1. Introduction

Over the next decade, power plant operators may face significant requirements to reduce emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon dioxide (CO_2), and mercury (Hg). At present, neither the future reduction requirements nor the complete timetable is known for any of these airborne emissions, and compliance planning is difficult. In response to the Clean Air Act Amendments of 1990 (CAAA90), power plant operators are now in the process of making reductions in power plant emissions of SO_2 and NO_x. Phase II of the CAAA90 SO_2 reduction program—lowering allowable SO_2 emissions to an annual cap of 8.95 million tons—became effective on January 1, 2000, and more stringent NO_x emissions standards for boilers also took effect in 2000. States are also beginning efforts to address visibility problems (regional haze) in national parks and wilderness areas throughout the country. Because power plant emissions of SO_2 and NO_x contribute to the formation of regional haze, these emissions may have to be further reduced to improve visibility in some areas. In the near future, it is expected that new national ambient air quality standards for ground-level ozone and fine particulates may necessitate additional reductions in NO_x and SO_2.

To reduce ozone formation, the U.S. Environmental Protection Agency (EPA) has promulgated a multi-State summer season cap on power plant NO_x emissions that would take effect in 2004. Emissions of fine particles (less than 10 microns in diameter) and their impacts on health are currently being studied. Fine particles are associated with power plant emissions of SO_2, and further reductions in SO_2 emissions could be required by as early as 2007 in order to reduce emissions of fine particles. In addition, the EPA recently decided that Hg emissions need to be reduced, and proposed regulations will be developed over the next 3 years. Further, if the United States ratifies the Kyoto Protocol or a similar international greenhouse gas mitigation treaty, energy-related CO_2 emissions will also have to be reduced.

With comprehensive standards changing according to different timetables, compliance planning is difficult. It can take several years to design, license, and construct new power plants and emission control equipment, which may then be in operation for 30 years or more. As a result, power plant operators must look far into the future to evaluate the economics of new investment decisions. Changing emission standards with different timetables add considerable uncertainty to investment planning decisions. An option that looks attractive to meet one set of SO_2 and NO_x standards may not be attractive if further reductions are required in a few years. Similarly, economical options for reducing SO_2 and NO_x may not be optimal if Hg and CO_2 emissions must also be reduced. Further complicating planning, some investments reduce multiple emissions simultaneously, such as flue gas desulfurization equipment that reduces SO_2 and Hg, making such investments more attractive under some circumstances. As a result, power plant owners currently are wary of making investments that may prove unwise a few years hence.

Recently, plans have been proposed that would require coordinated multi-emission reductions. Several bills have been introduced in Congress to address these issues: S. 1369, the Clean Energy Act of 1999, introduced by Senator Jeffords; S. 1949, the Clean Power Plant and Modernization Act of 1999, introduced by Senator Leahy; H.R. 2900, the Clean Smokestacks Act of 1999, introduced by Congressman Waxman; H.R. 2645, the Consumer, Worker, and Environmental Protection Act of 1999, introduced by Congressman Kucinich; and H.R. 2980, the Clean Power Plant Act of 1999, introduced by Congressman Allen (Table 1). Each of these bills contains provisions to reduce power plant emissions of NO_x, SO_2, CO_2, and Hg over the next decade. The bills use different approaches—traditional technology-specific emission standards, generation performance standards, explicit emission caps, or combinations of the three—but all call for significant reductions.

H.R. 2900 calls for reducing power plant NO_x and SO_2 emissions by 75 percent from 1997 levels, reducing power plant CO_2 emissions to 1990 levels, and reducing power plant Hg emissions by 90 percent, all by 2005. In addition, it requires that older plants be modernized to comply with the most recent new source performance standards within 5 years of the bill's passage.

S. 1369 has similar goals but takes a different approach, establishing explicit emission caps on NO_x, SO_2, CO_2, and Hg. The proposed annual caps are 1,660,000 tons for NO_x (approximately 73 percent below the 1997 level), 3,580,000 tons for SO_2 (approximately 73 percent below the 1997 level), 1,914,000,000 tons for CO_2 (the 1990 level), and 5 tons for Hg (a 90-percent reduction from the estimated 1997 level). The bill uses these caps to establish generation performance standards (GPS) to allocate emission allowances each year. For example, if the facilities subject to the emission cap generated a total of 2 billion megawatthours of electricity in a given year, the

Table 1. Congressional Bills With NO_x, SO_2, or CO_2 Power Plant Reduction Requirements

Bill Number	NO_x Target (Tons per Year)	SO_2 Target (Tons per Year)	CO_2 Target (Tons per Year)	Hg Target (Tons per Year)	Other
S. 1369	1,660,000	3,580,000	1,914,000,000 (approx. 1990 level)	90% reduction	20% RPS, GPS, PBF
S. 1949	90% removal at each plant, and no more than 0.15 pounds per million Btu	95% removal at each plant, and no more than 0.3 pounds per million Btu	GPS, 0.9 pounds CO_2 per kilowatthour for natural gas, 1.3 for oil, and 1.55 for coal	90% reduction from 1997 level	None
S. 172, H.R. 25	3,000,000 (70% below 1990 level)	4,500,000 (50% below CAAA90 level)	No requirement	Study	NO_x allowance program
H.R. 2645	1,660,000	3,580,000	1,710,000,000 in 2005 (10% below 1990 level); 1,425,000,000 in 2010 (25% below 1990 level); 380,000,000 in 2030 (80% below 1990 level)	Reduce to 0 by 2010	GPS, PBF, RPS, nuclear waste reductions
H.R. 2900	1,548,000 (75% below 1997 level)	3,273,000 (75% below 1997 level)	1,914,000,000 (approx. 1990 level)	90% reduction from 1997 level	Plants required to meet new plant standards when they reach 30 years of age
H.R. 2980	Approximately 1,831,925 (1.5 pounds per megawatthour using 1996-1998 average generation)	Approximately 3,663,850 (3.0 pounds per megawatthour using 1996-1998 average generation)	1,914,000,000 (approx. 1990 level)	70% reduction from level in flue gas	GPS for CO_2

CAAA90 = Clean Air Act Amendments of 1990. GPS = Generation Performance Standard (output based allocation of emission allowances). PBF = Public Benefits Fund. RPS = Renewable Portfolio Standard.

Sources: S. 1369, "Clean Energy Act of 1999," 106th Congress, 1st Session (July 14, 1999); S. 1949, "Clean Power Plant and Modernization Act of 1999," 106th Congress, 1st Session (November 17, 1999); S. 172, "Acid Deposition and Ozone Control Act," 106th Congress, 1st Session (January 19, 1999); H.R. 2645, "Electricity Consumer, Worker, and Environmental Protection Act of 1999," 106th Congress, 1st Session (July 29, 1999); H.R. 2900, "Clean Smokestacks Act of 1999," 106th Congress, 1st Session (September 21, 1999); H.R. 2980, "The Clean Power Plant Act of 1999," 106th Congress, 1st Session (September 30, 1999).

generation performance standard for CO_2 would be approximately 1 metric ton carbon equivalent per megawatthour (1,914,000,000 divided by 2,000,000,000). As a result, each generator would be allocated slightly less than 1 metric ton of emission allowances for each megawatthour generated for that year. Generators whose emissions exceeded their allocations of emission allowances would have to purchase credits from others. As generation changes over time, the GPS and the allocation of future allowances would also change.

S. 1369 also establishes a public benefits fund (PBF) created by collecting a small fee for each kilowatthour of electricity sold and used to support energy efficiency and renewable energy projects and to assist low-income households in meeting their energy needs. In addition, S. 1369 also would establish a renewable portfolio standard (RPS). The RPS requires that a specified share of generation sold by covered generators (all nonhydroelectric generators) must come from renewable sources. Those with qualifying renewable generation are to be issued credits that they can use to meet their own requirements or sell to others who do not generate the required share themselves. The required share begins at 2.5 percent in 2000 and grows to 20 percent in 2020.

The analysis described in this report was conducted at the request of the Subcommittee on National Economic Growth, Natural Resources, and Regulatory Affairs of the U.S. House of Representatives Committee on Government Reform.[1] In its request the Subcommittee asked the Energy Information Administration (EIA) to analyze the potential costs of various multi-emission strategies to reduce the air emissions from electric power plants. The Subcommittee requested that EIA examine cases with alternative NO_x, SO_2, CO_2, and Hg emission reductions and RPS requirements. This report examines NO_x, SO_2, and CO_2 emission limits. A second volume, to be published in early 2001, will examine Hg emission limits and RPS requirements.

This report provides an analysis of the potential impacts of efforts to reduce NO_x, SO_2, and CO_2 emissions from power plants, based on scenarios requested by the Subcommittee on June 29, August 17, and September 25, 2000. Expected costs to the energy sector and to consumers of meeting the specified emission caps are examined (see Chapter 2 for a discussion of the specific scenarios requested). The potential benefits of reduced emissions—such as might be associated with reduced health care costs—are not addressed, because EIA does not

[1]The letters requesting this study are included in Appendix J.

have expertise in this area.[2] The bibliography for this report includes several studies that address the benefits of reducing emissions. Readers should refer to the EPA and others for analysis of the potential benefits of emissions reductions.

In response to a later request from the Subcommittee, this analysis also includes four scenarios examining the potential impacts of requiring older coal-fired power plants either to be brought into compliance with current new source performance standards or to be retired. The EPA has taken action against the owners of 32 older coal plants, accusing them of making modifications without adding the emissions control equipment required by CAAA90. The first of the four scenarios—referred to as the New Source review (NSR) cases—assumes that the owners of each of the 32 plants will be required to add state-of-the-art emissions control equipment by 2005, or retire the plant if that is the economical choice. The second NSR case assumes that all coal-fired plants that currently do not have such control equipment must make the same decision by 2010. The third and fourth NSR cases are the same as the first two, except that they include caps on power sector emissions of NO_x, SO_2, and CO_2. Because Tampa Electric has settled its case, all the scenarios in this report assume that control equipment will be added to its Big Bend facility and that its F.J. Gannon plant will be converted to natural gas.

The analysis presented in this report should be seen as an examination of the steps that power suppliers might take to meet the emission caps specified by the Subcommittee. The specific design of the cases—timing, emission cap levels, policy instruments used, etc.—is important and should be kept in mind when the results are reviewed. For example, all the analysis cases assume that market participants—power suppliers, consumers, and coal, gas, and renewable fuel suppliers—would become aware of impending emission caps before their target dates and would begin to take action. If market participants do not anticipate the emission caps or foresee them earlier, the results would change. For example, in earlier EIA studies that looked at alternative program start dates for imposing a CO_2 emissions cap (or carbon cap), an earlier start date and longer phase-in period were found to smooth the transition of the economy to the longer run target.[3]

This study is not intended to be an analysis of any of the specific congressional bills that have been proposed, and the impacts estimated here should not be considered to be consequences of specific legislative proposals. All the proposals include provisions other than the emission caps studied in this analysis, and several would use different policy instruments to meet the emission targets. Moreover, some of the actions projected to be taken to meet the emission caps in this analysis may eventually be otherwise required as a result of ongoing environmental programs whose requirements currently are not specified (see discussion in Chapter 2, page 6).

[2]Reports by Burtraw, Chestnut, and the EPA cited in the bibliography of this report include discussions of health benefits.

[3]Energy Information Administration, *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity*, SR/OIAF/98-03 (Washington, DC, October 1998); and *Analysis of the Impacts of an Early Start for Compliance with the Kyoto Protocol*, SR/OIAF/99-02 (Washington, DC, July 1999).