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Climate Change: Comparison and Analysis of S. 1766 and S. 2191 (S. 3036)

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Summary

Several proposals designed to address greenhouse gases have been introduced in the 110th Congress. Two proposals, S. 1766, introduced by Senators Bingaman and Specter, and S. 2191, introduced by Senators Lieberman and Warner and reported by the Senate Committee on Environment and Public Works on May 20, 2008, are receiving increased scrutiny in preparation for Senate debate on S. 2191. On May 20, 2008, Senator Boxer introduced S. 3036, which is identical to the reported version of S. 2191 except that it contains a proposed budget amendment to make the bill deficit neutral. On June 2, 2008, the Senate invoked cloture on a motion to proceed on S. 3036, allowing discussion of the bill, but not allowing amendments to be introduced. As of June 4, 2008, it is unclear whether the Senate will agree on the motion to proceed, leading to further discussion and allowing amendments to be introduced.

The two proposals — S. 1766 and S. 2191 — would establish market-based systems to limit emissions of greenhouse gases. However, the proposals differ in how those systems would work. S. 2191 would establish an absolute cap on emissions from covered entities and would allow entities to trade emissions under that cap. S. 1766 would establish emissions targets on covered entities and allow those entities to either meet emission reduction targets through a trading program or make a safety valve payment in lieu of reducing emissions. Under both proposals, short-term U.S. emissions would likely be below a business-as-usual scenario, although reductions under S. 2191 are guaranteed by the cap and are projected to be larger, particularly over the long-term. In contrast, costs under S. 1766 are likely to be lower and more predictable than under S. 2191.

A major policy question is whether one is more concerned about the possible economic *cost* of the program and therefore willing to accept some uncertainty about the amount of reduction received (i.e., favoring a "safety valve" like S. 1766); or one is more concerned about achieving a specific *emission reduction* level with costs handled efficiently, but not capped (i.e., pure tradeable permits as in S. 2191). S. 2191 leans toward the quantity (total emissions) side of the equation; S. 1766 leans toward the price side of the equation.

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Introduction

Climate change is a global issue, but proposed responses generally would require action at the national level. In 1992, the United States ratified the United Nations Framework Convention on Climate Change (UNFCCC), which called on industrialized countries to take the lead in reducing the six primary greenhouse gases to 1990 levels by the year 2000.[1] For more than a decade, a variety of voluntary and regulatory actions have been proposed or undertaken in the United States, including monitoring of power plant carbon dioxide emissions, improved appliance efficiency, and incentives for developing renewable energy sources. However, greenhouse gas emissions have continued to increase.

In 2001, President George W. Bush rejected the Kyoto Protocol, which called for legally binding commitments by developed countries to reduce their greenhouse gas emissions.[2] He has also rejected the concept of mandatory emissions reductions.[3] Since then, the Administration has focused U.S. climate change policy on voluntary initiatives to reduce the growth in greenhouse gas emissions. In contrast, in 2005, the Senate passed a Sense of the Senate resolution on climate change declaring that Congress should enact legislation establishing a mandatory, market-based program to slow, stop, and reverse the growth of greenhouse gases at a rate and in a manner that "will not significantly harm the United States economy" and "will encourage comparable action" by other nations.[4]

A number of congressional proposals to advance programs designed to reduce greenhouse gases have been introduced in the 110th Congress. These have generally followed one of three tracks. The first is to improve the monitoring of greenhouse gas emissions to provide a basis for research and development and for any potential future reduction scheme. The second is to enact a market-oriented greenhouse gas

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[1] Under the United Nations Framework Convention on Climate Change (UNFCCC), those gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Some greenhouse gases are controlled under the Montreal Protocol on Substances that Deplete the Ozone Layer, and are not covered under UNFCCC.

[2] For further information, see CRS Report RL33826, *Climate Change: The Kyoto Protocol, Bali "Action Plan," and International Actions*, by Susan R. Fletcher and Larry Parker.

[3] President George W. Bush, *President Bush's Speech on Global Climate Change* (June 11, 2001).

[4] S.Amdt. 866, passed by voice vote after a motion to table failed 43-54, June 22, 2005.

reduction program along the lines of the trading provisions of the current acid rain reduction program established by the 1990 Clean Air Act Amendments. The third is to enact energy and related programs that would have the added effect of reducing greenhouse gases:[5] an example would be a requirement that electricity producers generate a portion of their electricity from renewable resources (a renewable portfolio standard). This report focuses on the second category of bills, and on two bills in particular: S. 1766 and S. 2191 (as reported).[6]

Note that CRS has a more comprehensive discussion of the costs and benefits of S. 2191 available.[7] *Many of the caveats and limitations about modeling and forecasting in that report are applicable to this one. Readers are urged to consult that report in addition to reading this one.*

Proposed Senate Legislation: Comparison of S. 1766 and S. 2191

S. 1766. Introduced July 11, 2007, by Senators Bingaman and Specter, S. 1766 would set emissions targets on most of the country's greenhouse gas emissions.[8] Beginning in 2012, covered entities would face emissions limits, with emissions targets set at their 2006 levels in 2020. The emissions targets would decline steadily until 2030, when the emission target would be set at the entities' 1990 levels. For each ton of carbon dioxide equivalent, covered entities can comply with the bill by submitting an allowance through a trading program or by paying a safety valve price (called a Technology Accelerator Payment or TAP). Under the trading program, allowances are allocated to various entities, including covered entities; eligible facilities (non-covered facilities that may be in covered sectors), such as coal mines and carbon-intensive industries; states; and parties conducting sequestration activities. Initially, 24% of all allowances are auctioned, a percentage that increases over time. The TAP is set at $12 per metric ton of carbon dioxide equivalent in 2012, increasing 5% annually above the rate of inflation. The bill also requires countries that do not take comparable action to control emissions to submit special

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[5] For discussions of relevant energy legislation, see CRS Report RL34294, *Energy Independence and Security Act of 2007: A Summary of Major Provisions*, by Fred Sissine, and CRS Report RL33831, *Energy Efficiency and Renewable Energy Legislation in the 110th Congress*, by Fred Sissine, et al.

[6] For a review of additional climate change related bills, see CRS Report RL34067, *Climate Change Legislation in the 110th Congress*, by Jonathan L. Ramseur and Brent D. Yacobucci.

[7] CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent Yacobucci.

[8] Greenhouse gas emitting activities such as methane emissions from landfills, coal mines, animal waste, and municipal wastewater projects, along with nitrous oxide emissions from agricultural soil management, wastewater treatment, and manure management, are not included under the targets, although credits for use by covered entities are available or may be generated by verified greenhouse gas reductions in these areas.

allowances (or their foreign equivalent) to accompany imports into the United States of covered greenhouse gas intensive goods and/or primary products.

S. 2191. Senators Lieberman and Warner introduced S. 2191 on October 18, 2007. As reported by the Senate Committee on Environment and Public Works the bill would cover emissions from petroleum producers and importers, facilities that produce or import more than 10,000 tons (of carbon dioxide equivalent) of fluorinated chemicals annually, any facility that uses more than 5,000 tons of coal annually, any natural gas processing plant or importer (including LNG), and any facility that emits more than 10,000 tons (of carbon dioxide equivalent) of HFCs annually as a byproduct of hydrochloro-fluorocarbon production. S. 2191 is estimated by its sponsors to reduce total U.S. greenhouse gas emissions 19% below 2005 levels by 2020 (up from 15% as introduced) and 63% below 2005 levels by 2050. The bill would establish a Carbon Market Efficiency Board to observe the allowance market and implement cost-relief measures if necessary. Like S. 1766, S. 2191 also requires countries that do not take comparable action to control emissions to submit special allowances (or their foreign equivalent) to accompany exports to the United States of any covered greenhouse gas intensive goods and primary products.

On April 10, 2008, a proposed amendment to S. 2191 was submitted to the Congressional Budget Office (CBO) to be included in the scoring of the bill. The amendment would provide for some of the auctioned revenues to be put aside for deficit reduction purposes. On May 20, Senator Boxer introduced S. 3036, which is identical to the reported version of S. 2191 except that it contains the above deficit reduction amendment. On June 2, 2008, the Senate invoked cloture on a motion to proceed on S. 3036.

Table 1 summarizes the major provisions of each bill.

Table 1: Comparison of Selected Provisions of S. 1766 and S. 2191

Topic	S. 1766 (Bingaman/Specter)	S. 2191 as reported, with deficit reduction amendment (S. 3036) (Lieberman/Warner)
Emission reduction/ limitation scheme	Emissions targets for all covered entities.	Absolute cap on total emissions from all covered entities.
Responsible agency	To be determined by the President.	EPA.
Greenhouse gases defined	Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6)	Same.
Specific emissions limits	In 2012, the emissions target for covered entities is set at 6.652 billion metric tons. Target is reduced annually thereafter until 2030. Emission target for covered sources in 2020 is 6.188 billion metric tons. Emission target for covered sources in 2030 is 4.819 billion metric tons. Reductions beyond 2030 would require additional congressional action. If the President determines that scientific, technological, and international considerations suggest further reductions are warranted, his/her recommendations are to be considered by Congress under expedited procedures.	In 2012, emissions from covered entities are capped at 5.775 billion metric tons. Cap is reduced annually thereafter until 2050. Emission cap for covered sources in 2020 is 4.924 billion metric tons. Emission cap for covered sources in 2030 is 3.860 billion metric tons. Emission cap for covered sources in 2040 is 2.796 billion metric tons. Emission cap for covered sources in 2050 is 1.732 billion metric tons.
Covered entities	Regulated fuel distributors include petroleum refineries, natural gas processing plants, and importers of petroleum products, coke, or natural gas. Regulated coal facilities are entities that consume more than 5,000 tons of coal a year. Regulated nonfuel entities are producers and importers of HFCs, PFC, SF_6, N_2O, or	Assuming no capture of greenhouse gases (GHGs), any producer or importer of petroleum- or coal-based liquid or gaseous fuel that emits GHGs, or any facility that produces or imports more than 10,000 tons carbon dioxide equivalent (CO_2e) of GHG chemicals annually; any facility that uses more than 5,000 tons of coal annually; any natural gas processing plant or importer

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	products containing such compounds, and adipic acid and nitric acid plants, aluminium smelters, and facilities that emits HFCs as a byproduct of HCFC production.	(including LNG); and any facility that emits more than 10,000 CO_2e of HFCs annually as a byproduct of hydrochloro-fluorocarbon production.
General allocating and implementing strategy	Two compliance systems are provided. Covered entities may choose which one to use or employ a combination of both: First, a tradeable allowance system is established. In 2012, 53% of allowances are allocated to covered and eligible industrial entities; 23% allocated to states and for sequestration and early reduction activities; 24% are auctioned to fund low income assistance, carbon capture and storage, and adaptation activities. The percentage auctioned increases steadily, reaching 53% by 2030. Second, a Technology Accelerator Payment (i.e., safety valve) may be paid in lieu of submitting one or more allowances.	A tradeable allowance system is established. Off the top, a share of allowances is auctioned for deficit reduction increasing from 6.1% in 2012 to 15.99% in 2031 and thereafter. Then the "remainder allowances" are distributed in 2012 (adjusted in future years) as follows: 38% of allowances to covered electric utilities, industrial facilities, and cooperatives, declining steadily to zero in 2031; 10.5% to states for conservation, extra reductions, and other activities; 7.5% for various sequestration activities; 11% allocated for electricity and natural gas consumer assistance; 5% for early reductions; 0.5% for tribal governments; 1% for methane reduction projects; and 21.5% (plus an early auction of 5%) auctioned to fund technology deployment, carbon capture and storage, low income and rural assistance, and adaptation activities, as well as program management. The percentage auctioned by the Climate Change Credit Corporation (CCCC) increases steadily, reaching 69.5% by 2031 and thereafter.
Public sale/auction of allowances	Beginning in 2012, 24% of available allowances are auctioned to fund low income assistance, technology, and adaptation activities. The percentage auctioned increases steadily, reaching 53% by 2030; after that it increases 1 percentage point annually through 2043. Revenues from the auction are to be deposited in one of three funds created by the	Beginning in 2012, 6.1% of total allowances are auctioned for deficit reduction. Further, 21.5% of "remainder allowances" (plus 5% from an early auction of 2012 remainder allowances) are auctioned to fund the activities of the CCCC. This percentage increases steadily to 69.5% by 2031 and thereafter. Revenues from the auction are to be deposited in one of ten funds created in the Department of the Treasury: Deficit Reduction Fund, Technology

Topic	S. 1766 (Bingaman/Specter)	S. 2191 as reported, with deficit reduction amendment (S. 3036) (Lieberman/Warner)
	Department of the Treasury: the Energy Technology Deployment Fund, the Climate Adaptation Fund, and the Energy Assistance Fund.	Deployment, Energy Independence Acceleration Fund, Energy Assistance Fund, Climate Change Worker Training Fund, Adaptation Fund, and the Climate Change and National Security Fund, as well as a fund for program management and two Emergency Firefighting Funds.
Cost-limiting safety valve	A Technology Accelerator Payment (TAP) (i.e., safety valve) may be paid in lieu of submitting one or more allowances. For 2012, the TAP price is set at $12 per metric ton, rising 5% above inflation annually thereafter. If the President determines the TAP should be increased or eliminated to achieve the act's purposes, his recommendations are to be considered by Congress under expedited procedures.	A Carbon Market Efficiency Board is established to observe the allowance market and implement cost-relief measures if necessary. Measures include increased allowance borrowing from future allocations; increased use of offsets and foreign allowances; expanded payback period for such allowances; lower interest charged for borrowed allowances; and expanded total borrowed allowances. Increased borrowing is limited to 5% of the emission cap and the repayment schedule cannot be longer than 15 years. If the President determines a national security emergency exists, the President may temporarily adjust, suspend, or waive any regulation promulgated under this program (subject to judicial review).
Penalty for non-compliance	Excess emissions penalties are equal to three times the TAP price for that calendar year. In addition, civil penalties are $25,000 a day for violating provisions of the act.	Excess emission penalties per ton are equal to the higher of $200 or three times the mean market price for allowances during the year the allowance was due, plus a 1-to-1 offset from a future year allocation.
Domestic Offsets / Credits	Establishes program to provide credits obtained through verified domestic reductions from non-covered activities (offsets). No limit the use of domestic offsets to meet allowance requirement.	Up to 15% of allowance requirement may be met through domestic offsets: emissions reductions from agricultural sequestration, land use change, forestry, manure management, and other specified activities. Percentage may be increased by the Carbon Market Efficiency Board
International Offsets / Credits	If the President determines that emission credits issued under foreign programs or foreign offset projects are comparable,	Up to 15% of allowance requirement may be met through certified foreign allowance markets. Percentage may be increased by the Carbon Market

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	he may promulgate rules allowing such credits or offsets to be used to meet the act's emission targets. No more than 10% of an entity's emissions target can be met through foreign emission credits and foreign offset projects.	Efficiency Board.
Banking	Banking of allowances is permitted; allowances may be saved for use in future years.	Banking of allowances is permitted; allowances may be saved for use in future years.
Early reduction credits and bonus credits	One percent of allowances available from 2012 through 2020 are allocated to early reductions reported under the 1992 Energy Policy Act's 1605(b) program, EPA's Climate Leaders Program, or a state-administered or privately administered registry. Geologic sequestration projects built from 2008 through 2030 receive bonus allowances for the first 10 years of operation.	Five percent of "remainder allowances" established for 2012 (declining steadily to zero in 2017) are allocated to early reductions reported under the 1992 Energy Policy Act's 1605(b) program, EPA's Climate Leaders Program, or a state-administered or voluntary program. Four percent of remainder allowances established for 2012 through 2035 are available on a steadily declining basis from 2012 through 2039 for geologic sequestration projects for electric generating plants built from 2008 through 2035. The bonus allowances are limited to the first 10 years of operation.
Revenue recycling	A new Energy Technology Deployment Fund is funded by TAP revenues and some auction proceeds. Activities to be funded include zero- or low-carbon energy, advanced coal and sequestration, cellulosic biomass, and advanced technology vehicles. A new Climate Adaptation Fund is funded by some auction proceeds. Activities to be funded include coastal, arctic, and fish and wildlife impact mitigation. A new Energy Assistance Fund is funded by some auction	Off the top, a growing share of allowances are auctioned for deficit reduction. Revenues received by "remainder allowance" auctions are to be received by the CCCC. Activities to be funded include technology deployment activities (including zero- or low-carbon energy, advanced coal and sequestration, cellulosic biomass, and advanced technology vehicles); assistance activities (including low income, weatherization, and rural assistance); worker transition assistance; and adaptation activities (including wildlife conservation and restoration, aquatic ecosystems, and

Topic	S. 1766 (Bingaman/Specter)	S. 2191 as reported, with deficit reduction amendment (S. 3036) (Lieberman/Warner)
	proceeds. Activities to be funded include low-income and rural energy assistance, and weatherization.	coastal habitats). Revenues would also fund a Climate Change and National Security Program within the U.S. Agency for International Development to report annually on the ramifications of climate change for national security. Such sums as are necessary to maintain a fund of $1.1 billion is directed toward wildland fire suppression activities by the Bureau of Land Management and the Forest Service.
Other key provisions	Provisions include periodic review of the activities of the nation's five largest trading partners, an National Academy of Sciences assessment of the status of climate change science, emission control technologies, and energy security implications. Beginning in 2019, requires foreign countries that do not take comparable emission reduction actions to submit international reserve allowances (or foreign equivalents) to accompany exports of any covered greenhouse gas intensive goods and primary products to the United States. Least-developed nations or those that contribute no more than 0.5% of global emissions are excluded. Proceeds from the sale of such reserve allowances are to be deposited in an International Energy Deployment Fund to encourage and finance international technology development.	Provisions require new appliance standards in 2012 and provide for new model building efficiency standards by 2010. Beginning in 2018, requires annual review of foreign countries' GHG control actions. Beginning in 2019, requires foreign countries that do not take comparable emission reduction actions to submit international reserve allowances (or foreign equivalents) to accompany exports of any covered greenhouse gas intensive goods and primary products to the United States. Least developed nations or those that contribute no more than 0.5% of global emissions are excluded. Requires periodic review of the bill's implementation and purposes by the NAS. Establishes a separate cap-and-trade program to limit U.S. production and consumption of HFCs. Establishes a low carbon fuel standard (LCFS) requiring transportation fuels to have, on average, 10% lower lifecycle emissions per unit of energy by 2020.

Results of Analyses

Two studies have been completed that compare S. 1766 and S. 2191 under the same baseline conditions.

The most comprehensive analysis has been conducted by the U.S. Environmental Protection Agency (EPA). The reports are entitled *EPA Analysis of the Low Carbon Economy Act of 2007: S. 1766 in the 110th Congress* (January 15, 2008), and *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008: S. 2191 in 110th Congress* (March 14, 2008).[9] The analyses employ a suite of models and basecases, along with some useful sensitivity analysis. This report will focus on three of the models and two basecases.[10]

- The first model is ADAGE: a computable general equilibrium (CGE) model developed by RTI International.[11] The S. 1766 and S. 2191 cases employing the reference basecase are designated EPA/ADAGE-REF in this report, while the cases employing the high technology basecase are designated EPA/ADAGE-TECH.

- The second model is IGEM: a CGE model developed by Dale Jorgenson Associates.[12] The cases employing the reference basecase are designated EPA/IGEM-REF in this report, while the cases employing the high technology basecase are designated EPA/IGEM-TECH.

- The third model is IPM: a dynamic, deterministic linear programming model of the U.S. electric power sector developed by ICF Resources. The cases employing the IPM model are designated EPA/IPM in this report.[13]

A second analysis has been conducted by the Energy Information Administration (EIA). The report is entitled *Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007* (April 2008) and included an updated analysis of S. 1766.[14] The analysis employs EIA's NEMS model:

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[9] The report and supporting model runs are available at [http://www.epa.gov/climatechange/economics/economicanalyses.html]

[10] Other EPA models focus on forests and agriculture, non-CO_2 gases, and climate assessment.

[11] For more information on the ADAGE model, see [http://www.rti.org/adage]

[12] For more information on the IGEM model, see [http://post.economics.harvard.edu/faculty/jorgenson/papers/papers.html]

[13] For more information on the IPM model, see [http://www.epa.gov/airmarkets/progsreg/epa-ipm/index.html]

[14] EIA's previous report was entitled *Energy Market and Economic Impacts of S. 1766, the Low Carbon Economy Act of 2007* (January 2008).

a macroeconomic forecasting model with extensive energy technology detail.[15] In addition to conducting a "core" analysis of S. 2191 using its preliminary *2008 Annual Energy Outlook (AEO) Baseline*, EIA also conducts some useful sensitivity analysis that focuses on the upside risk of increased energy prices under S. 2191. However, EIA did not update the sensitivity analysis it had previously conducted on S. 1766. The core[16] S. 2191 analysis and the updated S. 1766 analysis are designated EIA/NEMS in this report.

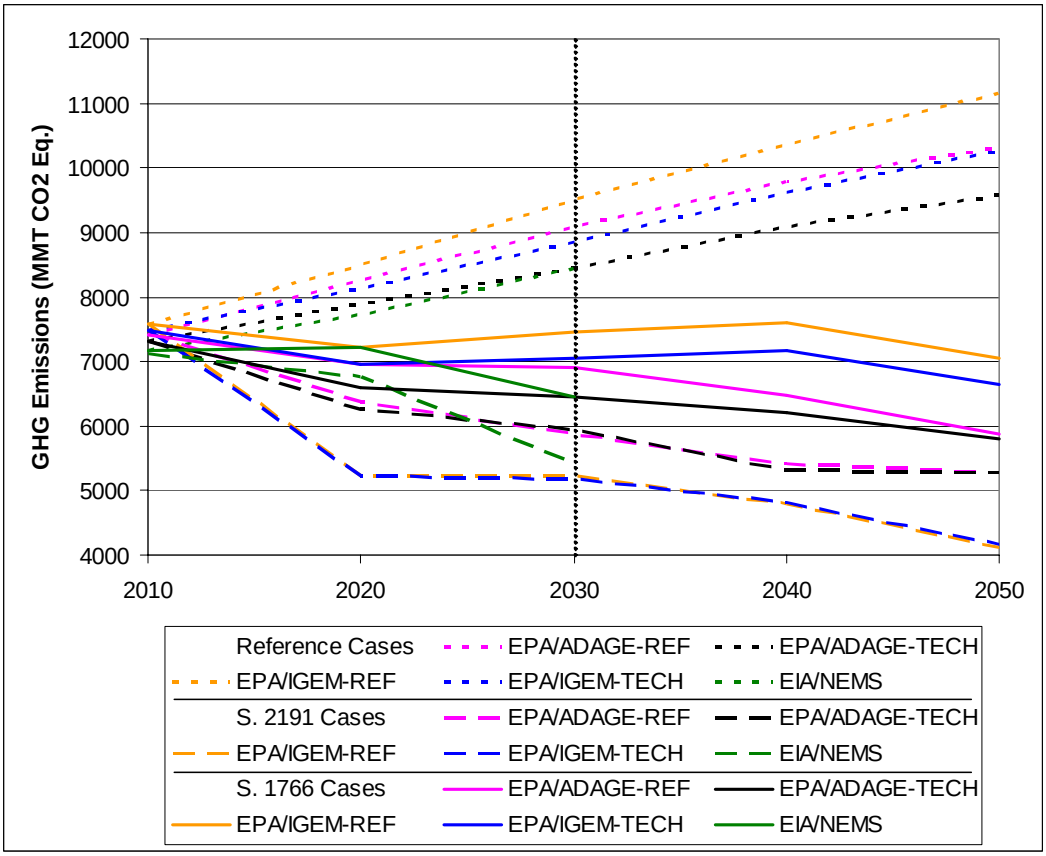
Emissions Reductions

Figures 1 and 2 present greenhouse gas emissions under S. 1766 and S. 2191 as estimated by the models. For S. 2191, the spread in projected emissions reductions is largely the result of two factors: (1) estimated emissions growth in the 10%-15% of the economy not covered under the bill, and (2) estimated use of international allowances or offsets to meet emission reduction requirements. If a covered entity submits an international allowance or offset for compliance purposes, the entity can emit a comparable amount domestically. This latter point is most evident in the ADAGE estimates. For S. 1766, the spread would also be in response to these uncertainties, although the EPA cases and EIA's updated analysis did not include international credits. What the figures do not show is that the TAP (safety valve) is increasingly used by covered entities after 2030, preventing the projected emissions from achieving the targets specified under the bill. This result is discussed more fully later.

[15] For more on the NEMS model, see [http://www.eia.doe.gov/oiaf/aeo/overview/index.html]

[16] The use of the word "core" should not imply that EIA believes it to be the most likely scenario.

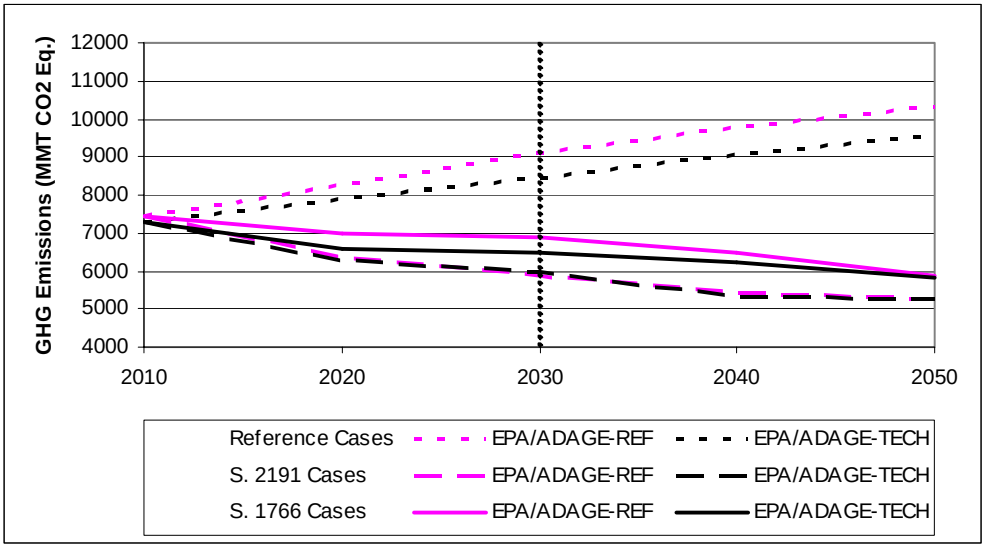
Figure 1. Total Estimated U.S. Greenhouse Gas Emissions Under S. 1766 and S. 2191

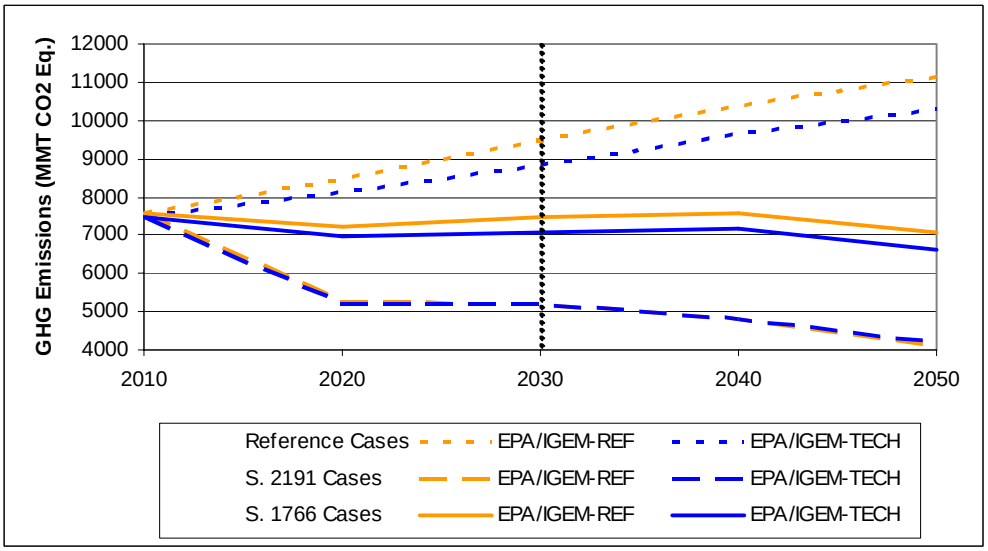


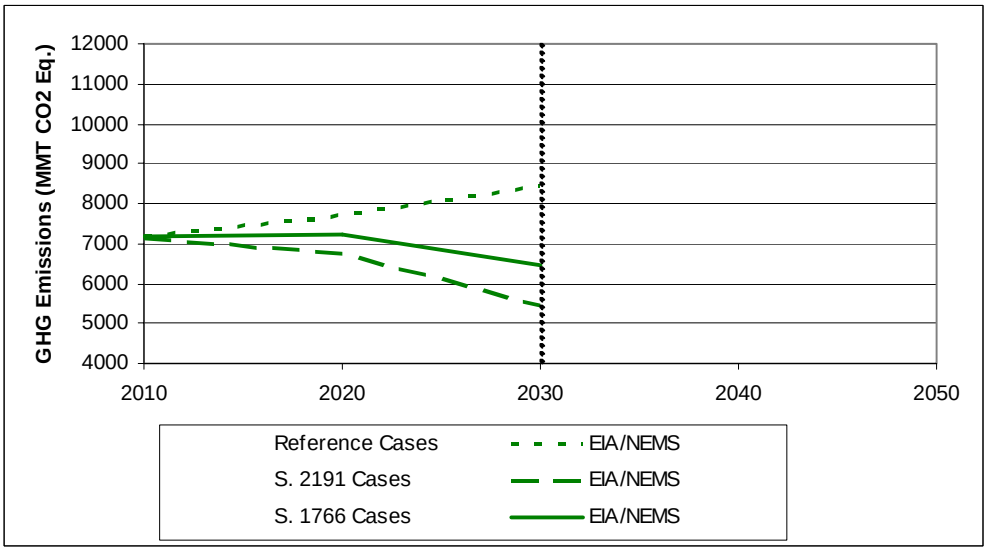
Sources for Figures 1 and 2: U.S. Environmental Protection Agency (EPA), *EPA Analysis of the Low Carbon Economy Act of 2007: S. 1766 in the 110th Congress* (January 15, 2008); EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008: S. 2191 in 110th Congress* (March 14, 2008); U.S. Energy Information Administration (EIA), *Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007* (April 2008).

Notes: Estimates beyond 2030 are speculative for three reasons: 1) beyond 2030, S. 1766 requires additional congressional action to further tighten the emissions cap; 2) EIA's NEMS model does not extend beyond 2030; and 3) projecting economic and environmental effects long-term is a very uncertain enterprise. For a discussion of those uncertainties, see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent Yacobucci.

Figure 2. Total Estimated U.S. Greenhouse Gas Emissions From Each Model Under S. 1766 and S. 2191



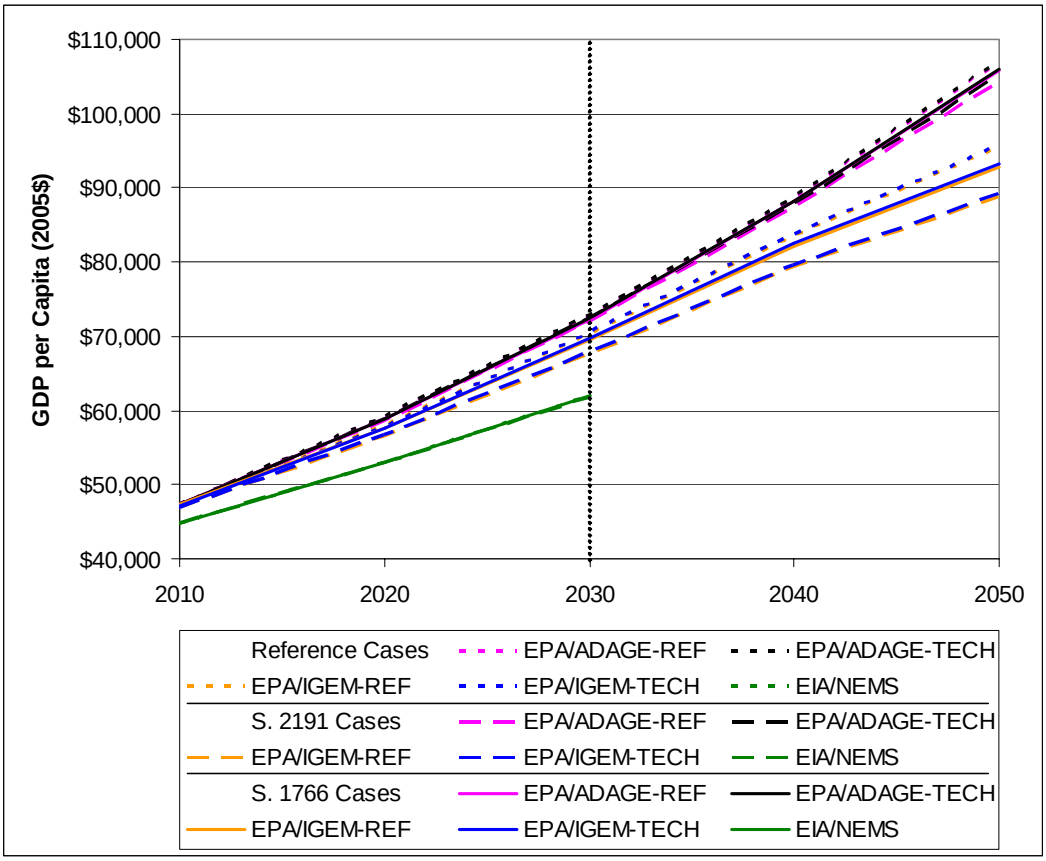




Impact on GDP Per Capita

Figures 3 and 4 present the estimated GDP per capita as estimated by each of the scenarios for the reference case and under S. 1766 and S. 2191. Not surprisingly, the GDP effects of both bills are absorbed by the uncertainty reflected in the reference case assumptions. In the five scenarios, the increase in GDP between 2010 and 2030 ranges between 62% and 81% in the base cases. Under S. 2191, the more stringent bill, the range is 62% to 80%. These figures indicate the models' conclusions that the economy continues to grow under S. 1766 and S. 2191, albeit at a somewhat slower rate than under their respective reference cases. The virtual superimposition of the curves in **Figures 3 and 4** shows how little variability there is between the base cases and the model results.

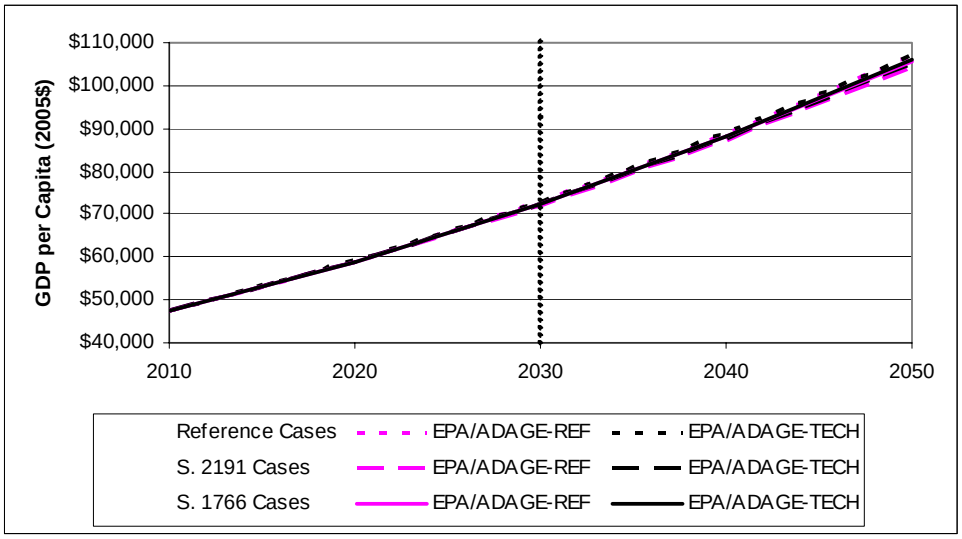
Figure 3. Estimated GDP per Capita (2005$) Under S. 1766 and S. 2191

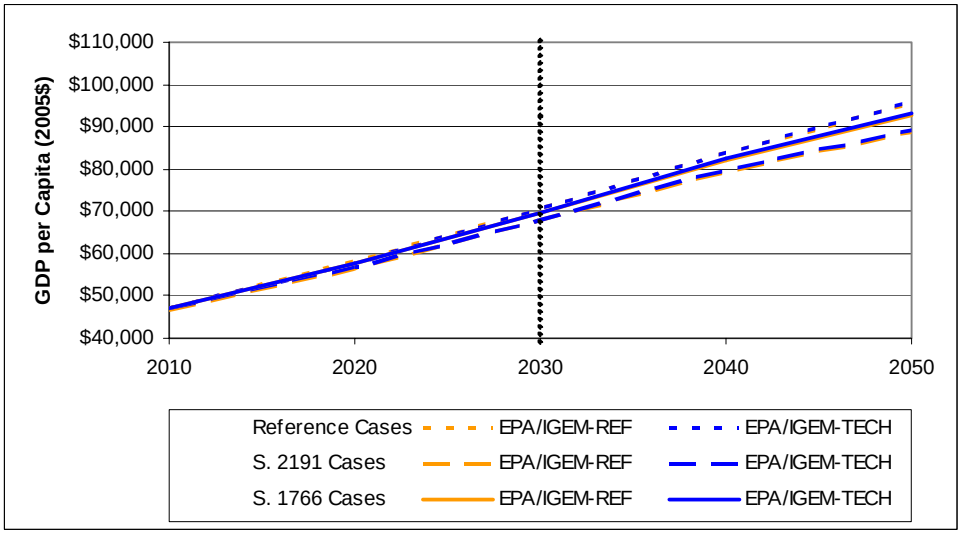


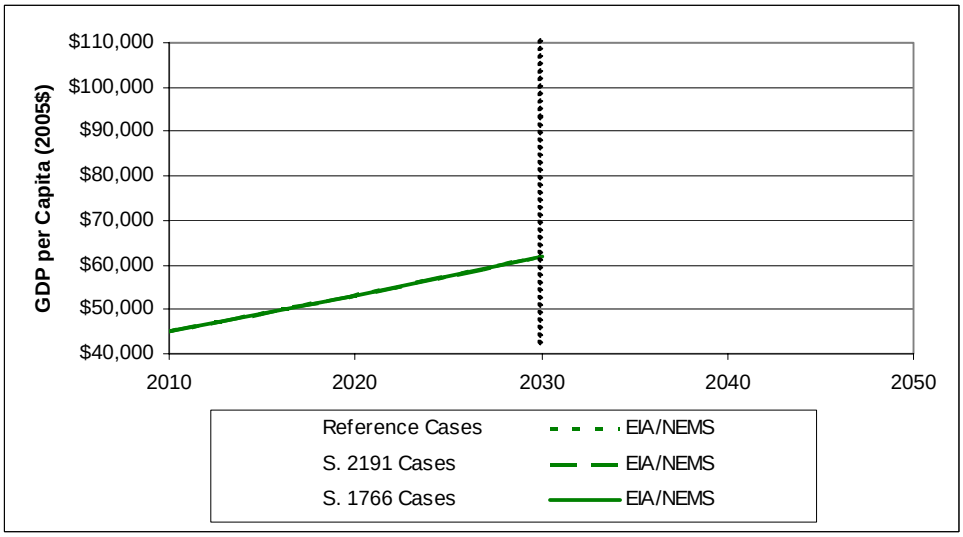
Sources for Figures 3 and 4: U.S. Environmental Protection Agency (EPA), *EPA Analysis of the Low Carbon Economy Act of 2007: S. 1766 in the 110th Congress* (January 15, 2008); EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008: S. 2191 in 110th Congress* (March 14, 2008); U.S. Energy Information Administration (EIA), *Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007* (April 2008).

Notes: Estimates beyond 2030 are speculative for three reasons: 1) Beyond 2030, S. 1766 requires additional congressional action to further tighten the emissions cap; 2) EIA's NEMS model does not extend beyond 2030; and 3) projecting economic and environmental effects long-term is a very uncertain enterprise. For a discussion of those uncertainties, see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036* by Larry Parker and Brent Yacobucci.

Figure 4. Estimated GDP per Capita (2005$) From Each Scenario Under S. 1766 and S. 2191

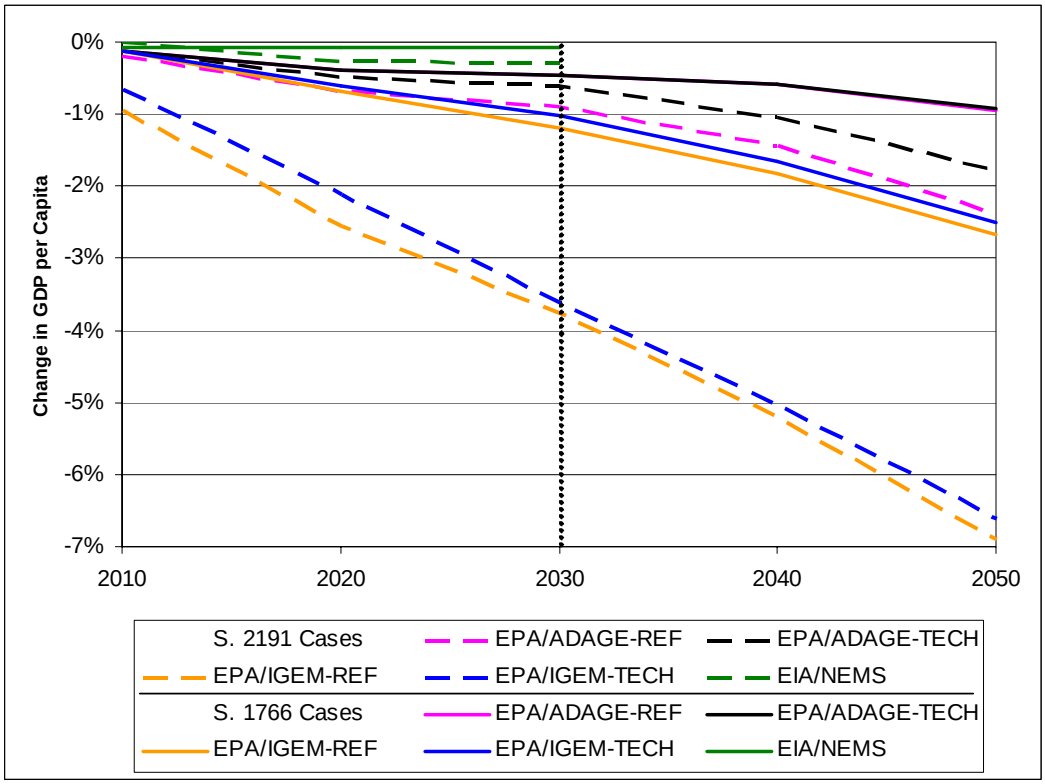






To help sort this out further, **Figures 5 and 6** present the relative percentage reduction in GDP per capita for the two bills. With the exception of the IGEM model, all projections for S. 1766 and S. 2191 showed a zero to 1% decrease in GDP per capita through 2030. As discussed in the previous CRS report, IGEM's higher estimates are the result of its structure and assumptions.[17]

Figure 5. Percentage Change in GDP Per Capita Under S. 1766 and S. 2191

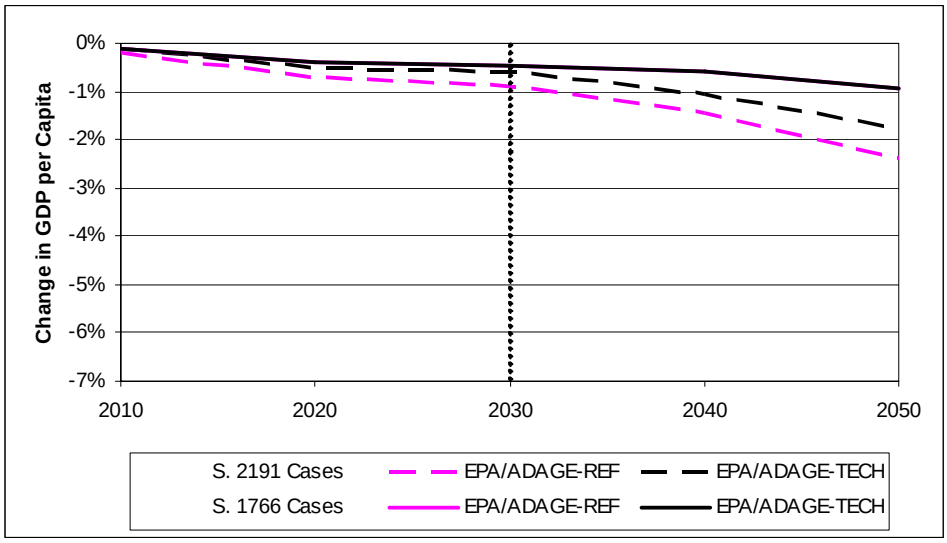


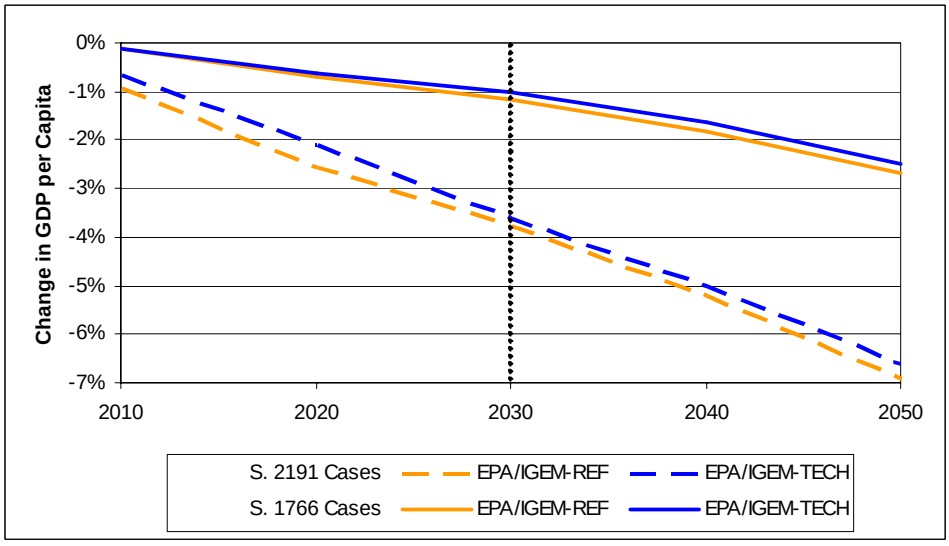
Sources for Figures 5 and 6: U.S. Environmental Protection Agency (EPA), *EPA Analysis of the Low Carbon Economy Act of 2007: S. 1766 in the 110th Congress* (January 15, 2008); EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008: S. 2191 in 110th Congress* (March 14, 2008); U.S. Energy Information Administration (EIA), *Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007* (April 2008).

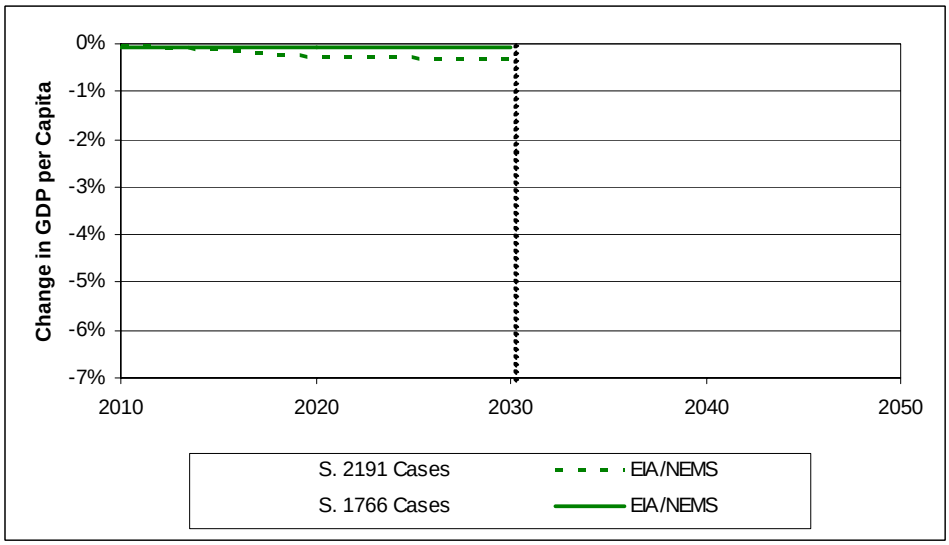
Notes: Estimates beyond 2030 are speculative for three reasons: 1) Beyond 2030, S. 1766 requires additional congressional action to further tighten the emissions cap; 2) EIA's NEMS model does not extend beyond 2030; and 3) projecting economic and environmental effects long-term is a very uncertain enterprise. For a discussion of those uncertainties, see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent Yacobucci.

[17] For example, the IGEM model assumes that as prices increase, people tend to work less and buy less, effectively multiplying the effect of any reduction in economic output. For a more detailed discussion, see CRS Report RL34489, p. 35.

Figure 6. Percentage Change in GDP per Capita From Each Scenario Under S. 1766 and S. 2191



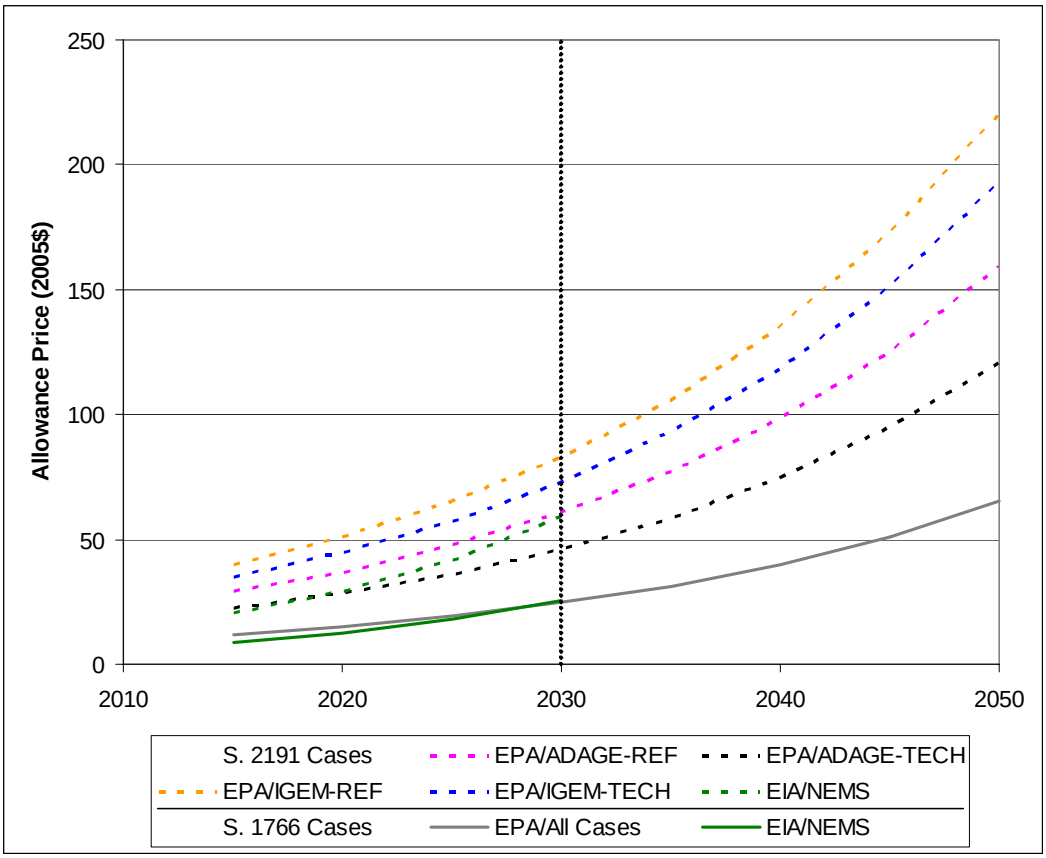




Allowance Prices

Figures 7 and 8 present the estimated allowance prices for S. 1766 and S. 2191. Generally, the figures indicate that S. 1766's TAP price is the controlling price, achieving the cost certainty for which the safety valve is designed. As expected, the allowance prices for S. 2191 slowly spread in the out-years, as evident in the figures. It should be noted that the EIA/NEMS case for S. 2191 mimics the extension of S. 2191 to 2050 by requiring the model to have a 5 billion allowance bank at the end of 2030. In the case of S. 1766, by 2030, the bank has been exhausted and covered entities are making TAP payments in lieu of additional reductions.

Figure 7. Projected Allowance Prices Under S. 1766 and S. 2191



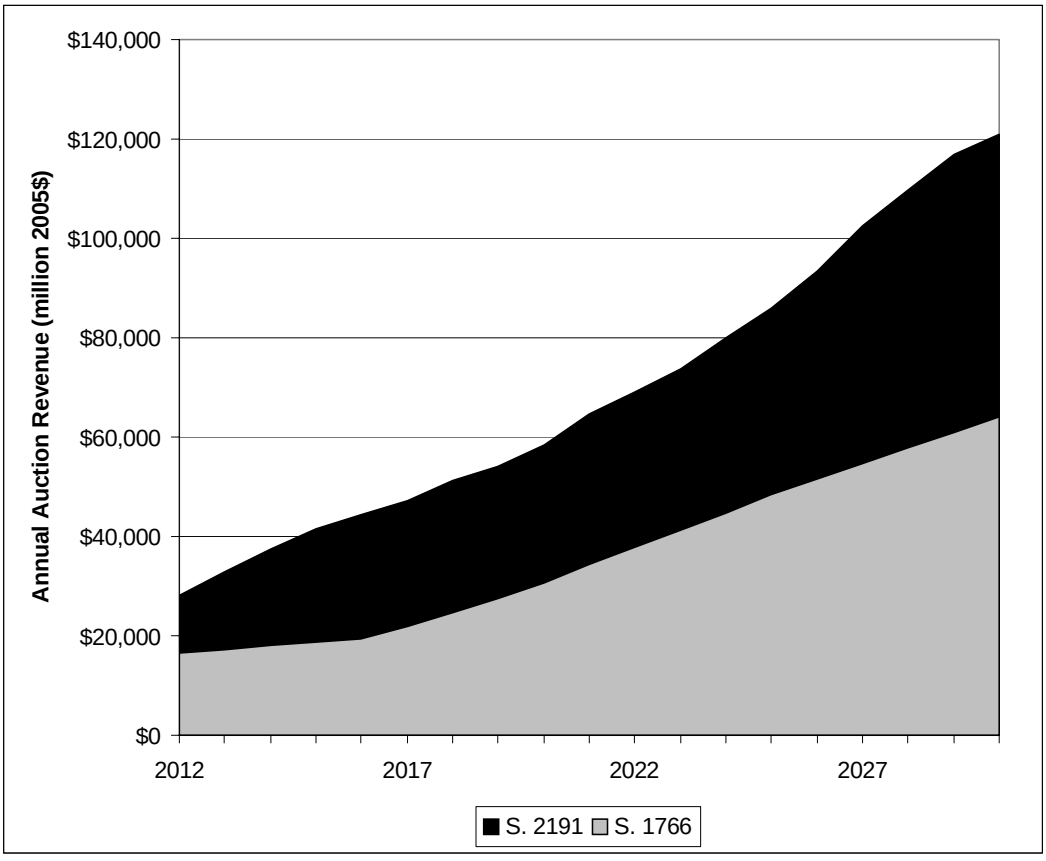
Sources for Figures 7 and 8: U.S. Environmental Protection Agency (EPA), *EPA Analysis of the Low Carbon Economy Act of 2007: S. 1766 in the 110th Congress* (January 15, 2008); EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008: S. 2191 in 110th Congress* (March 14, 2008); U.S. Energy Information Administration (EIA), *Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007* (April 2008).

Notes: Estimates beyond 2030 are speculative for three reasons: 1) Beyond 2030, S. 1766 requires additional congressional action to further tighten the emissions cap; 2) EIA's NEMS model does not extend beyond 2030; and 3) projecting economic and environmental effects long-term is a very uncertain enterprise. For a discussion of those uncertainties, see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent Yacobucci. For S. 1766, in both EPA models and in all cases presented, the allowance price is equal to the TAP ("safety valve") price for that year.

Auction Revenues

Both S. 2191 and S. 1766 would auction a significant portion of allowances, although auction revenues would be significantly higher in S. 2191 for two reasons: 1) S. 2191 allocates more allowances for auction; and 2) S. 2191's allowance prices are higher. Starting in 2012, both bills would auction roughly a quarter of all allowances. In later years, S. 2191 auctions a larger share of allowances than S. 1766: in 2030, S. 2191 would auction roughly 68% of allowances, while S. 1766 would auction 53%. Also, as shown in **Figures 7 and 8**, in all models, S. 2191 has higher prices than S. 1766 (in some cases two to three times as high). **Figure 9** shows estimated auction revenues based on allowance prices in the EPA/ADAGE-TECH case. Using allowance prices from the other scenarios would show an even wider discrepancy between auction revenues, as the EPA/ADAGE-TECH case presents the lowest allowance price for S. 2191, while all of the models peg S. 1766 allowance prices at or near the TAP price.

Figure 8. Estimated Annual Revenues From Allowance Auctions Under S. 1766 and S. 2191



Source: CRS Analysis of S. 2191 and S. 1766 using allowance price estimates from EPA/ADAGE-TECH case.

CRS has chosen to present auction revenues only to 2030 for two reasons. First, S. 1766 requires a new congressional vote (under special procedures) in order to continue beyond 2030. Second, based on the analyses available, the TAP becomes the dominant compliance strategy after about 2030, suggesting Congress may want to reassess its level at that time, if additional reductions are considered warranted.

Analysis: Addressing the Price versus Quantity Issue

S. 1766 and S. 2191 represent different answers to the choice between controlling the price and the quantity of emissions under a market-based control strategy. In general, market-based mechanisms to reduce greenhouse gas emissions focus on specifying either the acceptable emissions level (quantity) or compliance costs (price), allowing the marketplace to determine the economically efficient solution for the other variable. If one is more concerned about the possible economic cost (price) of the program, then use of a safety valve to limit costs could appear to some more appropriate, even through it introduces some uncertainty about the amount of reduction achieved (quantity). In contrast, if one is more concerned about achieving a specific emission reduction level (quantity), with costs handled efficiently, but not capped, a tradeable permit program without a safety valve may be viewed as more appropriate. In the case of these alternatives, S. 2191 leans toward the quantity (total emissions) side of the equation; S. 1766 leans toward the price side of the equation.

Uncertainty in Emissions Reductions

The projected emission reductions under S. 2191 are more certain than under S. 1766. There are two key sources of uncertainty for S. 2191: (1) the precise number of covered entities that must meet the reduction requirements and the future emissions growth from non-covered entities, and (2) the availability and use of international allowances that meet the bill's compliance requirement but do not reduce domestic emissions. S. 2191 is estimated to cover about 85% of the country's greenhouse gas emissions. In addition, the analyses presented here assume that international credits that meet S. 2191's eligibility requirements would be available at reasonable prices. In other analyses of S. 2191, this assumption is disputed.

S. 1766 has these uncertainties, plus an additional one in the form of the safety valve. As indicated in the Results section, the cases reviewed here generally assume that the allowance price equals the safety valve price or is very close. This results in banking in the early years of the program and use of that bank later. As the program approaches 2030, the bank is exhausted and covered entities begin making TAP payments. As illustrated in **Figure 10**, the result is an actual emissions level that is higher than the level targeted by the bill.[18]

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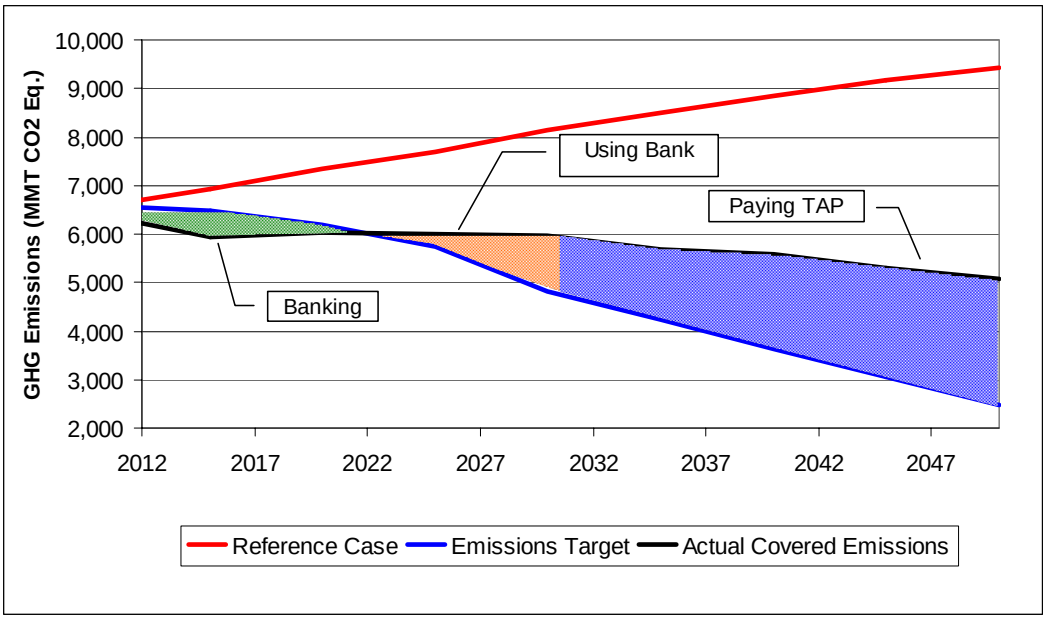
[18] In early years, as the bank is built up, both annual emissions and cumulative emissions are below the targets in the bill. As the bank is used up, annual emissions exceed the targets, and (continued...)

Because the TAP price becomes the allowance price over time in all cases under S. 1766, projected emissions exceed the bill's target once the TAP is triggered. This situation reveals the emissions uncertainty that a safety value introduces. The TAP price is a compliance strategy independent of the cap-and-trade compliance strategy. Thus, the actual emissions reduction under S. 1766 depends on the interplay between allowance prices and TAP prices. For example, EPA/IGEM-REF sensitivity analysis indicates unlimited availability of international credits would keep allowance prices below the TAP price.[19] EIA/NEMS does not project beyond 2030; however, none of the sensitivity analyses from EIA's previous analysis resulted in an allowance price below the TAP price in 2030. The result could change if the sensitivity analyses were updated to the 2008 *Annual Energy Outlook* (AEO) baseline (with lower projected baseline emissions and thus, presumably, lower compliance costs).

Figure 9. EPA/ADAGE Analysis of S. 1766



Source: CRS Analysis of data from EPA/ADAGE-REF S. 1766 case.

Uncertainty in Cost Estimates

The projected cost effects under S. 2191 are more uncertain than under S. 1766. A major source of uncertainty for S. 2191 is future business-as-usual growth in greenhouse gas emissions by covered entities. Because S. 2191 establishes a strict cap on greenhouse gas emissions from covered entities based on limits specified in the bill, any increased emissions resulting from continuing economic growth would have to be reduced or offset. The more robust the economic growth, the greater

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[18] (...continued)
cumulative emissions approach and eventually equal the bill target. When the TAP is included, once the bank is exhausted (and cumulative emissions are equal to the target) annual and cumulative emissions exceed the targets in all future years.

[19] However, S. 1766 allows covered entities to meet only 10% of allowance requirements through international offsets.

potential for higher emissions that would have to be offset to maintain the cap. In general, greater emissions reduction leads to higher costs. If economic growth is less robust, fewer reductions would be necessary and costs would be less.[20]

S. 2191 cost estimates are affected by several other uncertainties. As noted earlier, the span of estimated allowance prices under S. 2191 is significant. The differing estimates are based on varied assumptions about the availability of the following: (1) cost-effective energy efficiency improvements, (2) cost-effective non-CO_2 greenhouse gas reductions and other offsets, (3) cost-effective carbon capture and storage technology (CCS) and other low-carbon emitting technology, and (4) cost-effective international allowances and/or credits. With a program designed to achieve a least-cost solution through a market-based allowance trading system, restricting the availability of options — be they emissions reduction opportunities (i.e., offsets) or new technology — increases projected costs. Hence, the incentives and funding for new technology and the availability of offsets and credits under S. 2191 are critical to its long-term success.

S. 1766 cost estimates are not as sensitive to the factors identified above. Partly this is by design, and partly this is because S. 1766 targets less emission reductions than S. 2191. The reduction targets under S. 1766 are not as stringent as the emissions cap under S. 2191, as discussed earlier. Fewer emissions reductions required translates into lower costs. This is reinforced by the TAP price, which is projected to become the dominant compliance strategy in the long-term.

The effect of lower emission reduction targets is illustrated by the impact of the two bills on projected 2030 electric generation, as illustrated in **Table 2**. As discussed in CRS Report RL34489, in some ways, the interplay between nuclear power, renewables, and coal-fired capacity with CCS is a proxy for the need for a low-carbon source of electric generation in the mid- to long-term.[21] As indicated, a considerable amount of low-carbon generation will have to be built under S. 2191 in order to meet the reduction requirement. The amount of capacity constructed depends on the models' base case assumptions about future supply and demand and need for capacity replacement/retirement under S. 2191, along with the degree of consumer response to rising prices and incentives contained in S. 2191. The amount necessary under S. 1766 is substantially less as fewer existing facilities are retired or replaced. For example, EPA/IPM estimates that for 2025, about 193 gigawatts (GW) of oil-fired, natural gas-fired, and coal-fired capacity would be retired under S. 2191; it estimates only 95 GW of such capacity would be retired under S. 1766.

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[20] For more information, see CRS Report RL33970, *Greenhouse Gas Emission Drivers: Population, Economic Development and Growth, and Energy Use*, by John Blodgett and Larry Parker.

[21] CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent Yacobucci, p. 47.

Table 2. Assumptions about the Availability of Current Electric Generating Technologies and CCS in 2030

	Nuclear Power	Renewable Power	Natural Gas-fired	Coal with CCS
S. 1766				
EPA/ADAGE-REF	about 65 GW (built)	about 58 GW (built)	little	about 39 GW (built)
EPA/ADAGE-TECH	about 65 GW (built)	about 59 GW (built)	little	about 33 GW (built)
EPA/IPM (2025)	44 GW (limit and built)	11 GW (built)	6 GW (built)	99 GW (built)
EIA/NEMS	57 GW (built)	45 GW (built)	76 GW (built)	232 GW (built) (plus 19 GW no CCS)
S. 2191				
EPA/ADAGE-REF	about 71 GW (built)	about 58 GW (built)	little	165 GW (built)
EPA/ADAGE-TECH	about 70 GW (built)	about 61 GW (built)	little	89 GW (built)
EPA/IPM (2025)	44 GW (limit and built)	61 GW (built)	6 GW (built)	80 GW (built)
EIA/NEMS	264 GW (built)	112 GW (built)	77 GW (built)	64 GW (built)
AEO 2007 baseline	**12.5 GW**	**12.4 GW**	**88.2 GW**	**145 GW (no CCS)**

Source: EPA cases: "Data Annex" available on the EPA website at [http://www.epa.gov/climatechange/economics/economicanalyses.html] EIA/NEMS: EIA, *Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007* (April 2008).

Note: "Limit" is the maximum amount the model assumes can be built — it is not necessarily the amount the model determined would be built. "Built" is the amount the model determined needed to be built. "About" is an estimate by CRS of the additional capacity necessary for the increased electricity production projected by the model between 2010 and 2030 under S. 1766 and S. 2191 in the absence of capacity data being provided. The estimates are calculated assuming an 80% capacity factor for biomass, 90% for nuclear power and coal, 48% for renewables, and 85% for natural gas.

To put these numbers into historical context, from 1963 to 1985, 78 GW of nuclear power were ordered, constructed, and began operation.[22] For the 19-year period of 1966 through 1984, the country added 464 GW of generating capacity, including 210 GW of coal-fired capacity, 38 GW of hydropower, 27 GW of natural gas capacity (steam technology), 46 GW of oil-fired capacity, and 54 GW of peaking capacity to improve system reliability after the 1965 blackout. In addition to new additions, between 1965 and 1972, about 400 coal-fired generating units were converted to oil to meet environmental requirements. After the 1973 oil embargo, this trend was reversed, with 11 GW of capacity converted back to coal by 1983.[23] For a more recent example, from 2001 through 2005, the United States added about 180 GW of new capacity — almost all natural gas-fired.[24]

Like S. 2191, S. 1766's projected cost is affected by the assumed availability of cost-effective control measures, such as those noted above — energy efficiency improvements, non-CO_2 greenhouse gas reductions and other offsets, carbon capture and storage technology and other low-carbon emitting technology, and cost-effective international credits. However, S. 1766 does not represent as much of a shift in generation supply as does S. 2191. This is evident from the projected impact of S. 1766 on coal production for electricity generation, where the model results indicate stable production under S. 1766; under S. 2191, future coal production is heavily dependent on the models' assumptions about the availability and cost-effectiveness of CCS technology compared with alternatives, such as nuclear power.

Combined with a more modest reduction requirement, S. 1766's safety valve caps the upside risk of costs and ensures its costs would be lower than S. 2191. Although there are uncertainties in S. 1766's potential costs, its safety valve puts a strict upper limit on compliance cost — $12 a ton (nominal 2012$), increasing 5% annually in real terms. Besides putting an upper bound on cost, S. 1766's safety valve narrows the band of potential costs substantially; the remaining cost uncertainty is only with respect to the lower bound of costs.

Price versus Quantity: The Safety Valve

The purpose of a safety valve price is to bound the costs of any climate change control program (price) at the expense of reductions achieved (quantity).[25] In general, market-based mechanisms to reduce greenhouse gas emissions focus on specifying either the acceptable emissions level (quantity), or compliance costs (price), and allowing the marketplace to determine the economically efficient solution for the other variable. For example, a tradeable permit program sets the amount of emissions allowable under the program (i.e., the number of permits allocated caps

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[22] Compiled from EIA's Reactor Status List available from EIA's website.

[23] Energy Information Administration, *Fuel Choice in Steam Electric Generation: Historical Overview*, DOE/EIA-0472 (August 1985), pp. 5 and 7.

[24] Environmental Protection Agency, *EPA Analysis of the Low Carbon Economy Act of 2007: S. 1766 in the 110th Congress* (January 15, 2008), p. 49.

[25] See CRS Report RL33799, *Climate Change: Design Approaches for a Greenhouse Gas Reduction Program*, by Larry Parker.

allowable emissions), while letting the marketplace determine what each permit will be worth. Likewise, a carbon tax (or the safety valve contained in S. 1766) sets the maximum unit cost (per ton of CO_2) that one should pay for reducing emissions, while the marketplace determines how much actually gets reduced. In one sense, preference for a pure tradeable permit system or inclusion of a safety valve depends on how one views the uncertainty of costs involved and benefits to be received.[26]

For those confident that achieving a specific level of greenhouse gas reduction will yield significant benefits — enough so that even the potentially very high end of the marginal cost curve is not a concern — a pure tradeable permit program may be most appropriate. Greenhouse gas emissions would be reduced to a specific level, and in the case of a tradeable permit program, the cost involved would be handled efficiently, though not controlled at a specific cost level. This efficiency occurs because through the trading of permits, emission reduction efforts concentrate at sources at which controls can be achieved at least cost.

However, if one is more concerned about the potential downside risk of substantial control costs to the economy than of the benefits of a specific level of reduction, then including a safety valve may be most appropriate. In this approach, the level of the safety valve effectively caps the marginal cost of control that affected entities would pay under the reduction scheme, but the precise level of greenhouse gas reductions achieved is less certain. Emitters of greenhouse gases would spend money controlling greenhouse gas emissions up to the level of the safety valve. However, since the marginal cost of control among millions of emitters is not well known, the overall emissions reductions for a given safety valve level on greenhouse gas emissions cannot be accurately forecast. In essence, the safety valve contained in S. 1766 could be seen as a contingent carbon tax.

Conclusion

The two proposals — S. 1766 and S. 2191 — would establish market-based systems to limit emissions of greenhouse gases. However, the proposals differ in how those systems would work. S. 2191 would establish an absolute cap on emissions from covered entities, and would allow entities to trade emissions under that cap. S. 1766 would establish emissions targets on covered entities and allow those entities to meet those targets, either through trading program or by making a safety valve payment in lieu of reducing emissions. Under both proposals, short-term U.S. emissions would likely be below a business-as-usual scenario, although reductions under S. 2191 are guaranteed and projected to be larger, particularly over the long-term. In contrast, the cost of S. 1766 is likely to be less and more predictable than S. 2191.

Hence, a major policy question is whether one is more concerned about the possible economic cost of the program and therefore willing to accept some

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[26] For another discussion of this trade-off, see EPA, *Tools of the Trade: A Guide to Designing and Operating a Cap and Trade Program for Pollution Control* (June 2003), p. 2-5.

uncertainty about the amount of reduction received (i.e., a safety valve); or one is more concerned about achieving a specific emission reduction level with costs handled efficiently, but not capped (i.e., pure tradeable permits). S. 2191 leans toward the quantity (total emissions) side of the equation; S. 1766 leans toward the price side of the equation.