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Costs and Benefits of Clear Skies: EPA's Analysis of Multi-Pollutant Clean Air Bills

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Summary

The electric utility industry is a major source of air pollution, particularly sulfur dioxide (SO_2), nitrogen oxides (NOx), and mercury (Hg), as well as suspected greenhouse gases, particularly carbon dioxide (CO_2). On October 27, 2005, the Environmental Protection Agency (EPA) released a long-awaited analysis comparing the costs and benefits of alternative approaches to controlling this pollution. The alternative schemes focus on using market-oriented mechanisms directed at multiple pollutants to achieve health and environmental goals. The new analysis compares four versions of the Administration-based "Clear Skies" proposal to bills introduced by Senator Jeffords (S. 150) and Senator Carper (S. 843 of the 108th Congress), which would impose more stringent requirements.

This report, which will not be updated, examines EPA's analysis and adjusts some of its assumptions to reflect current regulations. The most important adjustment is the choice of baseline. The agency's analysis assumes as a baseline that, in the absence of new federal legislation, EPA and the states will take no additional action to control SO_2, NOx, Hg, or CO_2 emissions beyond those actions finalized by mid-2004. This baseline is put forth despite three rules recently promulgated by EPA that limit SO_2, NOx, and Hg emissions on a timeframe similar to that proposed by the Clear Skies legislation.

CRS reexamines EPA's data, producing cost and benefit estimates for each bill incremental to the costs and benefits of current law and promulgated regulations. The reanalysis finds that Clear Skies would have negligible incremental costs and added benefits of $6 billion in 2010 and $3 billion in 2020. For the same years, S. 843 would have annual net benefits 8 and 5 times as great as Clear Skies at annual costs of $4.2 billion and $3 billion, and S. 150 would have annual net benefits 10 and 16 times those of Clear Skies at annual costs of $23.6 billion and $18.1 billion.

EPA conducted limited sensitivity analyses to examine the effect on cost of select combinations of assumptions, including (1) the responsiveness of electricity demand to changes in price; (2) the availability of skilled labor to install control equipment; and (3) the growth of electricity demand and natural gas prices. However, some potentially useful combinations of assumptions were not examined. For example, if EPA had combined a relaxed skilled labor constraint with some responsiveness of electricity demand to changes in price, the cost of S. 150 and S. 843 would be substantially reduced. CRS also concluded that the Hg control costs used in the analysis may be substantially overstated because of dated assumptions.

Numerous benefits were not estimated by EPA, partly because of methodological difficulties. Benefits not estimated include the environmental (as opposed to health) benefits of controlling the pollutants; the health effects of mercury control; and any benefits from controlling CO_2 emissions. Thus, even though benefits exceeded costs for each of the options in both EPA's and our analysis, one should perhaps view the benefit estimates as a floor rather than a best estimate, particularly for S. 150 and S. 843, which include significant Hg and CO_2 reductions.

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Introduction

The electric utility industry is a major source of air pollution, particularly sulfur dioxide (SO_2), nitrogen oxides (NOx), and mercury (Hg), as well as suspected greenhouse gases, particularly carbon dioxide (CO_2). On October 27, 2005, the Environmental Protection Agency (EPA) released a long-awaited analysis comparing the costs and benefits of alternative approaches to controlling this pollution. Called multi-pollutant proposals, the alternative schemes focus on using market-oriented mechanisms to achieve health and environmental goals in simpler, more cost-effective ways. EPA's new analysis compares four versions of the Administration-based "Clear Skies" proposal to bills introduced by Senator Jeffords (S. 150) and Senator Carper (S. 843 of the 108th Congress), which would impose more stringent requirements.

The Administration has been reluctant to conduct such a study, citing the cost and difficulty of doing so, but it relented after the Senate Environment and Public Works Committee, on a tie vote, failed to report the Clear Skies bill (S. 131) in March 2005. One reason the bill failed to advance, according to its opponents, was the concern that an analysis comparing its provisions to those of Senator Jeffords' and Senator Carper's bills had not been conducted. The issue was raised again in April 2005, during confirmation hearings for Stephen Johnson, who was sworn in as EPA Administrator May 2. As one of his first official acts, he promised to conduct a cost-benefit analysis of Clear Skies and the other Senate bills, the results of which have now been released.

Why the Focus on Power Plants?

Electric utility generating facilities are a major source of air pollution. The combustion of fossil fuels (petroleum, natural gas, and coal), which accounts for about two-thirds of U.S. electricity generation, results in the emission of a stream of gases. These gases include several pollutants that directly pose risks to human health and welfare, including particulate matter (PM),[1] sulfur dioxide, nitrogen oxides, and mercury. PM, SO_2, and NOx are currently regulated under the Clean Air Act, and

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[1] Particulate matter is regulated depending on the particle size; current regulations address particles less than 10 microns in diameter (PM_{10}); EPA has promulgated regulations for particles less than 2.5 microns in diameter ($PM_{2.5}$) that are in the process of being implemented. SO_2 and NOx emissions could be affected by regulations of $PM_{2.5}$. Current concerns about emissions from fossil-fuel electric generating plants do not explicitly address PM, but could indirectly do so through attention to SO_2 and NOx.

EPA has finalized rules to regulate mercury. Other gases may pose indirect risks, notably carbon dioxide, which may contribute to global warming.[2] **Table 1** provides estimates of SO_2, NOx, and CO_2 emissions from electric generating facilities. As indicated, SO_2 and NOx emissions have declined over the past six years as regulations resulting from the 1990 Clean Air Act Amendments have taken hold. In contrast, CO_2 emissions, which are unregulated, have continued to rise. In 2003, fossil-fuel-fired electric generating plants accounted for about 72% of the country's SO_2 emissions, 24% of its NOx emissions, and 41% of its CO_2 emissions. Annual emissions of Hg from utility facilities are more uncertain; current estimates indicate about 45 tons (more than 40% of the country's total Hg emissions) come from electric generating units.

Table 1. Emissions from U.S. Fossil-Fuel Electric Generating Plants
(thousands of metric tons)

Emissions	1998	1999	2000	2001	2002	2003
SO_2	12,509	12,445	11,297	10,966	10,515	10,594
NOx	6,235	5,732	5,380	5,045	4,802	4,396
CO_2	2,313,013	2,326,558	2,429,394	2,379,603	2,397,937	2,408,961

Source: Energy Information Administration. Includes emissions from combined-heat-and-power plants.

The evolution of air pollution controls over time and the growing scientific understanding of health and environmental impacts of power plant emissions have led to a multilayered and interlocking patchwork of controls. Moreover, additional controls are now underway, particularly with respect to NOx as a precursor to ozone, to both NOx and SO_2 as contributors to $PM_{2.5}$, and to Hg as a toxic air pollutant. Also, under the United Nations Framework Convention on Climate Change, the United States agreed to voluntary limits on CO_2 emissions. The current Bush Administration has rejected the Kyoto Protocol, which would impose mandatory limits, in favor of a voluntary reduction program. In contrast to the Administration's position, in June, 2005, the Senate passed a Sense of the Senate resolution calling for mandatory controls on greenhouse gases that would not impose significant harm to the economy.[3]

For many years the complexity of the air quality control regime has caused some observers to call for a simplified approach. One focus of this effort is the "multi-pollutant" or "four-pollutant" approach. This approach involves a mix of regulatory and economic mechanisms that would apply to utility emissions of up to four pollutants in various proposals — SO_2, NOx, Hg, and CO_2. The objective would be to balance the environmental goal of effective controls across the pollutants covered with the industry goal of a stable regulatory regime for a period of years.[4]

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[2] Steam-electric utilities produce minor amounts of volatile organic compounds (VOCs), carbon monoxide (CO), and lead — on the order of 2% or less of all sources.

[3] Senate Amendment 866 to H.R. 6, The Energy Policy Act of 2005, (June 22, 2005)

[4] CRS Report RL30878, *Electricity Generation and Air Quality: Multi-Pollutant Strategies*, (continued...)

To some degree, this new approach already has been incorporated into existing law with three recently finalized rules: (1) the Clean Air Interstate Rule (CAIR), promulgated May 12, 2005, that caps emissions of SO_2 and NOx in the eastern U.S.; (2) the Clean Air Mercury Rule (CAMR), promulgated May 18, 2005, that caps emissions of Hg from coal-fired powerplants; and (3) the Clean Air Visibility Rule (CAVR), promulgated July 6, 2005, that focuses on SO_2 and NOx emissions that impair visibility surrounding national parks and wilderness areas.

More SO_2 and NOx reductions are in the pipeline. With new ambient air quality standards for ozone and fine particles taking effect nationwide in 2005, emissions of NOx (which contributes to the formation of ozone) and SO_2 (which is among the sources of fine particles) need to be reduced further. Mercury emissions are also a focus of concern: 44 states have issued fish consumption advisories for mercury, covering 13 million acres of lakes, 765,000 river miles, and the coastal waters of 12 entire states. Mercury enters water bodies from air emissions that are either deposited directly in them or are deposited on land and end up in water through precipitation run off.

Proposed Legislation

Many in industry, environmental groups, Congress, and the Administration agree that legislation that addresses power plant pollution in a comprehensive (multi-pollutant) fashion could achieve health and environmental goals in simpler, more cost-effective ways. In the 109th Congress, six bills have been introduced that would impose multi-pollutant controls on utilities.[5] Such legislation (the Administration version of which is dubbed "Clear Skies") would address SO_2, NOx, and Hg from electric generating facilities on a coordinated schedule, and would rely, to a large extent, on a system like that used in the acid rain program, where national or regional caps on emissions are implemented through a system of tradeable allowances. Some of the legislative proposals include CO_2 caps as well.

Key questions in the ensuing congressional debate have been how stringent the caps should be, how quickly reductions should be mandated, and whether carbon dioxide should be among the emissions subject to a cap. Regarding the stringency issue, all bills would eventually require a 70% to 80% reduction of both NOx and SO_2 emissions from 1998 levels. Regarding mercury, the bills eventually would require reductions of 70%-90%.

The Clear Skies bill (S. 131) would impose the least stringent standards and would be phased in over the longest period of time. For all three pollutants, the final Clear Skies deadlines would be 2018, but the actual 70% reduction targets might not be met for as long as a decade after that. The reason for the delay is the use of what are called "banking" provisions in the regulatory scheme. Because the deadlines are far in the future, utilities would be likely to "overcomply" in the early years of the

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[4] (...continued)
by (name redacted) and (name redacted).

[5] For a detailed comparison, see CRS Report RL32755, *Air Quality: Multi-Pollutant Legislation in the 109th Congress*, by (name redacted) and (name redacted).

program, building up credits that could be used in place of further emission reductions in later years. The Administration uses the projected overcompliance as a selling point for its approach, arguing that it will achieve reductions sooner than would a traditional regulatory approach with similar deadlines. But overcompliance in the early years would lead to large holdings of banked emission allowances to be used in place of actual reductions in later years, delaying achievement of emissions caps. In its analysis of the Clear Skies bill, EPA does not expect to see the full 70% emission reductions until 2026 or later.

The Jeffords and Carper bills also allow banking and trading of allowances; but, with earlier and more stringent caps on emissions, utilities would be unable to bank so many allowances and, thus, would reach full compliance at least a decade sooner than under Clear Skies.

With respect to carbon dioxide, Clear Skies would not impose controls on it, whereas the Jeffords and Carper bills would. The absence of CO_2 from the mix might lead to different strategies for achieving compliance, preserving more of a market for coal, and lessening the degree to which power producers might switch to natural gas or renewable fuels as a compliance strategy.

Options Examined in EPA's Analysis

The cost-benefit analysis released by EPA, October 27,[6] examined six options: four of the six were variants of the Administration's Clear Skies bill or its regulatory counterparts[7]; the other two options were Senator Carper's Clean Air Planning Act (S. 843 in the 108th Congress, but as of the date of the analysis, not yet introduced in the 109th) and Senator Jeffords' Clean Power Act (S. 150).

The results of the analysis show very little difference between the four Clear Skies options, so it may be best to think of them as one (for most purposes) and simplify the discussion to three principal choices: Clear Skies, Carper, and Jeffords. Of the four Clear Skies options that EPA examined, we have chosen the version most recently drafted, the Managers' Mark version, which was offered at the Senate Environment and Public Works Committee markup of S. 131 on March 9, 2005.[8]

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[6] Rather than a single document, the agency actually released a group of 45 documents: an 18-page "Comparison Briefing"; a 4-page table comparing the options; separate analyses of each of the six options; and 37 background documents. We refer to this group of 45 documents as the agency's cost-benefit analysis. The full package is available at [http://www.epa.gov/airmarkets/mp/].

[7] By "regulatory counterparts," we mean three rules promulgated by the agency in 2005 that have emission reduction and cap-and-trade provisions almost identical to those of Clear Skies. These are the Clean Air Interstate Rule (CAIR), promulgated May 12, 2005; the Clean Air Mercury Rule (CAMR), promulgated May 18, 2005; and the Clean Air Visibility Rule (CAVR), promulgated July 6, 2005.

[8] The Managers' Mark was chosen primarily because it was the most recent legislative version. When fully implemented, it also would have slightly greater benefits than the other three Clear Skies alternatives, according to EPA's analysis.

Discussion and CRS Reanalysis

Choice of Baseline Assumptions

EPA's Multi-Pollutant Regulatory Analysis assumes as a baseline that in the absence of new legislation, EPA and the states will take no additional action to control SO_2, NOx, Hg, or CO_2 emissions beyond those rules, regulations, or agreements finalized by mid-2004. This baseline is put forth despite three rules recently finalized by EPA that directly bear on SO_2, NOx, and Hg.[9]

Why EPA chose not to include three finalized rules that clearly delineate EPA's current approach to addressing SO_2, NOx, and Hg control is unclear.[10] Instead, EPA included the three regulations as a "sixth proposal" for controlling these pollutants – a curious designation for finalized rules. This report uses that analysis, the CAIR/CAMR/CAVR[11] case, for its baseline because it most accurately portrays the status of current and future clean air regulation with respect to these pollutants. Arguably, the uncertainty with respect to those rules (and others) is no more than the uncertainty about the specific provisions and implementation of any multi-pollutant legislation. For example, S. 843 was introduced in the 108th Congress. There is no guarantee that a 109th Congress or later version would maintain the deadlines contained in the 2003 proposal. Likewise, the Managers' Mark, almost by definition, was an evolving proposal and could change again if the Committee resumes consideration of it. Finally, the regulations supporting any passed legislation would be subject to some of the same uncertainties and delays as the finalized regulations that were not included in EPA's baseline. Controlling air pollution is a moving target and we believe it is important that any analysis work from updated baseline projections and assumptions when possible.

Choice of Benchmark Analysis

EPA's cost analysis places special emphasis on three basic parameters:

[9] Those are CAIR – the Clean Air Interstate Rule; CAMR – the Clean Air Mercury Rule; and CAVR – the Clean Air Visibility Rule

[10] One explanation might be that, while final, these rules have not yet been implemented and are being challenged in court. In this respect, however, they are not materially different from some pre-2004 rules. EPA's baseline modeling includes finalized, but not implemented, state rules and negotiated settlements, along with finalized EPA rules for which serious disputes still exist with respect to implementation (such as the Heavy Duty Diesel rule). A second possibility is that time constraints prevented EPA from updating its baseline assumption from 2003. Adjusting the model to incorporate more recent data and assumptions would have required a substantial commitment of time, delaying completion of the analysis As discussed later, the grounding of the analysis in 2003 (e.g., Hg control costs and natural gas supply assumptions) may be leading to unrealistic projections.

[11] CAIR – the Clean Air Interstate Rule; CAMR – the Clean Air Mercury Rule; and CAVR – the Clean Air Visibility Rule.

- Electric Demand Price Elasticity (Demand Response). EPA analyzes two scenarios: (1) zero price elasticity (i.e., no demand response to increasing electricity prices), and (2) a very inelastic short-term price elasticity (i.e., a very limited demand response to increasing electricity prices).

- Assumed Short-term Construction Constraints (Feasibility). EPA analyzes two scenarios (1) an assumed shortage in boilermaker labor that limits the amount of SO_2 and NOx emissions control equipment that can be built by 2010, and (2) an assumption that the market will respond to the demand for new equipment in a timely fashion (i.e., no constraint on short-term construction).

- Assumed Electricity Demand Growth and Natural Gas Supply. EPA analyzes two scenarios: (1) EPA's baseline assumption of 1.55% annual electricity demand growth and baseline natural gas prices of $3.34 per MMBtu in 2010 (1999 dollars), and (2) the Energy Information Administration[12] (EIA) baseline assumption of 1.83% annual electricity demand growth and baseline natural gas prices of $3.62 per MMBtu in 2010 (1999 dollars). Under EPA model, these prices rise under the impact of proposed legislation.

Based on these parameters, EPA developed four scenarios that include different combinations of these assumptions (as shown in Figure 1).

- *EPA's Base Case Scenario* assumes zero price demand elasticity, short-term construction constraints, and EPA electricity demand growth and natural gas supply assumptions.

- *No Construction Constraint Scenario* assumes zero price elasticity, no short-term construction constraints, and EPA's electricity growth and natural gas supply assumptions.

- *EPA Demand Response Scenario* assumes very inelastic short-term price elasticity, short-term construction constraints, and EPA's electricity growth and natural gas supply assumptions.

- *Higher Electricity Growth and Natural Gas Scenario* assumes zero price elasticity, short-term construction constraints, and EIA's higher electricity growth and natural gas supply assumptions.

This report uses EPA's Demand Response Scenario as the benchmark analysis. This choice is a compromise based on the three factors and lack of alternative combinations. Each of the scenarios raises questions; however, the strongest case can be made for including a short-term demand response function in the modeling.

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[12] EIA is the division of the Department of Energy responsible for official projections of energy supply, demand, prices, etc.

Electricity price elasticities are well established in the literature, particularly short-term elasticities.[13] The short-term price elasticities chosen by EPA to incorporate

Figure 1. EPA's Four Scenarios

Scenario	Elasticity of Demand	Construction Constrained?	Electricity Growth / Natural Gas
EPA's Base Case	zero	yes	EPA assumptions
No Construction Constraint	zero	no	EPA assumptions
EPA Demand Response (used by CRS)	assumes fairly inelastic demand response (*but not zero*)	yes	EPA assumptions
Higher Electricity Growth and Natural Gas Prices	zero	yes	higher EIA assumptions

into their Demand Response Scenario (the only scenario to contain the demand function) are well within the range suggested by the literature. Why EPA did not choose to include this refinement in all of the scenarios is unclear. However, EPA only included it in the one, so CRS chose it.

This is not to suggest that the other assumptions incorporated in the Demand Response Scenario are not debatable, particularly EPA's assumption with respect to boilermaker labor. EPA assumes in three of the four scenarios above that there will be limited boilermaker labor for constructing SO_2 and NOx control equipment until 2010, following which unlimited labor would be available.[14] This is an assumption EPA incorporated into its regulatory rulemaking on the Clean Air Interstate Rule (CAIR), also called the Interstate Air Quality Rule (IAQR). This constraint has been questioned by some, including the Institute of Clean Air Companies (ICAC), the trade association that represents the air pollution control industry. During the rulemaking on CAIR, ICAC conducted their own analysis of boilermaker labor

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[13] The classic survey of electricity price elasticities is Douglas R. Bohi, *Analyzing Demand Behavior: A Survey of Energy Elasticities*, Johns Hopkins University Press (1981). For more recent examination of residential electricity price elasticities, see Raphael E. Branch, "Short Run Income Elasticity of Demand for Residential Electricity Using Consumer Expenditure Survey Data," 14 *The Energy Journal* 4 (1993) pp. 111-121 and Yu Hsing, Estimation of Residential Demand for Electricity with the Cross-Sectionally Corrected and Time-wise Autoregressive Model," 16 *Resources and Energy Economics* (1994) pp. 255-263.

[14] Environmental Protection Agency, *Feasibility of Installing Pollution Controls to Meet Phase 1 Requirements of Various Multi-Pollutant Legislative Proposals*, Office of Air and Radiation (October 2005)

availability and found no constraint on construction, even if the 2015 deadline of CAIR was moved to 2010. As stated by ICAC:

> In summary, the air pollution control industry has demonstrated that they are able to install significant amounts of air pollution control equipment in short periods of time. This has been demonstrated more recently with the installation of SCRs [selective catalytic reduction controls] for the NOx SIP call as well as for control installations in both Germany and Japan. The resources required for the projected installations under the IAQR will also require a significant number of air pollution control installations but the resources required to complete them are not expected to be limiting. Factors such as the use of modular construction methods and non-union craft labor will reduce the demand for union boilermakers. This reduction in boilermaker demand combined with the six month increase in compliance time window will further reduce the demand on boilermaker labor. In the event of a shortage, additional boilermaker labor is available through the Canadian boilermaker union as well as from ship builders' and iron workers' labor pools. In conclusion, there will be more than sufficient boilermaker capacity to carry out the projected IAQR and control installation for 2010 and 2015. Even more significantly, it will be possible to complete the 2015 requirements in the 2010 timeframe.[15]

The assumption of limited boilernaker availability, which only affects the two most stringent alternatives (S. 843 and S. 150) is included in three of the four scenarios used by EPA in its analysis. The one scenario that removes this constraint simultaneously assumes zero price elasticity for electricity demand. Thus, despite questions with respect to this assumption, one is forced to choose whether to address it or to address the demand elasticity assumption. CRS believes that given the lack of an EPA alternative that includes both demand elasticity and no boilermaker constraint, it is more important to include a demand elasticity function in the benchmark analysis than to remove the questionable feasibility constraint.[16] Thus, we chose EPA's demand response scenario as our base case.

Finally, there is the important issue of future natural gas supply. There are no facts about the future and, therefore, sensitivity analysis is very important to understand the robustness of cost estimates. The natural gas supply curves developed for the EPA's model generally project more natural gas availability at lower prices than the natural gas supply curves developed by EIA. EPA provides one scenario with the steeper EIA supply curves – Higher Electricity Growth and Natural Gas Scenario – along with the short-term feasibility constraint and zero short-term price

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[15] Institute of Clean Air Companies, *IAQR Projected 2015 Control Technology can be Installed by 2010*, p. 10.

[16] Indeed, not including a demand response would compound the effects of the feasibility constraint discussed here. With the feasibility constraint and zero price elasticity, the model continues to build new generation capacity despite price increases, bumping into the feasibility constraints that further bump up prices that are not responded to. Not including a demand response function affects only the two non-Clear Skies bills. Including a proper demand response function into the analysis mitigates this effect to some degree.

elasticity. In the current market climate, it is difficult not to argue that the EIA curves may be more representative of future supplies than EPA's estimates. However, natural gas supply has a long history of volatility and the 15-year time frame of the analysis leaves plenty of room for debate.

Recognizing serious questions about EPA's feasibility constraints and the historic volatility of the natural gas market, this analysis uses the Demand Response Scenario as the basis of its discussion. Including a short-term demand function is fully justified based on the literature.

Results of the Analysis

Clear Skies. Clear Skies would cost substantially less than the other two bills, both in the short- and long-term. As indicated by **Tables 2 and 3,** Clear Skies' costs and benefits are minimal compared with the reconstructed baseline case. That Clear Skies has the lowest cost should not be surprising. Compared to the other bills, it has less stringent requirements and later deadlines, so, particularly in the early years, there is a vast difference in the annual costs of the three approaches. In particular, the provisions with respect to Hg are weak compared with the other two bills and there are no provisions for CO_2. More importantly, as discussed in a previous CRS report, Clear Skies is principally an attempt to revamp the Clean Air Act's existing structure with something more cost-effective.[17]

Clear Skies' benefits would also be substantially less than the Carper and Jeffords bills, which were designed to reduce pollution faster than existing requirements. In 2010, the Clear Skies bill would provide $6 billion in annual benefits, according to EPA, compared to benefits of $51 billion (Carper) and $83 billion (Jeffords). The benefits of Clear Skies almost merge with the baseline increase in later years, and continue to lag the two other bills, which have benefits of $19 billion and $66 billion annually in 2020. The higher benefits for the Carper and Jeffords bills reflect the fact that Clear Skies' required pollution caps are less stringent, and the implementation schedule is more relaxed.

As noted, EPA compares the three bills' effects to a baseline that does not include current Clean Air Act requirements. If one adjusts the baseline to reflect current Clean Air Act requirements (including the CAIR, CAMR, and CAVR rules, promulgated earlier this year), Clear Skies has essentially no incremental cost. Its benefits are also relatively small – equal to an additional 10% of the benefits of the newly promulgated rules in 2010 and only 2% of the benefits in 2020. This result suggests the success EPA has had in incorporating the market-based regulatory scheme of Clear Skies into its new regulations. At the same time, the analysis may bolster the arguments of Clear Skies' opponents, who maintain that the requirements of current law are at least as good as the Clear Skies requirements.

S. 150 (Jeffords). As indicated by **Tables 2 and 3**, Senator Jeffords' bill would have the greatest benefits. In 2010, its benefits would be $83 billion annually,

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[17] For additional discussion of these points, see CRS Report RL32782, *Clear Skies and the Clean Air Act: What's the Difference?* by (name redacted) and (name redacted).

$32 billion more than those of the Carper bill, and about 14 times the benefits of Clear Skies. In 2020, its benefits continue to exceed those of the other bills: at an estimated $66 billion annually, they are three-and-a-half times those of the Carper bill and 22 times those of Clear Skies.

Table 2. EPA 2010 Cost and Benefit Estimates for Three Multi-Pollutant Proposals, Compared with Existing Law
(in billions of 1999 dollars)

Bills	Cost Analysis	Benefit Analysis	
	EPA Demand Response Scenario (including short-term constraints)	EPA Ozone and $PM_{2.5}$ Health Benefits Estimates	Net Benefits Compared to Costs
S. 150	+$23.6	*+$83*	*+$59*
S. 843	+$4.2	*+$51*	*+$47*
Managers' Mark	+$0.2	*+$6*	*+$6*

Note: Benefit estimates presented represent the mid-point of the range provided by EPA.

Table 3. EPA 2020 Cost and Benefit Estimates for Three Multi-Pollutant Proposals, Compared with Existing Law
(in billions of 1999 dollars)

Bills	Cost Analysis	Benefit Analysis	
	EPA Demand Response Scenario (including short-term constraints)	EPA Ozone and $PM_{2.5}$ Health Benefits Estimates	Net Benefits Compared to Costs
S. 150	+$18.1	*+$66*	*+$48*
S. 843	+$3.0	*+$19*	*+$16*
Managers' Mark	0	*+$3*	*+$3*

Note: Benefit estimates presented represent the mid-point of the range provided by EPA.

S. 150 would also be the most costly bill. As discussed later, more than the other bills, the Jeffords bill suffers from the short-term construction constraints EPA imposed on the analysis. EPA maintains that a shortage of skilled labor will limit the number of scrubbers that can be installed by 2010. Lacking scrubbers, coal-fired power plants are forced to shut down in the agency's analysis of the bill. The Jeffords bill would reduce coal production and coal-fired electric generation by about 40%, according to EPA. Vast numbers of natural-gas-fired and renewable fuel generators would be required in their place, at great cost: the Jeffords bill would lead to an additional 65 gigawatts of generation from renewable sources (about 6 times the amount projected under either of the other options) and nearly 100 gigawatts of additional oil- and gas-fired capacity. By contrast, coal use would increase under either Clear Skies or the Carper bill.

While the cost of S. 150 may lead Clear Skies' proponents to characterize it as too costly, the net benefits of S. 150 (i.e., benefits minus costs) far exceed those of Clear Skies and S. 843.

S. 843 (Carper). As indicated by **Tables 2 and 3**, both the benefits and costs of S. 843 are lower than those of S. 150, but higher than those of Clear Skies. This is by design, as S. 843 attempts to achieve substantial emission reductions beyond those currently incorporated in the Clean Air Act, but allow sufficient time to avoid serious short-term price increases. As discussed later, the more phased-in schedule of the bill helps mitigate (but does not eliminate) the short-term constraints EPA imposes on the analysis. In addition, as discussed later, S. 843 develops a limited and flexible CO_2 requirement that achieves some reduction in the increase in carbon dioxide emissions at a nominal cost.

Sensitivity Analysis

EPA conducted a number of sensitivity analyses on the various bills. As noted earlier, three variables highlighted by the analyses were (1) price elasticity, (2) short-term construction constraints, and (3) higher electricity growth and more constrained natural gas supply. Unfortunately, these variables were not isolated from each other, but examined in selected combinations. As noted earlier, the benchmark analysis used for this report assumes limited short-term price elasticity, short-term construction constraints, and EPA's electricity growth and natural gas supply curves. The other three combinations that EPA analyzed were:

- *No Construction Constraint Scenario*, which assumes zero price elasticity, no short-term constraints, and EPA's electricity growth and natural gas supply curves;

- *EPA Base Case Scenario*, which assumes zero price elasticity, short-term constraints, and EPA electricity growth and natural gas supply curves; and

- *Higher Electricity Growth and Natural Gas Scenario*, which assumes zero price elasticity, short-term constraints, and EIA's higher electricity growth and natural gas supply curves.

The first alternative, the No Construction Constraint Scenario, removes EPA's assumed short-term construction constraint assumption contained in the benchmark analysis but includes a zero demand price elasticity assumption. As indicated in **Table 4,** this swap of assumptions is pretty much a wash for S. 843 and the Managers' Mark. Indeed, in the case of S. 843, the analysis indicates that the short-term construction assumptions are slightly more important to the cost analysis than the removal of any price elasticity. However, the assumption of zero demand price elasticity in this scenario has a substantial impact on the cost of S. 150, both short

(36% increase) and long-term (157% increase), as the removal of any price elasticity exceeds the saving gained by removing EPA short-term construction constraint assumptions. This is not surprising, given the significant compliance cost of S. 150 – a cost that, with zero elasticity assumed, results in no demand-side reaction from consumers.

Table 4. Incremental Cost of Alternative Assumptions Compared with the CRS Base Case

(in billions of 1999 dollars)

Bills	ZERO DEMAND PRICE ELASTICITY COST SCENARIOS					
	With No Assumed Construction Constraints (Alternative 1)		With EPA Assumed Construction Constraints			
			EPA's Base Case Scenario (Alternative 2)		With EIA Electricity Growth and Natural Gas Assumptions (Alternative 3)	
	2010	**2020**	**2010**	**2020**	**2010**	**2020**
S. 150	+$8.6	+$28.4	+$14.8	+$26.6	+$19.1	+$41.3
S. 843	-$0.3	+$0.1	+$3.6	+$0.4	+$4.5	+$1.2
Managers' Mark	+$0.1	+$0.1	0	+$0.1	-$0.1	-$0.1

The second alternative, the EPA Base Case Scenario, replaces the short-term price elasticity estimate of our benchmark analysis with an assumption of zero price elasticity. The short-term construction constraint assumptions are maintained. This case confirms the dramatic effect that removal of any short-term price elasticity has on the costs of S. 150 with increases of 63% in 2010 and 147% in 2020 over the benchmark analysis, and indicates the relative size of the effect on S. 843. For S. 843, removal of any price elasticity results in a cost estimate 86% higher than our benchmark estimate for 2010. Along with the first sensitivity analysis, this result suggests that demand response and short-term construction constraint assumptions heavily influence EPA's 2010 cost estimates for S. 843. In contrast, EPA's assumptions have little effect on S. 843 cost estimates in the long-term or for the Managers' Mark.

The third alternative, the Higher Electricity Growth and Natural Gas Scenario, essentially takes the zero price elasticity estimate and short-term construction constraint assumptions of the EPA Base Case Scenario and adds EIA's higher electricity growth assumptions and steeper natural gas supply curves. Compared with the benchmark analysis, this case maintains the short-term construction constraint assumption, removes any demand price elasticity, and employs EIA assumptions for electricity growth and natural gas supply. Not surprisingly, the combination of zero demand response, greater demand for electricity, and tighter natural gas supply results in higher costs, particularly for S. 150. Compared with the assumptions of the EPA Base Case, the effect of higher growth and natural gas costs in the context of zero demand response is most pronounced in the case of S. 150 and puts even more pressure on EPA's assumption of zero demand price elasticity, particularly for 2020. The impact on S. 843 is considerably less dramatic and is nonexistent for the Managers' Mark. However, the sensitivity analysis here is pretty limited and a more comprehensive analysis of future natural gas availability could be valuable in determining appropriate targets and timetables for any multi-pollutant legislation.

Cost Analysis Summary Points

- EPA's assumption of zero demand price elasticity has a dramatic impact on the S. 150 short and long-term cost estimates. This effect is accentuated when EIA higher electricity growth and natural gas assumption are employed, particularly over the long term. Removal of EPA's assumed short-term construction constraints reduces the effect some in the short-term, but does not overcome it.

- EPA's assumption of zero demand price elasticity and assumed short-term construction constraints appear to have significant and about equal effects on S. 843 in the short term. Both effects decrease substantially over the long term, even if EIA's higher cost assumptions are employed, because of S. 843's less aggressive time frame.

- EPA's assumptions have little effect on the Managers' Mark cost estimates, either short or long-term. This is not surprising as the basis of the Managers' Mark and much of newly-finalized regulations – Clear Skies – was developed using EPA's model. That the Managers' Mark has only an incremental impact on the cost and benefits of existing law and regulations ensures that its economic impact is minimal under any conditions compared with those of existing laws and regulations.

Specific Issues Highlighted

Carbon Dioxide Control Costs

Two of the bills analyzed by EPA, Senator Jeffords' S. 150 and Senator Carper's S. 843, contain provisions to reduce carbon dioxide emissions. The S. 150 provision sets an emissions cap of 2.05 billion tons annually beginning in 2010 (about 7% below 1990 levels). S. 843 would set an emissions cap of about 2.655 billion tons (estimated 2006 emissions) in 2009, decreasing to 2.454 billion tons (2001 emissions level) beginning in 2013. As indicated in **Table 5**, the more modest reduction requirement, combined with a slower reduction schedule, results in an order of magnitude lower costs for CO_2 allowances under S. 843 compared to S. 150.

The S. 150 reduction requirement and schedule are more representative of the requirements of the Kyoto Protocol than S. 843. As indicated in **Table 5,** adjusting S. 150's carbon dioxide reduction costs for 2005 dollars and metric tons results in costs of $19 a metric ton in 2010 and $33 a metric ton in 2020. This estimate range is within that of the current European Union market prices as the EU ramps up for meeting its more stringent 8% reduction below 1990 levels required under the Kyoto Protocol. The current EU price for a metric ton of carbon dioxide reduction is about $25.[18]

Table 5. EPA Estimates for Carbon Dioxide Allowance Prices – 2010 and 2020

(per short ton, except as noted)

	S. 843 Costs (1999$)	S. 150 (1999$)	S. 150 (per metric ton, estimated 2005$)
2010	$1	$16	**$19**
2020	$2	$27	**$33**

Mercury Control Costs

Given the short deadline for completing the study, EPA and its contractor did not develop new data on the cost or cost-effectiveness of control technologies, instead relying on assumptions used in conducting analyses of the CAIR and CAMR rules promulgated early in 2005. Those analyses used cost and cost-effectiveness data collected in 2003. As noted in an earlier CRS report, the effectiveness of mercury control technology has advanced rapidly since 2003. Thus, we conclude that the present analysis may overstate the cost of emission controls for mercury by a substantial margin. The air pollution control industry maintains that the cost of activated carbon injection (ACI) controls, which the model assumes would be imposed on about 40% of coal-fired plants under the Carper bill, is now only one-fourth what the cost would have been in 2003.[19]

EPA's Hg control cost assumptions have less of a distorting effect in its analysis of S. 150, simply because its other assumptions (discussed earlier) lead it to conclude that 40% of coal-fired plants would be shut down by 2010 under the bill.

Benefits Estimates

EPA's analysis and CRS's reanalysis of the data show benefits substantially outweighing costs for both S. 150 and S. 843. The benefits represent the monetized human health effects (principally reduced mortality) from reducing emissions of SO_2 and fine particles. Some of these benefits are summarized in **Table 6** below.

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[18] As of November 4, 2005, according to PointCarbon. For current EU prices in euros, see [http://www.pointcarbon.com/]

[19] CRS Report RL32868, *Mercury Emissions from Electric Power Plants: An Analysis of EPA's Cap-and-Trade Regulations,* by (name redacted).

Table 6: Selected Heath Effects Avoided by Proposals Over Baseline
(in annual incidences avoided)

Health Effect Avoided	S. 150		S. 843		Managers' Mark	
	2010	2020	2010	2020	2010	2020
Premature mortality	16,000	12,000	10,000	4,000	1,000	1,000
Chronic bronchitis	8,100	5,000	5,100	2,000	600	0
Non-fatal heart attacks	20,000	14,000	12,000	4,000	2,000	1,000
Hospital admissions/ER visits	22,000	14,000	15,000	5,000	2,000	1,000
Acute bronchitis	19,000	13,000	12,000	4,000	1,000	1,000

Note: These effects are incremental to the effects of the CAIR, CAMR, and CAVR rules.

Three other sets of likely benefits were not estimated, at least in part because of the methodological difficulty of doing so. First, the analysis makes no attempt to monetize environmental benefits, which are significant in the case of sulfur dioxide and mercury controls. SO_2 emissions are the primary cause of acid deposition, which harms aquatic life and affects forest growth, as well as damaging building materials. Reductions in SO_2 emissions could have significant environmental benefits, which are not estimated in the analysis. The emissions are also a significant factor in the formation of regional haze, the effects of which were also not monetized. Mercury deposition, as noted earlier, has led to widespread fish consumption advisories, with attendant economic impacts. The omission of environmental benefits has its greatest effect on S. 150 and S. 843 which have more aggressive SO_2, NOx, and Hg control schemes.

Second, the analysis does not model mercury heath effects. Agency analyses of the economic benefits of reducing Hg health effects have ranged from a few million dollars per year to several billion dollars per year.[20] The impact of omitting these benefits would be significant if one accepts the latter estimate. Once again, this omission has its greatest effect on S. 150 and S. 843, which have more aggressive Hg control schemes.

Finally, the analysis did not attempt to estimate the possible benefits of controlling CO_2 emissions. There is no accepted methodology for making such an estimate. Still, the absence of such a factor in the analysis may be a significant omission, which understates the potential benefits of the Jeffords and Carper bills. The Jeffords bill is the most aggressive of the three in regard to controlling CO_2

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[20] For additional discussion of the benefits of controlling mercury emissions, and EPA's varied estimates, see CRS Report RL32868, *Mercury Emissions from Electric Power Plants: An Analysis of EPA's Cap-and-Trade Regulations*, by (name redacted).

(whereas Clear Skies does not cap CO_2 emissions at all). Thus, the Jeffords bill may be most disadvantaged as a result of this factor.

Conclusion

In reexamining EPA's analysis, several points stand out in thinking about multi-pollutant legislation:

- EPA has been very successful in incorporating the caps of Clear Skies in now promulgated rules. As a result, after adjusting for those rules, EPA's analysis finds little cost and a small benefit associated with passage of Clear Skies legislation. The Jeffords and Carper bills, however, set more stringent standards than the promulgated rules. For both bills, the analysis shows benefits far outweighing additional costs.

- Carbon dioxide costs depend on the amount and schedule of any proposed reductions. The modest reduction requirement and relaxed implementation schedule of S. 843 results in nominal carbon dioxide reduction costs. As reduction requirements increase and implementation schedules tighten, costs rise.

- Mercury control costs are dependent on the timeliness of the data. The EPA analysis does not reflect current data on costs of Hg controls.

- EPA's benefit analysis is limited and incomplete, which works to the disadvantage of alternatives to Clear Skies that include more stringent standards.

Although it represents a step toward understanding the impacts of the legislative options, EPA's analysis is not as useful as one could hope. The combination of assumptions used in the analysis works in favor of the various Clear Skies alternatives by overstating the Hg control costs of the alternatives, and – through its assumption of constraints on labor availability – heavily penalizing short-term pollution reduction schedules. In addition, the analysis does not adequately analyze the effect that natural gas price volatility may have on implementation strategies and costs. The analysis suffers from being based on 2003 assumptions, both in terms of natural gas markets and Hg control costs. The result is an analysis that some will argue is no longer sufficiently up-to-date to contribute substantively to congressional debate.