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Perspectives on the Potential of Clean Coal Technologies to Reduce Emissions From Coal-Fired Power Plants

Statement for the Record of
Keith O. Fultz
Director, Energy Issues
Resources, Community, and Economic
Development Division

Before the
Subcommittee on Energy and Power
Committee on Energy and Commerce
House of Representatives

Mr. Chairman and Members of the Subcommittee:

We are pleased to submit a statement for the record on the preliminary results of two reviews we have underway for this Subcommittee on the Department of Energy's (DOE) Clean Coal Technology (CCT) program. Because our work is still ongoing, the views expressed in this statement are subject to change. As you know, the CCT program is designed to identify and support the demonstration of emerging technologies that will enhance the potential use of coal in meeting our nation's energy needs. We testified before this Subcommittee in June 1988 and April 1989 on the implementation and status of the CCT program, problems with funded demonstration projects, and the relationship of the program and pending acid rain control legislation.

One of our ongoing reviews is a nationwide study to obtain utilities' views on the extent to which they would consider using clean coal technologies with and without acid rain control legislation. The other is a review of DOE's process for evaluating and selecting demonstration projects for funding under the second round of the CCT program.

In summary, the preliminary results of our utility study show the following:

-- Utilities currently have plans to use clean coal technologies on only 5 percent of their existing coal-fired generating units before the year 2010. However, should acid rain control legislation be enacted, utilities indicate that they would give much greater consideration to using emerging clean coal technologies along with other options (such as switching to low-sulfur coal or using conventional scrubbers) to achieve emission reduction requirements.

-- Commercial availability--which is contingent upon successful demonstration of the technologies--is a key factor in determining when the technologies could be widely adopted. Although many of the emerging clean coal technologies may be commercially available between the mid-1990s and 2000, it may take another 5 to 10 years beyond the date of commercial readiness for the technologies to penetrate the market.

The preliminary results of our round-two project selection review show the following:

-- DOE's project evaluation criteria generally complied with congressional and other program guidance and DOE's evaluation and selection process seemed reasonable. DOE selected 16 projects representing a mix of technologies for a diversity of applications. Although DOE's evaluation showed that the technologies have the potential to reduce emissions where used, it also showed that the particular applications of the technologies to be demonstrated by nine projects have limited potential for achieving nationwide emission reductions.

Although clean coal technologies have the potential to reduce emissions from coal-fired power plants, on the basis of our ongoing reviews and the results of our prior clean coal technology work, we have reservations about whether these new technologies, at their current pace of development and anticipated time tables for widespread deployment, will contribute significantly to the nationwide reduction of acid rain-causing emissions during the next 15 years.

UTILITY STUDY

Before addressing our utility study results, I will provide some background on the scope and methodology of our study. To determine how utilities would respond to different emission reduction requirements and compliance dates, we developed a comprehensive questionnaire that included four hypothetical acid rain control scenarios. Our scenarios, which are summarized in attachment I, were based on our analysis of acid rain control bills introduced in the last Congress. In developing our questionnaire, we obtained technical assistance from utility industry groups, DOE, and the Environmental Protection Agency (EPA). We also visited several utilities to test the clarity of our questions.

We then randomly selected 480 of the nation's 1,503 fossil-fueled (coal, oil, and gas-fired) power-generating units that have at least 75 megawatts of generating capacity and mailed the questionnaire to the 138 utilities that owned or operated those units. We requested information on the utilities' current plans to use clean coal technologies at each of the 480 units. We also asked whether the utilities have considered what they would do at these units if acid rain control legislation were enacted. For those that had considered what they would do, we asked whether they would consider using clean coal or conventional technologies and options to meet both moderate and more stringent sulfur dioxide (SO2) and nitrogen oxide (NOx) emission reduction requirements on the units by the 1997 and 2004 compliance dates included in our scenarios. We also requested utilities' views on incentives for using clean coal technologies.

We received about a 95-percent response to our questionnaire. Although some clean coal technologies can benefit oil- and gas-fired generating units, our survey indicated that utilities would be primarily interested in the technologies for their coal-fired units. Of the 480 units in our survey, about 65 percent were coal

fired units. We will, therefore, focus our testimony on utilities' responses for coal-fired generating units only. The results of those responses are statistically projectable to the universe of 75-megawatt and greater coal-fired generating units nationwide.

To supplement the inforration obtained through our questionnaire, we visited four utilities that have actively pursued clean coal technologies to discuss their experiences. We also met with DOE and EPA officials and representatives of environmental groups, including the National Resources Defense Council and Greenpeace, to discuss clean coal technology issues.

Utility Questionnaire Responses

Few utilities have current plans to use emerging clean coal technologies at their existing power-generating units to reduce SO2 or NOx emissions. Our analysis showed that utilities planned to use such technologies on only 5 percent of their coal-fired units before 2010. The technologies to be used on these units were generally for retrofit applications and included low NOx combustion processes, sorbent injection, advanced flue gas scrubbers, and gas co-firing processes.

Utility Responses to Acid Rain Scenarios

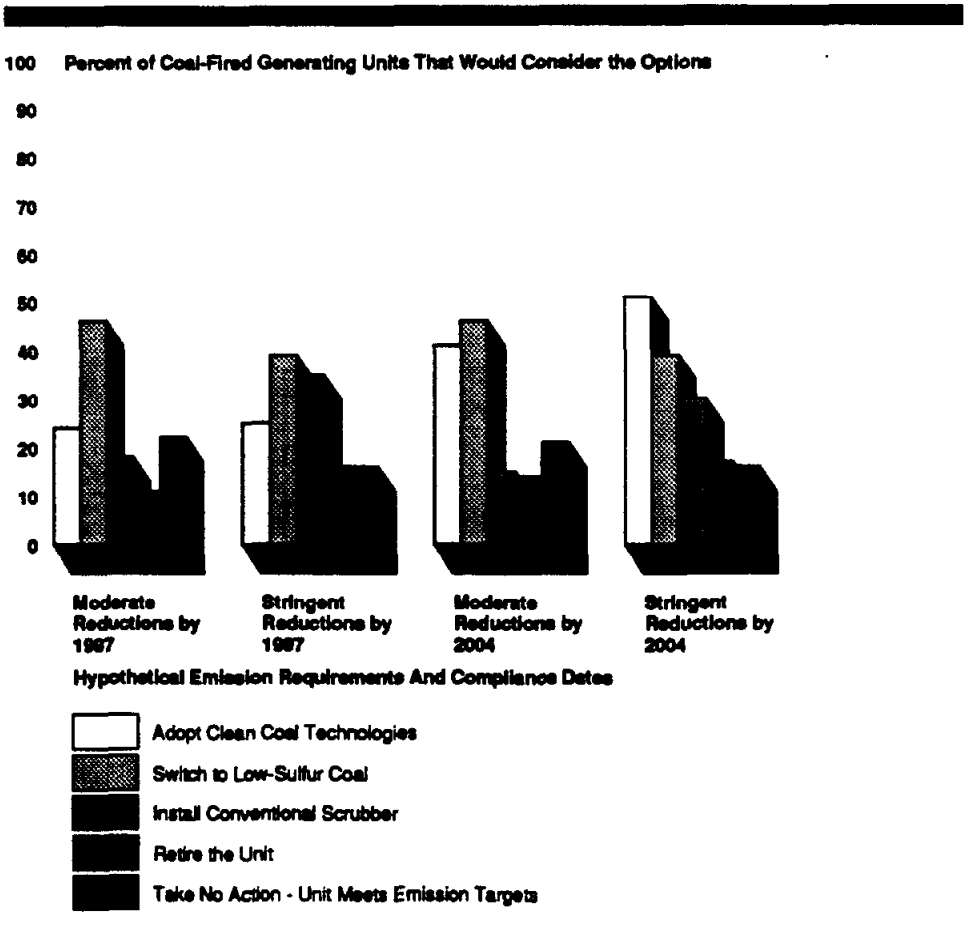
Utilities indicated that they had considered emission control options that would affect about 85 percent of the coal-fired units in our sample in the event that acid rain control legislation were enacted. They also indicated that legislation would be a primary incentive for them to consider using clean coal technologies.

SO2 Emission Reduction

As shown in figure 1, utilities indicated that they would give more consideration to using clean coal technologies as an option to

achieve SO2 emission reductions if they were given a longer time frame for compliance. Our analysis showed that utilities that have considered what they would do in response to acid rain control legislation would consider such technologies for up to 51 percent of their coal-fired units under a 2004 compliance deadline, but only up to 25 percent of their units under a 1997 compliance deadline. They cited in-boiler and in-duct sorbent injection technologies more frequently than other clean coal technologies, followed by advanced flue gas scrubbers and coal cleaning and upgrading processes. The utilities also indicated that about 22 percent of their units would already comply under our moderate SO2 emission reduction scenario, but given the more stringent reduction scenario for SO2 emissions, about 16 percent would comply.

Figure 1: Options to Reduce Sulfur Dioxide Emissions

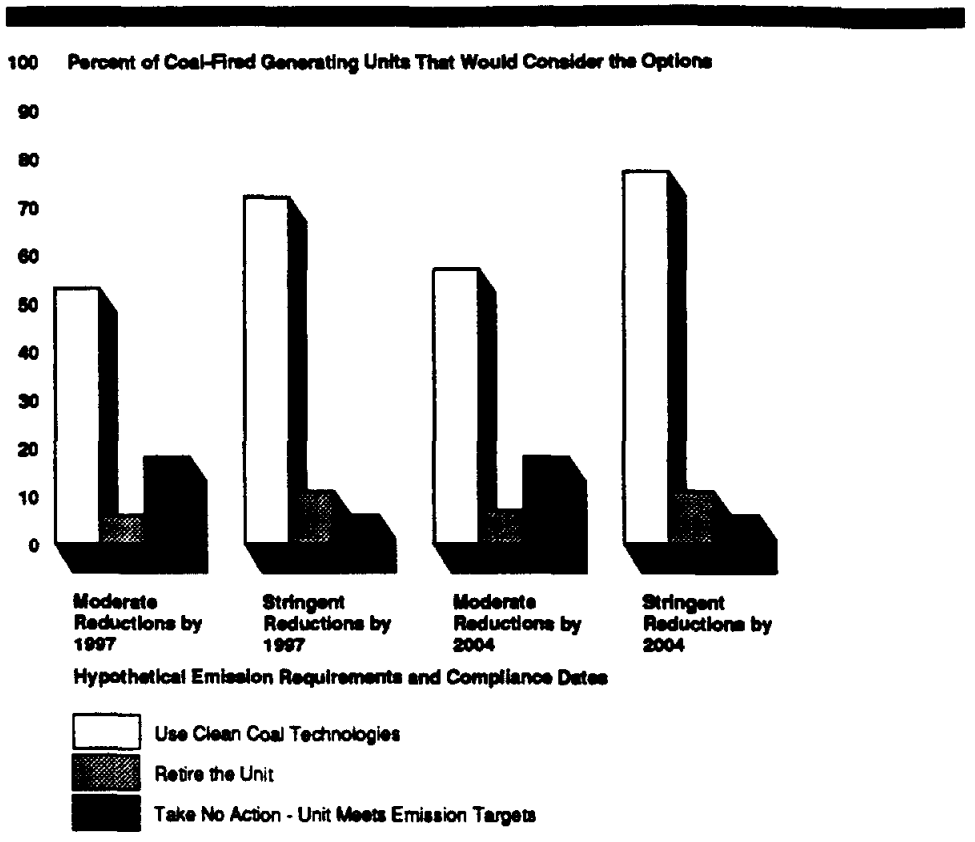


However, as shown in figure 1, clean coal technologies were not the most frequently cited options for reducing SO2 emissions under three of our four scenarios. The utilities would also consider conventional options, such as switching to low-sulfur coal (at up to 46 percent of their units) and using conventional scrubbers (at up to 35 percent of their units). For example, under a 1997 deadline with moderate emission reduction requirements, utilities would consider switching to low-sulfur coal almost twice as often as using clean coal technologies. Given the same 1997 deadline, but with more stringent emission reduction requirements, they still indicated that they would consider switching to low-sulfur coal or using conventional scrubbers in more instances than using clean coal technologies. Only under our 2004 deadline requiring stringent emission reductions did utilities indicate they would opt for clean coal technologies more frequently than conventional options.

NOx Emission Reduction

As shown in figure 2, the utilities indicated that their consideration to use clean coal technologies for NOx control was more sensitive to the severity of the emission reduction requirements than the compliance deadlines. They indicated that under either a 1997 or a 2004 deadline, they would consider such technologies to reduce NOx emissions at 53 to 57 percent of their coal-fired units under moderate emission reduction requirements and at 72 to 77 percent of their units under more stringent requirements. The utilities also indicated that about 18 percent of their units would already comply under our moderate NOx emission reduction scenario, but given the more stringent reduction scenario for NOx emissions, only about 6 percent would comply.

Figure 2: Options to Reduce Nitrogen Oxide Emissions



This high level of interest in clean coal technologies for NOx control is based on a group of technologies categorized as low-NOx combustion. Some low-NOx combustion technologies have been successfully demonstrated in newly constructed boilers. Although retrofitting boilers with low-NOx combustion equipment is still experimental, several utilities expressed confidence in the process based on their experience with using the technology in new boilers.

Factors Affecting Technology Use

Indications are that clean coal technologies, at their current pace of development, will probably not contribute significantly to the nationwide reduction of acid rain-causing emissions during the

next 15 years. According to DOE, utility, and coal industry estimates, many of the emerging technologies should become commercially available between the mid-1990s and 2000. However, some estimates indicate that it could take another 5 to 10 years beyond the date of commercial readiness for the technologies to penetrate the market and play a major role in controlling acid rain.

Clean coal technologies generally fall under two categories--retrofit and repowering. Retrofit technologies are designed to reduce emissions but do not improve a plant's fuel efficiency. Repowering technologies are designed to extend a plant's life, increase its generating capacity, and reduce emissions through improved fuel efficiency. Retrofit technologies are generally expected to be commercially available a few years earlier than repowering technologies.

Many factors will affect the commercialization of clean coal technologies, including whether the technologies can be successfully demonstrated in terms of their technical feasibility, cost effectiveness, and capability to reduce emissions. Some of the utilities we visited expressed doubts about the technical feasibility and reliability of many of the technologies and whether they will be able to achieve expected emission reductions. The relatively high level of confidence expressed for low-NOx combustion technologies was an exception. Ultimately, a utility's decision to invest in a clean coal technology would need to satisfy the same criteria as any other investment in the generating plant. On this point, next to acid rain control legislation, cost was the most frequently cited factor that would influence the decisions of our survey respondents to adopt clean coal technologies. Furthermore, such investment would need to be a prudent and cost-effective decision for the public utility commission to authorize a utility to recover the cost of bringing new technologies on line.

Technologies Must Be Successfully Demonstrated

Before clean coal technologies will be available for commercial order, they must first be successfully demonstrated. DOE's CCT program is an effort to expedite the demonstration of these technologies. According to some industry spokesmen, a technology is not successfully demonstrated until it has been replicated or has undergone multiple commercial demonstrations addressing a range of boiler designs, fuel types, and other operating variables. Potential users of clean coal technologies need a base of information and experience, gained through multiple demonstrations, upon which to judge costs, efficiency, reliability, and other issues. In this regard, about 41 percent of the utilities that responded to our questionnaire indicated that multiple demonstrations of the technologies that seemed most promising were the best way to commercialize clean coal technologies.

To date, only 3 of the 29 projects selected for funding under DOE's CCT program are in the demonstration phase. In our March 29, 1989, report[1] and our April 13, 1989, testimony[2] before this Subcommittee on the CCT program, we pointed out that seven of the nine funded round-one projects were experiencing coordination, equipment, and financing problems that caused delays in completing project phases, cost overruns, and proposed project modifications. We also pointed out that DOE had extended the demonstration completion date for two of the projects and expected to extend the demonstrations of other projects that were behind schedule. These problems and actions could delay the successful demonstration of the technologies.

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

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

Other Factors Affecting Market Penetration

Successful demonstration of clean coal technologies does not mean that they will be immediately and widely deployed. Once the technologies are successfully demonstrated, a utility still may decide that other options, such as switching to lower-sulfur coal or using conventional flue-gas scrubbers, are a more cost-effective method of reducing acid rain-causing emissions.

According to utility industry estimates, once available, at least another 5 to 10 years would be needed before clean coal technologies could be incorporated into the nation's electric generating base to achieve significant reductions in acid rain-causing emissions. Even when commercially available, the utility industry will likely be cautious in applying these new technologies. For example, a utility will likely test a successfully demonstrated technology on a single unit before installing it on other units.

Regulatory Issues

Apart from commercial availability, the utilities have indicated that at least two regulatory issues--cost recovery and EPA emission requirements--may affect their consideration of clean coal technologies. The industry is concerned about cost recovery because only a few state public utility commissions have developed specific incentives to allow utilities to recover demonstration costs for clean coal technologies, and none has specifically approved cost recovery for commercial applications of the technologies. At least two states (Florida and Ohio) have devised a program to allow for an accelerated recovery of demonstration costs. The uncertainty over cost recovery could impede industry participation in the development or deployment of clean coal technologies. About 33 percent of the utilities that responded to

our questionnaire indicated that increased flexibility by public utility commissions on cost recovery would be an incentive to use clean coal technologies.

Under EPA's regulatory requirements for power plant emissions, units that are substantially refurbished are held to the same stringent emission standards as newly constructed units. The industry is concerned that EPA may require units that are modified to demonstrate clean coal technologies to meet the more stringent emission standards. Although EPA has granted an exemption for a power plant unit demonstrating a clean coal technology and has indicated that it will continue to consider such exemptions (on a case-by-case basis), the industry is concerned that the units will be subjected to the more stringent standards after the demonstration ends, even if the technology is removed. According to DOE and the utility industry, such a requirement could discourage utilities from participating in the CCT program. For example, in June 1989, the M.W. Kellogg Company and DOE mutually agreed to halt an advanced coal gasification, combined cycle power-generating demonstration project, in part, because a potential host utility in New York would not commit itself to the project in view of the uncertainties surrounding this issue.

ROUND-TWO DEMONSTRATION PROJECTS

Now I would like to address our review of DOE's process for evaluating and selecting demonstration projects under round two of the CCT program. Under round one of the program, DOE looked for a broad slate of technologies to enhance the use of coal. Under the $575 million round-two program solicitation, however, the main focus is to demonstrate technologies that are capable of achieving significant nationwide SO2 and/or NOx emission reductions at existing coal-burning facilities. Other objectives call for the demonstrated technologies to be capable of being commercialized in the 1990s and to be more cost effective than current technologies.

In September 1988, DOE selected 16 projects (13 retrofit and 3 repowering) from the 55 proposals received.

Evaluation and Selection Process

We found that DOE's project evaluation criteria generally complied with congressional and other program guidance, and DOE's process for evaluating and selecting projects appeared reasonable. DOE appointed a selection official who, in turn, formed a Board to develop evaluation criteria and to evaluate the proposals. Forty-eight of the 55 submitted proposals met initial project submission criteria and underwent a comprehensive evaluation in which 11 criteria (six technical, four business and management, and one cost) were used to assess the proposals.

The Board used seven teams of experts consisting of about 100 DOE staff members to evaluate the 48 proposals. An assessment was made of each proposal's strengths and weaknesses against the criteria, and a rating was established for each criterion except cost. Using the teams' evaluations, in conjunction with its own review of the proposals, the Board evaluated and rated each proposal against the comprehensive criteria, developed an overall ranking of the proposals, and reached a consensus on each proposal's strengths and weaknesses.

Using the Board's evaluation results and additional overall program policy selection considerations, DOE's round-two selection official picked 16 projects. The projects selected were the highest ranked within their technologies and were consistent with the Board's overall ranking of proposals. Nine of the 16 projects were ranked the highest by the Board. Some lower-ranked projects were picked to provide a mix of technologies, which was one of the program policy factors considered by the selecting official in making the final proposal selections.

Some Technology Applications Appear To Have Limited Nationwide Emission Reduction Potential

The Board determined that the particular applications (design concepts and features) of the technologies to be demonstrated by 9 of the 16 projects had limited potential for reducing emissions on a nationwide basis. These nine projects are to receive about $281.4 million in federal funds. Also, two of these nine project proposals were rated weak regarding their plans to commercialize the technologies in the 1990s. However, because of strengths in satisfying other criteria, six of the nine were among the highest-ranked proposals.

According to DOE officials, these nine projects were selected to provide a wide range of technology choices for a diversity of applications. For example, several projects were selected to demonstrate technologies that could be used to reduce NOx emissions on different types of boilers in the utility industry--or to demonstrate technologies for use in other markets, such as the steel and cement industries. While these technologies have the potential to reduce emissions in the specific areas where they can be used, their application is limited for significantly reducing nationwide acid rain-causing emissions.

In judging a proposed technology's potential to reduce nationwide emissions, DOE estimated the extent to which the proposed technology can reduce nationwide SO2 and/or NOx emissions and transboundary air pollution when used at existing coal-fired facilities. The technologies' nationwide emission reduction potential for the nine selected projects with limited potential ranged from 0.2 to 2.2 million tons per year. In comparison, the technologies' nationwide emission reduction potential for the seven selected projects with greater potential ranged from 6.5 to 16.8 million tons per year. The administration's July 1989 legislative proposal to amend the Clean Air Act, which is under congressional

debate, calls for an annual nationwide reduction of 10 million tons in SO2 emissions below 1980 levels and 2 million tons in NOx emissions below the projected year 2000 levels by December 31, 2000.

The nine projects whose technologies were rated as having limited nationwide emission reduction potential are to demonstrate various applications of the following technologies or processes: flue gas cleanup to control NOx emissions, coal preparation, industrial processes, and atmospheric and pressurized fluidized-bed combustion repowering technologies. The other seven projects whose technologies were rated stronger in meeting nationwide emission reduction criteria are to demonstrate various applications of the following technologies: advanced slagging combustion, flue gas cleanup technologies to reduce both SO2 and NOx emissions or only SO2 emissions, and an integrated gasification, combined-cycle repowering technology.

Many Proposals Were Rated Weak in Meeting Several Criteria

As previously mentioned, we found that the 16 selected projects represented the highest-ranked proposals for their specific technology, even though some were limited in their potential to reduce nationwide emissions. In fact, a large portion of the total number of project proposals submitted in response to the round-two solicitation appeared to be weak in meeting the criteria relating to nationwide emission reduction potential. Our review of the Board's evaluation results showed that more than half of the 48 proposals had limited potential in this area. A large percentage of the 48 proposals were also weak in more than one area. For example, 60 percent of the proposals were rated weak in two or more of the evaluation criteria, and 50 percent in three or more criteria.

Besides having limited nationwide emission reduction potential, many proposals were rated weak in five other criteria, including

-- 27 in the adequacy of the sponsor's plan to commercialize the technology in the 1990s;

-- 17 in the technical readiness of the technology for demonstration;

-- 17 in the adequacy, appropriateness, and relevance of the project to demonstrate the technology and provide information to enable the private sector to make rational commercialization decisions;

-- 16 in the technical and management approach to design, construct, and operate the project; and

-- 14 in the adequacy and completeness of the plan to finance the project.

We have not conducted an in-depth analysis of the 32 projects not selected for round-two funding, and therefore we cannot draw any conclusions on their overall quality. We are offering this information as an observation to highlight our concerns regarding the potential of projects that might be available for funding in the following three rounds of the program--which represents over $1 billion in future funding. As you may recall, during our April 1989 testimony before this Subcommittee on the CCT program, we suggested that DOE might want to fund replications of the more promising technologies in order to demonstrate their potential as quickly as possible. While we understand DOE's desire to fund a variety of clean coal technologies, its ability to continue this policy could be limited depending on the quality of projects submitted in future rounds. If the quality of future projects is

disappointing, it may be more beneficial to search out and focus on those projects having the most widespread applications and the better chances of being successfully demonstrated.

CONCLUDING OBSERVATIONS

Emerging clean coal technologies can play an important role in reducing emissions from coal-fired power plants. A major issue is whether they will be commercially available for widespread deployment within the time frame needed to meet requirements of acid rain control legislation.

On the basis of our current reviews and past reports and testimonies on the CCT program, it appears that clean coal technologies should contribute, but in all likelihood not significantly, to the nationwide reduction of acid rain during the next 15 years. Few utilities have plans to use clean coal technologies in this time frame, and although utilities indicated that they would give much greater consideration to using such technologies if acid rain control legislation were enacted, the technologies are generally not expected to penetrate the market within the next 15 years.

The commercial availability of clean coal technologies will be affected by the pace at which demonstrations of various applications of the technologies are successfully replicated. Greater emphasis on funding multiple demonstrations of the more promising clean coal technologies could accelerate their successful demonstration and allow them to play a greater and more timely role in reducing acid rain-causing emissions.

ATTACHMENT I

QUESTIONNAIRE SCENARIOS FOR ACID RAIN CONTROL LEGISLATION

Scenario	Compliance date	Emission reduction requirement SO2	NOx
1 (near-term moderate)	1997	35% or to 1.0 lb./MMBtus	25% or to 0.6 lb./MMBtus
2 (near-term stringent)	1997	75% or to 0.8 lb./MMBtus	50% or to 0.4 lb./MMBtus
3 (long-term moderate)	2004	35% or to 1.0 lb./MMBtus	25% or to 0.6 lb./MMBtus
4 (long-term stringent)	2004	75% or to 0.8 lb./MMBtus	50% or to 0.4 lb./MMBtus

Note: For SO2 and NOx emissions under each scenario, utilities were asked to base their responses on the percentage reduction or the pounds per million British thermal units (lb./MMBtus) limit--whichever was less stringent.