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Report to the Chairman, Subcommittee on Energy and Environment, Committee on Science, House of Representatives

June 1996

ENERGY RESEARCH

Opportunities Exist to Recover Federal Investment in Technology Development Projects

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Resources, Community, and
Economic Development Division

B-271732

June 26, 1996

The Honorable Dana Rohrabacher
Chairman, Subcommittee on Energy and Environment
Committee on Science
House of Representatives

Dear Mr. Chairman:

The Department of Energy (DOE) is involved in many cost-shared technology development programs with the private sector. In general, a major objective of such programs is to help promote the development and commercialization of more efficient, environmentally attractive, and affordable technologies that will better utilize the nation's energy resources and enhance opportunities for domestic economic growth and employment. In view of the increasing importance of using creative methods to fund technology programs under today's budgetary constraints, you requested that we (1) determine the extent to which DOE requires repayment of its investment in cost-shared technology development, including the similarities and differences in the mechanisms used, and (2) identify the advantages and disadvantages of repayment. We focused most of our work on four DOE offices—Fossil Energy, Energy Efficiency and Renewable Energy, Environmental Management, and Nuclear Energy—because they fund most of the Department's cost-shared technology development programs and projects involving contracts and cooperative agreements.

Results in Brief

DOE generally does not require repayment of its investment in cost-shared technology development projects. We identified four programs in DOE that require repayment of the federal investment if the technologies are commercialized. The offices we reviewed plan to devote about $8 billion in federal funds to cost-shared projects, of which about $2.5 billion is subject to repayment. The four programs are the (1) Clean Coal Technology Program, which accounts for about 90 percent of the funds subject to repayment; (2) Metals Initiative Program; (3) Electric Vehicles Advanced Battery Program; and (4) Advanced Light Water Reactor Program, which requires repayment for some projects.

DOE recoups its investment under all four programs through royalties and fees paid under licensing agreements. A percentage of revenues from commercial sales of technologies is also applied toward repayment in

three of the programs and to a limited extent in the Advanced Battery Program. The Metals Initiative Program allows for the recovery of 150 percent of the federal investment, while the other three programs are limited to 100 percent.

The major advantage of having a repayment policy is that the federal government could recover some of its investment in successfully commercialized technologies. However, according to DOE officials, repayment could also discourage some in industry from commercializing technologies or participating in projects, create an administrative burden on both DOE and industry, and cause technologies to become less competitive in the marketplace. We believe many of the disadvantages can be mitigated by structuring a flexible repayment requirement with the disadvantages in mind. Because opportunities exist for substantial repayment in some of DOE's programs, requiring repayment would allow the government to share in the benefits of successfully commercialized technologies that could amount to hundreds of millions of dollars.

Background

DOE and the private sector are involved in hundreds of cost-shared projects aimed at developing a broad spectrum of cost-effective, energy-efficiency technologies that protect the environment; support the nation's economic competitiveness; and promote the increased use of oil, gas, coal, nuclear, and renewable energy resources. Universities and national laboratories also participate in many of these government-industry collaborations. Most of the projects that involve technology development beyond basic research are funded under cost-shared contracts, cooperative agreements, and cooperative research and development agreements (CRADAs).

The offices in our review are funding more than 500 projects under contracts and cooperative agreements with industry that are expected to cost more than $15 billion by the time they are completed. DOE plans to fund about $8 billion and industry the balance. The four programs that require repayment cover about 60 projects. The other programs cover more than 450 projects.

Four DOE Programs Have a Repayment Policy, and the Repayment Mechanisms Are Similar

Although DOE participates with the private sector in many cost-shared technology development programs, only four require repayment of the federal investment if the technology is ultimately commercialized. The mechanisms used for repayment are similar in that they generally require a portion of royalties and fees from licensing technologies and revenues from commercial sales.[1] Also, three programs provide for up to a 20-year repayment period and two allow flexibility on when repayment begins. A major difference in the programs is that one program provides for up to 150-percent repayment, while the other programs limit repayment to 100 percent.

Clean Coal Technology Program

The Clean Coal Technology Program is a partnership between the federal government and industry for sharing the costs of commercial-scale projects that demonstrate innovative technologies for using coal in a more environmentally sound, efficient, and economical manner. DOE is investing more than $2.2 billion in this program through the year 2003. The funds have been committed under cooperative agreements to more than 40 active and completed projects that were selected in five separate rounds of nationwide competitions for project proposals conducted from 1986 to 1993. DOE funds up to 50 percent of a project's cost, and the nonfederal participants fund the balance. Most of the projects are currently in the design, construction, or operation phases.

In 1985, when the program began, DOE made a programmatic decision in consultation with industry and the Congress to require the participants in the clean coal projects to repay the federal investment in projects within 20 years after a project ends if the technology is commercialized. For projects selected in the first round of competition, repayment was to come from (1) any net revenues generated from continued project operations and (2) revenues accruing from the commercial sale, lease, manufacture, licensing, or use of the technology. During rounds two and three, DOE changed the repayment provisions to respond to the industry's concerns and lessen the likelihood that the repayment requirements could hamper the project participants' competitiveness. Among other things, DOE (1) excluded net operating revenues as a required source of repayment, (2) reduced the percentage of revenues from technology sales that are

[1]DOE's national laboratories and energy research centers can receive royalties and fees from licensing patents for inventions, processes, and services that are developed under cost-shared CRADAs and other mechanisms. Although the provisions covering these agreements can also constitute a form of repayment, they are designed to provide the government with a way to share in the success of a technology and are independent of the government's contribution to the underlying technology. As agreed with your office, we excluded CRADAs as a specific focus of this review because there is no transfer of federal funds to industry participants.

subject to repayment, (3) excluded foreign sales from repayment, (4) eliminated an inflation adjustment requirement, (5) allowed a grace period before repayment begins to facilitate the technology's initial market penetration, and (6) provided for a waiver from repayment altogether if repayment would place the participants at a competitive disadvantage in the marketplace.[2]

According to DOE officials, three clean coal projects with a federal investment of about $36.2 million have progressed to the repayment phase. As of March 1996, DOE had received payments totaling about $377,000 for these projects.

Metals Initiative Program

Under the Metals Initiative Program, DOE shares in the cost of research and development projects intended to increase the energy efficiency and enhance the competitiveness of the domestic steel, aluminum, and copper industries. The projects are carried out under cooperative agreements. Industry is required to provide at least 30 percent of the funding, and DOE provides the balance. Industry participants establish a holding company for each project for the purpose of holding patents, licensing technology, tracking technology sales and use, and collecting and distributing licensing fees and other income.

Appropriations laws require repayment of the total federal investment up to one and one-half times (150 percent) from the proceeds of the commercial sale, lease, manufacture, or use of technologies developed under the program. The Metals Initiative Program is the only program that requires repayment that exceeds DOE's investment. According to DOE, repayment applies to all sales—domestic or foreign. As of September 1995, DOE had spent or obligated about $89 million for projects under this program. Although some patent applications have been filed and some licensing agreements have been negotiated, none of the projects have begun repayment yet, according to DOE officials.

Electric Vehicles Advanced Battery Development Program

In early 1991, Chrysler, Ford, and General Motors established the United States Advanced Battery Consortium to jointly sponsor research and testing to develop advanced batteries for electric vehicles. Later that year, DOE and representatives of the utility industry agreed to work together

[2]Changes in repayment provisions during the program and their potential implications are discussed in two prior GAO reports—Fossil Fuels: Lessons Learned in DOE's Clean Coal Technology Program (GAO/RCED-94-174, May 26, 1994) and Fossil Fuels: Improvements Needed in DOE's Clean Coal Technology Program (GAO/RCED-92-17, Oct. 30, 1991).

with the consortium under a cost-sharing arrangement. DOE is providing 50 percent of the funding, and the other 50 percent is being provided by the participating automobile companies, utilities, and battery developers. According to DOE, current plans call for federal contributions amounting to about $103 million for funding this research through 1996. DOE expects to approve additional funding for the continuation of the research after the consortium submits a proposal identifying its funding needs.

As discussed in our August 1995 report,[3] DOE is entitled to repayment of its financial contributions to the consortium if the advanced batteries are commercialized. Repayment is recommended in a Senate appropriations report. Under the terms of the cooperative agreement between DOE and the consortium, DOE's investment is to be repaid based on (1) the revenue received by the consortium or its battery developers from the licensing of patents to third-party domestic or foreign battery manufacturers and (2) any payments to the consortium or its contractors upon the liquidation or winding up of its business. In addition, one of the consortium's battery development contracts provides for repayment to DOE based on revenues from the domestic or foreign sale of batteries by the developer. The repayment period ends after DOE's total contribution has been repaid, or 20 years, whichever occurs first. The repayment obligation can be waived, in whole or in part, if DOE determines that repayment places the consortium or its battery developers at a competitive disadvantage. Three of the eight battery development contracts provide that repayment will not begin until battery sales by the developer and/or licensee reach a specified level.

Advanced Light Water Reactor Program

The reactor program focuses on making standardized advanced light water reactors available for orders during the 1990s to help meet the projected demand for new electrical generation capacity by 2010. DOE provides up to 50 percent of the funding for projects carried out with industry, and industry provides the balance. According to DOE, in 1986 when this program was begun, repayment was not considered because the main objective was to reduce the licensing and regulatory impediments that were contributing to extensive delays in the construction and permitting of nuclear power generating facilities. The objective evolved into a certification of advanced light water reactor designs to help restore the industry's confidence and reduce the financial risks in acquiring new nuclear plants at the appropriate time in the future. The repayment

[3]Electric Vehicles: Efforts to Complete Advanced Battery Development Will Require More Time and Funding (GAO/RCED-95-234, Aug. 17, 1995).

provisions covering domestic or foreign sales have been incorporated into two programs that are part of the Advanced Light Water Reactor Program.

In one of these programs—the advanced reactor design certification program—the Congress provided $14 million in additional funding for a specific contract, and an appropriations report recommended that this additional federal cost should be repaid from royalties on the first commercial sale of the reactor design. DOE will require repayment of this amount. DOE subsequently agreed to provide another $11 million in additional funding and may require that this amount be repaid, as well as any additional future funding provided under this contract. DOE's original contractual commitment of about $50 million is not subject to repayment. According to DOE officials, the Department also may provide for the recovery of any federal contributions in excess of the original $50 million commitment under another contract in the advanced reactor design certification program.

The other program—the "first-of-a-kind" engineering program—involves a cooperative agreement between DOE and the Advanced Reactor Corporation. According to DOE, in the development of this program, the participating electric generating utilities made a major commitment to provide cost-share funding and overall direction and technical advice to achieve a plant design that they would be willing to acquire at some future time. Because of their direct, substantial contributions to the plant designs, the utilities require reactor vendors to pay them royalties from the sale of the plant designs or technology to other customers. Since the utilities were going to require royalty payments, DOE decided to also require royalties proportionate to its share of the project's total costs. The cooperative agreement requires that DOE be repaid up to its total investment from the revenues received by the Advanced Reactor Corporation from the sale or use of the plant designs or technology developed under this program. The repayment period runs up to 20 years, or until the federal investment, which is expected to total $100 million, is repaid.

Advantages and Disadvantages of a Repayment Policy

A repayment policy provides both advantages and disadvantages. The main advantage is the recovery of the federal investment. We believe that many of the disadvantages and arguments against repayment can be mitigated by structuring a flexible policy that provides criteria and factors to consider in determining the application of repayment to individual programs or projects.

In 1991, DOE considered having a Department-wide policy to recover its investment in technology development projects and even developed a draft order with criteria and guidelines for determining when repayment is appropriate. But due to substantial opposition within the Department and the departure of the Deputy Secretary who was the primary supporter of this concept, the order was never implemented.

Advantages

The primary advantage of a repayment policy is that the government could recover some of its investment in the development of technologies. According to several DOE officials, a repayment requirement could also provide more assurance that the project proposals are sound and economically viable by discouraging proposals that are too marginal financially for their sponsors to commit to repayment.

As previously mentioned, the DOE offices in our review are funding projects with industry that are expected to cost more than $15 billion by the time they are completed. DOE's share of the planned funding is expected to total about $8 billion, and the nonfederal share about $7 billion, as shown in table 1. About $2.5 billion of the $8 billion is subject to repayment.

Table 1: Total Planned Funding for Cost-Shared Technology Development Projects Involving Contracts and Cooperative Agreements Within Four DOE Offices

Dollars in millions

	DOE's share				
Office	**Amount subject to repayment**	**Amount not subject to repayment**	**Total DOE planned funding**	**Nonfederal share**	**Total DOE and nonfederal share**
Fossil Energy	$2,232.3	$4,337.5	$6,569.8	$5,249.0	$11,818.8
Energy Efficiency and Renewable Energy	144.9	838.3	983.2	1,259.0	2,242.2
Environmental Management	0.0	46.3	46.3	18.0	64.3
Nuclear Energy	114.0	267.9	381.9	595.2	977.1
Total contracts and cooperative agreements	**$2,491.2**	**$5,490.0**	**$7,981.2**	**$7,121.2**	**$15,102.4**

Note: The amounts are in nominal dollars and represent the total funds spent and planned for active projects. DOE spent about $60.9 million for completed or terminated projects under the Metals Initiative Program.

Source: Prepared by GAO using DOE's data.

Except for the projects within the four programs that already require repayment, it is important to note that, for a variety of reasons discussed later, not all of the projects contained in the table would lend themselves to repayment. In addition, unless follow-on projects are undertaken, requiring new or amended contracts or cooperative agreements, only new projects not yet negotiated with industry would be appropriate for repayment.

While the potential repayment is difficult to quantify, DOE documents developed when the 1991 draft repayment policy statement was under consideration indicated that the potential is substantial. To illustrate the potential for repayment, we subtracted the approximately $2.5 billion in federal funding included in table 1 for projects already covered by repayment provisions from the approximately $8 billion total planned federal funding. The remaining cooperative agreements and contracts amount to about $5.5 billion. If one assumes that only 50 percent of this amount is dedicated to projects that would lend themselves to repayment, and that about 15 percent of research and development funds result in commercialized technologies (which DOE officials say is about average), then about $400 million could come back to the federal government in the form of repayment.

In discussing technology development programs and projects with DOE's Deputy Assistant Secretaries and other DOE officials, many of them agreed that certain types of projects might be appropriate candidates for repayment of the federal investment if the concept was employed at the beginning of the projects or new projects are undertaken in the future. The officials generally indicated that repayment should be more applicable to projects with a large federal investment where the federal contribution is easily identified, projects involving technologies that are close to commercialization, and projects in which the federal investment serves to reduce the costs and risks of providing the technology to potential users. The officials also said that technologies that have a large potential market and technologies that are likely to be commercialized in foreign countries are good candidates for requiring repayment of the federal investment. Some officials said that repayment should be directed at projects that have large, well-financed industry teams.

DOE officials indicated, for example, that the Reservoir Class Field Demonstration Program might be appropriate for repayment if future projects are undertaken. This program shares costs for demonstrations of existing and new technologies for increasing production from U.S. oil

fields that might otherwise be prematurely abandoned. The program operates on the premise that the characteristics of some oil formations are similar, and when small and major oil producers demonstrate technologies and processes that are successful in increasing production, other oil field operators may want to try them in their fields. Three rounds of demonstration projects have been undertaken, and more may be undertaken if funding becomes available. DOE has committed about $100 million to the 29 projects that are currently in the program. According to DOE, the projects may take from 3 to 7 years to complete.

The Advanced Turbine Systems Program is another program that DOE officials said might be appropriate for repayment if new projects are begun or current projects are amended. This program is intended to develop more efficient, advanced turbine systems for both utility and industrial electric power generation. According to DOE, the program is expected to cost about $700 million by the time it is completed in the year 2000. Depending on appropriations, DOE is planning to fund about $450 million of the total estimated cost, and industry participants are expected to fund the balance.

New cost-shared technology demonstration and commercial application programs authorized by the Energy Policy Act of 1992 would also be appropriate candidates for repayment if they are funded. In fact, the act requires DOE to establish procedures and criteria for the repayment of the federal investment in several authorized coal projects, but they have not been funded.

Many of the DOE officials we spoke with generally indicated a willingness to consider repayment, but they said that flexibility should exist to be able to structure or waive repayment to meet programmatic needs. Some officials believed that repayment may not be suitable for grants, universities, and small businesses or for projects that are directed at basic research. Others indicated that repayment should be waived if the federal investment is considered disproportionately small in comparison with the potential costs of administering the repayment process. Some DOE officials said that a stronger argument can be made for repayment if the technology developed is likely to be commercialized outside of the United States.

Appendix I provides a more detailed discussion of the types of projects that DOE officials believe would be the most appropriate or suitable for repaying the federal investment.

Disadvantages

DOE officials we spoke with and DOE's 1991 draft document on repayment policy also pointed out several disadvantages to the government or industry participants that would need to be addressed. These disadvantages, along with potential ways to structure repayment so as to mitigate the disadvantages, are discussed below.

According to DOE, most technologies funded by the Department require further development and/or funding to bring them to the marketplace after DOE's participation is complete. Some DOE officials believe that repayment could lower industry's rate of return on investment and discourage industry, especially small businesses, from commercializing such technologies. The officials also believe that repayment might discourage industry from participating in cost-shared technology development projects in technological areas that DOE wants to promote. In our October 1991 report, we recommended that DOE study the effect that repayment provisions have had on the industry's participation in the Clean Coal Technology Program. DOE agreed to do this but has not completed its study. Although a repayment requirement might have some influence on the timing of commercialization or participation in technology development projects, industry participants would not have to repay the federal investment unless the technology is commercialized. Therefore, repayment should be more favorable to industry than other sources of funding, such as a bank loan, which would have to be repaid with interest regardless of whether the technology is commercialized. According to a former DOE Deputy Secretary who supported the expansion of repayment programs, businesses expect some form of repayment as a normal cost of doing business.

DOE officials generally believe that repayment would create an administrative burden in negotiating, administering, auditing, and enforcing cost-sharing and repayment agreements. Both DOE and industry participants would need to establish a recordkeeping system for tracking the sales and use of technologies long after a project ends (up to 20 years in three of the programs that require repayment). According to DOE, the administrative and auditing costs may not make it worthwhile to pursue repayment. We believe one way of making the administrative burden less onerous and minimizing auditing requirements might be to require sample audits of industry participants' records. Another approach might be to require repayment only in those instances in which the amount of the return justifies the cost of necessary audits and other internal control measures. DOE officials indicated that they are studying the issue of ensuring proper repayment in the Clean Coal Technology Program.

Many DOE officials believe that obtaining increased cost-sharing by industry is preferable to requiring repayment of the federal investment. Some indicated that a repayment requirement could be used as a negotiating tool to obtain higher cost-sharing in lieu of repayment. The officials also argue that it may be better in terms of conserving federal resources to obtain an increased cost-share from all participants than to obtain repayment only from those successfully commercializing their technologies.

According to DOE, any repayment provisions must consider the effect of repayment on the ability of the entity carrying out the project to compete in the marketplace (proceed with commercialization of the technology and achieve a rate of return commensurate with the industry and the risk). DOE believes that if repayment obligations are too demanding, especially in the early years of technology sales, cash flows and profitability may not be sufficient for the organization responsible for repayment to remain in business, or licensing fees and costs may be too high for the technology to remain competitive with alternative technologies. We believe one way of mitigating this concern could be to allow a grace period after a project ends before requiring repayment to begin, as was done in two of the programs discussed above that require repayment. A grace period could be based on a specified period of elapsed time or a specified number of technology units sold before repayment begins.

Other Related Issue

Another issue is the disposition or use of the proceeds resulting from repayment. Many DOE officials indicated that any proceeds from repayment programs should flow back into the applicable program to leverage the federal funding that would be available for ongoing and future projects, rather than be deposited in the Treasury, which is the current practice. Under current policy, proceeds are available to either reduce the budget deficit or to be reallocated on the basis of national priorities.

Conclusions

While we do not believe that cost recovery should be a major objective, opportunities may exist for substantial recovery of taxpayers' dollars if DOE would adopt a policy to require repayment of its investment in successfully commercialized technologies. However, a repayment policy would need to be structured with enough flexibility so as not to interfere with program objectives or adversely affect industry's participation in projects and technology commercialization. Such a policy should provide criteria and factors to consider in determining whether it should be

applied to individual programs or projects. A properly structured policy could provide the flexibility needed to mitigate many of the arguments against having a policy.

Recommendation

We recommend that the Secretary of Energy develop and implement a Department-wide policy for requiring repayment of the federal investment in successfully commercialized cost-shared technologies. The policy should provide criteria and flexibility for determining which programs and projects are appropriate for repayment.

Agency Comments and Our Response

We provided a draft of this report to DOE for its review and comments. DOE said that it concurred with our conclusion that cost recovery should not be a major objective of a federal technology development program but pointed out that in its experience, there are individual projects and programs for which repayment provisions can work. DOE said that demonstration programs that are well advanced in the research and development pipeline are the most likely candidates for repayment. According to DOE, however, the real payback to the nation is in the societal benefits that flow out of federally funded research and development, including jobs, competitiveness in world markets for U.S. companies, and the resulting contributions to the U.S. economy of both domestic and export technology sales. We agree that these potential benefits are very important, but they are independent of the argument for recovering the taxpayers' share of investment in successfully commercialized technologies. If repayment under appropriate circumstances was an ancillary requirement for successfully commercialized technologies, it would allow the government to potentially recover some of its investment in technologies as well as enjoy the other positive benefits that might accrue.

In the case of environmental cleanup technologies, DOE said that the payback is in the form of cost avoidance to the government through the use of innovative technologies that reduce the cost of cleaning up the contaminated weapons complex. We recognized this major benefit in our draft report. However, we continue to believe that if such technologies have potential commercial application, new projects demonstrating the technologies should be considered for repayment of the federal investment.

DOE said that it agreed with our recommendation that a repayment policy should provide the flexibility for determining which programs and projects are appropriate for repayment. DOE believes that the policy should also have flexibility in determining the repayment terms, and when and how they should be applied so as not to adversely affect the development or introduction of technologies into the marketplace.

Appendix II contains the complete text of DOE's comments, along with our responses.

Our work was performed from August 1995 through April 1996 in accordance with generally accepted government auditing standards. Appendix III describes the scope and methodology of our review.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 15 days after the date of this letter. At that time, we will provide copies to the Secretary of Energy, appropriate congressional committees, and other interested parties. We will also make copies available to others upon request.

Please contact me at (202) 512-3841 if you have any questions or need additional information. Major contributors to this report are listed in appendix IV.

Sincerely yours,

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

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Abbreviations

CRADAs	cooperative research and development agreements
DOE	Department of Energy
GAO	General Accounting Office

Potential Repayment in DOE Cost-Shared Programs

This appendix discusses the Department of Energy's (DOE) cost-shared technology development programs administered under four major organizational areas—Fossil Energy, Energy Efficiency and Renewable Energy, Environmental Management, and Nuclear Energy. The appendix also summarizes the planned funding for technology development projects in each of the four areas and discusses the views of DOE officials on the types of programs and projects that would be the most appropriate or suitable for repayment of the federal investment.[4]

Fossil Energy Programs

DOE's fossil energy technology development programs support cost-shared projects with industry to foster the development and commercialization of coal, petroleum, and natural gas technologies. As shown in table I.1, DOE's planned funding for coal and special technology projects accounts for the largest portion, by far, of the nearly $6.6 billion that DOE is planning to invest in active fossil energy projects. More than $2.2 billion is committed to projects in the Clean Coal Technology Program, which requires repayment if the technologies are commercialized. Other large DOE investments in coal and special technology projects involve programs that are developing fuel cells, advanced turbine systems, and advanced pulverized coal systems.

DOE's Reservoir Class Field Demonstration Program accounts for about 90 percent of the Department's planned funding for cost-shared petroleum technology projects. This program demonstrates technologies and processes for increasing production from oil fields to prevent them from being prematurely abandoned. Natural gas technology projects focus on new and improved technologies for extracting, delivering, storing, and using natural gas.

[4]In this appendix, we use the term planned funding to include the total funds spent and planned for active technology development projects.

Table I.1: Planned Funding for Fossil Energy Cost-Shared Technology Development Projects

Dollars in millions

	DOE's share	Nonfederal share	Total
Coal and special technology projects			
Contracts	$853.0	$278.0	$1,131.0
Cooperative agreements	5,542.6	4,739.9	10,282.5
Petroleum projects			
Contracts	11.3	9.4	20.7
Cooperative agreements	100.1	133.6	233.7
Natural gas projects			
Contracts	34.0	52.8	86.8
Cooperative agreements	28.8	35.3	64.1
Total contracts	898.3	340.2	1,238.5
Total cooperative agreements	5,671.5	4,908.8	10,580.3
Total	**$6,569.8**	**$5,249.0**	**$11,818.8**

Source: Prepared by GAO using DOE data.

According to DOE officials in the fossil energy area, several fossil energy technology development programs may be appropriate candidates for repayment if new or amended projects are undertaken. Two of them—the Reservoir Class Field Demonstration Program and the Advanced Turbine Systems Program—have previously been discussed. According to the officials, the Fuel Cell Program might also be a possible candidate for repayment if DOE decides to help fund the costs and risks of providing fuel cell technology to potential users. DOE is planning to invest about $270 million through completion of active cooperative agreements to develop new, improved fuel cells for power generation. The officials indicated that the fuel cell industry is an infant industry, and the vision of the program is to enable the U.S. fuel cell industry to be strongly competitive in the international market after the year 2000.

According to DOE officials, the Advanced Pulverized Coal Program could also be a candidate for repayment as additional federal investment is committed to new projects. Under one aspect of this program, separate teams of industry partners are developing a conceptual design for a 400-megawatt power plant based on pulverized coal-firing technology incorporating advanced boiler design and innovative pollution control systems. DOE will then select one of the teams to develop and produce a

module to test and confirm the performance of that team's technology concept, which will serve as a prototype unit. DOE estimates that the entire effort will cost about $85 million, with DOE funding about 65 percent of the costs and industry funding the balance.

Regarding the natural gas projects, DOE officials said that the Gas-to-Liquids Conversion Program might be a likely future candidate for a repayment policy. The objectives of this program are to develop technologies for economic conversion of methane and other light hydrocarbon gases to liquids that can be used as clean-burning, alternative liquid transportation fuels or chemical feedstocks. DOE hopes that such technologies could one day make remote or low-quality gas supplies economical to produce and transport high-value liquids for use in petroleum and petrochemical markets.

DOE's Deputy Assistant Secretary for Gas and Petroleum Technologies told us that the potential for repayment of DOE's cost-share would be a key consideration in future gas and petroleum technology development program activities. However, the official said that funds may not be available for cost-sharing additional rounds of projects under the Reservoir Class Field Demonstration Program.

Energy Efficiency and Renewable Energy Programs

DOE's energy efficiency and renewable energy cost-shared technology development programs support projects conducted jointly with industry to develop advanced technologies for use in the transportation, utility, industrial, and building sectors of the economy. These programs cover a broad spectrum of activities, ranging from research and development to demonstration and deployment. Table I.2 shows the planned funding for active projects in each sector.

Table I.2: Planned Funding for Energy Efficiency and Renewable Energy Cost-Shared Technology Development Projects

Dollars in millions

	DOE's share	Nonfederal share	Total
Transportation projects			
Contracts	$259.2	$66.9	$326.1
Cooperative agreements	103.0	103.0	206.0
Utility projects			
Contracts	129.4	164.7	294.1
Cooperative agreements	133.3	384.2	517.5
Industrial projects			
Contracts	114.9	52.4	167.3
Cooperative agreements	225.5	168.3	393.8
Building projects			
Contracts	9.9	14.0	23.9
Cooperative agreements	8.0	305.5	313.5
Total contracts	513.4	298.0	811.4
Total cooperative agreements	469.8	961.0	1,430.8
Total	**$983.2**	**$1,259.0**	**$2,242.2**

Source: Prepared by GAO using DOE data.

Transportation technology programs are directed at developing and demonstrating advanced electric and hybrid propulsion systems, advanced propulsion system materials and other new light-weight transportation materials, and advanced light- and heavy-duty heat engines. Projects support a wide range of activities, including the development of advanced batteries for powering electric vehicles, fuel cell propulsion systems, improved energy storage technologies, high-efficiency turbine engine technologies, improved automotive piston engine technologies, clean diesel engine technologies, and alternative fueled vehicles.

Utility technology programs are directed at developing and demonstrating cost-effective and energy efficiency technologies for generating electric power from geothermal, solar thermal, biomass, photovoltaics, wind, hydroelectric, and other renewable resources. Projects are also directed at increasing the efficiency and reliability of energy storage and delivery systems.

DOE supports a wide range of industrial-related projects in collaboration with the private sector to help industry develop and deploy advanced energy efficiency, renewable energy, and pollution-prevention technologies for industrial applications. The Department focuses on seven manufacturing industries that account for over 80 percent of the energy used and wastes produced by the manufacturing sector. These industries include aluminum, chemicals, forest products, glass, metalcasting, petroleum refining, and steel. According to an October 1995 DOE report,[5] over 70 of the more than 350 industrial-related projects supported by DOE in the past 20 years have resulted in commercialized technologies.

DOE also develops and promotes advanced, cost-effective, energy efficient, and renewable energy technologies for commercial and residential buildings, appliances, and building equipment. The building systems program involves research, development, and deployment activities that enable building owners and developers to capture significant energy savings opportunities by combining research on optimal systems designs with programs that deploy these energy efficiency strategies in the construction of new buildings and retrofit of existing buildings.

According to DOE's Deputy Assistant Secretary for Transportation Technologies, several projects administered by his office could have been candidates for repayment if the concept had been required at the beginning of the projects. He indicated, for example, that repayment may be appropriate in the hybrid vehicle development program where the federal investment is large and major companies are involved. He also identified some other examples involving projects to develop advanced materials, reduce manufacturing costs, or improve fuel economy. He pointed out that if technologies are relatively close to commercialization, or if the government is planning to undertake a program to reduce the costs and risks of deployment, it would be easier to support repayment with the private sector and make it work. He also indicated that repayment might be appropriate if follow-on development projects are undertaken for some technologies and the federal investment is easily identified.

The Deputy Assistant Secretary for Utility Technologies said that the most appropriate candidates for repayment for projects that his office administers are those involving plant-scale operations, such as the Solar 2 plant, geothermal facilities, wind plants, and biomass gasifier plants. He indicated that the next most appropriate candidates would be projects that

[5]Impacts: Summary of Results from Programs Conducted by the Office of Industrial Technologies (DOE, Oct. 1995).

are developing stand-alone systems components, such as prototype generators, advanced wind turbines, and dish Sterling solar units. He said his third choice would be manufacturing assistance programs.

The Deputy Assistant Secretary for Industrial Technologies said that most of the industrial technologies could be considered likely candidates for repayment. We were told that while many of the industrial projects involve large manufacturing companies, many highly specialized, smaller firms are also typically involved as partners in these projects. However, the Metals Initiative Program is the only program that requires repayment for projects that the Deputy Assistant Secretary's office administers. As previously mentioned, repayment in that program is legislatively mandated.

Environmental Management Programs

DOE's environmental management technology development program provides new or improved methods for use in cleaning up DOE's sites across the United States that have been contaminated from decades of weapons production activities. According to DOE, these methods either reduce risks to workers, the public, or the environment; reduce cleanup costs; or provide a problem solution that currently does not exist.

Under this program, DOE and the private sector undertake cost- shared projects to demonstrate the capability of industry technologies and methods for cleaning up contamination at DOE sites. The projects generally involve development, validation, testing, and evaluation of the technologies and methods. If the technologies are proven successful, both DOE and industry benefit. Table I.3 shows the planned funding for active projects.

Table I.3: Planned Funding for Environmental Management Cost-Shared Technology Development Projects

Dollars in millions

	DOE's share	Nonfederal share	Total
Environmental management projects			
Contracts	$36.1	$13.7	$49.8
Cooperative agreements	10.2	4.3	14.5
Total	**$46.3**	**$18.0**	**$64.3**

Source: Prepared by GAO using DOE data.

According to DOE program officials, the Department does not require repayment of its investment in environmental management projects because most of the technologies or processes have already had significant expenditures by the private sector in the development phase before the industry partners entered into cooperative work with the government. DOE also expects significant savings under the environmental management technology development program through the use of the technologies or processes at cleanup sites.[6] We were told, for example, that the dynamic underground stripping process removes petroleum from groundwater 40 times faster than conventional methods. According to DOE, using this improved process, which cost $13.8 million to develop, saved taxpayers $19 million in fiscal year 1994 at one cleanup site alone.

DOE program officials agreed that some of the processes under development in their cost-shared projects may have potential commercial application. The officials also agreed that if the technologies or processes have commercial potential, they could have been candidates for repayment of the federal investment. But, the officials indicated that any such repayment would be small in comparison with the potential cost avoidance savings that are expected from using successfully demonstrated technologies or processes to cleanup DOE sites.

Nuclear Energy Programs

DOE's Office of Nuclear Energy administers the Advanced Light Water Reactor Program under cost-shared partnerships with industry. This program is intended to eliminate barriers to efficient and cost-effective operation of nuclear powerplants and maintain standards of safety in their design and operation. The program's primary focus is to make standardized advanced reactors available in time to help meet projected future power generation needs. The planned funding for light water reactors is shown in table I.4

[6]"Savings" here is defined as estimated reduction in DOE costs. Budgetary savings would only result if the Congress captured these cost reductions by reducing appropriations and lowering the discretionary spending caps.

Table I.4: Planned Funding for Nuclear Energy Cost-Shared Technology Development Projects

Dollars in millions

	DOE's share	Nonfederal share	Total
Light water reactor projects			
Contracts	$281.9	$431.2	$713.1
Cooperative agreements	100.0	164.0	264.0
Total	**$381.9**	**$595.2**	**$977.1**

Source: Prepared by GAO using DOE data.

The overall program involves three major components: a design certification program for advanced reactors, a first-of-a-kind engineering program for advanced reactors, and a program to extend the life of aging commercial nuclear powerplants. Four cost-shared projects are being funded under separate contracts to design, test, and obtain Nuclear Regulatory Commission certification of advanced reactor designs. Two other projects are being funded under a cooperative agreement to develop the detailed engineering design of two advanced reactors in order to promote commercial standardization, produce reliable construction schedules and cost estimates, and facilitate construction preparations. Additional projects are developing technologies for assessing material degradation of systems and components at operating nuclear powerplants.

As previously discussed, DOE may require repayment of any additional federal funds provided in excess of $50 million under two of the contracts in the design certification program. According to DOE, the contractors have agreed to this arrangement. DOE requires repayment of its total investment under the cooperative agreement in the first-of-a-kind engineering program. DOE officials said that they were also looking for opportunities for DOE to share in any patents that may be developed based on technologies developed under the commercial operating reactors program.

Comments From the Department of Energy

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

Department of Energy
Washington, DC 20585

MAY 2 4 1996

Mr. Victor S. Rezendes
Director, Energy and Science Issues
Resources, Community, and
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U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Rezendes:

This is in response to your letter to Secretary Hazel O'Leary dated May 10, 1996. The Department of Energy appreciates the opportunity to review and comment on the General Accounting Office draft report, Energy Research: Opportunities Exist to Recover Federal Investment in Technology Development Projects (GAO/RCED-96-141).

See comment 1.

We concur with your conclusions, stated on page 16 of the draft, that recovery should not be a major objective of a Federal R&D program. We believe that the real payback to the nation is in the societal benefits that flow out of federally funded R&D, including jobs, competitiveness in world markets for U.S. companies, and the resulting contribution to the U.S. economy of both domestic and export technology sales. Also, in the case of environmental cleanup technologies R&D, the payback is in the form of cost avoidance to the Government through use of innovative technologies that reduce the cost of cleaning up the contaminated weapons complex.

See comment 1.

Our experience does indicate, however, that there are individual projects and programs for which repayment provisions can work. Fossil Energy's Clean Coal Technology Demonstration Program is an example. Principal issues in assessing the positive reception of the repayment provisions in the Clean Coal Program include the fact that the projects are well down the R&D pipeline (that is, they are commercial demonstration projects); and that there was flexibility in designing the repayment provisions. Projects that are in the early R&D phases would not be suitable candidates for repayment.

See comment 1.

The fundamental issue here, to avoid adversely impacting technology development or introduction, is to have flexibility in developing a repayment policy. We concur with your recommendation on page 16 of the draft that a repayment policy should provide flexibility for

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determining which programs and projects are appropriate for repayment. We would also add that the policy should have flexibility in determining repayment terms, and when and how they should be applied. Additional, specific comments are contained in the Enclosure.

Very truly yours,

Patricia Fry Godley
Assistant Secretary
for Fossil Energy

Enclosure

Enclosure

Additional comments on the General Accounting Office draft report

Energy Research: Opportunities Exist to Recover Federal Investment in Technology Development Projects (GAO/RCED-96-141).

See comment 2.

- The report does not adequately stress the "reasonableness" test -- a dollar limit, below which no repayment would be considered. The cost vs. potential benefit of attempting repayment for small R&D projects is not considered.

See comment 3.

- While the overall report covers the major issues, the analyses are very cursory in nature. It is not apparent on page 11 that the criteria above has been applied to a determination of the dollar amount ($400M) of additional projects that would probably lend themselves to repayment. When one considers that much of our R&D expenditures are focused on the early and mid stages of technology development, it is difficult to determine which technologies will have a sufficient level of commercial success to make repayment the preferred method to the Government versus up-front cost sharing. In addition, the report does not sufficiently elaborate on the tradeoffs between up-front cost sharing and downstream repayments (if success is achieved). As alluded to on page 15, it is logical that requiring downstream repayments will decrease upstream cost sharing. As part of this cost analysis trade-off, the costs to the Government of administering (even with suggested auditing techniques) repayments over potentially a 20 year period needs to be estimated. Such an analysis would provide insight on the criteria that should be used to formulate a recommended policy that minimizes the overall Federal costs.

The following are GAO's comments on the Department of Energy's letter dated May 24, 1996.

GAO's Comments

1. The issues raised in DOE's letter are addressed in the agency comments section of our report. The issues in the enclosure to DOE's letter are addressed below.

2. Our report points out that the costs of administering, auditing, and enforcing repayment agreements should be considered in determining whether to pursue repayment on specific projects. In fact, we suggested that DOE should only require repayment in those instances where the amount of the potential return justifies the cost of necessary audits and other internal control measures. We also pointed out that there may be ways to reduce the cost of such control measures, but it was beyond the scope of this review to design such measures. Once cost-effective control measures are developed, DOE could then address the related costs on a case-by-case basis in determining whether to apply repayment to specific projects.

3. Our hypothetical example of potential repayment if future projects are funded at the level planned for active projects is for illustrative purposes only. We included an assumption that half of the projects may not lend themselves to repayment. Projects in which the potential costs of obtaining repayment would exceed the potential benefits would fall in this category, along with projects that are too early in the technology development process to lend themselves to repayment.

We disagree with DOE's comment that our report does not sufficiently elaborate on the tradeoffs between up-front cost-sharing and downstream repayments if the technologies are commercialized. We pointed out that DOE generally prefers to have increased industry cost-sharing, and that some DOE officials believe that it may be better to obtain increased cost-sharing from all participants than to obtain repayment only from those that successfully commercialize their technologies. We believe that even with increased industry cost-sharing, however, an argument can be made that taxpayers have an interest in the repayment of taxpayers' dollars when technologies developed with federal funds are successfully commercialized. See comment 2 for our response to DOE's point that administrative costs should be considered in deciding whether to require repayment.

Scope and Methodology

To determine the extent to which the Department of Energy (DOE) requires repayment of its investment under cost-shared technology development and demonstration programs, including the similarities and differences in the mechanisms used for repayment, we interviewed DOE officials responsible for administering such programs; reviewed DOE reports and program documents, congressional budget requests, relevant legislation and congressional reports, and various private sector reports and publications that discuss the programs; and drew from our past reviews and reports on such programs. We also talked with several DOE attorneys, an official of DOE's Office of Inspector General, and a former congressional subcommittee staff member who had been responsible for appropriations for many DOE technology development programs.

To identify advantages and disadvantages of having or not having a repayment policy, we interviewed many DOE officials involved in administering cost-shared technology development and demonstration programs, including several Deputy Assistant Secretaries; DOE policy officials and attorneys; and a former Deputy Secretary of DOE and his former Executive Assistant. We also reviewed DOE reports and other documents that discussed the advantages and disadvantages of a repayment policy, including DOE files relating to a 1991 draft repayment policy that was never implemented.

To obtain a perspective on DOE's investment in technology development projects, we asked DOE to provide us with information on the estimated total federal and nonfederal funding planned for active cost-shared technology development projects funded under contracts and cooperative agreements. We focused on the major organizational areas of DOE that fund most of the Department's cost-shared technology development projects involving contracts and cooperative agreements—Fossil Energy, Energy Efficiency and Renewable Energy, Environmental Management, and Nuclear Energy—and we asked DOE to exclude any projects involving grants and basic research. We used the DOE information in our discussions with DOE officials to obtain their views on the types of programs and projects that might be appropriate for repayment if future projects are undertaken. We also used the information to illustrate what the repayment potential might be if DOE had a repayment policy and future projects are undertaken.

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Related GAO Products

Electric Vehicles: Efforts to Complete Advanced Battery Development Will Require More Time and Funding (GAO/RCED-95-234, Aug. 17, 1995).

Fossil Fuels: Lessons Learned in DOE's Clean Coal Technology Program (GAO/RCED-94-174, May 26, 1994).

Fossil Fuels: Improvements Needed in DOE's Clean Coal Technology Program (GAO/RCED-92-17, Oct. 30, 1991).

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