

GAO

Report to the Chairman, Environment,
Energy, and Natural Resources
Subcommittee, Committee on
Government Operations, House of
Representatives

October 1991

FOSSIL FUELS

Improvements Needed in DOE's Clean Coal Technology Program



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Resources, Community, and
Economic Development Division

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The Honorable Mike Synar
Chairman, Environment, Energy,
and Natural Resources Subcommittee
Committee on Government Operations
House of Representatives

Dear Mr. Chairman:

As you requested, this report assesses the progress of the demonstration projects funded under the first three rounds of the Department of Energy's Clean Coal Technology Program. The report makes recommendations to the Secretary of Energy concerning effective use of program funds.

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

This work was performed under the direction of Victor S. Rezendes, Director, Energy Issues, who can be reached at (202) 275-1441. Other major contributors to this report are listed in appendix I.

Sincerely yours,



J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

Coal provides about 25 percent of the nation's energy needs, but emissions from coal combustion contribute to air pollution, particularly acid rain. In 1986 the Department of Energy (DOE) began implementing the Clean Coal Technology (CCT) Program to help the nation make greater use of its vast coal reserves. The program is intended to provide advanced, more efficient, and environmentally acceptable coal utilization technologies. Under this government-industry program, DOE funds up to 50 percent of the costs of industry-sponsored projects to demonstrate commercial-scale applications of innovative clean coal technologies. Industry and other nonfederal sources fund the balance.

Concerned about the effectiveness of the CCT Program and the manner in which it is managed, the Chairman, Environment, Energy, and Natural Resources Subcommittee, House Committee on Government Operations, requested that GAO determine (1) whether funded projects are experiencing delays, cost overruns, or performance problems; (2) why projects have been withdrawn from the program; (3) whether federal funds are being used effectively; and (4) whether DOE is adequately protecting its investment.

Background

The Congress has appropriated a total of \$2.75 billion for the CCT Program, which is being implemented through a series of competitive solicitations, or rounds of projects. DOE evaluates and selects projects on the basis of proposals submitted by sponsors in response to each solicitation. As of September 1991, three rounds of funded projects were in various stages of implementation. DOE selected round-four projects in September 1991. A fifth-round solicitation is planned for March 1992 and a sixth round has been proposed. In most of the projects, the coal is either cleaned before it is burned or burned in a different way, or the exhaust flue gases are cleaned after the coal is burned. The demonstrations, conducted by industry sponsors, are intended to generate design, construction, and operational data necessary for potential users to judge the commercial potential of the technologies.

Results in Brief

As of September 1991, about half of the 32 ongoing funded projects were progressing on schedule and within cost estimates. Fifteen projects had experienced delays, cost increases, and/or reductions in scope, and others were expected to have such problems. Equipment failures, additional equipment requirements, and problems in scheduling tests were contributing factors. Most projects were not far enough along for DOE to determine whether they will achieve their objectives. An additional 13

projects had been withdrawn because of financing and other problems; 5 of these had received DOE funds totaling about \$21.2 million.

GAO believes that DOE's selection of some projects, while meeting selection criteria, may not be the most effective use of federal funds. For example, some projects are demonstrating technologies that might have been commercialized without federal assistance. GAO also identified projects that might have limited potential for widespread use and projects that have proven not to be economically viable.

GAO also questions whether DOE has done all that it could to ensure that its investment is adequately protected. Specifically, DOE continued to fund some projects that it knew were experiencing financing problems and that were eventually withdrawn from the program. DOE has since improved controls over project costs. In addition, although DOE intends to recoup its investment by sharing in sales of demonstrated technologies, it has made several policy changes, because of industry complaints, that make such recovery less likely. Finally, DOE has not established procedures for independently reviewing sponsors' final project reports to ensure that they contain sufficient and accurate information for potential users of the technologies. DOE began developing such procedures during GAO's review and plans to complete them by late 1991.

Principal Findings

Many Projects Have Not Progressed as Planned

Of the 32 ongoing funded projects, 15 were not progressing as initially planned. They had fallen behind their scheduled milestones, incurred cost overruns, and/or scaled back the scope of their planned work for several reasons. Delays resulted from equipment failures, site availability problems, difficulties in scheduling tests around plant outages, and other factors. Cost increases occurred because of inflation; additional equipment requirements; and unexpected design, construction, or testing costs. Scope reductions generally resulted from cost increases.

Most ongoing projects have not progressed far enough for DOE to assess whether they will ultimately achieve their performance objectives. As of September 1991, only three projects had completed the demonstration phase. DOE believed that these projects had generally accomplished their objectives, although their testing plans had not been fully completed and

final project reports had not been issued for two of the projects. In addition to the ongoing projects, 13 other projects had been withdrawn from the program because the sponsors were unable to arrange or provide financing, obtain corporate management support, secure a project site, or come to terms with other participants. DOE had invested about \$21.2 million in five of the withdrawn projects.

Some Projects May Not Be the Most Effective Use of Federal Funds

Many of the projects are, or will be, generating design, construction, and operational data that may be useful to the private sector in deciding whether to use the technologies. However, DOE has funded some projects that may have limited potential for return on the federal investment. For example, to achieve a diversity of technologies, DOE selected some projects that will demonstrate technologies already in commercial use overseas or new combinations of commercially available technologies. Although further demonstration of these technologies may be warranted, GAO questions whether selection of these projects was the best use of limited federal resources because there is evidence that some of these technologies might have been commercialized without federal assistance. DOE does not assess whether technologies are likely to be commercialized without federal assistance before selecting projects.

DOE has also selected some projects that are demonstrating technologies that may not be widely used because they are not expected to reduce emissions by as much as existing technology does or because they serve a limited market of potential users. DOE selected these projects despite these limitations largely because it wanted to demonstrate a diverse mix of technologies. Such selections again raise questions as to whether DOE is making the most effective use of program funds.

In addition, DOE selected three projects even after questioning their economic viability during the proposal evaluation process, in order to obtain a mix of technologies. Because of such problems, the projects were subsequently withdrawn from the program. GAO believes proposals found to have serious economic viability problems during DOE's evaluation process are a poor risk and should be ineligible for selection.

DOE Needs to Better Protect Its Investment

DOE also funded cost increases on some projects that experienced financial difficulty after they were selected, and three of these projects were eventually withdrawn from the program. DOE has subsequently improved its management controls over project costs. A new policy on project funding will require that justifications for additional funding

include a cost-benefit analysis and a determination that the project will be completed if the additional funds are provided.

DOE requires that project sponsors eventually repay the federal investment in demonstration projects from revenues resulting from the subsequent use of the technologies. But DOE has reduced the likelihood of recouping its investment by reducing the percent of sales revenues subject to repayment, eliminating an inflation adjustment, and allowing repayment to be delayed. DOE made these changes in response to industry complaints and because of a concern that industry would reduce its participation in the program. DOE, however, has not analyzed the impact of industry's dissatisfaction on program participation or the effect of these changes on the likelihood of recovering its investment.

Finally, DOE's field organizations that administer the CCT Program have been inconsistent in their approach to evaluating project sponsors' reports and communicating the results of such evaluations to potential users. During GAO's review, DOE headquarters began to develop uniform procedures for reviewing and commenting on sponsors' final project reports and assessing the results of the demonstrations. DOE's independent evaluation could be an important factor in potential users' decisions on whether to buy the technology. DOE headquarters officials have met with field officials several times to discuss these matters and intend to establish such procedures but have not worked out the details.

Recommendations

As the program matures, GAO believes DOE needs to refine its project selection process to make the most effective use of the limited available resources. Specifically, GAO recommends that the Secretary of Energy (1) assess whether proposed projects will demonstrate technologies that might be commercialized without federal funds, (2) consider whether the potential market for a proposed technology is large enough to warrant demonstrating the commercial application of the technology with federal funds, and (3) avoid selecting projects that have financing or economic viability weaknesses. GAO is making other recommendations directed at recovering the federal investment in demonstration projects and improving reporting on the results of completed projects.

Agency Comments

GAO discussed the information in this report with DOE officials and incorporated their comments where appropriate. However, as requested, GAO did not obtain written agency comments on a draft of this report.

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Abbreviations

CCT	Clean Coal Technology
DOE	Department of Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
METC	Morgantown Energy Technology Center
NO _x	nitrogen oxides
PETC	Pittsburgh Energy Technology Center
SO ₂	sulfur dioxide

Introduction

Coal, an abundant energy resource, is used to meet about 25 percent of the nation's energy needs, and coal-burning power plants generate over 55 percent of the nation's electricity. However, coal combustion produces emissions of sulfur dioxide (SO₂) and nitrogen oxides (NO_x), which contribute to the formation of acid rain. Acid rain can damage forests, lakes, and streams. Coal combustion also produces emissions of carbon dioxide, which contributes to the concentration of "greenhouse gases" in the atmosphere. There is worldwide concern that the global climate may be changing as a consequence of increased atmospheric concentrations of carbon dioxide and other greenhouse gases.

To help furnish the energy-consuming marketplace with a number of advanced, more efficient, and environmentally acceptable coal utilization technologies, the Department of Energy (DOE), at the direction of the Congress, began implementing the Clean Coal Technology (CCT) Program in 1986. The program assists private sector, commercial-scale demonstrations of innovative coal technologies on a cost-share basis by funding up to 50 percent of a project's design, construction, and demonstration costs. The project's sponsor and other nonfederal participants provide the remaining funds. The program's broad goal is to accelerate the demonstration of emerging technologies and provide potential users with the information they need to judge the technologies' readiness and capabilities for commercial application. Some of these new technologies are designed for industrial use, but the most significant market is expected to be electric utilities with coal-fired power plants. We reported on the outlook for utilities' use of clean coal technologies in May 1990.¹

DOE, electric utilities, and the coal industry see clean coal technologies as a means to reduce the economic and environmental impediments that limit the full consideration of coal as a future energy source. The emission control technology currently used by U.S. coal-burning utilities—conventional flue gas scrubbing²—effectively reduces SO₂ emissions, but it is costly and labor-intensive and creates a large quantity of waste. Scrubbers also consume a portion of the electricity that the power plant generates. Clean coal technologies are expected to provide utilities and

¹Fossil Fuels: Outlook for Utilities' Potential Use of Clean Coal Technologies (GAO/RCED-90-165, May 24, 1990).

²Conventional flue gas scrubbing describes a number of processes for capturing sulfur dioxide. The utility's flue gas is exposed to lime or a limestone compound that reacts with and captures the sulfur in the gas, leaving the cleaned gas to be expelled through the smokestack.

industries with a range of more cost-effective options for reducing emissions, and some are expected to generate electricity more efficiently than conventional, coal-fired power plant technology. Other clean coal technologies are expected to expand the use of coal through processes designed to convert coal to liquid fuels or other fuel forms.

Clean Coal Technology Program

The Congress has appropriated a total of \$2.75 billion for the CCT Program to fund five solicitations (or rounds) of demonstration projects. About \$400 million was provided for round one of the program, \$575 million each for rounds two and three, and \$600 million for round four; an advance appropriation of \$600 million has been made available for round five. Legislation has been proposed in the Congress to allow DOE to use funds left over from clean coal solicitations to fund additional rounds of projects.

In issuing solicitations for project proposals, DOE identified the criteria and policy factors that it would use to evaluate proposed projects. The evaluation criteria were revised from round to round but they generally included (1) project factors, such as the project's adequacy and the technology's readiness for the proposed demonstration; (2) commercialization factors, including the sponsor's commercialization plan and the technology's potential contribution to emission reductions; and (3) business criteria, including the sponsor's plan for financing the project. Diversity of technical methods and approaches was a policy factor for project selection in the first four rounds.

As of September 1991, 33 projects remained in the program from the first three rounds (including 32 with cooperative agreements). Another 13 projects had been selected but were withdrawn from the program. DOE issued the round-four solicitation in January 1991 and received 33 proposals. Nine round-four projects were selected in September 1991. The round-five solicitation is scheduled to be issued by March 1, 1992, but may be delayed pending the outcome of congressional debate over when round five should start.

The round-one solicitation was directed at demonstrating a broad slate of technologies to enhance the use of coal for all market applications. It was open to technologies that were expected to burn coal more cleanly, efficiently, or economically than conventional technologies and to technologies that were intended to replace oil and natural gas. DOE issued its first solicitation in February 1986 and received 51 proposals. Of the nine projects that were initially selected, four were still in the program as of

September 1991, four had been withdrawn by the sponsors, and one had been terminated by DOE. Several other proposals were designated as potential replacement projects if needed. Of the eight replacement projects ultimately selected for funding, four were still in the program and four had been withdrawn. We issued two reports³ and testified twice⁴ on the status and problems of the round-one program.

The program's focus changed for the round-two solicitation. Round two's objective was to demonstrate innovative clean coal technologies capable of achieving significant reductions of SO₂ and NO_x emissions at existing coal-burning facilities and more cost-effective than conventional technologies in reducing emissions. The emphasis on a technology's emission reduction potential was linked to recommendations in a joint report by U.S. and Canadian special envoys that addressed environmental problems associated with transboundary air pollution.⁵ DOE issued the round-two solicitation in February 1988 and received 55 proposals. Of the 16 projects selected in September 1988, 12 were still in the program and 4 had been withdrawn. We reported on the round-two selection process in March 1990.⁶

DOE conducted its third solicitation in May 1989 and selected 13 projects in December 1989 from the 48 proposals submitted. Round three was open to technologies that are capable of achieving significant SO₂ or NO_x reductions at existing facilities and that could provide for future energy needs in an environmentally acceptable manner. The objectives of the fourth round are generally similar to the third-round objectives.

Clean Air Act Amendments of 1990

The acid rain provisions of the Clean Air Act Amendments of 1990 promote the use of clean coal technology. The amendments address the acid rain problem by requiring utilities to further reduce emissions from their coal-fired power plants. The new emissions requirements will be phased in, with the first phase starting in 1995 and the second in the year 2000. Utilities can obtain a 4-year extension, to December 31, 2003,

³Fossil Fuels: Commercializing Clean Coal Technologies (GAO/RCED-89-80, Mar. 29, 1989) and Fossil Fuels: Status of DOE-Funded Clean Coal Technology Projects as of March 15, 1989 (GAO/RCED-89-166FS, June 29, 1989).

⁴Views on DOE's Clean Coal Technology Program (GAO/T-RCED-88-47, June 22, 1988) and Status of DOE-Funded Clean Coal Technology Projects (GAO/T-RCED-89-25, Apr. 13, 1989).

⁵Drew Lewis and William Davis, Joint Report of the Special Envoys on Acid Rain (Jan. 1986).

⁶Fossil Fuels: Pace and Focus of the Clean Coal Technology Program Need to Be Assessed (GAO/RCED-90-67, Mar. 19, 1990).

for generating units that will be repowered with a qualifying clean coal technology to comply with the second phase of emission reductions.

Objectives, Scope, and Methodology

Concerned about the effectiveness of the CCT Program and the manner in which it is managed, the Chairman, Environment, Energy, and Natural Resources Subcommittee, House Committee on Government Operations, requested that we determine

- whether funded projects are experiencing delays, cost overruns, or performance problems;
- why projects have been withdrawn from the program, and how much DOE has spent on them;
- whether federal funds are being used effectively for this program; and
- whether DOE is adequately protecting its investment.

To address the first concern, we reviewed the status and progress of the 32 demonstration projects that were being funded under approved cooperative agreements as of September 1991. Our work was primarily conducted at DOE's Pittsburgh Energy Technology Center (PETC) and Morgantown Energy Technology Center (METC), which oversee the projects. We reviewed cooperative agreements, progress reports, and other relevant documents in the CCT Program offices and project files at the two energy centers to obtain information on which projects were behind schedule or experiencing higher costs, the extent of the delays and cost increases, why the problems occurred, and whether the projects had been scaled back or restructured. We also discussed these issues, and the actions taken to modify project cooperative agreements, with the project managers and other DOE officials at the two energy centers. In addition, we obtained DOE project managers' views on the general accomplishments of the three projects that were substantially completed as of September 1991. We also interviewed the sponsors of 11 projects to obtain further insight on their projects.

To address the second concern, we reviewed project and related files at the energy centers and met with DOE project managers and headquarters officials to determine why 13 other projects were withdrawn from the program and how much DOE had spent on them.

To address the concern about the effective use of federal funds, we discussed program management and policy questions, and project selection issues with DOE headquarters officials. We reviewed DOE's criteria and

congressional guidance on selecting projects. We also reviewed DOE documents on the evaluation of project proposals to determine whether DOE had concerns about the financial and economic viability of projects and the prospects for commercialization of the technologies at the time it selected the projects. In addition, we reviewed project and other files at the two energy centers to obtain information on the commercialization outlook for the demonstration technologies and whether similar technologies were in use or being tested elsewhere in the world.

Finally, to address the concern about the protection of DOE's investment, we reviewed DOE's policies and congressional guidance on providing additional funds to cover project cost increases and recovering the federal investment in projects. We discussed these policies, as well as DOE's plans for reviewing and accepting sponsors' final project reports, with DOE officials.

Our work was performed from August 1990 through September 1991 in accordance with generally accepted auditing standards. We discussed the information in this report with DOE officials and incorporated their comments where appropriate. However, as requested, we did not obtain written agency comments on a draft of this report.

Many Projects Have Experienced Problems in Design, Construction, or Operation

Although about half of the ongoing funded clean coal technology projects are progressing on schedule and within cost estimates, 15 projects have experienced cost increases, delays, and/or reductions in scope, and others are expected to have such problems. Equipment failures, site availability problems, additional equipment requirements, and problems in scheduling tests were among the factors that contributed to this situation. Three projects had completed operations as of September 1991, and although final performance reports had not been issued for two of these projects, the results looked promising for all three projects, according to DOE. However, most projects are not far enough along for DOE to determine whether they will meet their performance objectives. In addition, DOE invested about \$21.2 million in 5 of the 13 projects that were withdrawn from the program because of financing and other problems.

Status of Projects

Of the 33 projects in rounds one, two, and three of the CCT Program as of September 1991, 32 had approved cooperative agreements between DOE and the sponsor and 1 was in the process of formulating an agreement. Of the 32 projects with agreements, 10 were in the design phase, 13 were under construction, and 9 were in the demonstration phase,¹ as shown in table 2.1. Three of the nine projects in the demonstration phase had completed operations, and their sponsors were developing or had recently issued a final report on their performance and test results.

Table 2.1: Phase of Projects Under Agreements, as of September 1991

Phase	Number of projects			Total
	Round one	Round two	Round three	
Design	1	3	6	10
Construction	1	6	6	13
Demonstration	6	3	0	9
Total	8	12	12	32

¹Projects have three basic phases or budget periods: (1) design and permitting, (2) construction and startup, and (3) operation (demonstration). During the first phase, preliminary and detailed designs are completed and environmental and construction permits and licenses to build and operate the project are obtained. During the second phase, the site is prepared, equipment is obtained, the project is constructed, and the operational system is tested. The first two phases may overlap to avoid delays in obtaining and testing equipment. During the third phase, the project is operated and operational data are collected, analyzed, and reported.

Projects That Have Exceeded Their Expected Costs, Missed Milestones, or Reduced Their Scope

Many projects have not progressed in accordance with the original milestones and cost estimates set forth in the cooperative agreements between DOE and the projects' sponsors. Almost half (15) of the ongoing funded projects had exceeded their expected costs, fallen behind their scheduled milestones, and/or scaled back the scope of their demonstration activities. Projects experiencing such problems are shown in table 2.2.

Table 2.2: Projects With Cost Increases, Delays, or Reductions in Scope, as of September 1991

Project	Sponsor	Cost increase (millions)	Final completion date extended (months)	Scope reduced
Pressurized fluidized-bed combustion system (Tidd plant)	The Ohio Power Co.	\$26.0	21	No
Limestone injection multistage burner	The Babcock & Wilcox Co.	^a	13	Yes
Advanced cyclone combustor	Coal Tech Corp.	0.2	29	Yes
Coal quality expert computer model	ABB Combustion Engineering, Inc.		3	No
Circulating fluidized-bed combustor	Colorado-Ute Electric Assoc., Inc.		15	Yes
Gas reburning/sorbent injection	Energy and Environmental Research Corp.	^b	20	Yes
WSA-SNOX flue gas cleaning	ABB Combustion Engineering, Inc.		3	No
Low-NO _x cell-burner retrofit	The Babcock & Wilcox Co.	0.2	6	No
Pressurized fluidized-bed combustion system (Sporn plant)	The Ohio Power Co. & The Appalachian Power Co.		6	No
Gas suspension absorption system for flue gas desulfurization	Airpol, Inc.		12	No
SNRB flue gas cleanup	The Babcock & Wilcox Co.	0.8		No
Coal reburning for cyclone boiler NO _x control	The Babcock & Wilcox Co.	2.0		No
Blast furnace granulated-coal injection system	Bethlehem Steel Corp.		^c	No
Cement kiln flue gas recovery scrubber	Passamaquoddy Tribe	2.4		No
LIFAC sorbent injection desulfurization	LIFAC-North America		4	No

^aAbout \$553,000 was transferred from the demonstration phase to cover cost increases in the design phase, but the project's total cost estimate was not increased.

^bAbout \$5.9 million was transferred from the demonstration phase to cover cost increases in the design and construction phases, but the project's total cost estimate was not increased.

^cThe design phase of this project was extended 6 months, but the final completion date was not changed.

In total, 8 projects had exceeded their overall cost estimates and/or their design phase cost estimates, 12 had extended their final completion dates and/or their design phase completion dates, and 4 had reduced

their scope. Several of the 15 projects experienced more than one of these problems.

Projects That Have Experienced Cost Increases

As of September 1991, six ongoing projects had experienced overall cost increases that were projected to total about \$31.6 million, or 15 percent of their combined original estimated cost. The projects' sponsors agreed to absorb about \$28.9 million of the total increase and DOE funded about \$2.7 million.² Most of the increase occurred in one project in which the sponsor agreed to absorb the entire \$26-million projected cost increase. In the other five cases, both DOE and the sponsors contributed additional funds to cover the increase—DOE provided about \$2.7 million and the sponsors provided about \$2.9 million.

In two additional cases, DOE transferred about \$3.1 million of its funds and allowed the sponsors to transfer about \$3.4 million of their funds from the demonstration phase of the projects to the design and construction phases to cover higher costs in these phases. One of these projects is nearly completed and is expected to stay within its original overall cost estimate. However, the other project dropped one of its three sites after the design phase was completed and transferred all of the remaining funds for that site to its other two sites to keep the project's overall costs from increasing. Consequently, the construction and demonstration funds for the remaining two sites have been increased by about \$11 million, but the project's overall cost estimate has not changed.

DOE officials indicated that at least two other projects were expected to experience cost increases in their design and construction phases. They also indicated that further cost increases are likely as more projects move into the construction and demonstration phases, which tend to be the most costly phases.

Projects That Are Behind Schedule

Many projects have not progressed as quickly as originally planned. As of September 1991, 12 of the ongoing projects were behind schedule. DOE has amended their cooperative agreements, extending the final completion dates of 11 of these projects by 3 to 29 months and extending the design phase (but not the final completion date) of 1 other project by 6 months, as shown in table 2.2.

²DOE has the discretion under Public Law 99-190 to share in funding project cost increases. DOE can provide additional funds of up to 25 percent of its original investment in a project for this purpose if stipulated in the cooperative agreement.

One of the projects that was 6 months behind schedule is facing an uncertain future. DOE officials told us that the American Electric Power Company, which owns the companies cosponsoring the pressurized fluidized-bed combustion project at the Sporn plant, has determined that this project cannot be completed as planned. Preliminary engineering and design work has shown that it would be more technically and economically attractive to build a new plant, rather than repower the existing Sporn plant to increase capacity. However, the American Electric Power Company's current forecasts indicate that the company will not need new coal-fired, base-load electrical generation capacity until after the year 2000. DOE officials are considering a request from the project's cosponsors to significantly extend the design phase and restructure the project—which would delay the project's scheduled completion date by more than 5 years. These officials indicated that DOE had not yet decided whether this project will be continued or terminated.

According to DOE officials, at least three other projects are expected to experience delays. Two projects that were in the design phase were to be located in Tallahassee, Florida, but will now be built elsewhere because of opposition from citizens' groups and changes in the economic viability of the original sites. The site for an advanced integrated gasification combined cycle project was changed to another location in Florida, but DOE was still searching for a new site for a circulating fluidized-bed combustor project. The third project, designed to demonstrate emissions control at coke production facilities, was substantially constructed. However, we were told that this project will not be able to proceed into the demonstration phase in February 1992, as scheduled, because the sponsor (Bethlehem Steel Corporation) plans to shut down its coke production facilities at the project site for at least 2 years for economic and environmental reasons. The demonstration project cannot operate while the coke production facilities are idle.

In addition, DOE extended the design phase of two projects by 4 and 6 months to permit the sponsor to prepare, and DOE to process and approve, applications to start construction. However, these extensions have not delayed the projects because the sponsor started construction activities with its own funds. According to the sponsor's project managers, they had to maintain the construction schedules as originally planned to coordinate with scheduled shutdowns of the electric generating units on which the project will be demonstrated.

Projects With Reductions in Scope

For four projects, the scope of demonstration activities was reduced from that anticipated in the cooperative agreement. As mentioned above, the scope of one project was reduced considerably because costs had escalated so much that the demonstration planned for three sites will now be carried out at only two sites in order to stay within the overall project cost estimate. In another case, a project operated for about 100 hours less than planned because funds were exhausted, although DOE and the project sponsor concluded that the objectives of the project were generally accomplished. Two other projects did not complete all the tests planned, in one case to stay within the project's total cost estimate, and in the other to prevent further delays in completing the project sponsor's final report. DOE officials told us that the omitted tests were not needed to accomplish the projects' objectives.³

Reasons for Delays and Cost Overruns

Projects have not progressed as expected for a variety of reasons: Delays have resulted from equipment failures, site availability problems, and difficulties in scheduling project work around plant outages or other activities at the project site. Cost increases have occurred because of inflation, unexpected additional design, construction, or testing costs, and the need to install additional equipment that was not in the original project proposal. Sometimes such factors have triggered both delays and increased costs, and projects were then reduced in scope or withdrawn from the program. The following are examples of projects that experienced delays or cost increases.

- During the design phase of the first-round project that dropped a site, the sponsor (Energy and Environmental Research Corporation) identified higher costs for design and construction and additional equipment requirements that would have increased the project's overall costs considerably if the three sites had been retained. Because of the elimination of the construction and demonstration work planned for one site, the project was expected to stay within its originally approved \$30-million cost estimate. However, the project was expected to take at least 20 months longer to complete than initially scheduled because of additional time spent in completing the design work at the three sites, developing final cost estimates, satisfying environmental requirements, and resolving how to handle the cost increase.
- A first-round project sponsored by Coal Tech Corporation cost about \$200,000 more than originally anticipated and took more than 2 years

³Technical assessments of the impact of deleting or shortening planned tests were beyond the scope of our review.

longer than planned. Construction and equipment costs were higher than expected, and many problems occurred in getting the equipment to function properly. Also, the sponsor used the combustor in the clean coal project to perform tests not related to the project, and coordination problems in scheduling tests contributed to the delays. In addition, the sponsor took longer than planned to analyze the demonstration results and prepare the final project report.

- A first-round project sponsored by Colorado-Ute Electric Association, Inc., experienced operating problems resulting from boiler and auxiliary equipment malfunctions. Testing was halted for extended periods so that equipment could be repaired or replaced, and engineers needed additional time to determine why the problems occurred and how to correct them. As a result of these and other delays, the project's completion date was extended by 15 months.

It Is Too Early to Determine Whether Most Projects Will Meet Their Performance Objectives

Most projects in the CCT Program have not yet reached the demonstration phase. Therefore, it is too early to tell whether they will meet the performance objectives set forth in their cooperative agreements. Of the nine projects in the demonstration phase as of September 1991, three had completed operations. The sponsor of one of the completed projects issued a final report in late September 1991, but final reports on the other two projects were still being developed. According to DOE project managers, these three projects generally accomplished what they set out to do, although none of them fully completed their testing plans. Final determination of whether these projects achieved their objectives will have to await completion and DOE review of the final project reports.

Projects That Have Been Withdrawn From the Program

In addition to the ongoing projects that experienced problems, 13 projects selected in the first two rounds of the CCT Program have been withdrawn from the program. Eight were withdrawn by their sponsors during pre-award discussions without completing cooperative agreements. Therefore, DOE had not funded them. Generally, the projects withdrawn during the pre-award discussions were cancelled because the sponsors were unable to arrange or provide financing, obtain corporate management support, secure a project site, or come to terms with other participants.

The other five projects had completed cooperative agreements: four round-one projects were withdrawn in the design phase and a round-two project was withdrawn in the construction phase. DOE incurred costs of about \$21.2 million on these five projects, as shown in table 2.3.

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Table 2.3: Projects Withdrawn From the CCT Program After DOE Had Invested Money

Dollars in Millions		
Project	Sponsor	DOE's cost
Advanced slagging combustor	TRW, Inc.	\$7.6
Prototype commercial coal/oil co-processing plant	Ohio Clean Fuels, Inc.	5.4
Low-NO _x /SO ₂ burner retrofit for cyclone boilers	TransAlta Resources Investment Corp.	4.0
Underground coal gasification	Energy International, Inc.	3.3
Advanced coal gasification combined cycle power generation project	M.W. Kellogg Company	0.9
Total		\$21.2

Sponsors' financing difficulties also played a major role in the decisions to terminate the five funded projects. For example, the advanced coal gasification combined cycle power generation project was withdrawn from the program because the sponsor (M.W. Kellogg Company) was unable to formalize an agreement with a utility to buy the power to be generated by the project. Under the original project concept, the sponsor planned to design, build, and operate a plant to demonstrate the technology. However, the utility that was expected to purchase the electricity could not pay the price needed to make the project economically viable. With DOE approval the sponsor attempted to redesign the project and pursue another site. But the utility that planned to provide an existing plant and sell the electricity for the restructured project withdrew because of concern that it might have to meet more stringent environmental regulations if the technology was installed at its plant. The sponsor also attempted to place the project at another site, but found that the project would not have been economically viable at that location. The sponsor withdrew from the program in June 1989, after DOE had spent about \$900,000 on the project's preliminary design phase.

In another case, the low-NO_x/SO₂ burner retrofit project for cyclone boilers was recently withdrawn during the construction phase because the sponsor (TransAlta Resources Investment Corporation) projected that the project would incur major cost increases exceeding 70 percent. According to DOE, the cost increases related primarily to engineering and construction delays, and technical and other schedule problems. DOE also pointed out that pilot-scale tests of the low-NO_x/SO₂ burner produced inconsistent results that could not satisfactorily verify the burner's expected performance and contributed to the project's termination.

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The other three funded projects that were withdrawn from the program and the reasons for their withdrawal are discussed in more detail in chapters 3 and 4.

Some Projects May Not Be the Most Effective Use of Federal Funds

DOE selected projects representing a broad mix of technologies and potential users in each of the first three rounds of the program. Many of the projects are, or will be, generating design, construction, and operational data that should be useful to the private sector in making more effective pollution control and power-generating decisions in the future. However, DOE selected some projects that are demonstrating technologies that might have been commercialized without federal assistance or might have limited potential for widespread use beyond the demonstration project, and other projects that have proven not to be economically viable. Such projects may not be the most effective use of federal funds.

Some Technologies Might Have Been Commercialized Without Federal Aid

In evaluating project proposals, DOE considers whether the project is appropriate and relevant to (1) contribute to the enhancement of technologies, techniques, or processes and (2) provide new information to enable the private sector to make rational commercial decisions on using the particular technology. However, DOE may not be giving enough consideration to determining whether some of the technologies need to be demonstrated through the CCT Program or whether they have been or are being adequately demonstrated outside the program.

We identified some projects that will demonstrate technologies already in commercial use overseas or that are, in essence, new combinations of commercially available technologies. Although these were among the highest ranked proposals submitted for the particular category of technology, and further demonstration of such technologies may be warranted, we question whether their selection is the best use of limited federal resources. Three projects illustrate our concerns.

A third-round project sponsored by the Bethlehem Steel Corporation is to demonstrate the injection of granulated coal into blast furnaces to replace coke for steel-making—thereby reducing harmful emissions from coke production. Before selecting this project, DOE noted that the technology was already in use in several smaller scale blast furnaces in Great Britain. Furthermore, the project participants were already undertaking substantial efforts to market the technology and had established business relationships with potential users. DOE considered these factors to be strengths when it evaluated the technical readiness of the technology for demonstration and the project participants' commitment to commercialization. This project was the highest DOE-ranked proposal within its technology category and was also highly ranked among all the proposals. However, information that Bethlehem Steel provided to DOE

before the cooperative agreement was signed showed that this technology was projected to be sold commercially in the United States while the demonstration project was under construction. According to DOE officials, the project was funded anyway to demonstrate an industrial technology that can be used cost-effectively in a larger U.S. facility using U.S. coals.

A second-round project sponsored by Southern Company Services, Inc., (a subsidiary of Southern Company, which owns several electric utilities) is to demonstrate advanced overfire air and two types of low-NO_x burner technologies (separately and in combination) to reduce NO_x emissions at a tangentially fired 180-megawatt boiler.¹ These technologies have been tested separately in the United States and are commercially available. One of the low-NO_x burner technologies is already in use in the United States, and the other is being demonstrated at a 160-megawatt boiler in Italy. A Southern Company Services official told us that the company did not want to risk waiting for the results from the Italian project and decided to demonstrate these technologies on one unit in its system. If successful, the technologies could then be used on other units in its system in time to meet the NO_x emission requirements of the Clean Air Act. DOE officials said that the demonstration is needed to provide long-term operating data on the technologies' NO_x emission reduction capability because past demonstrations in the United States and Japan had provided only short-term data. They also indicated that the project is valuable as a first-time demonstration of the combination of these technologies on U.S. coal and equipment. However, the owner of the technologies believes that they have been sufficiently demonstrated and currently offers them for sale in the United States and overseas. According to a DOE official, this project strongly met most of DOE's evaluation criteria and was selected to help provide a diversity of technologies.

Lastly, a second-round project sponsored by Bethlehem Steel Corporation is to demonstrate SO₂ control at coke production facilities. This project consists of four component technologies that have already been demonstrated individually and in some combinations. DOE officials acknowledged that this was a relatively low-risk technology from a user's perspective but said this is the first time that all four technologies will be used together. According to DOE, the sponsor is using this project

¹Advanced overfire air controls NO_x formation by regulating the amount of air available during combustion, while low-NO_x burners control NO_x formation by regulating the fuel/air mix during combustion.

to meet state SO₂ emission requirements within the deadline established by a court order. DOE's evaluation of the project proposal noted that the sponsor had spent more than \$125,000 investigating the technological and economic feasibility of the technology and considered this factor to be strong evidence of the sponsor's commitment to the project. According to a DOE official, the project was selected to provide a diversity of technologies.

When we discussed the issue of whether some of the technologies would have been commercialized without federal assistance with DOE headquarters officials, they argued that the need to accelerate the demonstration of technologies to meet the Clean Air Act's requirements could lead to the selection of technologies close to commercialization. While we agree that acceleration of technology demonstration is an objective of the CCT Program, nothing prevents a sponsor that intends to expeditiously demonstrate a technology with its own funds from applying for DOE assistance. The availability of federal funds could be a substantial incentive for such sponsors to submit their projects for consideration. All projects that pass minimum eligibility requirements are evaluated and ranked for selection, and DOE makes no attempt to eliminate those projects likely to be funded without federal assistance. Although the evidence is not conclusive, DOE's selection of projects such as those discussed above raises concerns that DOE may be investing in technologies that could advance in the commercial marketplace without federal funding.

Some Projects Show Little Promise for Widespread Use

Demonstrating innovative technologies is not the only goal of the CCT Program—commercial acceptance of such technologies is the ultimate measure of the program's success, according to a DOE report. Although many of the technologies, if successfully demonstrated, should have potential for commercialization, some may not be widely used because of their limited potential to reduce emissions or the limited market of potential users.

As discussed in chapter 1, beginning with round two of the program, a major objective has been to select projects that can demonstrate technologies capable of achieving significant reductions of SO₂ and NO_x emissions from existing coal-burning facilities. However, as discussed in our March 1990 report,² DOE rated many of the round-two projects selected for funding as weak in their technology's potential to reduce SO₂ and/or NO_x

²GAO/RCED-90-67, Mar. 19, 1990.

emissions on a nationwide basis. Nevertheless, these projects were the highest ranked proposals submitted for the mix of technologies that DOE wanted to see demonstrated.

In our current review, we found that the technologies to be demonstrated in some of the funded round-two and -three projects were not expected to reduce emissions by as much as existing technologies do. For example, DOE's evaluation of two project proposals indicated that the technologies to be demonstrated were expected to reduce SO₂ emissions by 50 percent at the projects' sites. In comparison, conventional scrubber technology can reduce SO₂ emissions by 90 percent. These proposed technologies were expected to be more cost-effective than existing technology for reducing emissions (on the basis of cost-per-ton of pollutant removed), and the projects were among the highest rated proposals submitted for the mix of technologies that DOE wanted to see demonstrated. However, it is questionable whether the technologies will be widely used to meet the Clean Air Act's requirements for SO₂ emissions because existing technology can do the job better. This is particularly so if potential users want to accumulate emission credits for their own use or for sale to others by reducing emissions below legislative requirements.³ While we recognize that the first three rounds of projects were selected before the Clean Air Act Amendments of 1990 were enacted, many legislative proposals calling for stringent emission limits had been debated in the Congress before round-two and -three projects (which were to emphasize emission-reduction capability) were selected.

DOE officials indicated that utilities and industrial firms may choose to use a particular technology that does not reduce emissions as much as other technologies do if it involves a lower capital investment or can be used in combination with other options, such as switching to low-sulfur coal to reduce emissions. While we do not disagree, we question whether demonstrating such technologies through the CCT Program is the best use of federal funds.

In addition, some of the projects in the program are, or will be, demonstrating technologies that are directed at relatively small markets of potential users. For example, Bethlehem Steel's third-round granulated coal project, discussed earlier, is targeted towards a limited market of

³Under the Clean Air Act Amendments of 1990, utilities can accumulate emission allowances by reducing emissions below requirements. These allowances can be used to expand their systemwide capacity or can be sold to other utilities that may not be able to meet emission limitations.

potential users. Information the project sponsor submitted to DOE indicates that only 24 U.S. blast furnaces can potentially use this technology, and only 12 are actually expected to use it. DOE's evaluation of the project proposal ranked it highly but noted that the technology had limited potential to reduce nationwide SO₂ and NO_x emissions and would have a small effect on supplying future energy needs from coal. As already indicated, this project was selected to provide a diversity of technologies.

According to DOE, another highly ranked, round-two project sponsored by Southern Company Services, Inc.—to demonstrate a process using catalysts to substantially reduce NO_x emissions—is unlikely to be widely used to meet the Clean Air Act's requirements because of the technology's relatively high potential cost in comparison with low NO_x burners and other NO_x reduction technologies that are expected to meet the emission requirements. Commercialization of this project's technology also faces potential patent infringement obstacles in the United States. According to DOE, after the project was selected, two patent holders for commercially available catalysts declined to participate in the project, and DOE had to assume liability for potential patent infringement lawsuits against seven other catalyst suppliers to obtain their participation in the project. DOE believes the risk of a lawsuit during the demonstration is relatively low. However, DOE indicated that the patent holders want to market their catalysts in the United States and may take legal action to block commercialization of catalysts demonstrated in this project. According to DOE officials, this project was selected to provide a diversity of technologies and was funded, in spite of the legal obstacles, because DOE expects that catalyst suppliers will be willing to take the risk of commercializing successfully demonstrated catalysts if there is a demand for this technology.

Selection of the above projects may ensure demonstration of a diversity of technologies. However, DOE's funding of technologies with limited emission reduction potential or potentially limited markets raises questions as to whether DOE is making the most effective use of program funds.

Economic Viability of Some Projects Was Questionable When Projects Were Selected

DOE questioned the economic viability and financing of three projects but selected them anyway to obtain the mix of technologies that it wanted to see demonstrated. The economic viability of these projects depended on the sponsors' ability to sell the products produced by the demonstration projects, either during or after the demonstration phase. All three projects experienced financial difficulties because the sponsors could not find buyers for their products, and the projects have been withdrawn from the program or terminated, as discussed below.

DOE selected a round-one project to liquify coal and upgrade heavy oils to produce liquid fuels, even though DOE's evaluation of the project proposal noted that the sponsor's financing plan and ability to fund the project were unsatisfactory. The sponsor's original plan was to build and operate a commercial coal/oil co-processing plant at an existing site and sell the end product on the open market to refineries. But during the preliminary design phase, the projected cost of distributing the produced fuels increased significantly, affecting the project's economic viability. With DOE's approval, the sponsor (Ohio Clean Fuels, Inc.) attempted to restructure the project and find a utility that would buy the fuel and provide a demonstration site. However, the sponsor could not secure agreements for a buyer or a site. In June 1990, DOE suspended its financial participation in the project—after spending \$5.4 million—but allowed the sponsor additional time to relocate the project to improve its economic viability and attract other cost-sharing participants. The sponsor ultimately submitted a proposal to restructure the project under a consortium of three companies and link it to a refinery. However, DOE still had serious concerns about the prospects for obtaining private financing and terminated the project in June 1991. This project was the highest ranked project in its technology category and was relatively highly ranked among all the proposals. According to DOE officials, this project also was selected to help provide a diversity of technologies.

Another round-one project was to provide synthesis gas for an ammonia/urea plant to be designed, built, and operated with project funds. In selecting this underground coal gasification project, DOE noted in its evaluation that the sponsor (Energy International, Inc.) did not have firm financing commitments and the technology did not have much commercialization potential. During the design phase, the sponsor could not obtain private financial backing for the project. When the urea market declined, the sponsor proposed restructuring the project to produce ammonia only, but on a larger scale, to attract financial backing. Even after DOE approved the restructured proposal, the sponsor still

could not obtain financing for its share of the project, partly because the ammonia market also declined. In December 1989, the sponsor informed DOE that it could not proceed into the construction phase. The project was withdrawn from the program by the sponsor in December 1989, after DOE had spent about \$3.3 million during the design phase. This project was the only underground coal gasification project proposal submitted in round one and was ranked in the bottom half of all the proposals. According to DOE officials, it was selected to provide a diversity of technologies.

Finally, DOE selected a round-two coal preparation project to demonstrate the production and use of a coal water slurry fuel. However, DOE's evaluation indicated that the sponsor's financial condition, ability to fund the project, and financing plan were unsatisfactory. DOE noted that the sponsor (Otisca Industries, Ltd.) had a poor financial history and that there was no assurance that the sponsor would continue in business. DOE also noted weaknesses in the sponsor's plan for commercializing the technology. After 27 months of attempting to formalize a cooperative agreement, the sponsor withdrew this proposal from the program in December 1990 because of an inability to obtain private funding for the project. Although DOE did not obligate any funds to the project, the project used DOE staff resources and tied up funds tentatively dedicated to the project during the 27-month period. According to DOE officials, this project was chosen despite financial ability questions in order to provide a diversity of technologies. Although the project was the highest ranked coal preparation project, it was ranked in the bottom third of all round-two proposals.

Selecting projects such as those discussed above raises questions that DOE apparently let its desire for a broad mix of technologies outweigh serious concerns about the economic viability of the projects. DOE headquarters officials with whom we discussed these projects said that the projects probably would not have been selected using procedures now in place. On the basis of lessons learned in the early rounds of the CCT Program, they said that project financing has been given more emphasis and weight in evaluating and ranking round-three and -four project proposals. Also, sponsors and other project participants now have more time after the cooperative agreement is signed to better define the project, develop more realistic cost estimates, and obtain firm financial commitments. According to the officials, these changes should help minimize the risk of selecting projects with financing and economic viability weaknesses.

Although DOE's changes may help reduce this risk, projects with financing and economic viability problems could still be selected as long as they are ranked for selection consideration and other evaluation factors score well. We believe projects that are found to have serious concerns about economic viability during the proposal evaluation process are a poor risk for limited federal resources and should be ineligible for participation in the CCT Program.

Conclusions

In selecting projects, DOE gives greater weight to those projects that will demonstrate technologies most ready for commercial use. However, nothing prevents a sponsor who intends to develop and demonstrate a technology without federal funding from submitting a project proposal for consideration. It is up to DOE to make sure federal funds are spent where they will have the greatest impact. While the evidence is not conclusive, some of the technologies DOE selected may have been commercialized without federal funding. These selections raise questions about whether federal funds are being spent where needed most.

In selecting projects, DOE also attempts to obtain a diversity in terms of a mix of technologies to be demonstrated as well the types of potential users. This was at least a factor in DOE's selection of some projects whose technologies may have been commercialized without federal assistance. It was also a factor, if not a major reason, why several projects were selected to demonstrate technologies that may not be widely used, or were picked even though DOE recognized that the projects had serious economic viability weaknesses. Three projects with recognized economic viability weaknesses were ultimately withdrawn from the program or were terminated at a total cost to DOE of about \$8.7 million. Such selections again raise questions about whether DOE is achieving the most effective use of limited federal funds.

We recognize that demonstration of a diversity of technologies is an important program objective; however, it should not override sound selection decisions. In our March 1990 report on the evaluation and selection of round-two project proposals, we concluded that subsequent rounds of the CCT Program should focus on the most promising technologies. We continue to believe that this approach would help ensure the most effective use of federal funds.

Recommendations

To obtain maximum benefits from CCT Program funds, we recommend that the Secretary of Energy direct the Assistant Secretary for Fossil

Energy to take the following actions in evaluating and selecting additional projects:

- Include as a factor in project selection decisions an assessment of whether the technology to be demonstrated is likely to be commercialized without federal assistance and avoid selecting technologies that could advance in the marketplace without federal funding.
- Determine that the potential market for the proposed technology is large enough to warrant demonstrating the commercial application of the technology with federal funds.
- Make projects ineligible for selection if their financing or economic viability is in doubt.

DOE Could Better Protect Its Investment in Demonstration Projects

DOE has not always comprehensively considered whether projects were likely to be successfully completed when it provided additional funding to cover cost increases. Some projects were withdrawn from the program after receiving additional funds. DOE has also made several changes in its policy for recouping its investment in projects that will make it less likely that such investment will ever be recovered. In addition, DOE has not established procedures and guidelines to ensure that sponsors' final project reports provide sufficient and accurate information for potential users who are deciding whether to use the demonstrated technology.

DOE Continued to Fund Some Troubled Projects

Once a project is underway, it passes through several decision points (phases or budget periods) when DOE and the sponsor must decide whether to continue funding the project, or to scale back or terminate the project because of cost increases or other circumstances. DOE allowed some projects to continue even though the prospects for successfully completing the projects were in doubt. In some cases DOE and the sponsor used funds planned for later phases of the project to cover cost increases in earlier phases. In other cases DOE and the sponsor provided additional funds to cover cost increases.

Three of the round-one projects that were subsequently withdrawn from the program were provided with funds to cover cost increases in their design phase before they were terminated. For example, TRW, Inc., estimated in August 1989 that costs for its advanced slagging combustor project would increase by \$21 million (from \$49 million to \$70 million), and DOE granted time extensions from early January 1990 to late October 1990 (about 10 months) for TRW to complete the design work and obtain additional funding from other sources. DOE officials were aware by March 1990 that TRW might not have funds to continue into the construction phase. Nevertheless, in October 1990, even though DOE was aware that the project would probably have to be terminated, DOE again modified the agreement by extending the design phase to January 1991 and providing TRW with \$1.5 million for DOE's share of the cost increases. DOE officials estimated that \$900,000 of this amount was used to fund design-related cost increases and \$600,000 was used to help pay for a final project report. The project was terminated in January 1991, after DOE had invested a total of \$7.6 million. A DOE official told us that funding was continued in order to obtain a project report on the results of the design phase. He said the report provided information that should be useful to a third-round project demonstrating the same technology on a larger scale or to anyone interested in the technology.

In another case discussed earlier, Energy International, Inc., was unable to obtain financing for its underground coal gasification project because of a decline in the market for one of the project's end products. From August 1988 to August 1989, DOE shifted a total of about \$632,000 of its funds allocated for the construction and demonstration phases to the design phase while the sponsor attempted to redesign the project to make it more economically viable. The sponsor was still unable to obtain financing to begin construction and informed DOE in December 1989 that it could not proceed with the project. The project was withdrawn in December 1989, after DOE had spent about \$3.3 million on the design phase. Morgantown Energy Technology Center (METC) officials told us that they continued funding this project until it was withdrawn because the sponsor kept indicating that it could obtain financial backing and was continuing to put its own funds in the project. They said that in hindsight, however, the project could have been terminated sooner.

In some cases DOE scaled back or restructured projects because of projected cost increases. In other cases DOE gave sponsors time extensions to resolve problems with their projects without shifting funds among phases, providing additional funds, or scaling back the project.

DOE officials at the Pittsburgh Energy Technology Center (PETC) and METC told us that they considered the specific circumstances of each project in deciding how to handle cost increases and time extensions. However, beginning with round two of the program, DOE headquarters stopped allowing funds to be shifted among project phases to cover cost increases because of concerns that the demonstration period might have to be shortened to keep the project within overall cost estimates. DOE officials told us that DOE headquarters now monitors changes in project funding and scope of work. To increase DOE's funding or reduce the scope of a project, PETC and METC project managers must now submit justifications for additional funding and evaluations of the potential effects of proposed changes in project scope to DOE headquarters for review and approval. DOE officials said that they also monitor any significant project delays, but that changes in a project's schedule that do not involve additional funds do not need headquarters approval.

Because many projects have not reached the construction stage and additional projects will be selected, DOE may have more occasions to decide whether projects should be continued, scaled back, or terminated in the face of rising costs. DOE officials expect cost increases on at least two more projects and indicated that other projects are likely to experience cost increases as the program progresses. The officials said that

DOE planned to implement a new policy in October 1991 on the use of unobligated program funds, which will (1) include improved procedures for requesting additional funds to cover cost increases and project modifications and (2) require that such requests include a cost-benefit analysis of what is to be gained from the additional funding and a determination that the project will be successfully completed if the funds are provided. These changes, along with the prohibition on shifting funds from later project phases to cover cost increases, should help improve DOE's controls over project costs.

Changes to DOE's Recoupment Policy May Decrease the Prospects for Recovering the Federal Investment

DOE's policy is to recover its investment in clean coal technology demonstration projects through sharing in revenues from the subsequent use of the technology. However, because DOE has changed the way the recoupment payment is determined and shortened the repayment period, it is less likely to recover all of its investments in round-three projects.

For round-one projects, DOE's policy called for recoupment to come from the sum of (1) net revenues generated from project operations after the demonstration phase ends—such as the continued generation and sale of electricity—to be shared in proportion to the overall cost-share for the project¹ and (2) revenues from the commercial sale, lease, or licensing of the technology. However, the round-one recoupment requirements were not well received by project sponsors, and according to DOE, this dissatisfaction contributed to delays in formalizing cooperative agreements.

Responding to unfavorable comments from industry, DOE revised its recoupment policy in round two by eliminating the requirement that revenues from post-demonstration operations be used as a basis for recovering its investment. According to DOE officials, this requirement affected some sponsors' ability to obtain financing and was a factor in causing several of the round-one projects to be withdrawn from the program. DOE retained the provision basing repayment on revenues from the sale or licensing of the technology, but did not include leasing revenues as a source of repayment. Specifically, round-two repayment is to be based on

¹A project may or may not be dismantled at the completion of the cost-shared demonstration. However, the sponsor's decision on whether to dispose of the facility or to continue operating the facility at its own expense must be included in the project proposal.

- 2 percent of the gross revenues from the sale of equipment (in the United States and elsewhere) manufactured as the result of the demonstration technology's commercialization and
- 3 percent of the royalties that the technology owner receives from licensing the technology to other parties to sell.

A round-two change that strengthened recoupment provisions requires that repayment be adjusted for inflation. Repayment is to continue until the federal investment, adjusted for inflation, has been recovered or until 20 years have elapsed after the demonstration ends, whichever occurs first.

Beginning in round two, for purposes of recoupment, DOE and the sponsor are to mutually agree on the portion of a facility that represents the demonstration technology and establish a "technology envelope" around that portion to identify what is new. Repayment is to apply only to the portion of the technology that is identified as being inside the technology envelope. In some cases this technology envelope is so small that DOE may never receive any money from the commercialization of the technology. For example, the technology envelope for Bethlehem Steel Corporation's coke oven gas-cleaning project is the engineering effort or "know how" to connect four commercially available component units together. A DOE official told us that this is only a small portion of the project's cost. He said that since the envelope covers only the engineering effort to connect the systems, DOE will not get any repayment from the sale of the four components. DOE is funding about \$13.5 million of this project's \$45-million cost.

DOE weakened the likelihood of recovering its investment in round-three projects by

- reducing the percent of gross revenues from equipment sales subject to repayment from 2 percent to 0.5 percent;
- limiting repayment to sales of the demonstrated technology in the United States only;
- permitting a sponsor to negotiate a grace period from repayment of up to 5 years after the demonstration ends or until 10 percent of projected sales over the repayment period is attained, whichever occurs first, to facilitate introduction of the demonstrated technology into the marketplace;
- eliminating the requirement that repayment was to be adjusted for inflation; and

- adding a provision that project sponsors can forgo repayment if DOE determines that repaying the federal investment will place the sponsor at a competitive disadvantage in the domestic or international markets.

These changes could reduce the likelihood that the federal government will recover its investment. According to DOE officials, the changes were made because of industry's continued concerns about recoupment provisions. For example, the provisions allowing a grace period for beginning repayment and waiving repayment responsibility altogether were added to allow for the possibility that repayment could hamper the competitiveness of participants.

DOE's recoupment policy for round-three projects also included two provisions that could increase potential revenues subject to repayment. One provides that repayment can be based on 0.5 percent of the gross revenues from leasing equipment that is manufactured and embodies the demonstrated technology. This source of revenue had applied to round-one but not round-two projects. The other provision increased the percent of gross fees subject to repayment from the licensing of the demonstrated technology from 3 percent to 5 percent. However, DOE does not expect much repayment to occur from leasing revenue sources. Also, both provisions are subject to the grace period for repayment.

DOE has not analyzed how much industry's interest and participation in the CCT Program would have lessened if the recoupment provisions had not been weakened. DOE also has not analyzed the effect of these changes on the likelihood of recovering the federal investment in demonstration projects. Such analyses could provide an indication of the potential long-term costs to the federal government and confirm whether the weaker recoupment provisions are necessary to achieve adequate participation in the program. When we discussed recoupment with DOE headquarters officials, they said that little attention has been given to evaluating the implications of the changes in the recoupment provisions and that there is now a need to reevaluate this aspect of the program.

DOE Needs to Ensure That Sponsors' Final Project Reports Accurately Portray Demonstration Results

DOE has not established procedures for reviewing sponsors' final project reports and assessing the adequacy of the reported project results. It is in DOE's interest to ensure that these reports provide accurate and sufficient data on the design, construction, and operation of projects so that potential users can adequately judge the capabilities and commercial readiness of demonstrated technologies and make informed decisions on whether to use them.

As discussed in chapter 2, as of September 1991, three demonstration projects had been completed but the sponsors' final project reports had not been issued on two of these projects. A PETC-managed project was completed in June 1990, and the sponsor submitted a draft of its final project report to PETC for review in December 1990. PETC officials told us that the project manager and other members of their CCT Program staff had reviewed the draft report and returned it to the sponsor several times for revisions. The sponsor's report was accepted by DOE in August 1991 and was issued publicly in September. The officials also said that DOE would prepare and issue a separate evaluation report on the project. Another PETC-managed project was completed in August 1991, and PETC expected to receive a draft of the sponsor's final project report by December. A METC-managed project was completed in January 1991, and the sponsor submitted a draft of the final project report to METC in June 1991. A METC official told us that the draft report was reviewed by a group from within the CCT Program and research and development staffs. METC officials expected the sponsor's final report to be issued in the late fall, but they were not sure whether DOE would issue a separate evaluation report on the project.

During our review, DOE headquarters officials began to develop uniform procedures for PETC and METC to use in assessing the adequacy of sponsors' final project reports and preparing a separate DOE evaluation on each project. These officials had held meetings with the two energy centers to discuss the type of guidance needed but had not worked out the details. They said that PETC wanted to issue a separate evaluation report on each project or add a section to the sponsor's report providing PETC's views, but METC wanted to wait until all projects demonstrating a particular technology were completed and then issue a separate evaluation report on the technology. Also, the officials were uncertain as to how in-depth DOE's evaluation should be. The DOE officials did not expect to resolve these issues or have uniform procedures and guidelines in place until late 1991.

Conclusions

DOE shifted funds among project phases or provided additional funds to cover cost increases in some round-one projects, even though it had indications that the projects might be unable to proceed into the construction phase. Some of these projects were subsequently withdrawn from the program. Because DOE headquarters has stopped allowing funds to be shifted among project phases and has strengthened procedures for approving proposed changes in project scope and additional funding requests, we are not recommending any further action.

Although DOE's policy is to recover its investment in clean coal demonstration projects if the technology is commercialized, DOE has reduced its chances of recovering its investment by changing the basis used for determining the amount of repayment required from the sale or use of the technology and shortening the repayment period. These changes resulted from industry's continuing dissatisfaction with the recoupment concept. DOE, however, has not analyzed the impact of such dissatisfaction on program participation or the effect of the revised recoupment policy on the likelihood of recovering the federal investment. The results of such analyses could be useful in determining the potential costs of the recoupment policy's weaker provisions and whether such costs are necessary to achieve adequate participation in the program. Because the CCT Program provides a commercial showcase for technology developers, DOE should reconsider whether the repayment provisions need to be strengthened so as to provide reasonable assurance that DOE will recover its investment in successful projects.

Finally, DOE needs to continue its effort to establish appropriate uniform procedures for independently assessing and reporting on the adequacy of sponsors' final project reports, so that potential users can depend on the reported results.

Recommendations

We recommend that the Secretary of Energy direct the Assistant Secretary for Fossil Energy to take the following actions:

- Analyze the effect that recoupment provisions have had on industry participation in the CCT Program and the likelihood of recovering the federal investment. On the basis of this analysis, DOE should reevaluate its recoupment policy to determine whether it should be strengthened to provide greater assurance that the federal investment in successfully demonstrated technologies will be recovered.
- Complete the development of procedures for assessing and reporting on the adequacy of sponsors' final project reports.

Major Contributors to This Report

Resources,
Community, and
Economic
Development Division,
Washington, D.C.

Judy A. England-Joseph, Associate Director
Gregg A. Fisher, Assistant Director
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Related GAO Products

Energy Reports and Testimony: 1990 (GAO/RCED-91-84, Jan. 1991).

Energy: Bibliography of GAO Documents January 1986-December 1989
(GAO/RCED-90-179, July 1990).

Fossil Fuels: Outlook for Utilities' Potential Use of Clean Coal Technologies
(GAO/RCED-90-165, May 24, 1990).

Utilities' Potential Use of Clean Coal Technologies (GAO/T-RCED-90-56,
Mar. 28, 1990).

Fossil Fuels: Pace and Focus of the Clean Coal Technology Program
Need to Be Assessed (GAO/RCED-90-67, Mar. 19, 1990).

Perspectives on the Potential of Clean Coal Technologies to Reduce
Emissions From Coal-Fired Power Plants (GAO/T-RCED-90-3,
Oct. 18, 1989).

Fossil Fuels: Status of DOE-Funded Clean Coal Technology Projects as of
March 15, 1989 (GAO/RCED-89-166FS, June 29, 1989).

Status of DOE-Funded Clean Coal Technology Projects (GAO/T-RCED-89-25,
Apr. 13, 1989).

Fossil Fuels: Commercializing Clean Coal Technologies (GAO/RCED-89-80,
Mar. 29, 1989).

Views on DOE's Clean Coal Technology Program (GAO/T-RCED-88-47,
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