating for solar collectors and a new low-cost solar water heating system.

Table VI.3: Photovoltaic Energy Systems Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive[a]	Typical partners (company names)
Fundamental Research				
Measurement & Characterization	100/0	[b]	100/0	National Renewable Energy Laboratory
Basic Research/ University Programs	60/40	Competitive request for proposal (RFP)	100/0	University of Utah
Advanced Materials & Devices				
Thin Film Partnerships	36/64	Competitive RFP	96/4	Siemens Solar Industries
Crystalline Silicon/High Efficiency Devices	63/37	Competitive RFP	94/6	Research Triangle Institute
Collector Research & Systems Development				
Manufacturing R&D (PVMaT)	8/92	Competitive RFP	100/0	ASE Americas
System Engineering & Reliability	68/32	Competitive RFP	84/16	Southwest Technology Development Institute
PV Integrated Building Opportunities (PV: BONUS)	0/100	Competitive RFP	100/0	Energy Conversion Devices, Inc.
Climate Change Action Plan (PV- COMPACT)	0/100	Competitive RFP	80/20	Utility Photovoltaic Group

[a]Major noncompetitive procurements typically are unique or special projects initiated through unsolicited proposals or are unique projects specified through congressional appropriations.

[b]The procurement mechanism was not identified by DOE.

Table VI.4: Photovoltaic Energy Systems Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive[a]	Typical partners (company names)
Fundamental Research				
Measurement & Characterization	100/0	[b]	100/0	National Renewable Energy Laboratory
Basic Research/ University Programs	60/40	Competitive request for proposal (RFP)	100/0	Johns Hopkins University
Advanced Materials & Devices				
Thin Film Partnerships	35/65	Competitive RFP	96/4	Solarex Corporation
Crystalline Silicon/High Efficiency Devices	60/40	Competitive RFP	94/6	California Institute of Technology
Collector Research & Systems Development				
Manufacturing R&D (PVMaT)	7/93	Competitive RFP	100/0	AstroPower, Inc.
System Engineering & Reliability	68/32	Competitive RFP	79/21	New Mexico State University
PV Integrated Building Opportunities (PV: BONUS)	0/100	Competitive RFP	100/0	Solar Design Associates
Climate Change Action Plan (PV-COMPACT)	0/100	Competitive RFP	80/20	Interstate Renewable Energy Council

[a]Major noncompetitive procurements are typically the result of unsolicited proposals for highly specialized or unique work or for unique projects specified in congressional appropriations.

[b]The procurement mechanism was not identified by DOE.

Table VI.5: Solar Thermal Energy Systems Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Thermal Systems Research/Thermal Systems Research	68/32	Laboratory subcontracts, CRADAs	98/2	3M, ELI
Power Applications Research/Dish/ Engine Development	9/91	Laboratory subcontracts	100/0	SAIC, Stirling Thermal Motors, Arizona Public Service
Power Applications Research/Power Tower Development[a]	18/82	Cooperative agreement	18/82	Southern California Edison, Bechtel, Rockwell
Power Applications Research/SolMaT Initiative	12/88	Laboratory subcontracts	100/0	SAIC, Rockwell, McDonnell Douglas
Power Applications Research/Systems & Industrial Assistance	71/29	Laboratory subcontracts	90/10	Kramer Junction, Harper Lake, Daggett Leasing

[a]Rationale for major noncompetitive procurements: The Solar Two Project (under Power Tower Development) was initiated by a consortium of U.S. utilities to retrofit the existing 10 MW_e Solar One Power Tower Pilot Plant to add molten-salt storage capability. Although noncompetitive, the consortium actively solicited membership and no interested industry participant was excluded. The consortium members had unique resources and expertise and prior experience with Solar One.

Table VI.6: Solar Thermal Energy Systems Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Thermal Systems Research/Thermal Systems Research	63/37	Laboratory subcontracts, CRADAs	98/2	3M, ELI
Power Applications Research/Dish/ Engine Development	11/89	Laboratory subcontracts	100/0	SAIC, Stirling Thermal Motors, Arizona Public Service
Power Applications Research/Power Tower Development[a]	30/70	Cooperative agreement	30/70	Southern California Edison, Bechtel, Rockwell
Power Applications Research/SolMaT Initiative	17/83	Laboratory subcontracts	100/0	SAIC, Rockwell, McDonnell Douglas
Power Applications Research/Systems & Industrial Assistance	61/39	Laboratory subcontracts, CRADAs	88/12	Kramer Junction, Harper Lake, Daggett Leasing

[a]Rationale for major noncompetitive procurements: The Solar Two Project (under Power Tower Development) was initiated by a consortium of U.S. utilities to retrofit the existing 10 MW_e Solar One Power Tower Pilot Plant to add molten-salt storage capability. Although noncompetitive, the consortium actively solicited membership and no interested industry participant was excluded. The consortium members had unique resources and expertise and prior experience with Solar One.

Table VI.7: Biopower/Biofuels Energy Systems Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Biofuels Energy Systems/Ethanol Production	67/33	Contract, cooperative agreements	70/30	Arkenol
Biofuels Energy Systems/Biodiesel Production[a]	34/66	Contracts, cooperative agreements	34/66	USDA Office of Energy
Biofuels Energy Systems/Feedstock Production	65/35	Contracts/ laboratory subcontracts	85/15	Oklahoma State University
Biofuels Energy Systems/Regional Biomass Energy Program[b]	1/99	Interagency agreements, grants, contracts	34/66	Shirel Lumber Company
Biofuels Energy Systems/ Thermochemical Conversion	100/0	Contract	100/0	Closeout of program
Thermochemical Conversion	89/11	Contract	100/0	[d]
Systems Development[c]	7/93	Contract	51/49	Westinghouse, Hawaii Cane & Sugar, Niagra Mohawk, Minnesota Valley Alfalfa Producers
Biomass for Cogeneration	OIT project	[d]	[d]	[d]
Municipal Solid Waste	OIT project	[d]	[d]	[d]

[a]Major noncompetitive procurements in the Biofuels/Biodiesel subcategory were small projects involving companies with unique capabilities together with cost-share opportunities.

[b]Major noncompetitive procurements for Regional Program, highly leveraged (cost-share) projects, addressing regional, state and local interests were identified and supported with state energy offices and the private sector involvement.

[c]Major noncompetitive procurements for Hawaii Direct Gasifier and Vermont Indirect Gasifier projects were one of a kind opportunities to demonstrate technologies and were awarded noncompetitively.

[d]Office of Industrial Technologies project. DOE did not provide any procurement information.

Table VI.8: Biopower/Biofuels Energy Systems Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Biofuels Energy Systems/Ethanol Production	60/40	Contracts, cooperative agreements	65/35	BC International
Biofuels Energy Systems/Biodiesel Production[a]	14/86	Contract, laboratory subcontracts	40/60	Columbus Food, National Biodiesel Board, American Sightseeing Company, Fats & Proteins Research Institute
Biofuels Energy Systems/Feedstock Production	50/50	Contract, laboratory subcontracts	85/15	U.S. Forest Service, Northcentral Forest Experiment Station
Biofuels Energy Systems/Regional Biomass Energy Program[b]	1/99	Interagency agreements, contracts, cooperative agreements, grants	35/65	Applied Agricultural Technologies
Thermochemical Conversion	100/0	Management & operating contract	100/0	[c]
Systems Development[d]	9/91	Contract	50/50	Westinghouse, Niagra Mohawk, Minnesota Valley Alfalfa Producers, Iowa Electric
Biomass for Cogeneration	OIT program	[e]	[e]	[e]
Feedstock Production	OTT program	[f]	[f]	[f]
Regional Program	OTT program	[f]	[f]	[f]

[a]Major noncompetitive procurements for the Biodiesel subcategory supported projects in which the proposers had unique capabilities and there was cost-sharing needed by the program.

[b]Major noncompetitive procurements for the Regional Biomass Energy Program focus on regional, state, and local opportunities, identified and co-funded with state and local agencies and the private sector.

[c]The work was performed inhouse.

[d]Major noncompetitive procurements for Hawaii Direct Gasifier and Vermont Indirect Gasifier projects were one of a kind opportunities to demonstrate technologies and were awarded noncompetitively.

[e]Office of Industrial Technologies program. DOE did not provide any procurement information.

[f]Office of Transportation Technologies. DOE did not provide any procurement information.

Table VI.9: Wind Energy Systems Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Applied Research/ Core Research	74/26	Subcontract	18/82	AWS Scientific, Embedded Systems, Airfoils, Inc.
Applied Research/ University Research	43/57	Subcontract	100/0	North Carolina A&T, Georgia Tech University, University of Illinois
Applied Research/ Wind Hybrid Systems	93/7	Subcontract	0/100	University of Massachusetts
Applied Research/ Avian Research	30/70	Subcontract	90/10	University of California, WEST, Inc.
Turbine Research/ Near Term Research and Testing	0/100	Subcontract	100/0	Cannon/Wind Eagle, Zond, R Lynette
Turbine Research/ Next Generation Turbine Project	0/100	Subcontract	100/0	Wind Turbine Co, Zond
Turbine Research/ Small Wind Turbine Project	0/100	Subcontract	100/0	Windlite, Cannon/Wind Eagle, World Power Tech, Bergey Windpower
Turbine Research/ Supporting Research, Testing, and Management	97/3	Subcontract	100/0	Ohio State
Cooperative Research and Testing/Industry Support	36/64	Subcontract	14/86	American Wind Energy Association
Cooperative Research and Testing/Certification and Standards	100/0	[a]	[a]	[a]
Cooperative Research and Testing/Utility Analysis	57/43	Subcontract	0/100	Princeton Economic Research Incorporated, Electrotek, AWS Scientific (U*WRAP)[b]
Cooperative Research and Testing/National Wind Technology Center Operations	67/33	Subcontract	100/0	Mountain Valley Energy

[a]The work was performed inhouse.

[b]Utility Wind Resource Assessment Program (U*WRAP).

Table VI.10: Wind Energy Systems Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Applied Research/ Core Research	53/47	Subcontract	13/87	AWS Scientific, NASA Ames, Mech Dynamics, Dynamic Designs
Applied Research/ University Research	24/76	Subcontract	100/0	North Carolina A&T
Applied Research/ Wind Hybrid Systems	63/37	Subcontract	41/59	University of Massachusetts
Applied Research/ Avian Research	58/42	Subcontract	38/62	Boise State University
Turbine Research/ Near Term Research and Testing	a	a	a	a
Turbine Research/ Next Generation Turbine Project	a	a	a	a
Turbine Research/ Small Wind Turbine Project	a	a	a	a
Turbine Research/ Supporting Research, Testing, and Management	85/15	Subcontract	100/0	McNiff Light Industry
Cooperative Research and Testing/Industry Support	63/37	Subcontract	12/88	American Wind Energy Association
Cooperative Research and Testing/Certification and Standards	71/29	Subcontract	33/67	Underwriters Laboratory, American Wind Energy Association
Cooperative Research and Testing/Utility Analysis	37/63	Subcontract	45/55	Princeton Economic Research Incorporated, Utility Wind Interest Group
Cooperative Research and Testing/National Wind Technology Center Operations	85/15	Subcontract	41/59	Mountain Valley Energy

[a]DOE did not provide procurement information for the turbine research subcontracts funded from uncosted obligations balances in fiscal year 1997.

Table VI.11: Geothermal Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Geothermal Electric				
Exploration/ Production Technology	80/20	Grants, contracts	95/5	Oxbow, CalEnergy, Caithness, Far West, Unocal
Drilling Technology	80/20	Contracts	85/15	Halliburtton, AZ Grant, Baker Hughes INTEQ, Security Diamond Products, Hughes Christensen, Unocal, Tonto, Schlumberger, International Logging
Hot Dry Rock Fenton Hill Experimental Site	50/50	Contracts	95/5	Project in closeout mode.
Energy Conversion Technology	80/20	Contract	95/5	CalEnergy, Pacific Gas & Electric, Unocal, Douglas Energy
Site Development Activities	0/100	Grants, cooperative agreements	0/100	Unocal, Calpine Corp., Northern California Power Agency, Pacific Gas & Electric
Geothermal Heat Pumps	80/20	Grants, cooperative agreements	95/5	Geothermal Heat Pump Consortium—over 100 member companies, consisting of utilities and service and equipment companies.

Table VI.12: Geothermal Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Geothermal Electric				
Exploration/ Production Technology	80/20	Grants, contracts	95/5	Oxbow, CalEnergy, Caithness, Far West, Unocal
Drilling Technology	80/20	Contracts	90/10	Halliburtton, AZ Grant, Baker Hughes INTEQ, Security Diamond Products, Hughes Christensen, Unocal, Tonto, Schlumberger, International Logging
Hot Dry Rock Fenton Hill Experimental Site	50/50	Contracts	95/5	Project in Closeout mode.
Energy Conversion Technology	80/20	Contract	95/5	CalEnergy, Pacific Gas & Electric, Unocal, Douglas Energy
Site Development Activities	0/100	Grant	0/100	Unocal, Calpine Corp., Northern California Power Agency, Pacific Gas & Electric
Geothermal Heat Pumps	80/20	Grant	95/5	Geothermal Heat Pump Consortium—over 100 member companies, consisting of utilities and service and equipment companies.

Table VI.13: Hydrogen Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Research and Development				
Production	66/34	Solicitation	95/5	Texaco, Air Products, SRT Inc., Praxair
Storage	68.5/31.5	Solicitation	100/0	A.D. Little, Energy Conversion Devices, Inc., Materials & Electrochemical Research Corp., Praxair
Utilization	61/39	Solicitation	100/0	International Fuel Cells Corp., DCH Technology, Inc.
Systems Analysis	32.6/67.4	Solicitation	85/15	National Hydrogen Association, Sentech, Hydrogen Fuel Cell Letter, Directed Technologies, 122 West Longitude
Technology Validation	38.5/61.5	Solicitation	100/0	City of Palm Desert, Dupont, Bluebird

Table VI.14: Hydrogen Program, Fiscal Year 1997

Amounts in percents

Budget category/subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Research and Development				
Production	55/45	Solicitation	95/5	Texaco, Air Products, SRT Inc., Praxair
Storage	53/47	Solicitation	100/0	Energy Conversion Devices, Inc., A.D. Little, Materials & Electrochemical Research Corp., Praxair
Utilization	47/53	Solicitation	95/5	International Fuel Cell Corp., DCH Technology Inc.
Systems Analysis	30/70	Solicitation	85/15	National Hydrogen Association, Sentech, Hydrogen Fuel Cell Letter, Directed Technologies
Technology Validation	25/75	solicitation	100/0	Teledyne Brown, International Fuel Cell Corp., MC Power, Energy Conversion Devices, Inc.

Table VI.15: Hydropower Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Hydropower Development	67/33	Competitive	97/3	Voith Hydro, Inc.

Table VI.16: Hydropower Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
Hydropower Development	45/55	Competitive	84/16	Alden Research Laboratory

Table VI.17: Electric Energy Systems and Storage Program, Fiscal Year 1996

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
High-Temperature Superconductivity Research & Development				
Superconductivity Partnership[a] Initiative	80/20	Cooperative agreements	100/0	Electric Power Research Institute, Reliance, Lockheed Martin
2nd Generation Wire Initiative[a]	100/0	CRADA	100/0	Midwest Superconductivity
Strategic Research[a]	90/10	CRADA	100/0	American Superconductor, Intermagnetics General, Southwire
Energy Storage Research & Development				
Integration	28/72	Competitive contract	75/25	GNB Technologies
Components	62/38	Competitive contract	75/25	JCI, ZBB
Analysis	69/31	Competitive contract	75/25	Frost & Sullivan
Electric & Magnetic Fields Research & Development[b]	56/44	Competitive contracts, grants	98/2	The member companies[c] of EEI, APPA, NRECA & NEMA

[a]There are no major noncompetitive procurements. The outsourced funding is for small laboratory subcontracts ($100,000 or less) to universities to obtain unique expertise needed by the program.

[b]Major noncompetitive procurement is the contract with the National Academy of Sciences (NAS) that is required by law (section 2118 of EPA Act). NAS provides scientific review of all completed research.

[c]Edison Electric Institute (EEI), American Public Power Association (APPA), National Rural Electric Cooperative Association (NRECA), and National Electrical Manufacturers Association (NEMA).

Table VI.18: Electric Energy Systems and Storage Program, Fiscal Year 1997

Amounts in percents

Budget category/ subcategory	Laboratory inhouse/ outsourced	Primary procurement mechanism(s)	Competitive/ noncompetitive	Typical partners (company names)
High-Temperature Superconductivity Research & Development				
Superconductivity Partnership[a] Initiative	80/20	Cooperative agreements	80/20	Electric Power Research Institute, Reliance, Lockheed Martin
2nd Generation Wire Initiative[a]	100/0	CRADA	100/0	3M, Midwest Superconductivity
Strategic Research[a]	95/5	CRADA	100/0	American Superconductor, Intermagnetics General, Waukeshau Electric
Energy Storage Research & Development				
Integration	12/88	Competitive contract	75/25	AC Battery Corp., Virginia Power
Components	29/71	Competitive contract	75/25	JCI, ZBB
Analysis	26/74	Competitive contract	75/25	Energetics
Electric & Magnetic Fields Research & Development[b]	48/52	Competitive contracts, grants	98/2	The member companies[c] of EEI, APPA, NRECA, and NEMA

Note: The tables in this appendix were developed by GAO from data provided by DOE.

[a]There are no major noncompetitive procurements. The outsourced funding is for small laboratory subcontracts ($100,000 or less) to universities to obtain unique expertise needed by the program.

[b]Major noncompetitive procurement is the contract with the National Academy of Sciences (NAS) that is required by law (section 2118 of EPA Act). NAS provides scientific review of all completed research.

[c]Edison Electric Institute (EEI), American Public Power Association (APPA), National Rural Electric Cooperative Association (NRECA), and National Electrical Manufacturers Association (NEMA).

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