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Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007

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Executive Summary

This report responds to a request from Senators Lieberman and Warner for an analysis of S. 2191, the Lieberman-Warner Climate Security Act of 2007 and a subsequent analysis request from Senators Barasso, Inhofe, and Voinovich.[1] S. 2191 is a complex bill regulating emissions of greenhouse gases (GHG) through market-based mechanisms, energy efficiency programs, and economic incentives.[2] Title I of S. 2191 establishes a cap on emissions of greenhouse gases beginning in 2012 through an emission allowance program. The Title I allowance program covers energy-related carbon dioxide (CO_2), methane, nitrous oxide, perfluorocarbons, sulfur hexafluoride, and hydrofluorocarbons (HFCs) emitted from production of hydrochlorofluorocarbons (HCFCs). Sources that are exempt from the Title I cap, but which have other emission reduction incentives under the bill, include most non-CO_2 agricultural emission sources, emissions from coal mines and landfills, and the other HFCs. The emissions covered under Title I represented approximately 87 percent of total GHG emissions in 2006 as reported by the Energy Information Administration (EIA) in its inventory.[3]

The Title I caps decline gradually from 5,775 million metric tons (mmt) CO_2-equivalent in 2012 (7 percent below 2006 emission levels), to 3,860 mmt in 2030 (39 percent below 2006 levels), and 1,732 mmt in 2050 (72 percent below 2006 levels). The bill specifies that an increasing share of the allowances would be auctioned, while the remainder would be distributed for transition assistance to covered entities, energy consumers, and manufacturers as incentives for carbon sequestration; to States with programs for exceeding Federal targets; and to fund forest protection and research. Auction proceeds would be used to fund low-carbon energy technology programs.

The emission allowances created under the bill are tradable and bankable. Allowance obligations also may be offset by registered reductions in domestic emissions of exempted sources or by emission allowances from other countries with comparable emissions laws, with the maximum offsets from domestic and international sources each capped separately at 15 percent of the total allowance obligation that applies in each year. The bill includes substantial economic incentives for carbon capture and storage, as well as biogenic carbon sequestration, to further offset GHG emissions. S. 2191 also calls for more stringent appliance efficiency standards and building efficiency codes, including some of the requirements now mandated under the Energy Independence and Security Act of 2007 (EISA).

While this analysis is as comprehensive as possible, it does not address several important provisions of S. 2191. For example, the report does not assess the impacts of the Title X provisions regulating the consumption of HFCs, nor does it evaluate the transportation fuels standard requiring percentage reductions in life-cycle GHG emissions called for in Title XI. Also not addressed are the provisions of Section 3902 that call for the allocation of allowances to new fossil generators as a function of their generation.

[1] The request letter from Senators Warner and Lieberman is provided in Appendix A, while the request for additional analysis from Senators Barrasso, Inhofe, and Voinovich is in Appendix B.
[2] A detailed summary of the bill, obtained from Senator Lieberman's web site, is provided in Appendix C.
[3] Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2006*, DOE/EIA-0573(2006)(Washington, DC, November 2007), web site www.eia.doe.gov/oiaf/1605/ggrpt/index.html.

While the Title I emissions caps in S. 2191 decline through the year 2050, the modeling horizon in this report runs only through 2030. However, the increasing need to pursue high-cost emissions reductions beyond 2030, driven by tighter caps and continued economic and population growth, is reflected in the modeling by assuming that a positive balance of banked allowances is held at the end of 2030.

Analysis Cases

To analyze the provisions of S. 2191, several alternative cases were prepared (Table ES1). These cases, while not exhaustive, are meant to analyze some of the key areas of uncertainty that impact the analysis results:

- The **S. 2191 Core Case** represents an environment where key low-emissions technologies, including nuclear, fossil with carbon capture and sequestration (CCS), and various renewables, are developed and deployed in a timeframe consistent with the emissions reduction requirements without encountering any major obstacles, even with rapidly growing use on a very large scale, and the use of offsets, both domestic and international, is not significantly limited by cost or regulation.
- The **S. 2191 No International Offsets Case**, is similar to the S. 2191 Core Case, but represents an environment where the use of international offsets is severely limited by cost or regulation. The regulations that will govern the use of offsets have yet to be developed and their availability will depend on actions taken in the United States and around the world.
- The **S. 2191 High Cost Case** is also similar to the S.2191 Core Case except that the costs of nuclear, coal with CCS, and biomass generating technologies are assumed to be 50 percent higher than in the Core Case. There is great uncertainty about the costs of these technologies, as well as the feasibility of introducing them rapidly on a large scale. While the costs assumed in the High Cost Case are more closely aligned with recent cost estimates than those in the Core Case, it is unclear if the recent cost increases are a short- or long-run phenomenon. The High Cost Case, which raises the cost of key low- and no carbon electric generation technologies, falls between the Core Case and the Limited Alternative Case discussed below.
- The **S. 2191 Limited Alternatives Case** represents an environment where the deployment of key technologies, including nuclear, fossil with CCS, and various renewables, is held to their Reference Case level through 2030, as are imports of liquefied natural gas (LNG). The inability to increase the use of these technologies causes covered entities to turn to other options in response to S.2191.
- **The S. 2191 Limited/No International Case** combines the assumptions from the S. 2191 Limited Alternatives and S. 2191 No International Offset Cases.

In addition to the S.2191 cases, the report also includes a case that represents S. 1766, the Low Carbon Economy Act of 2007. EIA's earlier analysis of S.1766[4] used a reference case with

[4] Energy Information Administration, *Energy Market and Economic Impacts of S.1766, the Low Carbon Economy Act of 2007*, SR/OIAF/2007-06 (Washington, DC, January 2008), web site www.eia.doe.gov/oiaf/servicerpt/csia/index.html.

Table ES1. Analysis Cases[5]

Case Name	Assumptions
Non-Policy Case	
Reference	• *AEO2008* Reference Case, which includes the provisions H.R. 6, the Energy Independence and Security Act of 2007, and assumes a continuance of other current laws and regulation • Non-CO_2 emissions growth based on Environmental Protection Agency "with measures" and "voluntary technology adoption" cases
Policy Cases	
S. 2191 Core	Primary S. 2191 policy case. Key assumptions include: • *AEO2008* Reference Case assumptions • Cap-and-trade policy from Title I capping the emissions of Group I GHGs (CO_2, methane, nitrous oxide, sulfur hexafluoride, and perfluorocarbons) and Group II gases (hydrofluorocarbons) emitted from HCFC production). • Key low-emissions technologies, including nuclear and coal with carbon capture and sequestration (CCS), are developed and deployed in a timeframe consistent with the emissions reduction requirements without encountering any major obstacles, even with rapidly growing use on a very large scale. • Bonus credit incentives for CCS • Nonenergy GHG abatement supply, as a function of allowance costs, derived from information provided by the Environmental Protection Agency • The Title X cap-and-trade program for other Group II GHGs (hydrofluorocarbons) is not represented.
No International Offsets	S. 2191 Core Case with the compliance option from international offsets assumed to be unavailable
S. 2191 High Cost	S. 2191 Core Case with assumed higher costs for key electricity generating technologies: • CCS, nuclear and biomass plant costs 50 percent higher than in S. 2191 Core Case
S. 2191 Limited Alternatives	S. 2191 Core Case with assumed limits on several carbon reduction technologies for electric power generation and limits on LNG imports: • CCS not available by 2030 • Nuclear and biomass power plant additions limited to *AEO2008* Reference Case level • LNG imports limited to *AEO2008* Reference Case level
S. 2191 Limited Alternatives / No International	Combines the assumptions in the Limited Alternatives and No International Offsets Cases.
S. 1766 Update	Updated evaluation of S. 1766, the Low Carbon Economy Act of 2007, recently evaluated by EIA under *AEO2007* Reference Case assumptions. Key assumptions include: • *AEO2008* Reference Case assumptions • S. 1766 cap and trade policy • S. 1766 bonus credit incentives for CCS • S. 1766 technology accelerator payment (TAP) price, which establishes a limit on the allowance price, growing at 5 percent per year in real dollars • Nonenergy GHG abatement supply, as a function of allowance costs, derived from information provided by the Environmental Protection Agency

[5] All of the cases examined in this analysis incorporate the passage of the Energy Independence and Security Act of 2007, which was enacted on December 19, 2007.

significantly higher projected energy use and emissions than the reference case used in this report, which reflects the provisions of EISA and other updates.

Key Findings

S. 2191 significantly reduces projected GHG emissions compared to the Reference Case from the *Annual Energy Outlook 2008* (*AEO2008*)[6]. Relative to the Reference Case, projected covered emissions in the S. 2191 cases, net of offsets, are 27 percent to 36 percent lower in 2020 and 45 percent to 56 percent lower in 2030 (Table ES2). The range each year reflects the different emissions compliance paths taken in each of the cases.

The electric power sector accounts for the vast majority of the emissions reductions, with new nuclear, renewable, and fossil plants with CCS serving as the key compliance technologies in most cases. In the S. 2191 cases **t**he electric power sector is projected to account for between 82 percent and 87 percent of energy-related CO_2 emissions reductions in 2020 and between 82 percent and 92 percent of such reductions in 2030. The reductions are achieved mainly through the deployment of new nuclear, renewable, and fossil plants with CCS. Many existing coal plants without CCS are projected to be retired early because retrofitting with CCS technology is generally impractical.

If new nuclear, renewable, and fossil plants with CCS are not developed and deployed in a timeframe consistent with the emissions reduction requirements, covered entities are projected to turn to increased natural gas use to offset reductions in coal generation, resulting in markedly higher delivered prices of natural gas. Natural gas generation falls below the Reference Case level in most of the S. 2191 cases, but in the S. 2191 High Cost, S. 2191 Limited Alternatives, and S. 2191 Limited Alternatives/No International Cases natural gas generation is between 8 percent and 82 percent above the Reference Case level in 2020 and between 21 percent and 142 percent above it in 2030. Total natural gas consumption in 2030 is 2.7 trillion cubic feet greater in the Limited Alternatives Case and 4.4 trillion cubic feet higher in the Limited Alternatives/No International Case than in the Reference Case. The combination of higher wellhead natural gas prices and higher allowance prices under these conditions doubles the estimated impact of S. 2191 on the delivered price of natural gas to electric generators and industrial users if international offsets remain available, and quadruples that impact if international offsets are also unavailable.

Emissions reductions in the residential, commercial, industrial, and transportation sectors are small relative to those in the electric power sector. The energy price increases resulting from the allowance program are generally not large enough in most of the S. 2191 cases to induce consumers to make large changes in their energy use. For example, motor gasoline prices in the cases are 22 to 49 cents per gallon (9 to 21 percent) higher than in the Reference Case in 2020 and 41 to 101 cents per gallon (17 to 41 percent) higher than in the Reference Case in 2030. In addition, since all cases include the 35-mile–per-gallon corporate average fuel economy (CAFE) standard recently enacted, many of the lowest cost vehicle efficiency options are

[6] Energy Information Administration, *Annual Energy Outlook 2008*, DOE/EIA-0383(2008)(Washington, DC, April 2008), web site www.eia.doe.gov/oiaf/aeo/index.html.

Table ES2. Summary Emissions Compliance and Energy Market Results

(million metric tons CO_2-equivalent, except as noted)

	2006	2020							2030						
			S. 2191 Cases							S. 2191 Cases					
		Refer-ence	Core	High Cost	Limited Alter-natives	No Inter-national Offsets	Limited / No Inter-national	S. 1766 Update	Refer-ence	Core	High Cost	Limited Alter-natives	No Inter-national Offsets	Limited / No Inter-national	S. 1766 Update
Greenhouse gas emissions															
Energy-related carbon dioxide	5890	6384	5587	5548	5520	5005	4777	6009	6851	4020	4573	4786	3821	4319	5038
Other covered emissions[1]	292	331	303	299	299	299	287	276	381	347	336	336	336	336	437
Total covered emissions	6182	6715	5890	5848	5819	5304	5064	6285	7232	4368	4909	5122	4157	4656	5475
Total greenhouse gas emissions	7014	7729	6770	6716	6679	6167	5910	7224	8441	5429	5968	6179	5217	5709	6441
Emissions reduction from Reference case															
Energy-related carbon dioxide	- -	- -	797	836	864	1379	1607	375	- -	2831	2278	2066	3030	2532	1813
Carbon capture and storage	- -	- -	*147*	*85*	*0*	*144*	*0*	*182*	- -	*386*	*325*	*0*	*226*	*0*	*1258*
Other covered emissions	- -	- -	28	32	33	32	44	61	- -	34	44	44	44	44	88
Nonenergy carbon dioxide	- -	- -	2	3	4	4	7	1	- -	4	6	7	5	12	2
Offset Credits															
Noncovered emissions	- -	- -	132	142	149	146	160	67	- -	144	144	144	144	144	97
International allowances	- -	- -	739	739	737	0	0	0	- -	577	579	581	0	0	0
Biogenic carbon sequestration[2]	- -	- -	148	282	385	339	578	128	- -	435	437	435	436	435	479
Biogenic carbon sequestration, Sec. 3701	- -	- -	246	246	246	246	246	- -	- -	193	193	193	193	193	- -
Total (including carbon sequestration)	- -	- -	2092	2280	2417	2147	2643	633	- -	4217	3682	3470	3853	3359	2479
Compliance summary															
Allowances issued (cap)	- -	- -	4924	4924	4924	4924	4924	6189	- -	3860	3860	3860	3860	3860	4818
Covered emissions, less offset credits[1, 2]	6182	6715	4872	4685	4548	4818	4325	6218	7232	3212	3749	3963	3578	4077	5378
Net allowance bank change	- -	- -	52	239	376	106	599	(28)	- -	648	111	(103)	282	(217)	(560)
Allowance bank balance	- -	- -	336	2587	2914	106	2926	1476	- -	5027	4896	4974	5028	4876	(808)
Allowance price (2006 dollars per metric ton CO_2-equivalent)	- -	0	30	38	44	42	76	13	0	61	78	91	85	156	26
Delivered energy prices (2006 dollars per unit indicated)															
Motor gasoline, transport (per gallon)	2.63	2.36	2.58	2.63	2.66	2.65	2.84	2.45	2.45	2.86	2.95	3.05	3.01	3.46	2.63
Jet fuel (per gallon)	2.00	1.79	2.05	2.13	2.19	2.16	2.49	1.90	2.07	2.62	2.74	2.88	2.81	3.48	2.30
Diesel (per gallon)	2.71	2.50	2.78	2.86	2.91	2.88	3.15	2.61	2.68	3.20	3.32	3.45	3.39	4.00	2.93
Natural gas (per thousand cubic feet)															
Residential	13.80	11.74	13.41	14.19	14.96	14.07	17.55	12.17	13.30	16.77	18.68	20.60	18.59	24.91	13.99
Electric power	7.07	6.11	7.52	8.30	9.04	8.06	11.68	6.53	7.13	9.95	11.75	13.95	11.64	18.24	7.74
Coal, electric power sector (per million Btu)	1.69	1.72	4.49	5.24	5.83	5.51	8.81	2.93	1.78	7.21	8.91	10.07	9.40	16.11	4.23
Electricity (cents per kilowatthour)	8.91	8.61	9.06	9.54	9.90	9.28	10.93	8.75	8.85	9.82	11.82	12.66	9.75	14.52	9.51
Energy consumption (quadrillion Btu)															
Liquid fuels	40.1	42.2	41.3	41.1	41.0	40.7	40.6	41.7	44.0	42.0	41.8	41.9	41.5	40.9	42.9
Natural gas	22.3	24.0	22.4	23.2	24.2	22.2	26.6	22.9	23.4	19.4	22.6	26.2	19.8	27.9	20.1
Coal	22.5	25.9	20.6	19.2	17.6	15.0	8.7	24.9	29.9	7.8	11.4	8.1	4.1	3.3	26.7
Nuclear power	8.2	9.1	10.2	9.2	9.1	12.7	9.1	9.6	9.6	30.0	15.2	9.6	31.7	9.6	12.8
Renewable/Other	6.5	9.7	13.4	14.2	14.0	15.8	17.5	10.3	11.2	14.2	19.1	21.7	15.7	23.0	11.6
Total	99.5	110.8	107.9	107.0	105.9	106.4	102.4	109.4	118.0	113.4	110.1	107.5	112.8	104.7	114.1
Purchased electricity	12.5	14.5	14.2	14.1	14.0	14.1	13.7	14.5	16.1	15.3	14.9	14.7	15.3	14.2	15.8
Electricity generation (billion kilowatthours)															
Petroleum	85	76	49	51	49	44	48	51	82	39	45	47	38	49	43
Natural gas	806	833	761	901	1094	760	1516	768	741	427	897	1558	530	1794	390
Coal	1988	2357	1890	1754	1606	1373	766	2296	2838	703	1066	703	307	224	2784
Nuclear power	787	868	979	886	868	1220	868	919	917	2877	1460	917	3036	917	1228
Renewable	385	588	918	953	882	1136	1198	652	657	920	1347	1527	1052	1618	708
Total	4051	4723	4595	4544	4500	4534	4396	4686	5235	4966	4816	4753	4964	4602	5153

[1] Sources included in other covered emissions under S. 2191 Title I differ from those under S. 1766. Under S. 1766, all of the fluorinated gases and nitrous oxide from nitric and adipic acid are covered.

[2] Under S. 2191, registered increases in biogenic carbon sequestration can qualify as an offset. Under S. 1766, an allowance incentive encourages this sequestration but it does not count as an offset.

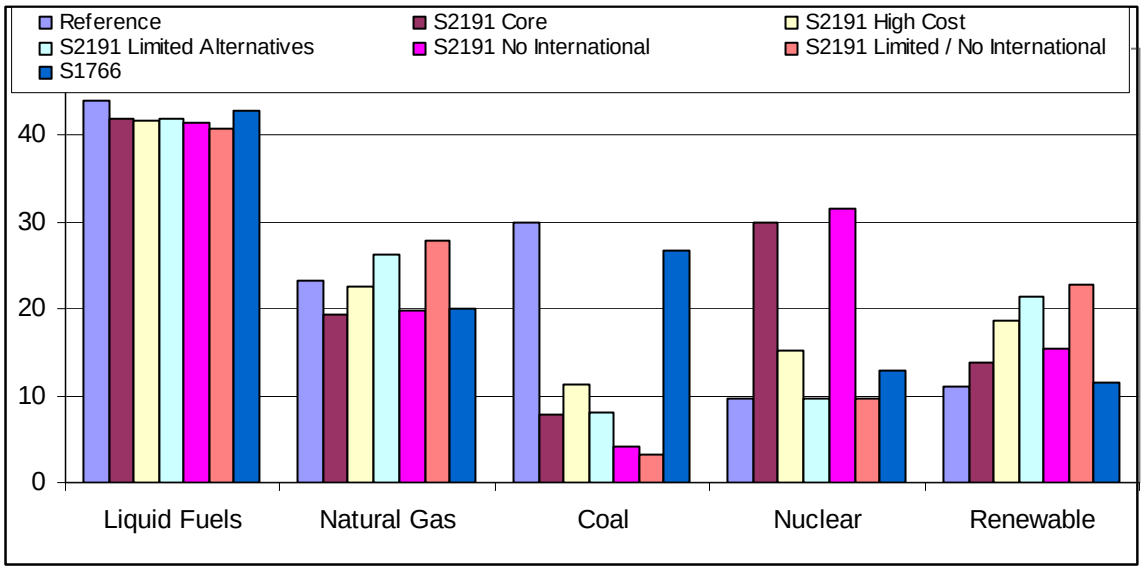
Source: NEMS runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A

- - : Not Applicable

adopted in all cases, including the Reference Case. Only in the S. 2191 Limited Alternatives and Limited Alternatives/No International Cases, which have the highest long-term allowance prices, do price-driven energy efficiency investments play a larger role.

Total coal consumption is significantly reduced. Despite the addition of as much as 64 gigawatts of new coal capacity with CCS through 2030 in one case, total coal consumption in 2030 ranges between 62 percent and 89 percent below the Reference Case level in the S. 2191 cases (Figure ES1). The increased use of coal at these new facilities with CCS is not large enough to offset the reduction that occurs because of the retirement and reduced utilization of existing coal plants. It is possible that the continued addition of coal plants with CCS post-2030 could lead to resurgence in coal use, but these plants will continue to face competition from other low-emission technologies. To offset the reduction in coal use, the power industry is projected to increase its use of nuclear power, renewable fuels, and natural gas.

Figure ES1. Primary Energy Consumption by Fuel in 2030
(quadrillion Btu)

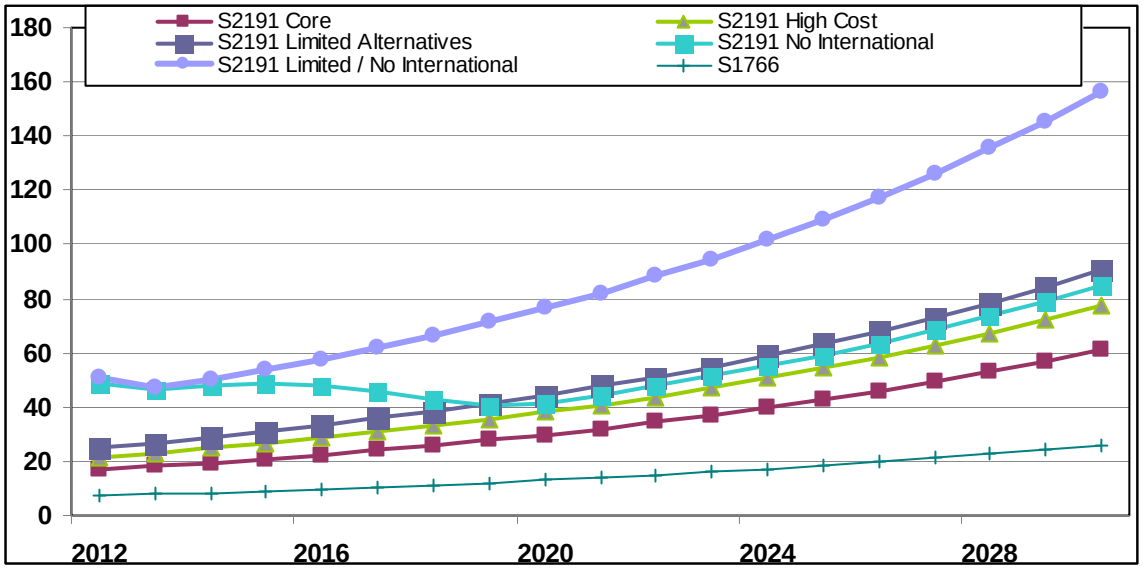


Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A.

GHG allowance prices are sensitive to the cost and availability of low-carbon generating technologies and emissions offsets. Estimated allowance prices in the S. 2191 cases range from $30 to $76 per metric ton CO_2-equivalent in 2020 and from $61 to $156 per metric ton CO_2-equivalent in 2030 (Figure ES2). The highest prices in the first 5 years of the cap-and-trade program occur when international offsets are not assumed to be available. The highest prices in the long term occur when it is assumed that key low-emissions technologies including nuclear, fossil with CCS, and various renewables are not developed and deployed in a timeframe consistent with the emissions reduction requirements and international offsets are limited by cost or regulation.

Figure ES2. Allowance Prices

(2006 dollars per metric ton CO_2-equivalent)



Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A.

S. 2191 increases energy prices and energy bills for consumers. Relative to the Reference Case, the price of using coal for power generation, including the cost of holding allowances, is between 161 percent and 413 percent higher in 2020 and between 305 percent and 804 percent higher in 2030 in the S. 2191 cases. The price of electricity is between 5 percent and 27 percent higher in 2020 and between 11 percent and 64 percent higher in 2030 in the S. 2191 cases. Under S. 2191, average annual household energy bills, excluding transportation costs, are between $30 and $325 higher in 2020 and $76 to $723 higher in 2030.

S. 2191 increases the cost of using energy, which reduces real economic output, reduces purchasing power, and lowers aggregate demand for goods and services. The result is that projected real gross domestic product (GDP) generally falls relative to the Reference Case. Adverse economic impacts generally increase over time as higher cost emissions abatement options are required as emissions caps become more stringent while population and economic activity levels continue to grow. Total discounted GDP losses over the 2009 to 2030 time period range from $444 billion (-0.2 percent) to $1,308 billion (-0.6 percent) across the S. 2191 cases (Table ES3). Similarly, the cumulative discounted losses for personal consumption range from $546 billion (-0.2 percent) to $1,425 billion (-0.6 percent). GDP losses in 2030, the last year explicitly modeled in this analysis, range from $27 billion to $163 billion (-0.1 to -0.8 percent) while consumption losses in that year range from $58 billion to $149 billion (-0.4 to -1.1 percent). Economic impacts are largest when it is assumed that key low-emissions technologies including nuclear, fossil with CCS, and various renewables are not developed and deployed in a timeframe consistent with the emissions reduction requirements and international offsets are not available.

Table ES3. Macroeconomic Impacts of S. 2191 Cases and S. 1766 Update Cases Relative to the *AEO2008* Reference Case

(billion 2000 dollars, except where noted)

	S. 2191 Cases					S1766 Update
	Core	**High Cost**	**Limited Alternatives**	**No International Offsets**	**Limited Alternatives No International**	
Cumulative Real Impacts 2009-2030 (Present Value using 4% Discount Rate)						
GDP						
Change	(444)	(729)	(912)	(546)	(1,306)	(66)
Percent Change	-0.2%	-0.3%	-0.4%	-0.2%	-0.6%	-0.03%
Consumption						
Change	(558)	(785)	(946)	(780)	(1,422)	(145)
Percent Change	-0.3%	-0.5%	-0.6%	-0.5%	-0.9%	-0.1%
Industrial Shipments (excludes services)						
Change	(1,340)	(1,723)	(2,031)	(2,430)	(3,684)	(722)
Percent Change	-1.3%	-1.7%	-2.0%	-2.4%	-3.6%	-0.7%
Nominal Revenue collected 2012-2030[a]	2,851	3,650	4,282	4,416	7,659	987
2020 Impacts (not discounted)						
GDP						
Change	(43)	(63)	(76)	(64)	(141)	(11)
Percent Change	-0.3%	-0.4%	-0.5%	-0.4%	-0.9%	-0.1%
Consumption						
Change	(47)	(65)	(78)	(65)	(137)	(14)
Percent Change	-0.4%	-0.6%	-0.7%	-0.6%	-1.2%	-0.1%
Industrial Shipments (excludes services)						
Change	(100)	(130)	(153)	(197)	(306)	(55)
Percent Change	-1.4%	-1.8%	-2.1%	-2.8%	-4.3%	-0.8%
Nominal Revenue collected[a]	113	144	168	158	300	45
2030 Impacts (not discounted)						
GDP						
Change	(59)	(120)	(136)	(27)	(163)	(12)
Percent Change	-0.3%	-0.6%	-0.7%	-0.1%	-0.8%	-0.1%
Consumption						
Change	(68)	(109)	(121)	(58)	(149)	(16)
Percent Change	-0.5%	-0.8%	-0.9%	-0.4%	-1.1%	-0.1%
Industrial Shipments (excludes services)						
Change	(233)	(313)	(354)	(319)	(589)	(139)
Percent Change	-2.9%	-3.9%	-4.4%	-4.0%	-7.4%	-1.7%
Nominal Revenue collected[a]	326	419	492	455	881	117

[a] Includes revenues from allowance auctions and revenues generated by the resale of allowances distributed to non-emitters. These values are not discounted.

Note: All changes shown are relative to the Reference Case.

Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A.

S. 2191 impacts industrial activity, including manufacturing, to greater extent than it affects the overall economy. Industrial shipments in 2030, excluding services, are reduced by $233 billion to $589 billion (-2.9 to -7.4 percent), with the largest impacts occurring in the Limited Alternatives/No International Case.

Significant revenue will be generated through Federal allowance auctions and allowance sales by State governments and other non-emitters given free allowances. By 2030, approximately 84 percent of the total allowances allocated are auctioned directly by the Federal government or given to parties including State governments and the U.S. Department of Agriculture that are expected to sell them to covered entities. The total revenue from these auctions and sales ranges from $113 to $290 billion in 2020 and from $326 to $853 billion in 2030.

Additional Insights

The potential for and the timing of the development, commercialization, and deployment of low-emissions electricity generating technologies such as nuclear power, coal with CCS, and dispatchable renewable power is a major determinant of the energy and economic impacts of S. 2191. The absence of these technologies is estimated to significantly increase compliance costs. Key technologies face a variety of technical and cost challenges and, in some cases, additional questions regarding public acceptance of their widespread deployment. As noted in previous EIA reports, both technical and acceptance barriers to key low-emissions technologies can be directly influenced by policy design choices. For example, while a mechanism to relax compliance pressure that is tied directly to the level of compliance costs or other measures of economic impact could affect the amount of emissions reduction achieved, it might also discourage stakeholders who view GHG emissions limitation as the highest environmental protection priority from pursuing efforts to block the deployment of nuclear power, CCS, or other technologies that, from their perspective, may raise important, but lesser, environmental concerns. Absent such a mechanism, such stakeholders may be less motivated to accept technologies that raise any environmental concern, regardless of their importance to GHG abatement at low cost.

Besides changing the projected mix of new electricity generation capacity, compliance with the S. 2191 cap-and-trade program will also significantly increase the total amount of new electric capacity that must be added between now and 2030 due to the retirement of many existing coal-fired power plants that would be expected to continue operating beyond 2030 in its absence. Obstacles to siting major electricity generation projects and/or the transmission facilities needed to support the greatly expanded use of renewable energy sources are not explicitly considered in this report. However, the additional capacity needs in all of the S. 2191 cases suggest the need for review of siting processes so that they will be able to support a large-scale transformation of the Nation's electricity infrastructure by 2030.

While forecasting policy change is beyond EIA's mandate, an argument can be made that, all else being equal, public and industry awareness of climate change as a major policy issue can potentially impact energy investment decisions even if no specific policy change actually occurs. Any adjustment to reflect the influence of climate change as an unresolved policy issue, while raising costs in the Reference Case, would generally reduce the estimated incremental impact resulting from the full implementation of a given policy response. For example, to the extent that concern over the climate change issue serves to depress investment in new coal-fired power plants, the primary effect would be most evident in the Reference Case, where significant coal builds are projected after 2015, and not in

the S. 2191 or S. 1766 policy cases, where few if any conventional coal-fired power plants are projected to be built. Since policy impacts are measured in terms of the difference between cases that incorporate policy changes and the Reference Case baseline, the impact of modeling adjustments to reflect the impact of climate issues awareness on investment in high-emission technologies would generally be to reduce, rather than increase, the estimated impact of a given policy response on delivered energy costs.

Details involving some of the provisions not addressed in this analysis could have a significant impact on the energy and economic impacts of S. 2191. For example, the performance-based allocation of allowances to new fossil generators under Section 3902 could significantly alter the investment decisions of powerplant builders, encouraging continued construction of new generating plants that use fossil fuels and raising the overall costs of compliance with the GHG cap-and-trade program. This provision, and several others, are open to a variety of interpretations with widely varying implications for energy and economic impacts.

As previously noted, the modeling horizon for this analysis ends in 2030. The emissions targets for the 2030 to 2050 period are likely to be very challenging because opportunities for further reductions in the power sector are limited.

1. Background and Scope of the Analysis

Background

This report responds to a request from Senators Lieberman and Warner for an analysis of S. 2191, America's Climate Security Act of 2007 and a subsequent analysis request from Senators Barasso, Inhofe, and Voinovich.[1] S. 2191 is a complex bill regulating emissions of greenhouse gases (GHG) through market-based mechanisms, energy efficiency programs, and economic incentives. A detailed summary of the bill, obtained from Senator Lieberman's web site, is included in Appendix C.

Title I of S. 2191 establishes a cap on annual emissions of greenhouse gases beginning in 2012, covering energy-related carbon dioxide (CO_2), methane, nitrous oxide, perfluorocarbons, sulfur hexafluoride, and hydrofluorocarbons (HFCs) emitted from production of hydroclorofluorocarbons (HCFCs). Regulated entities who must submit emission allowances include coal consumers using over 5,000 tons per year, suppliers of oil and natural gas, and producers and importers of covered fluorinated gases. Sources that are exempt from the Title I cap, but which have other emission reduction incentives under the bill, include most non-CO_2 agricultural emission sources, emissions from coal mines and landfills, and the other HFCs. The emissions covered under Title I represented approximately 87 percent of total GHG emissions in 2006 as reported by the Energy Information Administration (EIA) in its inventory.[2]

The Title I caps decline gradually from 5,775 million metric tons (mmt) CO_2-equivalent in 2012 (7 percent below 2006 emission levels), to 3,860 mmt in 2030 (39 percent below 2006 levels), and 1,732 mmt in 2050 (72 percent below 2006 levels). Titles II, III, and IV specify how the caps would be administered and provide details on allowance distribution and the use of auction proceeds to ameliorate impacts and promote emission reductions. The bill specifies that an increasing share of the allowances would be auctioned, while the remainder would be distributed for transition assistance to covered entities, energy consumers, and manufacturers, as incentives for CO_2 sequestration, to States for exceeding Federal targets, and to fund forest protection and research. Auction proceeds would be used to fund low-carbon energy technology programs.

The emission allowances created under the bill are tradable and bankable. Allowance obligations may be offset by registered reductions in domestic emissions of exempted sources or by emission allowances from other countries with comparable emissions laws, with the maximum offsets from domestic and international sources each capped separately at 15 percent of the total allowance obligation that applies in each year. The bill includes substantial economic incentives for carbon capture and storage (CCS), as well as biogenic carbon sequestration, to further offset GHG emissions. Title V calls for more stringent appliance efficiency and building

[1] The request letter from Senators Warner and Lieberman is provided in Appendix A, while the request for additional analysis from Senators Barrasso, Inhofe, and Voinovich is in Appendix B.

[2] Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2006*, DOE/EIA-0573(2006)(Washington, DC, November 2007), web site www.eia.doe.gov/oiaf/1605/ggrpt/index.html.

efficiency codes, including some of the requirements now mandated under the Energy Independence and Security Act of 2007 (EISA).

This report does not address the possible impacts of Titles VI through XI. Title VI calls for international policies to encourage emissions reductions, Title VII requires program reviews and studies, Title VIII calls for assessment of geological carbon sequestration issues, and Title IX deals with "miscellaneous issues."

Title X separately caps the consumption of other HFCs beginning in 2010, chemicals that serve primarily as substitutes for ozone-depleting substances (ODS). Emissions of these substances accounted for approximately 2 percent of total GHG emissions in 2006. While Title X caps ***consumption*** of the HFCs, the associated ***emissions*** occur gradually from leaks or from scrappage of the products in which the chemicals are used, such as refrigerators and air conditioners. This analysis does not evaluate feasibility or potential economic impacts of Title X, as this requires special expertise and access to proprietary manufacturer data.

Finally, Title XI imposes a requirement on the supply of transportation fuels requiring a reduction in so called "life-cycle" GHG emissions relative to a baseline. In the absence of the details on the specific methodologies underpinning such a regulation, EIA did not attempt to model this provision.

Also not addressed are the provisions of Section 3902 that call for the allocation of allowances to new fossil generators as a function of their generation. It is unclear whether this provision applies to all new fossil-fired generators, including those with CCS, or just to those facilities without CCS. If it only applied to new fossil plants without CCS it could significantly impact power sector compliance decisions. The provisions call for allocating new fossil generators allowances at a rate equal to the average rate of all new generators added over the five years preceding the passage of the bill. These allowances come from the pool of allowances set aside for new generators which starts at 19 percent of allowances in 2012, but falls to 1 percent of allowances by 2030. Since the vast majority of these new generators were natural gas facilities, new natural gas facilities without CCS would receive enough allowances to cover all of their emissions while new coal plants without CCS would receive about half of the allowances they would need until the pool of allowances set aside for electricity generators was exhausted. Such a performance-based allocation of allowances to new fossil generators would alter the investment decisions of power plant builders, encouraging them to continue to rely on new GHG-emitting fossil generators and raising the overall costs of compliance with the GHG cap-and-trade program. While full simulations of the potential impacts of this provision were not prepared, partial tests suggest that new fossil generators would capture a large share of the allowances set aside for electricity generators, natural gas generation would be higher, allowance prices would be higher, electricity prices would be slightly lower in the near term, but higher in the longer term.

Methodology

The analysis of energy sector and energy-related economic impacts of the various GHG emission reduction proposals in this report is based on results from EIA's National Energy Modeling System (NEMS), used for projections in the *Annual Energy Outlook 2008 (AEO2008)*.[3] NEMS projects emissions of energy-related CO_2 emissions resulting from the combustion of fossil fuels, representing about 84 percent of total U.S. GHG emissions today.

The EIA Reference Case is designed to reflect only current laws and policies. Because analysis of alternative policies at the request of the U.S. Congress and/or the Administration is a core part of the EIA mission and because EIA does not take a position or speculate on potential policy changes, such changes are not included in the Reference Case. If assumptions about "expected" policy changes such as future fuel economy standards, taxes, caps on GHG emissions, or new regulatory requirements for conventional pollutants, were included in the Reference Case, it could not be used as a baseline in assessing the impacts of alternative policy proposals in these areas. For this reason, EIA Reference Case projections are not directly comparable with private energy forecasts that include estimates of policy change in their scenarios.

Although forecasting policy change is beyond EIA's mandate, a reasonable argument can be made that, all else being equal, public and industry awareness of a major policy issue alone can potentially impact energy investment decisions. For example, the possibility of future action to control GHG emissions during the expected operating lifetime of new power generation facilities could favor investment in no- and low-GHG-emission technologies relative to high-GHG-emission alternatives, even if no specific policy change actually occurred. Such an effect might be incorporated in models by penalizing technologies that are perceived to be risky due to policy concerns. However, applying such adjustments on an *ad hoc* basis is difficult, since the extent of any future disadvantage borne by new high-GHG emission generators that begin construction prior to the enactment of a new policy will depend heavily on the details of the policy design and implementation.

It is also important to recognize that any adjustment that is made in the Reference Case to reflect the influence of an unresolved policy issue, while raising costs in the Reference Case, would generally reduce the estimated impact resulting from the implementation of a given policy response. For example, to the extent that concern over the climate change issue serves to significantly depress investment in new coal-fired power plants, the primary effect would be most evident in the Reference Case, where significant coal builds are projected after 2015, and not in policy cases reflecting a significant cap-and-trade program for GHG emissions, where few if any conventional coal-fired power plants are projected to be built. Since policy impacts are measured in terms of the difference between cases that incorporate policy changes and the Reference Case baseline, the impact of modeling adjustments to reflect the impact of unresolved policy issues would generally be to reduce, rather than increase, the estimated impact of a given policy response on delivered energy costs.

[3] Energy Information Administration, *Annual Energy Outlook 2008*, DOE/EIA-0383(2008)(Washington, DC, April 2008), web site www.eia.doe.gov/oiaf/aeo/index.html.

NEMS endogenously calculates changes in energy-related CO_2 emissions in the analysis cases. The cost of using each fossil fuel includes the costs associated with the GHG allowances needed to cover the emissions produced when they are used. These adjustments influence energy demand and energy-related CO_2 emissions. The GHG allowance price also determines the reductions in projected baseline emissions of other GHGs based on assumed abatement cost relationships. With emission allowance banking, NEMS solves for the time path of permit prices such that cumulative emissions match the cumulative emissions target without requiring allowance borrowing and with price escalation consistent with the average cost of capital to the electric power sector. Assumptions for allowance banking are discussed in a following section.

The NEMS Macroeconomic Activity Module (MAM), which is based on the Global Insight U.S. Model, interacts with the energy supply, demand, and conversion modules of NEMS to solve for an energy-economy equilibrium. In an iterative process within NEMS, MAM reacts to changes in energy prices, energy consumption, and allowance revenues, solving for the effect on macroeconomic and industry level variables such as real gross domestic product (GDP), the unemployment rate, inflation, and real industrial output.

Under S. 2191, the allowance obligations are imposed on an "upstream" basis for natural gas and petroleum and on a downstream basis on coal consumers. This regulatory approach has implications for how allowance costs are reflected in the modeling of delivered energy prices:

- The allowance requirement for coal-related CO_2 emissions is an incremental opportunity cost of using coal. For modeling purposes, we have added the allowance cost to the delivered price of coal to reflect the opportunity cost faced by coal consumers. For oil and natural gas pricing, we assume that the allowance costs associated with the related CO_2 emissions are passed through in the delivered prices, with some exceptions noted below.
- Under Sec. 1204, allowances will be required for all GHG emissions from natural gas, including fugitive methane emissions associated with natural gas production and processing. Therefore, an adjustment to the delivered cost of fuel was made in NEMS to account for the allowance cost of these natural-gas-related methane emissions, in addition to the adjustment for CO_2 emissions from natural gas combustion.
- Methane and nitrous oxide emissions associated with stationary and mobile fuel combustion would be subject to the allowance requirement. However, the cost of these allowances is not reflected in the allowance cost adjustments in delivered fuel prices, as these emissions are not disaggregated in the model by fuel source.
- CO_2 emissions from refineries' direct fuel combustion of petroleum-based fuels would be subject to the allowance requirement. However, the incremental cost of these allowances is not explicitly reflected in delivered petroleum prices, as the Petroleum Market Module of NEMS is not structured to represent such costs explicitly.
- Under Sec.1202, the credit for geological sequestration is available to the owner or operator of a facility that is subject to the allowance submission requirement. This would appear to exclude CCS in power plants that use natural gas or petroleum from eligibility. The credit would thus only apply to coal-fired plants with CCS. A separate bonus allowance incentive under Title III is provided for CCS projects, subject to emissions capture performance criteria and an overall program limit on allowances for this purpose.

The Title III credit would be available to any CCS project, including natural gas CCS. For this analysis, it was assumed that the natural gas and coal would be eligible for both the Sec. 1202 CCS credit and the Title III bonus allowances.

Non-CO_2 Emission Coverage and Abatement Assumptions

To represent nonenergy-related GHG emissions abatement and increases in biogenic carbon sequestration, EIA applied the same methodologies and data sources described in its evaluation of S. 280, the Climate Stewardship and Innovation Act of 2007.[4] However, the number of source classifications was disaggregated to better match regulatory coverage provisions under S. 2191. The level of detail in these baselines and any corresponding abatement supply assumptions are specified by the categories presented in Table 1. Table 1 also indicates whether the source was considered as covered or uncovered under the S. 2191 Title I cap, with a comparison to the corresponding assumptions under S. 1766, the Low Carbon Economy Act of 2007.

Table 1: Classification of Non-CO_2 Emissions Sources for S. 2191 and S. 1766 Coverage, Baseline, and Abatement Assumptions

(million metric tons CO_2-equivalent)

Emission Source		2006 Emissions	S. 2191 Title I	S. 1766
Methane	Landfills	147	Uncovered	Uncovered
	Coal Mining	65	Uncovered	Uncovered
	Natural Gas/Oil Systems	172	Covered	Uncovered
	Stationary/Mobile Combustion	14	Covered	Uncovered
	Other	208	Uncovered	Uncovered
Nitrous Oxide	Agriculture	227	Uncovered	Uncovered
	Stationary and Mobile Combustion	69	Covered	Uncovered
	Adipic and Nitric Acid Production	14	Uncovered	Covered
	Other	6	Uncovered	Uncovered
Fluorinated Gases	HFCs from HCFC-22 Production	15	Covered	Covered
	Other HFCs and Substitutes for Ozone-Depleting Substances	121	Uncovered (capped under Title X)	Covered
	Perfluorocarbons	7	Covered	Covered
	Sulfurhexafluoride	16	Covered	Covered
Domestic Biogenic Carbon Sequestration	Agriculture and Forestry	- -	Eligible as Offsets and for Sec. 3701 Incentive Program	Eligible under Incentive Program
International Allowances	Multiple Emission Sources	- -	Eligible as Offsets	Ineligible as Offsets

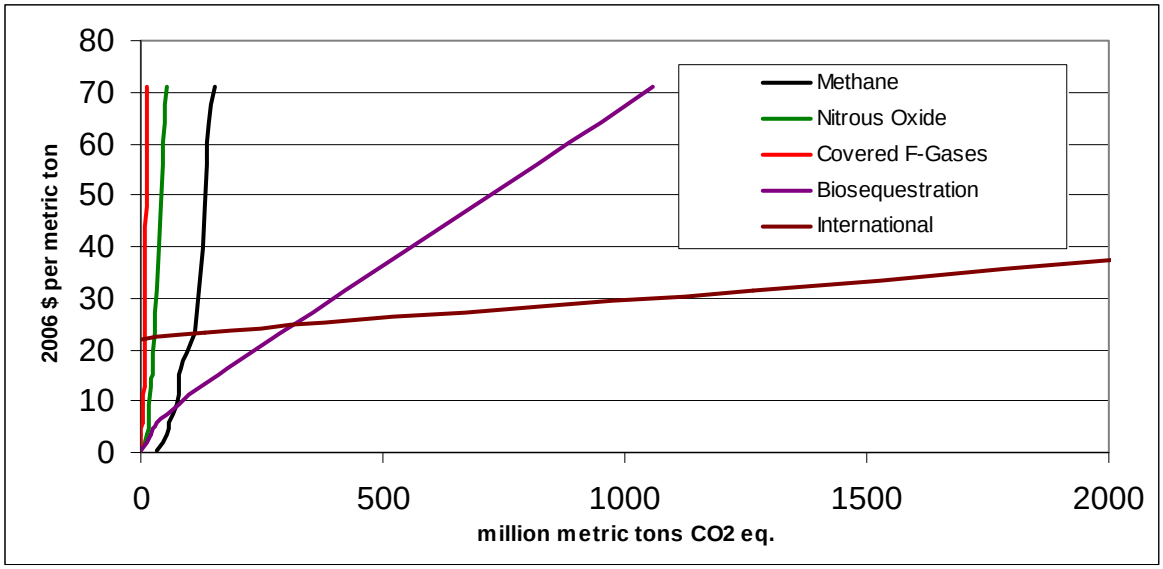
Source: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2006*, DOE/EIA-0573(2006) (Washington, DC, November 2007), web site www.eia.doe.gov/oiaf/1605/ggrpt/index.html.

The economic abatement potential assumed for the domestic non-CO_2 gases is relatively small compared to the potential for domestic biosequestration and international sources (Figure 1). The cost and availability of international sources is highly uncertain and depends on widespread adoption of limits on GHGs and the establishment of global international allowance trading. S. 2191 limits the use of international allowances to those from countries with mandatory, absolute

[4] Energy Information Administration, *Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007*, SR/OIAF/2007-04 (Washington, DC, July 2007), web site www.eia.doe.gov/oiaf/servicerpt/csia/index.html.

caps on GHG emissions of comparable degrees of stringency and enforcement. Countries without comparable allowance programs could, however, potentially supply offsets to the international market and free up qualifying allowances for sale to the United States. Therefore, no change in assumed cost and availability of international allowances was made to represent the strict comparability provisions for international offsets under S. 2191. However, the issue of availability of international offsets is addressed in a sensitivity case that excludes them.

Figure 1: Assumed Supply of Emissions Abatement and Offsets from Nonenergy Emissions Sources, 2020



Source: Office of Integrated Analysis and Forecasting, derived from Environmental Protection Agency studies as described in Energy Information Administration, *Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007*, SR/OIAF/2007-04 (Washington, DC, July 2007), web site www.eia.doe.gov/oiaf/servicerpt/csia/index.html.

Furthermore, the possibility that the United States could be a net supplier of allowances or offsets internationally was not considered. With international trading in allowances, the S. 2191 allowances could be sold abroad, ultimately raising the domestic allowance price to international levels.

Under S. 2191, certified increases in biosequestration can be used as either offsets or qualify under the Sec. 3701 incentive program, but not both. Under Sec. 3701, up to 5 percent of allowances are available as incentives for increases in biosequestration or reductions in agricultural GHG emissions. This analysis assumes that the Sec. 3701 allowance incentives are exchanged for increases in biogenic sequestration. In addition, the supply of biosequestration available at a given allowance price is assumed to be used first for the Sec. 3701 program based on the allowance price. Any excess supply that would exceed the 5-percent limit under Sec. 3701 limit is assumed to be sold on the offset market.

Allowance Banking and Borrowing

To reflect banking incentives and trading arbitrage, allowance prices escalate at a rate no higher than 7.4 percent per year in real terms during intervals when allowance balances are held. This rate reflects the average cost of capital in the electric power sector, where a significant share of emissions reduction investments is expected to occur. S. 2191 permits up to 15 percent of the allowance obligation to be borrowed from future allowance supplies, subject to a 10-percent allowance increase per year borrowed.[5] The 10-percent real rate of interest would presumably preclude such borrowing, except in situations involving shocks or surprises that are not considered in this analysis. As a result, allowances prices are estimated such that borrowing does not occur.

S. 2191 calls for increasingly stringent emissions caps beyond 2030, the forecast horizon for NEMS. Meeting these post-2030 caps will require significant emission reductions outside the electricity sector, the predominant source of early emissions reductions and increasing price pressure, absent significant technological breakthrough in transportation and other uses dependent on fossil fuels. As a result, we assume there will be an allowance bank balance at the end of 2030. To roughly estimate the magnitude of the 2030 allowance balance, trial simulations that accelerated the emissions targets for various post-2030 dates to 2030 were made to observe the variation in banking levels in the period before 2030. Based on these trial runs, the bank balance assumption for 2030 was set at 5 billion metric tons. This level of allowance banking is consistent with the greater difficulty complying with the post-2030 targets under continued growth in population and the economy, yet balanced by the technological progress likely to help mitigate the economic cost of abatement. While the level of banking would also depend on other economic assumptions, such as the availability and cost of international offsets, the 5-billion-ton-balance assumption was applied in all the cases analyzed.

Appliance Efficiency and Building Codes

Section 3302 of the S. 2191 allocates a portion of the allowances distributed to States to promote energy efficiency and mitigate the impact on low-income consumers. To reflect the impact of these programs, the incremental cost of the most energy-efficient appliances in each residential end-use category was reduced by half. In most cases, the relevant technologies represented the two most efficient options in each class. For example, if the cost difference between the least and most efficient air conditioners was $1000, the cost differential was reduced to $500, in effect simulating a rebate for buying the more efficient appliance.

Section 5201 provides incentives for meeting and strengthening building codes. To represent these incentives, the residential building codes were tightened by 30 percent in 2015 and 50 percent in 2025, relative to the building codes assumed in the Reference Case.

[5] Section 2303 requires that the quantity of borrowed allowances to satisfy a given emission obligation be factored by 1.1 times the number of years after the "use year" and before the "source year" of the borrowed allowance. The wording can be interpreted as allowing 1 year of borrowing without any interest imposed. The intent is assumed to be, however, that a full 10-percent interest penalty on borrowed allowances is to be charged, without a free year of interest.

Allowances to Load-Serving Entities and Fossil-Fired Powerplant Owners

Under Section 3401, 9 percent of allowances are distributed to electric load-serving entities (LSE) where the proceeds can be used to reduce the cost impact of the program or promote energy efficiency programs. Under Section 3901, 1 percent of allowances are allocated to rural electric cooperatives for transition assistance. In this analysis it was assumed that all of the allowance proceeds from this 10-percent allocation are used to reduce electricity prices by lowering the distribution markups.

Under Section 3901, a share of allowances are allocated to fossil-fuel-fired electric powerplant owners, beginning with 19 percent from 2012 to 2017, then declining gradually each year to 1 percent in 2030. It was assumed that the impact of this free allocation depends on how the powerplants are regulated within each region. For unregulated producers, the benefits of the free allocation of allowances are not passed on to consumers. However, for regulated providers, where electricity prices are set under cost of service procedures, the cost benefits of the free allowances are assumed to be passed on to electricity consumers.

Analysis Cases

There is significant uncertainty regarding the potential impacts of S. 2191. A set of five cases simulating the S.2191 policy were prepared, varying assumptions regarding the cost and availability of various technologies and compliance offset options (Table 2). While the cases do not span the full range of possibilities, they provide some indication of the impact of the more important analytical assumptions:

- The **S. 2191 Core Case** represents an environment where key low-emissions technologies, including nuclear, fossil with carbon capture and sequestration (CCS), and various renewables, are developed and deployed in a timeframe consistent with the emissions reduction requirements without encountering any major obstacles, even with rapidly growing use on a very large scale, and the use of offsets, both domestic and international, is not significantly limited by cost or regulation.
- The **S. 2191 No International Offsets Case**, is similar to the S. 2191 Core Case, but represents an environment where the use of international offsets is severely limited by cost or regulation. The regulations that will govern the use of offsets have yet to be developed and their availability will depend on actions taken in the United States and around the world.
- The **S. 2191 High Cost Case** is also similar to the S.2191 Core Case except that the costs of nuclear, coal with CCS, and biomass generating technologies are assumed to be 50 percent higher than in the Core Case. There is great uncertainty about the costs of these technologies, as well as the feasibility of introducing them rapidly on a large scale. While the costs assumed in the High Cost Case are more closely aligned with recent cost estimates than those in the Core Case, it is unclear if the recent cost increases are a short- or long-run phenomenon. The High Cost Case, which raises the cost of key low- and no carbon electric generation technologies, falls between the Core Case and the Limited Alternative Case discussed below.

- The **S. 2191 Limited Alternatives Case** represents an environment where the deployment of key technologies, including nuclear, fossil with CCS, and various renewables, is held to their Reference Case level through 2030, as are imports of liquefied natural gas (LNG). The inability to increase their use of these technologies causes covered entities to turn to other options in response to S.2191.
- **The S. 2191 Limited/No International Case** combines the assumptions from the S. 2191 Limited Alternatives and S. 2191 No International Offset Cases.

In addition to the S.2191 cases, the report also includes a case that represents S. 1766, the Low Carbon Economy Act of 2007. EIA's earlier analysis of S.1766[6] used a reference case with significantly higher projected energy use and emissions than the reference case used in this report, which reflects the provisions of EISA and other updates.

[6] Energy Information Administration, *Energy Market and Economic Impacts of S.1766, the Low Carbon Economy Act of 2007*, SR/OIAF/2007-06 (Washington, DC, January 2008), web site www.eia.doe.gov/oiaf/servicerpt/csia/index.html.

Table 2: Analysis Cases

Case Name	Assumptions
Non-Policy Case	
Reference	• *AEO2008* Reference Case, which includes the provisions H.R. 6, the Energy Independence and Security Act of 2007, and assumes a continuance of other current laws and regulations • Non-CO_2 emissions growth based on Environmental Protection Agency "with measures" and "voluntary technology adoption" cases
Policy Cases	
S. 2191 Core	Primary S. 2191 policy case. Key assumptions include: • *AEO2008* Reference Case assumptions • Cap-and-trade policy from Title I capping the emissions of Group I GHGs (CO_2, methane, nitrous oxide, sulfur hexafluoride, and perfluorocarbons) and Group II gases (hydrofluorocarbons) emitted from Hydrochlorofluorocarbon production). • Key low-emissions technologies, including nuclear and coal with carbon capture and sequestration (CCS), are developed and deployed in a timeframe consistent with the emissions reduction requirements without encountering any major obstacles, even with rapidly growing use on a very large scale. • Bonus credit incentives for CCS • Nonenergy GHG abatement supply, as a function of allowance costs, derived from information provided by the Environmental Protection Agency • The Title X cap–and-trade program for other Group II GHGs (hydrofluorocarbons) is not represented
No International Offsets	S. 2191 Core Case with the compliance option from international offsets assumed to be unavailable
S. 2191 High Cost	S. 2191 Core Case with assumed higher costs for key electricity generating technologies: • CCS, nuclear and biomass plant costs 50 percent higher than in S. 2191 Core Case
S. 2191 Limited Alternatives	S. 2191 Core Case with assumed limits on several carbon reduction technologies for electric power generation and limits on LNG imports: • CCS not available by 2030 • Nuclear and biomass power plant additions limited to *AEO2008* Reference Case level • LNG imports limited to *AEO2008* Reference Case level
S. 2191 Limited Alternatives / No International	Combines the assumptions in the Limited Alternatives and No International Offsets Cases
S. 1766 Update	Updated evaluation of S. 1766, the Low Carbon Economy Act of 2007, recently evaluated by EIA under *AEO2007* Reference Case assumptions. Key assumptions include: • *AEO2008* Reference Case assumptions • S. 1766 cap and trade policy • S. 1766 bonus credit incentives for CCS • S. 1766 technology accelerator payment (TAP) price, which establishes a limit on the allowance price, growing at 5 percent per year in real dollars • Nonenergy GHG abatement supply, as a function of allowance costs, derived from information provided by the Environmental Protection Agency

2. Results

This section presents the results of the analysis, focusing on the effects of S. 2191 in the Core Case. The results of additional cases that vary technology cost and availability assumptions are also discussed where relevant, along with some comparisons to the S. 1766 Update Case. The impacts on GHG emissions, energy markets, and the economy are presented in turn. Table 3 compares the projections in the *AEO2008* Reference Case to the projections in the five S. 2191 cases and the S. 1766 Update. A full set of tables for all cases is available on the EIA web site.

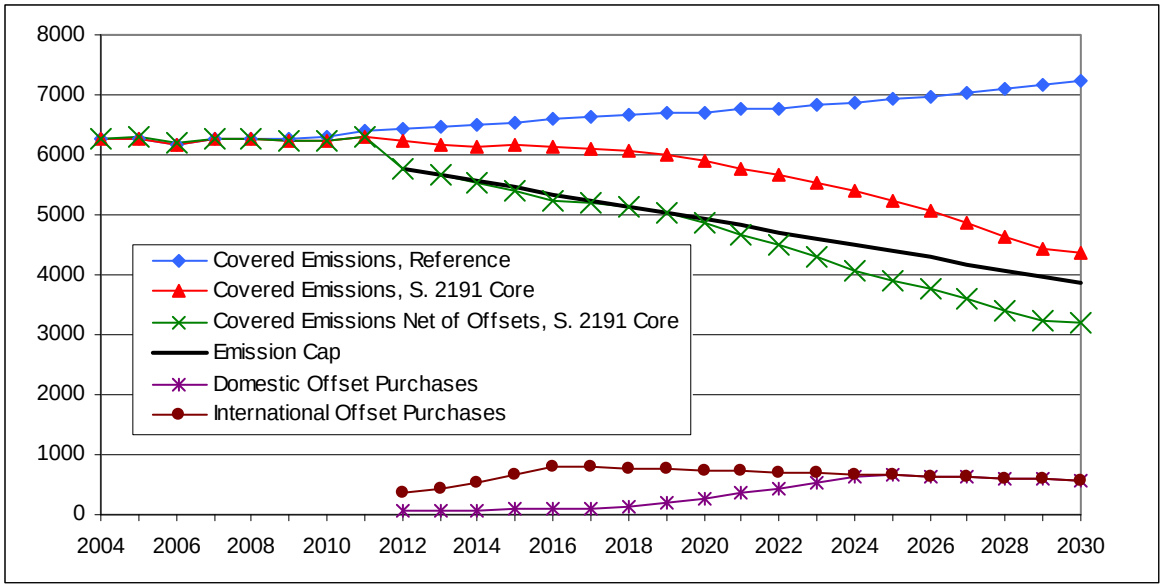
Greenhouse Gas Emissions and Allowance Prices

Under the S. 2191 Title I cap-and-trade program, GHG emission levels are governed by the quantity of allowances issued each year, the availability and limits on offsets, and the economics of banking allowances for future use. As discussed in Chapter 1, an underlying assumption is that the ability to sell or bank allowances for the future will promote a gradual escalation in allowance prices. The allowance prices and levels of emissions banking are estimated in concert such that covered emissions, less allowed offsets, meet the allowance caps over a period of time.

Figure 2 compares projections of the S. 2191 covered emissions under Title I in the Reference Case and the S. 2191 Core Case, relative to the emissions cap. Because entities can meet up to 15 percent of the allowance obligation with domestic offsets and 15 percent from international offsets, the graph also depicts the projected offsets purchased, along with the covered emissions net of offsets for comparison to the cap.

Figure 2: Covered GHG Emissions and Offset Usage in the Reference and S. 2191 Core Cases, 2006-2030

(million metric tons CO_2-equivalent)



Source: National Energy Modeling System runs AEO2008.D030208F and S2191.D031708A.

Table 3: Summary Emissions and Energy Market Results

(million metric tons CO_2-equivalent, except as noted)

	2006	2020							2030						
			S. 2191 Cases							S. 2191 Cases					
		Refer-ence	Core	High Cost	Limited Alter-natives	No Inter-national Offsets	Limited / No Inter-national	S. 1766 Update	Refer-ence	Core	High Cost	Limited Alter-natives	No Inter-national Offsets	Limited / No Inter-national	S. 1766 Update
Greenhouse gas emissions															
Energy-related carbon dioxide	5890	6384	5587	5548	5520	5005	4777	6009	6851	4020	4573	4786	3821	4319	5038
Other covered emissions[1]	292	331	303	299	299	299	287	276	381	347	336	336	336	336	437
Total covered emissions	6182	6715	5890	5848	5819	5304	5064	6285	7232	4368	4909	5122	4157	4656	5475
Total greenhouse gas emissions	7014	7729	6770	6716	6679	6167	5910	7224	8441	5429	5968	6179	5217	5709	6441
Emissions reduction from Reference case															
Energy-related carbon dioxide	- -	- -	797	836	864	1379	1607	375	- -	2831	2278	2066	3030	2532	1813
Carbon capture and storage	- -	- -	*147*	*85*	*0*	*144*	*0*	*182*	- -	*386*	*325*	*0*	*226*	*0*	*1258*
Other covered emissions	- -	- -	28	32	33	32	44	61	- -	34	44	44	44	44	88
Nonenergy carbon dioxide	- -	- -	2	3	4	4	7	1	- -	4	6	7	5	12	2
Offset Credits															
Noncovered emissions	- -	- -	132	142	149	146	160	67	- -	144	144	144	144	144	97
International allowances	- -	- -	739	739	737	0	0	0	- -	577	579	581	0	0	0
Biogenic carbon sequestration[2]	- -	- -	148	282	385	339	578	128	- -	435	437	435	436	435	479
Biogenic carbon sequestration, Sec. 3701	- -	- -	246	246	246	246	246	- -	- -	193	193	193	193	193	- -
Total (including carbon sequestration)	- -	- -	2092	2280	2417	2147	2643	633	- -	4217	3682	3470	3853	3359	2479
Compliance summary															
Allowances issued (cap)	- -	- -	4924	4924	4924	4924	4924	6189	- -	3860	3860	3860	3860	3860	4818
Covered emissions, less offset credits [1, 2]	6182	6715	4872	4685	4548	4818	4325	6218	7232	3212	3749	3963	3578	4077	5378
Net allowance bank change	- -	- -	52	239	376	106	599	(28)	- -	648	111	(103)	282	(217)	(560)
Allowance bank balance	- -	- -	336	2587	2914	106	2926	1476	- -	5027	4896	4974	5028	4876	(808)
Allowance price (2006 dollars per metric ton CO_2-equivalent)	- -	0	30	38	44	42	76	13	0	61	78	91	85	156	26
Delivered energy prices (2006 dollars per unit indicated)															
Motor gasoline, transport (per gallon)	2.63	2.36	2.58	2.63	2.66	2.65	2.84	2.45	2.45	2.86	2.95	3.05	3.01	3.46	2.63
Jet fuel (per gallon)	2.00	1.79	2.05	2.13	2.19	2.16	2.49	1.90	2.07	2.62	2.74	2.88	2.81	3.48	2.30
Diesel (per gallon)	2.71	2.50	2.78	2.86	2.91	2.88	3.15	2.61	2.68	3.20	3.32	3.45	3.39	4.00	2.93
Natural gas (per thousand cubic feet)															
Residential	13.80	11.74	13.41	14.19	14.96	14.07	17.55	12.17	13.30	16.77	18.68	20.60	18.59	24.91	13.99
Electric power	7.07	6.11	7.52	8.30	9.04	8.06	11.68	6.53	7.13	9.95	11.75	13.95	11.64	18.24	7.74
Coal, electric power sector (per million Btu)	1.69	1.72	4.49	5.24	5.83	5.51	8.81	2.93	1.78	7.21	8.91	10.07	9.40	16.11	4.23
Electricity (cents per kilowatthour)	8.91	8.61	9.06	9.54	9.90	9.28	10.93	8.75	8.85	9.82	11.82	12.66	9.75	14.52	9.51
Energy consumption (quadrillion Btu)															
Liquid fuels	40.1	42.2	41.3	41.1	41.0	40.7	40.6	41.7	44.0	42.0	41.8	41.9	41.5	40.9	42.9
Natural gas	22.3	24.0	22.4	23.2	24.2	22.2	26.6	22.9	23.4	19.4	22.6	26.2	19.8	27.9	20.1
Coal	22.5	25.9	20.6	19.2	17.6	15.0	8.7	24.9	29.9	7.8	11.4	8.1	4.1	3.3	26.7
Nuclear power	8.2	9.1	10.2	9.2	9.1	12.7	9.1	9.6	9.6	30.0	15.2	9.6	31.7	9.6	12.8
Renewable/Other	6.5	9.7	13.4	14.2	14.0	15.8	17.5	10.3	11.2	14.2	19.1	21.7	15.7	23.0	11.6
Total	99.5	110.8	107.9	107.0	105.9	106.4	102.4	109.4	118.0	113.4	110.1	107.5	112.8	104.7	114.1
Purchased electricity	12.5	14.5	14.2	14.1	14.0	14.1	13.7	14.5	16.1	15.3	14.9	14.7	15.3	14.2	15.8
Electricity generation (billion kilowatthours)															
Petroleum	85	76	49	51	49	44	48	51	82	39	45	47	38	49	43
Natural gas	806	833	761	901	1094	760	1516	768	741	427	897	1558	530	1794	390
Coal	1988	2357	1890	1754	1606	1373	766	2296	2838	703	1066	703	307	224	2784
Nuclear power	787	868	979	886	868	1220	868	919	917	2877	1460	917	3036	917	1228
Renewable	385	588	918	953	882	1136	1198	652	657	920	1347	1527	1052	1618	708
Total	4051	4723	4595	4544	4500	4534	4396	4686	5235	4966	4816	4753	4964	4602	5153

[1] Sources included in other covered emissions under S. 2191 Title I differ from those under S. 1766. Under S. 1766, all of the fluorinated gases and nitrous oxide from nitric and adipic acid are covered.

[2] Under S. 2191, registered increases in biogenic carbon sequestration can qualify as an offset. Under S. 1766, an allowance incentive encourages this sequestration but it does not count as an offset.

Source: NEMS runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A

- - : Not Applicable

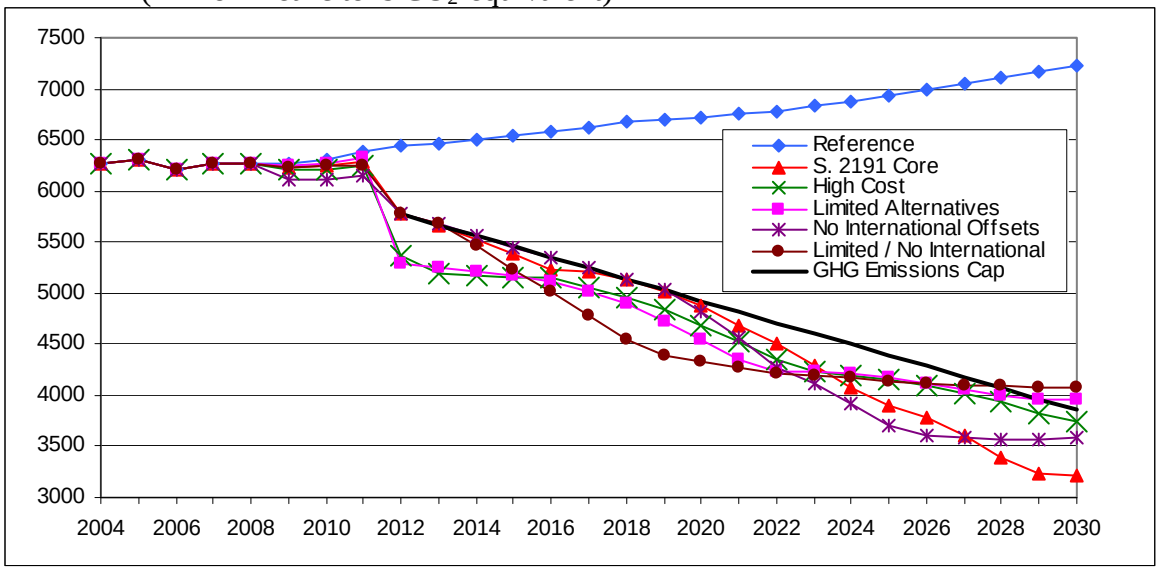
As indicated in Figure 3, covered emissions net of offsets are projected to be below the gradually declining cap, causing a bank of allowances to accumulate through 2030. Because the modeling horizon ends in 2030, a sizable allowance bank balance in 2030 is assumed to be amassed in anticipation of the increasing allowances prices that would likely occur under declining post-2030 caps, given continued population and economic growth. As a result, cumulative emissions net of offsets through 2030 are projected to be about 5 billion metric tons lower than actually required by the allowance caps over that period.

The 15-percent limit on international offsets becomes binding in the S. 2191 Core Case in 2016, while the domestic limit is first reached in 2025. Because the emission caps are declining, the absolute quantity of offsets also declines over time, once the percentage limits becomes binding.

The projected allowance prices and compliance results depend on the assumed availability of international offsets and the cost and availability of low carbon energy sources. Projected emissions in the Reference Case and the five S. 2191 cases vary, as depicted in Figure 3. The various compliance paths across these cases reflect different patterns of allowance bank accumulation (Figure 4), along with the estimated allowance price trajectories that shape the compliance response (Figure 5).

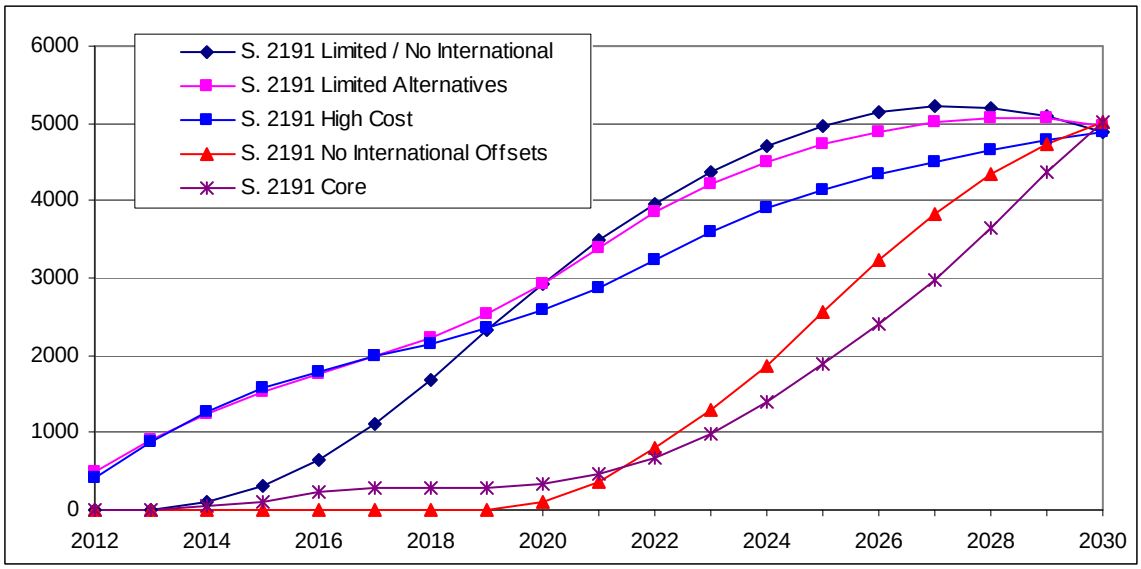
Figure 3: Covered Emissions Net of Offsets for the Reference and S. 2191 Cases

(million metric tons CO_2-equivalent)



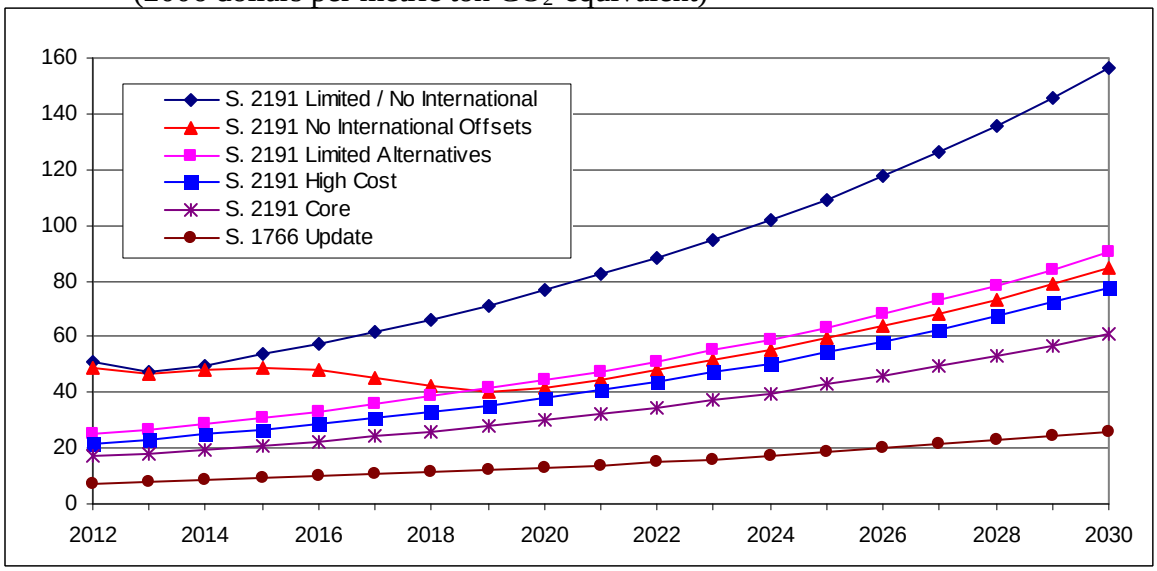
Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A.

Figure 4: End-of-Year Allowance Bank Balance in the S. 2191 Cases, 2012 to 2030
(million metric tons CO_2-equivalent)



Source: National Energy Modeling System runs S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, and S2191BIVNOI.D033108A

Figure 5: Allowance Prices in the S. 2191 Cases and the S. 1766 Update Case
(2006 dollars per metric ton CO_2-equivalent)



Source: National Energy Modeling System runs S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A.

As shown in Figure 4, there is a relatively low level of allowance bank accumulation in the first 10 years of the allowance program in the S. 2191 Core case, and the allowances banked in any single year over that period account for less than 5 percent of the yearly cap. After 2022, the allowance banking escalates as low-carbon emissions sources in the electric power sector

emerge, inducing a build-up of allowance balances in anticipation of the increasingly stringent post-2030 emission targets. As shown in Figure 5, projected allowance prices in the S. 2191 Core case are $17 in 2012 (2006 dollars) and rise at the assumed 7.4-percent rate to $61 in 2030.[1]

In the S. 2191 High Cost and S. 2191 Limited Alternatives Cases, where carbon mitigation options are more costly or unavailable through 2030, allowance prices are driven up, and considerably more allowance banking takes place in the first 10 years of the program. Allowance prices in 2030 are $78 in the S. 2191 High Cost Case and $91 in the S. 2191 Limited Alternatives Case. The higher allowance price levels accelerate the use of offsets, and the limits on domestic and international offsets are reached 2 to 4 years earlier than in the S. 2191 Core Case.

The allowance price path from 2012 through 2019 in the S. 2191 No International Offsets case departs from the growing price trajectory seen in the other S. 2191 cases. Without international offsets, allowance prices are driven higher initially, compared to the S. 2191 Core case. For example, the allowance price in 2012 is $48 in the No International Offsets case, compared to $17 in the Core case. The allowance price rises to levels necessary to meet the emissions cap in 2012 through fuel-switching and early investment in efficiency and carbon-neutral technologies. Meeting the gradually declining caps over the next few years is achieved without any significant allowance price increases. While an outlook for steady or falling allowance prices could create an incentive to borrow allowances against future obligations, as permitted under S. 2191, the effective 10-percent interest penalty on such borrowing and the 15-percent borrowing limit are assumed to preclude this option.

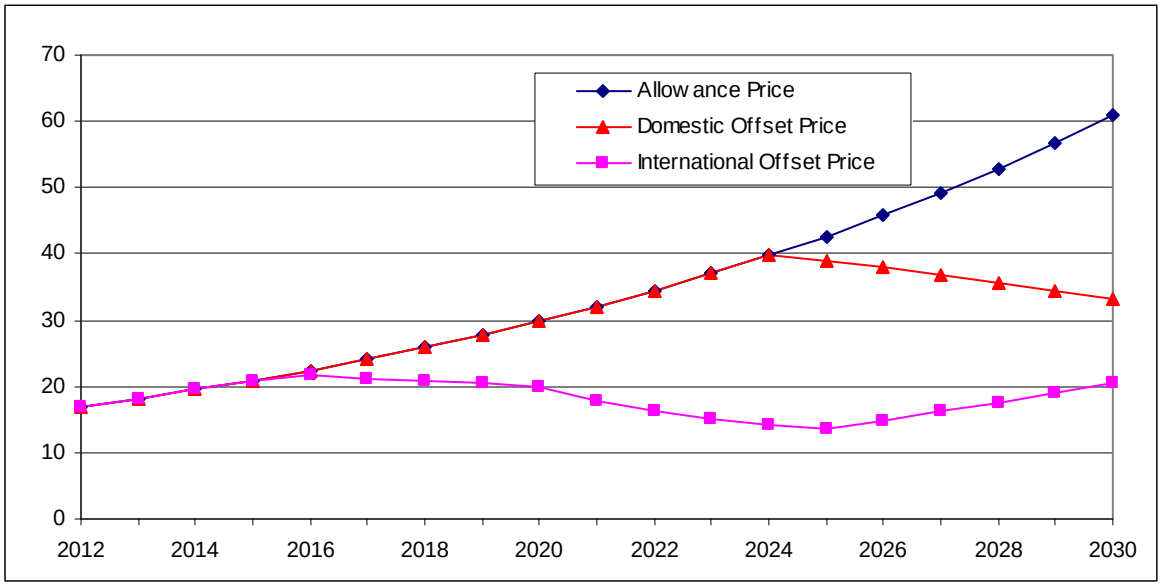
In the S. 2191 Limited Alternatives/No International Case, where compliance options are most limited, the allowances prices are driven to the highest levels among the cases considered, $51 in 2012 and $156 in 2030.

Allowance and Offset Prices

The independent limits on domestic and international offsets will influence their pricing relative to allowance prices (Figure 6). When neither offset limit is binding, the prices in the two offset markets would be expected to clear at the same price as in the allowance market. When the use of either domestic or international offsets reaches the maximum, competition to supply a fixed quantity of offsets will tend to drive down the offset price below the allowance price. This situation occurs beginning in 2016 for international offsets and in 2025 for domestic offsets in the S. 2191 Core Case.

[1] Each allowance represents one metric ton of CO_2-equivalent emissions. A price for an allowance is expressed in 2006 dollars per metric ton of CO_2-equivalent emissions.

Figure 6: Allowance and Offset Prices in the S. 2191 Core Case
(2006 dollars per metric ton CO_2-equivalent)



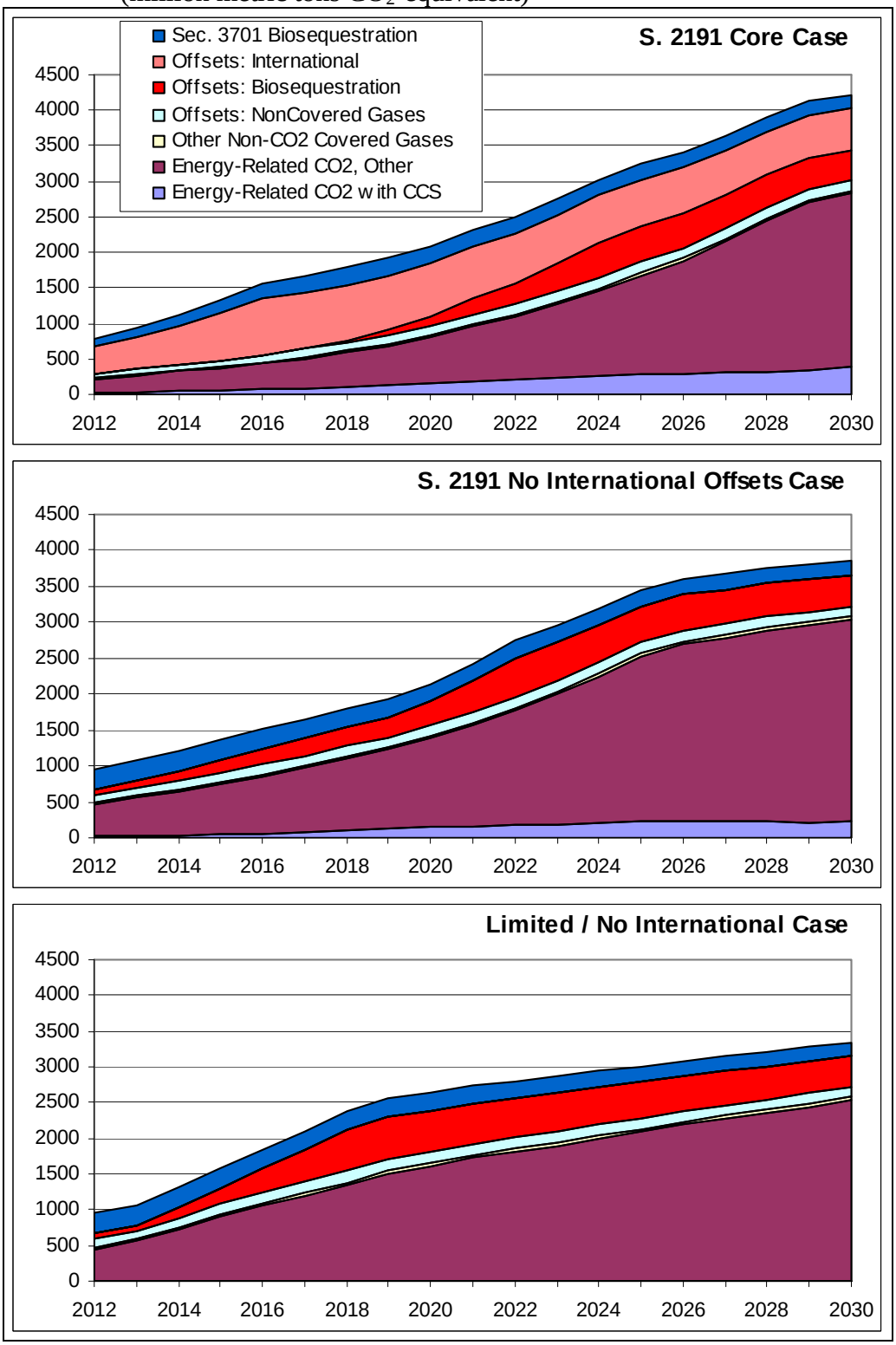
Source: NEMS run S. 2191.D031708A.

Emissions Impacts by Source and Sector

The allowance program and other incentives under S. 2191 are expected to result in substantial covered emissions reductions in energy-related CO_2 and other GHG emissions. Under the offset provisions, emission reductions from non-covered entities also occur, along with increases in biogenic carbon sequestration from domestic forestry and agriculture and credited decreases in emissions abroad. Under Section 3701, an allowance distribution program provides a supplementary incentive for agricultural and forestry emissions reductions and sequestration. As seen in Figure 7, S. 2191 Core Case, the emissions reductions from CO_2 account for less than half of the total compliance response in the first 10 years of the program, when lower cost offsets and non-CO_2 abatement opportunities predominate. The CO_2 share of compliance measures increases over time with more stringent reduction requirements and with greater turnover of electric power plants, energy-using equipment, vehicles, and appliances. This growing contribution of CO_2 reductions occurs in the other policy cases as well, but the degree of response and the relative share of offsets used in the compliance response differ among the cases.

Figure 7: GHG Emissions Reductions in the S. 2191 Core, S. 2191 No International Offsets, and the S. 2191 Limited/No International Cases

(million metric tons CO_2-equivalent)



Source: National Energy Modeling System runs S. 2191.D031708A, S. 2191NOINT.D032508A and S. 2191BIVNOI.D033108A.

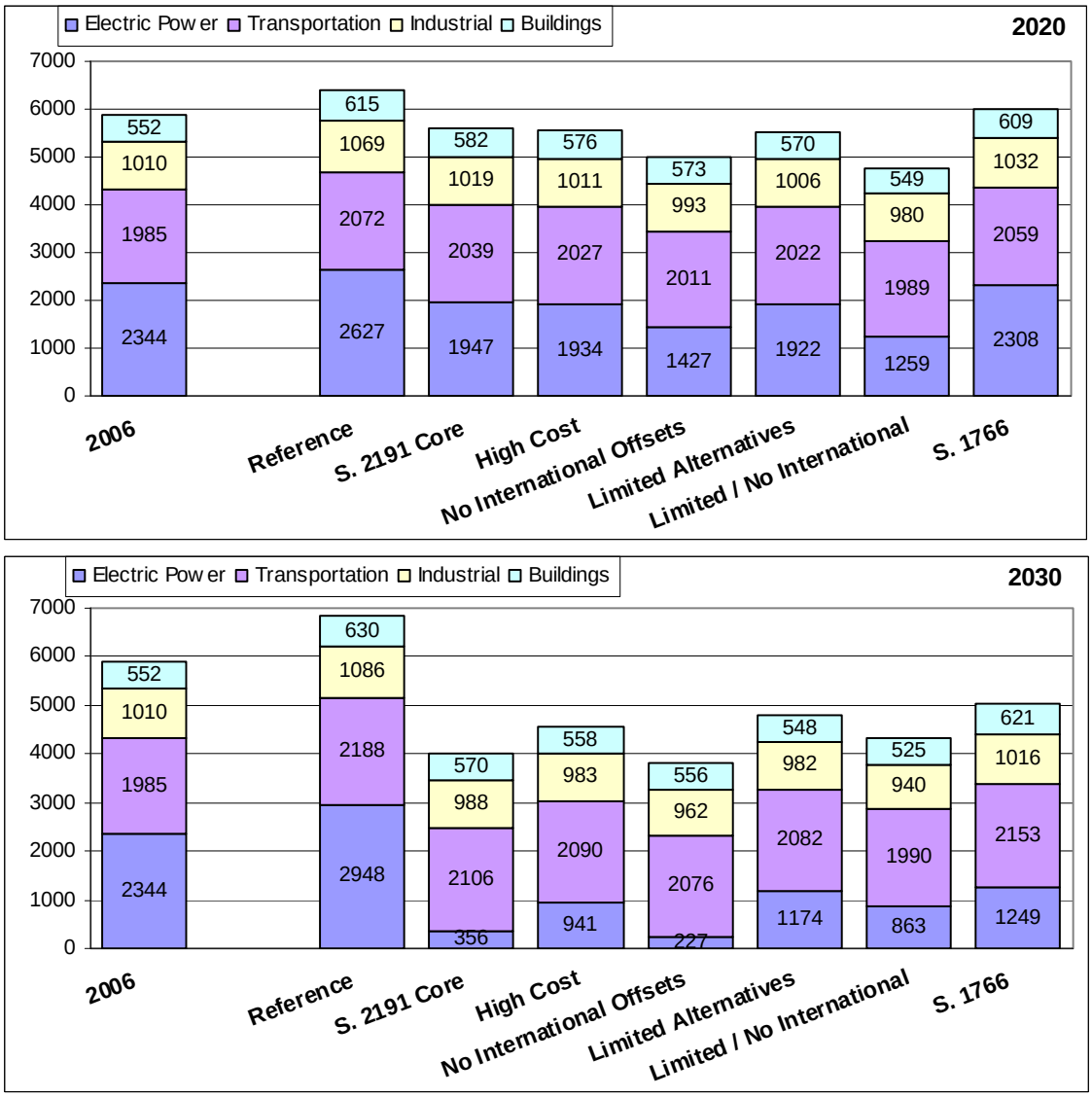
As indicated in Figures 8 and 9, most of the energy-related CO_2 emissions reductions occur in the electricity sector, with less than 20 percent of direct emissions occurring in the buildings, industrial, and transportation sectors in all the cases examined.[2] The electricity sector reductions stem from the use of more efficient, less carbon-intensive sources of generation. This results from a variety of factors, particularly the industry's current dependence on coal, the availability and economics of technologies to switch from coal to less carbon-intensive energy sources, and the comparative economics of fuel switching in other sectors. A relatively small share of the electricity-related CO_2 emissions reductions results from reduced electricity demand.

Comparison of GHG Emissions in the S. 2191 and S. 1766 Cases

The covered emissions and allowance caps under Title 1 of S. 2191 and S. 1766 are compared in Figure 10, relative to the emissions in the *AEO2008* Reference Case. Because the categories of emissions that are covered differ slightly in the two bills, the covered emissions for the Reference Case are presented under each. The caps under S. 1766 in the first few years are actually slightly above the Reference Case emissions. Since S. 1766 was introduced, EIA released its *AEO2008*, with revised Reference Case projections of CO_2 emissions. The *AEO2008* Reference Case assumes lower economic growth and higher energy prices than in the *AEO2007* Reference Case, and also accounts for the emission reduction impacts of EISA. As a result, meeting the S. 1766 cap requires lower emission reductions from the *AEO2008* Reference Case compared to the *AEO2007* Reference Case. Emissions in the *AEO2008* Reference Case would be in compliance with the S. 1766 caps from 2012 to 2017, after taking into account allowance banking. On a cumulative basis from 2012 to 2030, compliance with the S. 1766 cap would require reductions (or offsets) from the *AEO2008* Reference Case emissions of 16 billion metric tons CO_2 equivalent, while compliance with S. 2191 requires a cumulative reduction of 37 billion metric tons CO_2 equivalent.

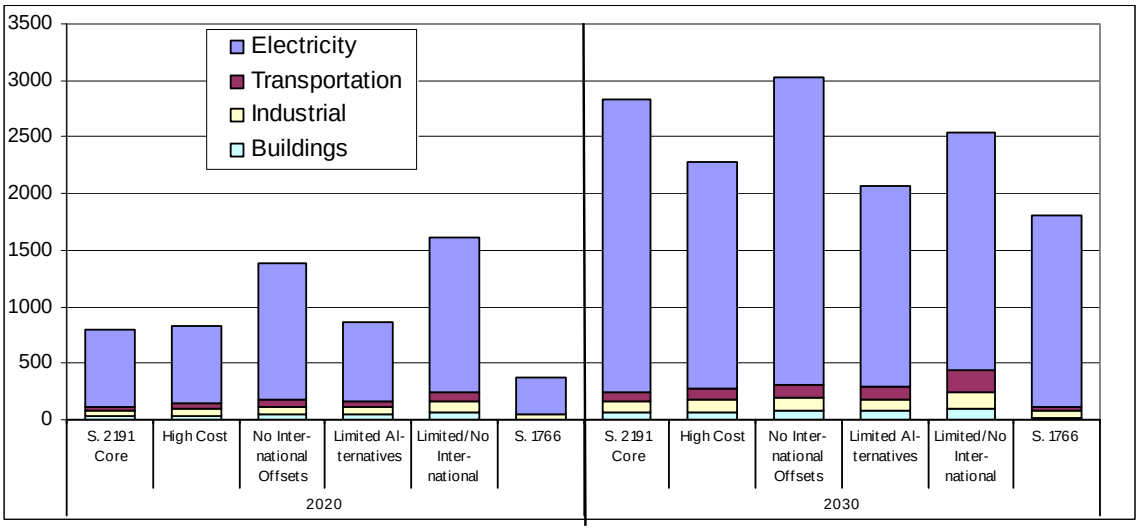
[2] In Figures 9 and 10, all emissions from purchased electricity are shown in the electricity sector. Some of the emissions changes between cases reflect different levels of electricity usage in addition to direct emissions from generation.

Figure 8: Energy-Related CO_2 Emissions by Sector
(million metric tons)



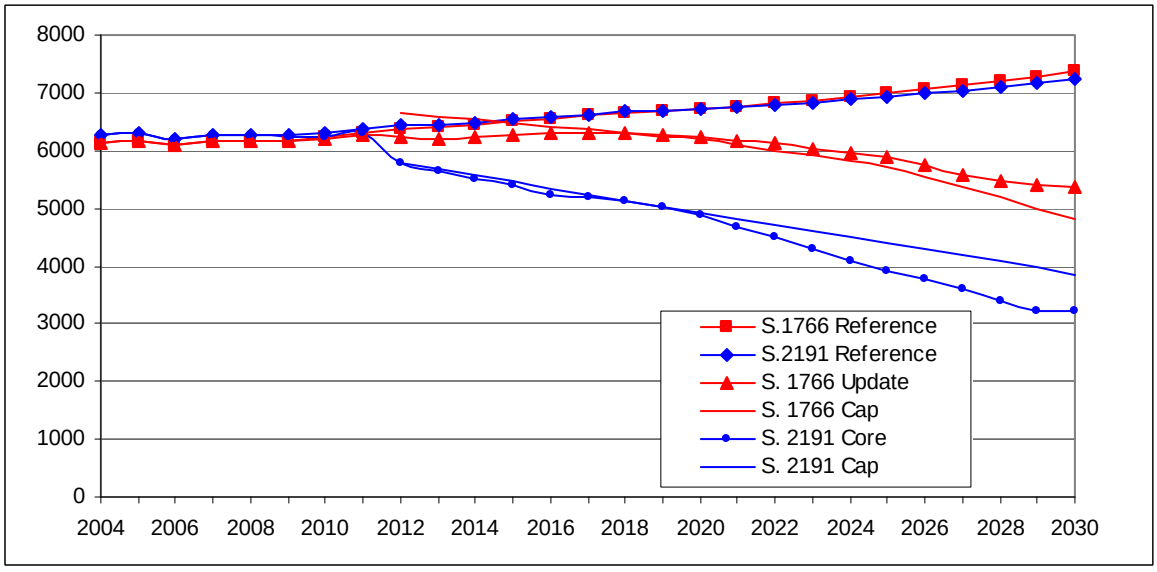
Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A.

Figure 9: Energy-Related CO_2 Emission Reductions from Reference Case
(million metric tons)



Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A.

Figure 10: Covered Greenhouse Gas Emissions Net of Offsets in the S. 2191 Core and S. 1766 Update Cases Compared to the Reference Case
(million metric tons CO_2-equivalent)



Source: National Energy Modeling System runs AEO2008.D030208F, S. 2191.D031708A, and S1766_08.D031508A.

Energy Market Impacts

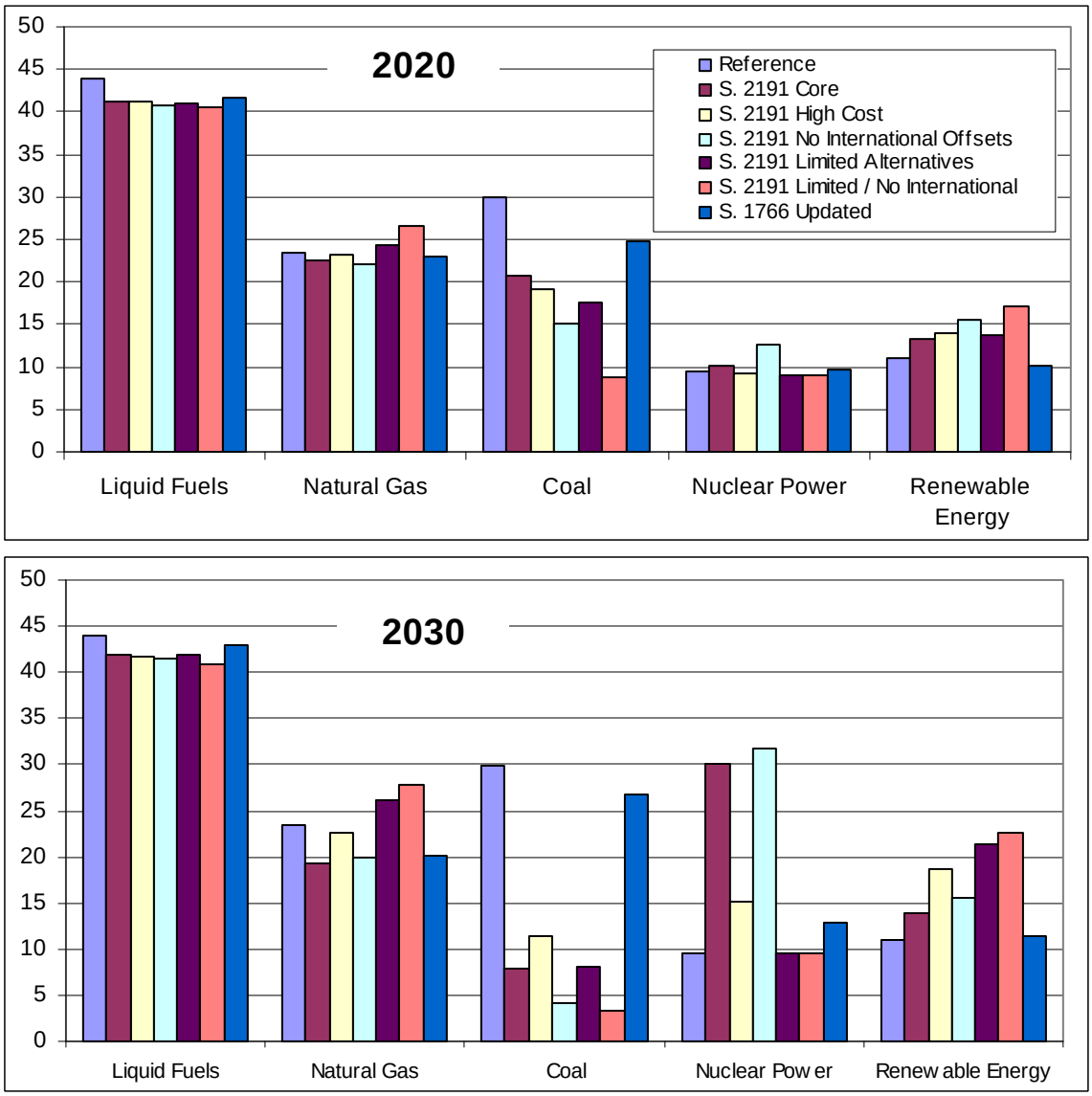
Energy consumers are expected to face higher costs of using energy as a result of the S. 2191 allowance program. The cost of the allowances requirements imposed on fuel suppliers will tend to be passed on to consumers through higher petroleum and natural gas prices. Coal consumers, directly responsible for submitting allowances for their coal-related CO2 emissions, will incur higher cost of using coal, reflecting the cost of the associated allowance requirements. Electricity generators will also pass their higher fuel costs, as well as their higher incremental capital cost, to their customers, partially offset by the S. 2191 provisions that distribute allowances to reduce economic impacts. Table 2, presented earlier, summarizes the projected impacts on the delivered cost of energy under S. 2191. Detailed sets of projection tables on energy production, consumption, and prices for each case accompany the presentation of this report on EIA's web site.[3]

The impacts of S. 2191 on energy prices are closely linked to the allowance price, so the energy prices are significantly greater when key compliance options such as international offsets, nuclear power, and CCS are assumed to be unavailable or more costly, driving up the allowance prices. For example, projected prices for motor gasoline in 2030 are $2.46 per gallon (2006 dollars) in the Reference Case, $2.86 per gallon in the S. 2191 Core Case, and $3.46 in the Limited Alternatives/No International Case. Average electricity prices, net of the mitigating effect from allowance distribution incentives, range from 8.9 cents per kilowatthour in the Reference Case to 9.8 cents in the S. 2191 Core Case and 14.5 cents in the Limited Alternatives/No International Case. Under S. 2191, average annual household energy bills, excluding transportation costs, are between $30 and $325 higher in 2020 and $76 and $723 in 2030.

Energy-related emissions will be influenced by both the higher energy costs from the allowance program, as well as the S. 2191 incentives that promote energy efficiency and low-carbon fuel sources. Overall, the use of fossil fuels generally decreases relative to the Reference Case, while the use of renewable energy sources and nuclear power increases (Figure 11). As discussed earlier, the greatest impacts from the higher energy costs occur in the electricity sector, with reductions in the use of coal and increases in nuclear and renewable fuels, relative to the Reference Case in most cases. The impacts tend to grow over time as the caps become more stringent and the allowance price increase. In the S. 2191 Core, the S. 2191 High Cost, and the S. 2191 No International Offsets Cases, total natural gas consumption is lower than in the Reference Case over the 2012 to 2030 period. In the Limited Alternatives and Limited Alternatives/No International Cases, where compliance options are assumed to be limited, projected natural gas use exceeds the Reference Case and nuclear power remains at the Reference Case level.

[3] See www.eia.doe.gov/oiaf/service_rpts.htm.

Figure 11: Total Energy Consumption by Source
(quadrillion Btu)



Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A.

Electricity Sector Emissions, Generation, and Prices

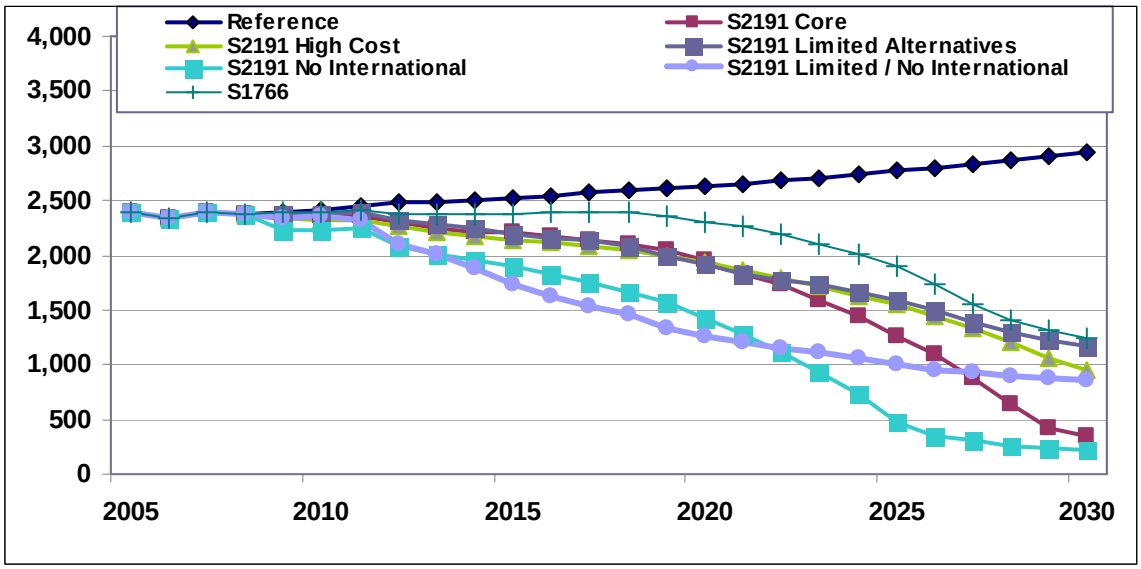
The provisions of S. 2191 alter electric power projections by favoring low-carbon technologies such as coal plants that sequester CO_2, renewable facilities, and nuclear power. The impact of CCS technology is also affected by the provisions that provide multiple allowances to these plants for each ton of CO_2 sequestered. In several analyses of proposals to reduce greenhouse gas emissions, EIA has found that the electric power sector would first turn to increased use of nuclear and renewable fuels, before coal power plants with CCS. However, the bonus

allowances provided for CCS in S. 2191 improve its relative economics, though nuclear and renewable fuels still play a larger role. The shifts in the generation mix lead to lower CO_2 emissions from the electricity sector, higher electricity prices, and lower electricity demand than in the Reference Case. The higher electricity prices are due to the higher capital costs of cleaner, more efficient technologies and the costs of holding allowances, both of which are partially offset by lower fuel expenditures.

Emissions

In the Reference Case, which assumes no policy to reduce GHG emissions, power sector CO_2 emissions are projected to increase 26 percent between 2006 and 2030 as the industry increases its use of fossil fuels, particularly coal (Figure 12). In the S. 2191 cases, power sector CO_2 emissions are expected to be 26 percent to 52 percent below the Reference Case level in 2020 and 60 percent to 92 percent below the Reference Case level in 2030. In the S. 2191 Core Case and S. 2191 No International Offsets Case, the power sector greatly reduces the use of fossil fuels and lowers emissions by 85 to 90 percent between 2006 and 2030. In the S. 2191 High Cost and S. 2191 Limited Alternatives Cases the nuclear, renewable, and sequestration technologies are assumed less economic or unavailable, and emissions in the power sector are not reduced as significantly, but still fall by 50 to 60 percent over the forecast.

Figure 12: Electric Power Sector Carbon Dioxide Emissions
(million metric tons)



Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.d033108A and S1766_08.D031508A.

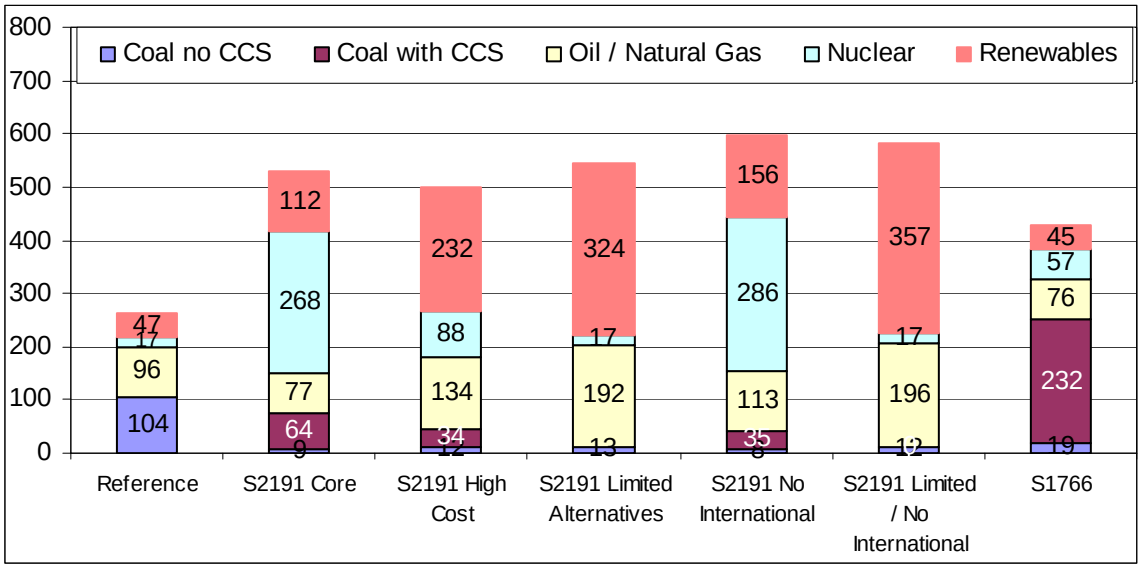
Capacity and Generation

In the Reference Case, coal plants without CCS meet a large share of new capacity requirements through 2030 (Figure 13). Absent regulations limiting GHG emissions, coal plants tend to be the

most economical option for meeting continuous, or baseload, demand. New natural gas plants are also added in the Reference Case, but tend to be more economical for meeting intermittent loads. Most of the renewable capacity added in the Reference Case is in response to State renewable portfolio standards.

Figure 13: Cumulative Electricity Generating Capacity Additions

(gigawatts)



Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.d033108A and S1766_08.D031508A.

Under S. 2191, new coal builds without CCS are almost eliminated. There is also a dramatic increase in power plant retirements, with almost two-thirds of existing coal plants projected to retire by 2030 in the S. 2191 Core Case and many of the retiring plants must be replaced by new capacity to meet demand. To meet this demand, most cases build a mix of coal with CCS, nuclear, and renewable technologies, primarily wind and biomass. The bonus credits provided to CCS under S. 2191 make coal with CCS economic, with 34 to 64 gigawatts (GW) of additions projected by 2030 across the S. 2191 cases that allow CCS builds. The Reference Case projects 17 GW of new nuclear capacity by 2030, but under S. 2191, nuclear builds by 2030 range from 88 GW to 286 GW, when allowed to grow. Renewable capacity also grows significantly, representing between 21 percent and 61 percent of all new capacity by 2030 across the S. 2191 cases. Note that the additions of new coal plants with CCS is much larger under the provisions of S. 1766 because the bonus allowances for CCS are not limited to a certain share of allowances as they are under S. 2191.

When technologies with CCS, nuclear, and biomass are constrained to Reference Case levels, the addition of new natural gas capacity grows significantly, with additions more than double that of the Reference Case by 2030. However, in the S. 2191 Core Case, natural gas additions are below those in the Reference Case, as CCS is not as economic on combined-cycle plants as coal, and other non-fossil technologies are built instead of natural-gas-fired plants without CCS.

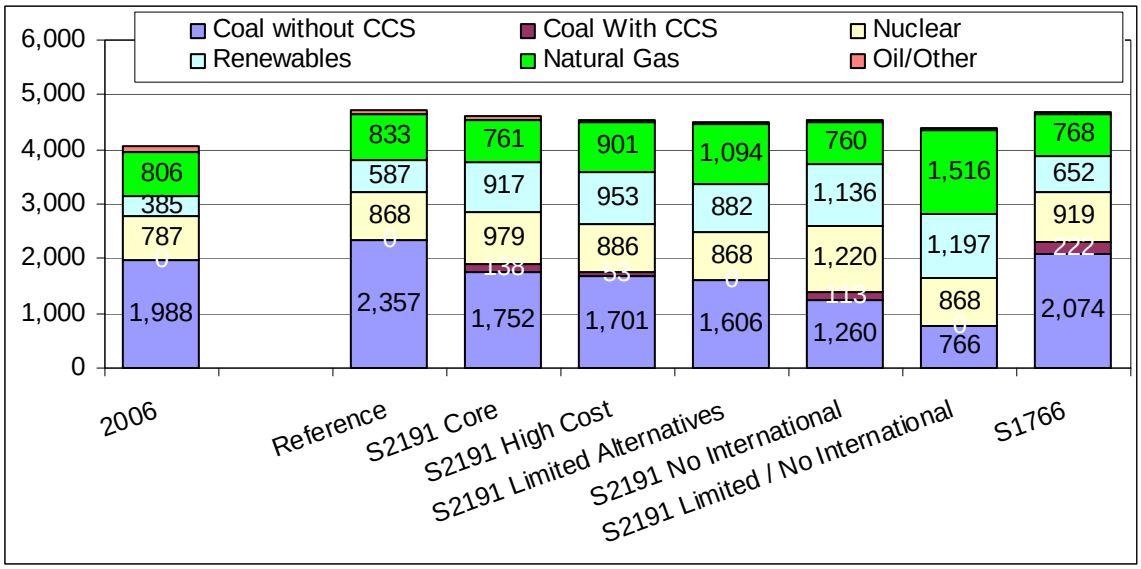
Changes in electricity generation are consistent with capacity choices and are influenced by the GHG allowance price (Figures 14 and 15). In the Reference Case, coal generation grows to 2,838 billion kilowatthours in 2030, an increase of 43 percent over 2006 levels, providing 54 percent of total electricity needs. In the S. 2191 cases, coal generation drops significantly, contributing less than one-quarter of total electricity generation in all cases, with the S. 2191 Limited Alternatives/No International Case seeing the biggest decline to just 5 percent of total electricity from coal in 2030. Although new coal capacity with CCS is added in most cases, the generation from these new plants is more than offset by reductions from the retirement of existing coal capacity. In the S. 2191 High Cost and S. 2191 Limited Alternatives Cases, coal generation is above that in the Core Case, but still much lower than the Reference Case. In those cases, the higher costs or limited availability of key non-fossil technologies result in fewer coal retirements than in the S. 2191 Core Case. However, this results in higher CO_2 emissions in these cases.

Nuclear generation follows the capacity additions, growing most significantly in the S. 2191 Core and S. 2191 No International Cases. In the Reference Case, nuclear generation grows by 17 percent between 2006 and 2030, reaching 917 billion kilowatthours and providing 18 percent of total generation. In the S. 2191 Core Case, nuclear grows to 2,877 billion kilowatthours in 2030, more than triple the Reference Case level. If nuclear costs are higher than expected, then new nuclear is still projected, but at lower levels. The S. 2191 High Cost Case projects nuclear generation will be almost 60 percent higher than in the Reference Case in 2030.

In most cases, natural gas generation goes down under the provisions of S. 2191. In the Reference Case, natural gas generation drops 8 percent by 2030, relative to 2006 levels, and in the S. 2191 Core Case natural gas generation is 47 percent below current levels. However, in the S. 2191 Limited Alternatives Case, natural gas generation more than doubles from the Reference Case level by 2030, due to the limited availability of new plants with CCS, as well as new nuclear and biomass capacity. This case demonstrates the importance of the development and deployment of key low-carbon generating technologies like nuclear, renewables, and fossil with CCS in a timeframe consistent with the emission reduction requirements of S. 2191. Without them, allowance prices would be higher and greater demands would be placed on natural gas markets.

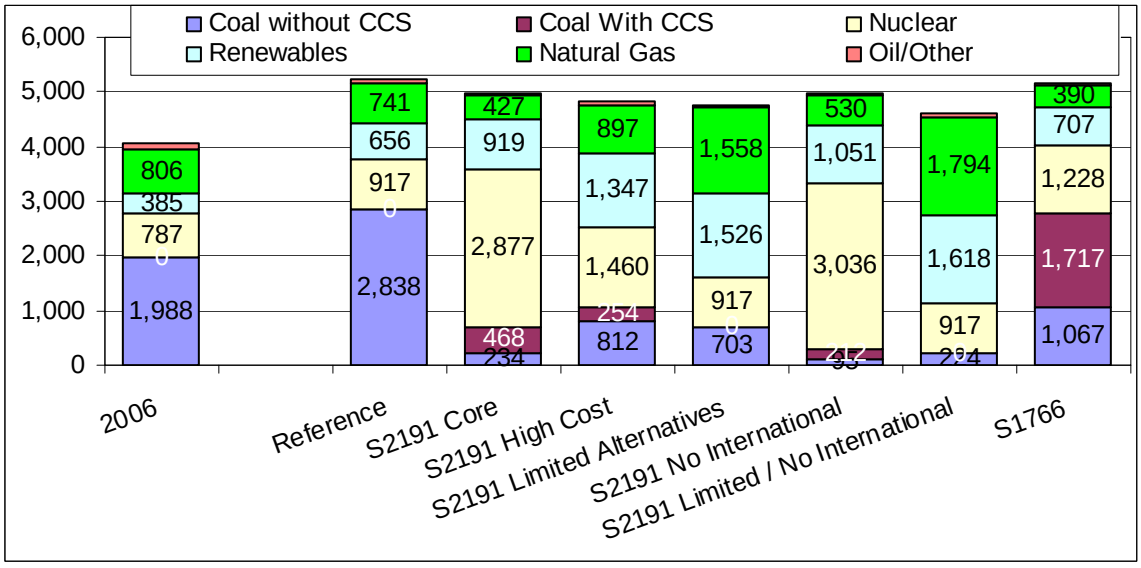
Renewable generation is dramatically higher under the provisions of S. 2191, growing between 40 percent and 146 percent above generation in the Reference Case in 2030. The vast majority of the increase is from wind generation, followed by biomass generation. Through 2020, some of the increase in biomass generation is through increased co-firing at coal plants, but after 2020 the co-firing output begins to decline and is below the Reference Case level by 2030 in all but the S. 2191 High Cost Case. Initially co-firing is an economic way to reduce CO_2 emissions without investing in new capacity, but as the allowance price increases over the forecast, the economics shift to favor less CO_2-intensive generation. In the S. 2191 Limited Alternatives Case, biomass supplies are limited so that no increase in either dedicated plants or co-firing is possible relative to the reference case. In this case, other renewable types such as solar and offshore wind are built.

Figure 14: Generation by Fuel in Alternative Cases in 2020
(billion kilowatthours)



Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.d033108A and S1766_08.D031508A.

Figure 15: Generation by Fuel in Alternative Cases in 2030
(billion kilowatthours)

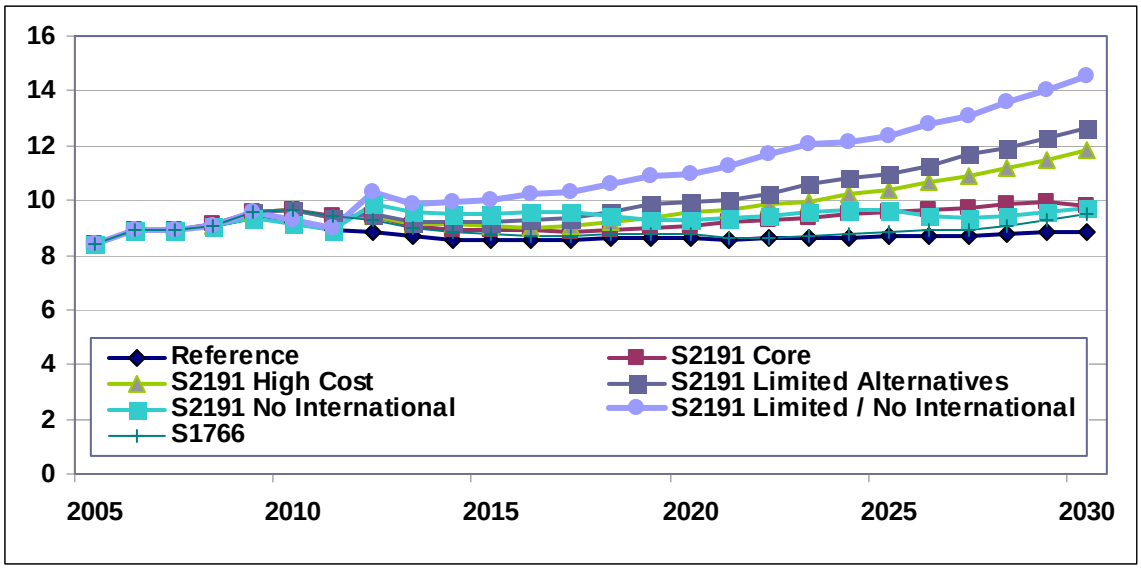


Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.d033108A and S1766_08.D031508A.

Price and Demand

S. 2191 is expected to lead to higher electricity prices and lower electricity demand, with much greater impacts in the High Cost and Limited Alternatives Cases. In the S. 2191 Core Case, electricity prices reach 9.1 cents per kilowatthour in 2020 and 9.8 cents in 2030 (Figure 16). These prices are 5 percent and 11 percent higher, respectively, than the prices in the Reference case. The largest increase is seen in the S. 2191 Limited Alternatives/No International case, where electricity prices reach 14.5 cents per kilowatthour in 2030. This is due to both the higher allowance price and the higher costs of the technologies available to build.

Figure 16: Electricity Prices
(2006 cents per kilowatthours)



Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.d033108A and S1766_08.D031508A.

The allocation of allowances to load serving entities in S. 2191 does limit the impact on electricity prices slightly. EIA assumes the value of these allowances would be passed on to consumers through a reduced distribution price. The impact of this provision is to reduce average distribution prices by around one-half cent per kilowatthour.
Total consumer expenditures for electricity in the S. 2191 Core Case are $126 billion higher than in the Reference Case over the 24-year projection period.[4] This added expenditure is a 3-percent increase in consumers' total electricity costs. The higher prices stem from suppliers' increased capital and fixed costs together with costs of holding allowances. These higher costs are partially offset by lower quantities of fossil fuel purchased and less generation.

[4] Costs accumulated from 2005 through 2030. All dollar values are 2006 dollars. Accumulated costs are discounted to 2005 using a 7-percent discount rate per guidance from Office of Management and Budget Circular A-94.

The higher electricity prices, which are 11 to 64 percent higher by 2030, and programs to stimulate more efficient electricity use under S. 2191 are projected to result in a damping of electricity demand by 5 to 11 percent in 2030. The impact on electricity demand in the S. 2191 Core Case is mostly due to the demand-side efficiency programs in S. 2191, while the higher electricity prices are more important in the cases with higher allowance prices. Projected total sales in the Reference Case increase to 4,972 billion kilowatthours in 2030, a 30-percent increase from 2006. The S. 2191 Core Case results in a 2030 aggregate demand of 4,731 billion kilowatthours, 5 percent below the Reference Case level.

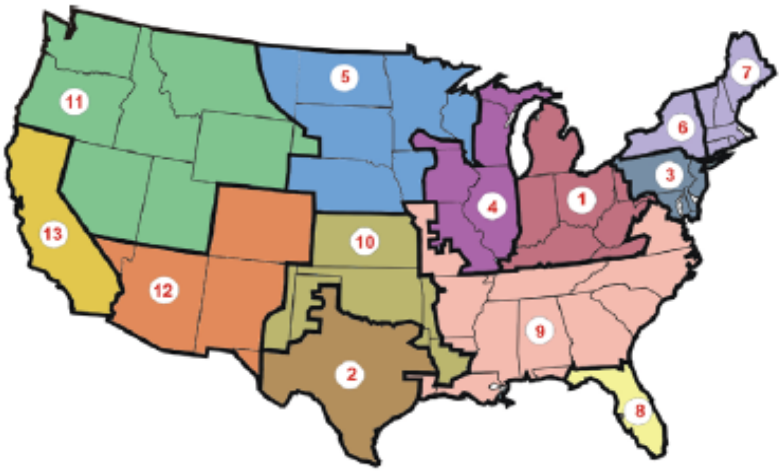
Regional electricity prices vary for many reasons including the demand characteristics, the mix of generating sources used, the availability and delivered prices of different resources and fuels, the regulatory regime, and the local costs of construction (Figures 17 and 18). Generally the largest changes in prices caused by the provisions of S. 2191 would be expected in regions that are most reliant on coal and regions where electricity prices are set competitively, so that the incremental costs of allowances reflected in fuel pricing will flow directly through to consumers. In regions with cost of service regulation, average electricity prices are moderated by the pass-through of allowance values from fossil plant owners who receive a share of allowances for free. S. 2191 also allocates a fixed 9 percent of allowances to load-serving entities that would also help moderate the average electricity bills in both regulated and unregulated regions.

As shown in Figure 20, all regions are expected to see prices increases in most of the S. 2191 cases. Competitively priced regions such as the Electric Reliability Council of Texas, the Mid-Atlantic Area Council, New York, and New England see especially large increases in the S. 2191 cases where alternatives are limited, because the high costs of allowances in those cases are passed directly through to consumers as higher marginal generating costs. In contrast, cost-of-service based regions with little reliance on coal, such as California, see much smaller price increases. In the S. 2191 Core Case, where all generating alternatives are available at the costs consistent with those of a few years ago, a couple of regions could have fairly small price increases or even small price declines in the later years relative to the Reference Case, because the stimulus to build nuclear and renewables drives their costs down over time.

Coal Market Impacts

Because coal has the highest carbon content of any of the key fossil fuels, the cost of using coal when a GHG cap–and-trade program is imposed increases dramatically (Figures 19 and 20). For example, in 2020 the cost of using coal in a plant that does not have CCS equipment is between 161 percent and 413 greater than in the Reference Case. By 2030 the increase in coal costs to a plant without CCS equipment is even larger, ranging from 305 percent to 804 percent greater than in the Reference Case. The vast majority of this cost increase is due to the need to hold allowances to cover the CO_2 emissions that will be generated when the coal is used to produce electricity. The underlying delivered price of coal without the allowance costs is actually lower in the S. 2191 cases because of the reduced consumption of coal.

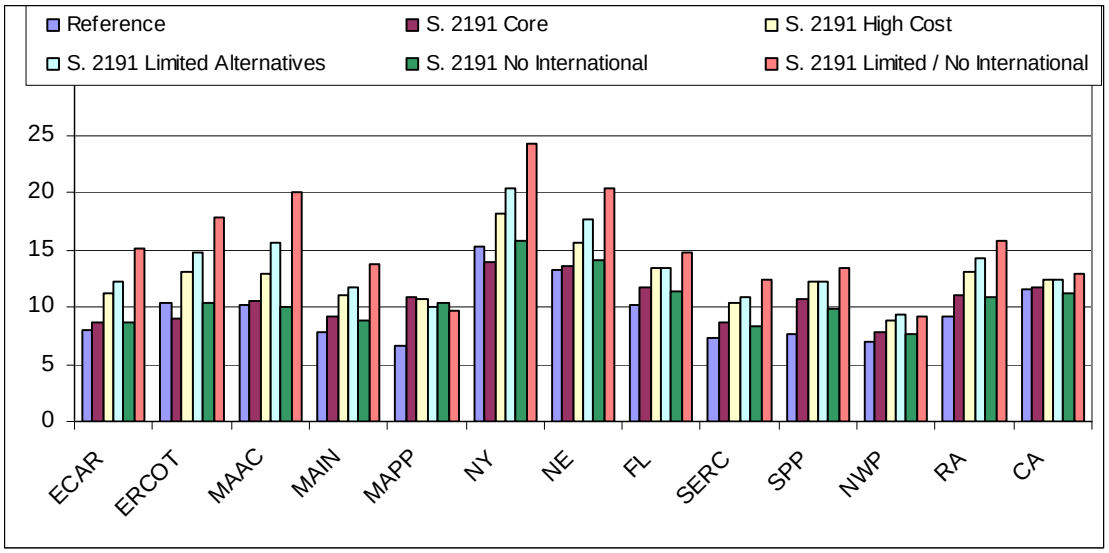
Figure 17: Electricity Regions in the National Energy Modeling System



1 East Central Area Reliability Coordination Agreement (ECAR)
2 Electric Reliability Council of Texas (ERCOT)
3 Mid-Atlantic Area Council (MAAC)
4 Mid-America Interconnected Network (MAIN)
5 Mid-Continent Area Power Pool (MAPP)
6. New York (NY)
7. New England (NE)
8. Florida Reliability Coordinating Council (FL)
9. Southeastern Electric Reliability Council (SERC)
10. Southwest Power Pool (SPP)
11. Northwest Power Pool (NWP)
12. Rocky Mountain Power Area, Arizona, New Mexico, and Southern Nevada (RA)
13. California (CA)

Figure 18: 2030 Electricity Prices

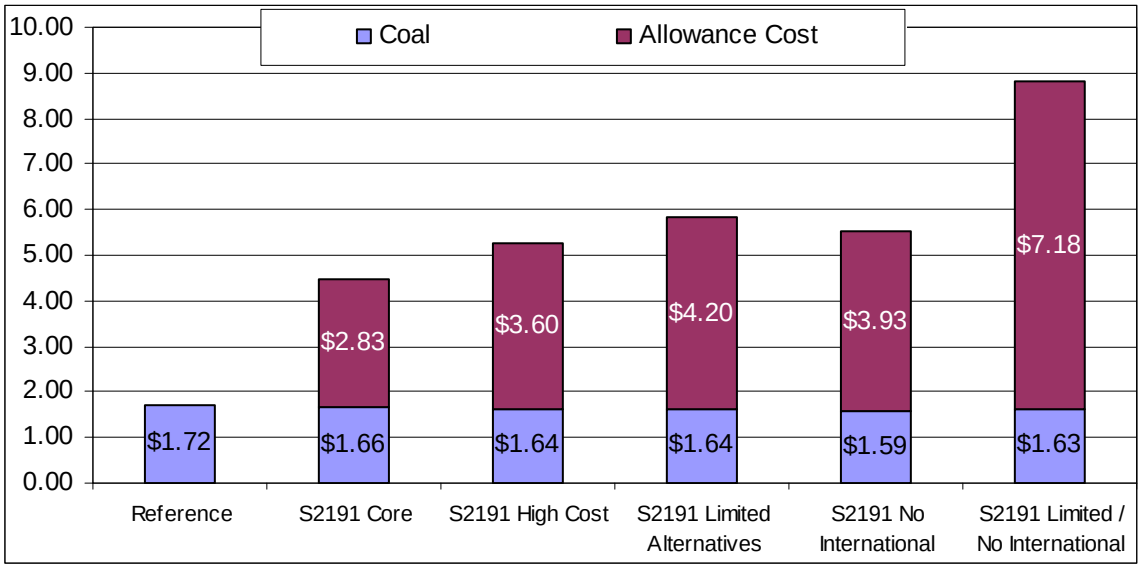
(2006 cents per kilowatthours)



Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.d033108A and S1766_08.D031508A.

Figure 19: 2020 Coal Costs to Electricity Generators

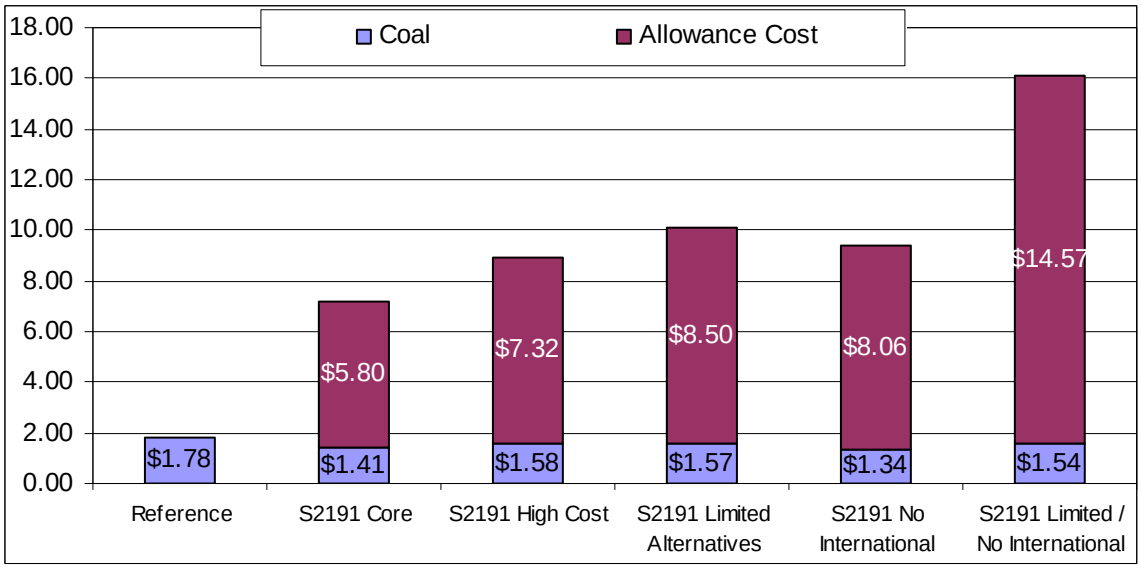
(2006 dollars per million Btu)



Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A and S2191BIVNOI.D033108A.

Figure 20: 2030 Coal Costs to Electricity Generators

(2006 dollars per million Btu)



Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A and S2191BIVNOI.D033108A.

Coal production volumes (in tons) are projected to be 64 to 89 percent lower in the alternative cases in 2030 compared to the Reference Case. The production levels in 2030 across the cases are consistent with the low national coal production levels last seen in the first quarter of the 20th century. For example, in the S. 2191 Core Case, the total coal production of 414 million tons is

just 28 percent of coal production projected in the Reference Case in 2030 and 36 percent of 2006 coal production. The largest decline in coal production in 2020 and 2030 occurs in the S. 2191 Limited Alternatives/No International Case which has the highest allowance costs.

Lower coal consumption in the S. 2191 cases disproportionately affects western coal producers, because they are expected to meet most of the growth in coal demand in the Reference Case. In the Reference Case, 567 million tons of western coal is projected from the highly productive large surface mines of Wyoming's Powder River basin in 2030. In the S. 2191 cases, this same region is projected to supply between 8 and 77 million tons of coal in 2030.

Economic Impacts

Implementing the S. 2191 GHG allowance program will affect the economy through two key mechanisms. First, the cost of using energy, particularly fossil fuels and electricity, will be increased by the requirement to lower total emissions and submit allowances for any ongoing emissions. Second, the auctioning of allowances together with the free distribution of allowances to non-emitting sources will generate revenue that will be spent on programs designed to help businesses and consumers reduce their emissions or ameliorate the impacts associated with higher energy prices.[5] However, as the share of allowances auctioned and the price of allowances grow over time in the S. 2191 cases, the revenue to the government that could be redistributed also grows, while the economy slows. Without other changes, a full rebate of these funds would cause the Federal deficit to increase above baseline levels. In all of the cases in this analysis, it is assumed that the amount of money rebated is limited to the level that maintains the Federal deficit at the baseline level.

Allowance Revenues

Allowance revenue for redistribution is generated by the direct auctioning of allowances by the Federal government and the sale of allowances freely allocated to non-emitting companies, States, and other government programs. The total cumulative allowance revenue collected for redistribution over the next 22 years ranges from $2.8 trillion (nominal) in the S. 2191 Core Case to $7.6 trillion in the Limited Alternatives/No International Case (Figure 21). Figure 22 shows how the overall allowance related revenues, including those that are grandfathered to covered sources, are distributed throughout the macroeconomy.

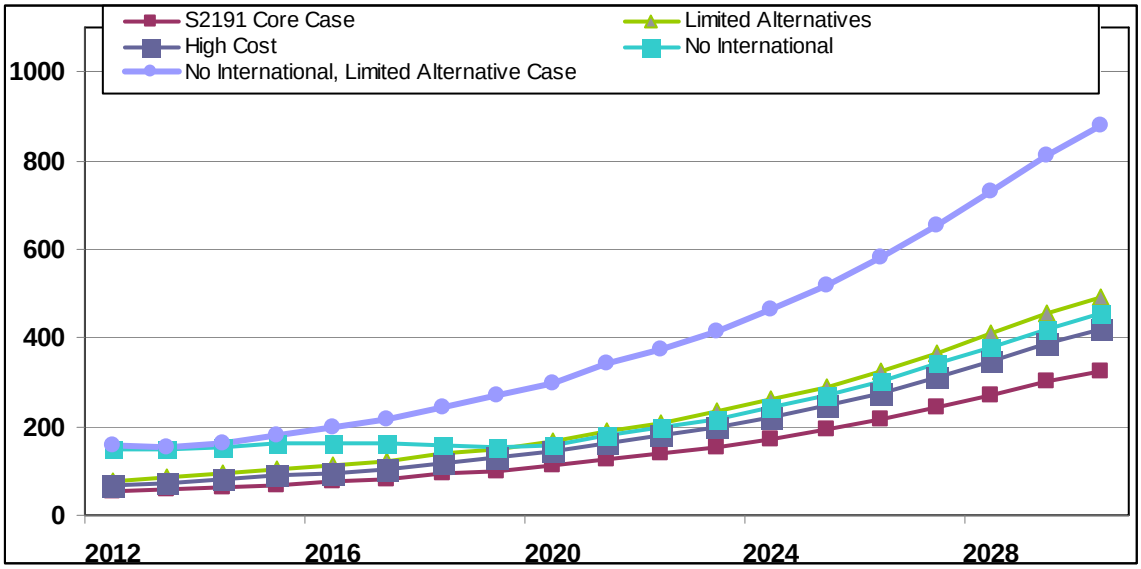
Impacts on Energy and Aggregate Prices

Rising energy costs influence the aggregate economy through their effect on prices and energy expenditures. Figure 23 shows the percentage changes in both the consumer and producer indices for energy prices in the S. 2191 cases. Figure 24 highlights the All-Urban Consumer Price Index (CPI), a measure of aggregate consumer prices in the economy. The CPI for energy, a summary measure of energy prices facing households at the retail level, increases by

[5] The revenues described here include those created by the direct auctioning of allowances together with the free allocation of allowances to noncovered recipients. These noncovered recipients, including States and Indian tribes, are assumed to sell the allowances to covered entities generating revenue for their use.

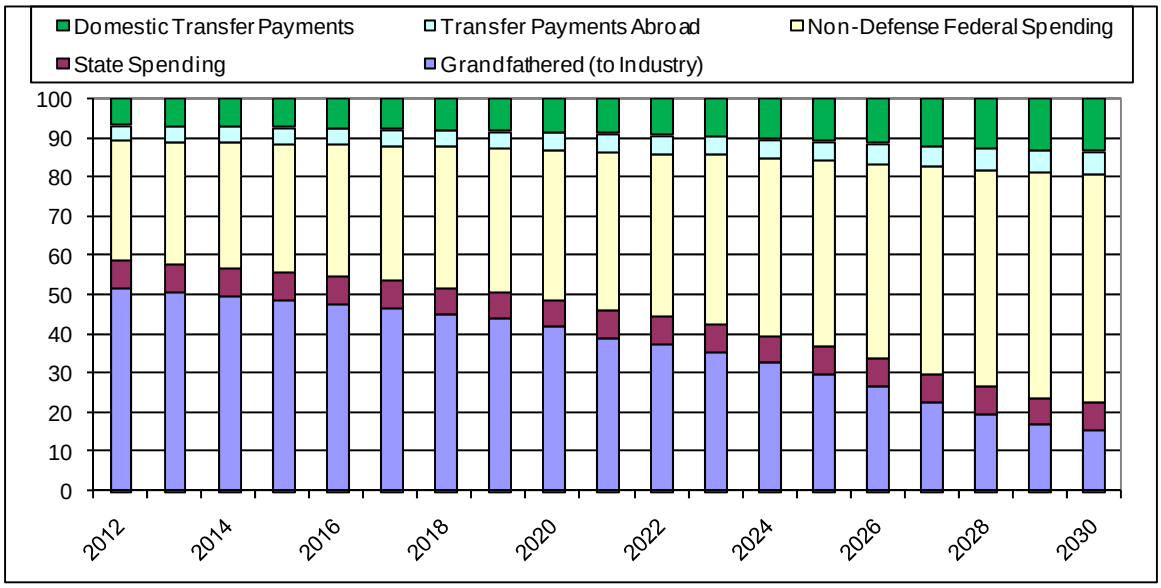
approximately 18 percent above the Reference Case level by 2030 in the S. 2191 Core Case. Industrial energy prices increase 10 percentage points more, at 29 percent above Reference Case levels since S. 2191 provides incentives to keep consumer energy prices lower. Except for the cases restricting international offsets, energy prices rise rather gradually over the forecast horizon, unlike the pattern of energy prices in recent history (Figure 25). If measured from 2008 energy prices, it takes 22 years in the S. 2191 Core Case to reach the same percentage change that current energy prices have increased from 2003 to 2008.

Figure 21: Carbon Allowance Revenues Redistributed to Economy
(billion nominal dollars)



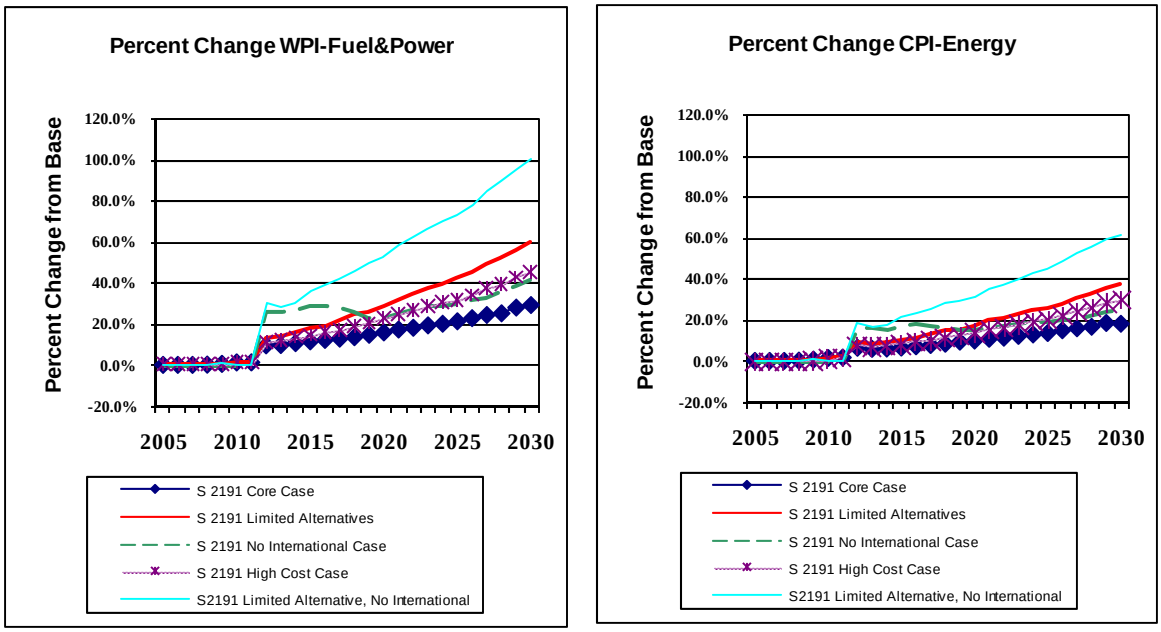
Source: National Energy Modeling System runs S2191d031708a; S2191BIVd031608a; S2191HCd031708a; S2191NOINTL.D032508a , S2191BIVNOI033108a relative to results in runs AEO2008d030208f.

Figure 22: Shares of Grandfathered and Redistributed Allowance Revenue
(percent)



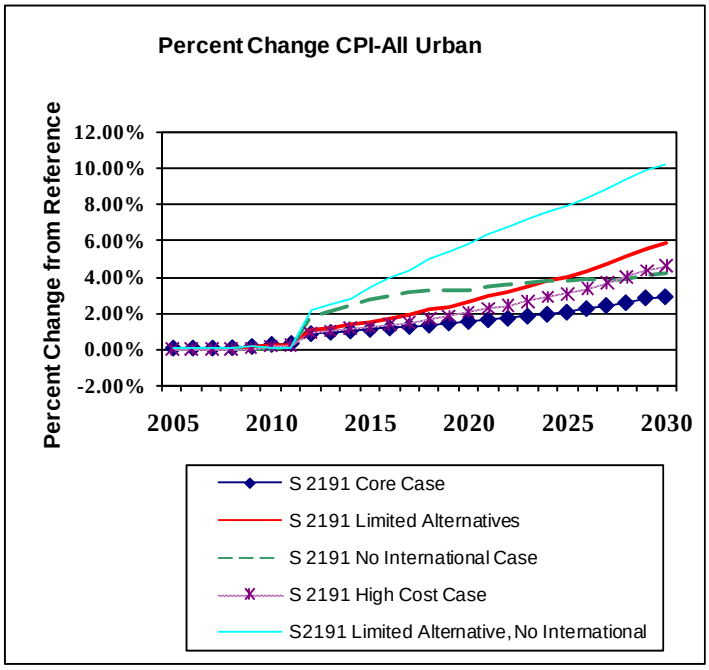
Source: Energy Information Administration, Office of Integrated Analysis and Forecasting.

Figure 23: Consumer and Producer Energy Prices
(percent change from Reference Case)



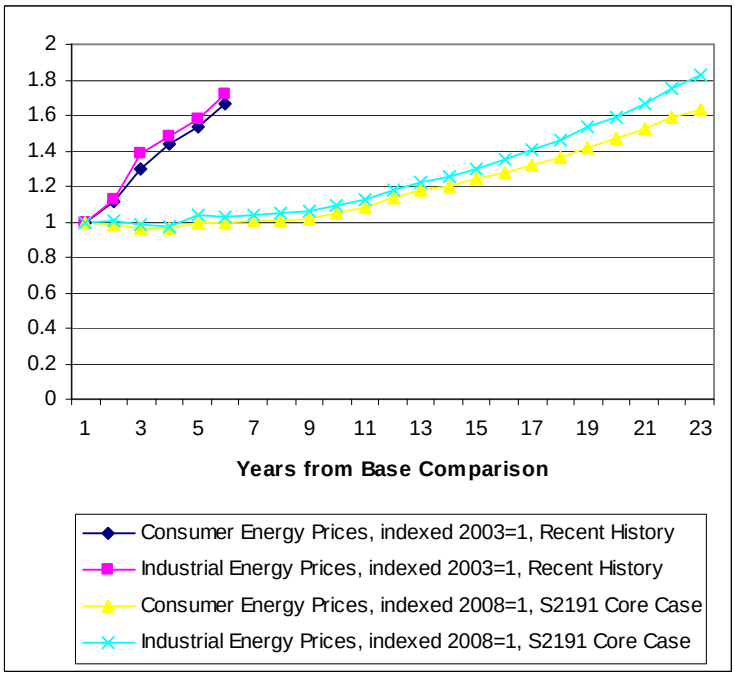
Source: National Energy Modeling System runs S2191d031708a; S2191BIVd031608a; S2191HCd031708a; S2191NOINTL.D032508a , S2191BIVNOI033108a relative to results in runs AEO2008d030208f.

Figure 24: Consumer Prices, Percent Change from Reference Case



Source: National Energy Modeling System runs S2191d031708a; S2191BIVd031608a; S2191HCd031708a; S2191NOINTL.D032508a, S2191BIVNOI033108a relative to results in runs AEO2008d030208f.

Figure 25: Energy Price Change, Recent History Versus the S. 2191 Core Case



Source: National Energy Modeling System runs AEO2008d030208f and S2191d031708a.

If commercialization of low-carbon generating technologies or availability of offsets becomes more difficult, then the increase in energy prices more than doubles that of the S. 2191 Core Case. In the Limited Alternatives/No International case, consumer energy prices increase as much as 62 percent and industrial energy prices by 100 percent above Reference Case levels, with overall consumer prices rising by 10 percent above the Reference Case in 2030.

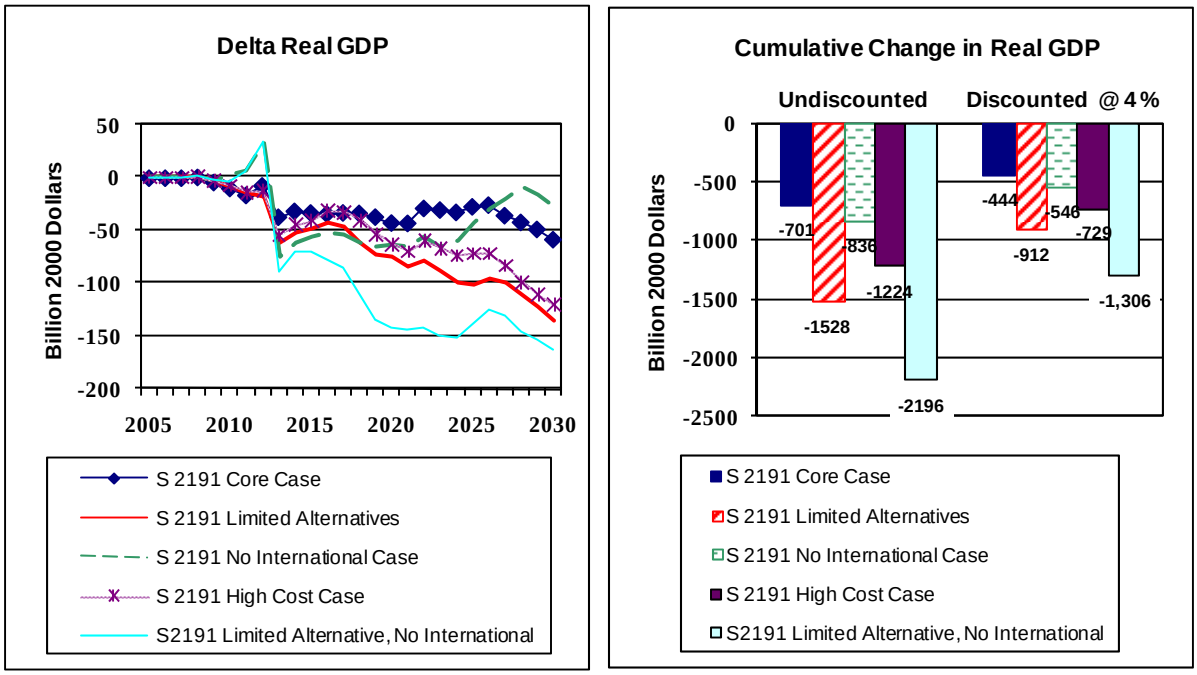
Ultimately, the consumer sees higher prices directly through final prices paid for energy-related goods and services and higher prices for other goods and services using energy as an input. If the cost increases cannot be passed on to consumers, labor and capital stock may be reallocated. Figure 24 shows that increase in consumer prices range between 3 percent above Reference Case levels in the S. 2191 Core Case by 2030, and 4.2, 4.6, 5.8, and 10.1 percent in the No International Offset, High Cost, Limited Alternatives, and Limited Alternatives/No International Cases, respectively.

Real GDP and Consumption Impacts

The higher delivered energy prices lower real output for the economy. They reduce energy consumption, but also indirectly reduce real consumer spending for other goods and services due to lower purchasing power. The lower aggregate demand for goods and services results in lower real GDP relative to the Reference Case (Figure 26 and Table 4). Relative to the Reference Case, real GDP in 2030 is $163 (0.8 percent) lower in the Limited Alternatives/No International Case and $27 billion (0.1 percent) lower in the No International Offsets Case. In the S. 2191 Core Case, real GDP is 59 billion (0.3 percent) lower in 2030. Over the entire forecast period, the cumulative present value GDP loss reaches $444 billion in 2000 dollars (0.2 percent) in the S. 2191 Core Case. The Limited Alternatives/No International Case shows the largest real discounted GDP loss between 2009 and 2030, reaching $1.3 trillion (0.6 percent).

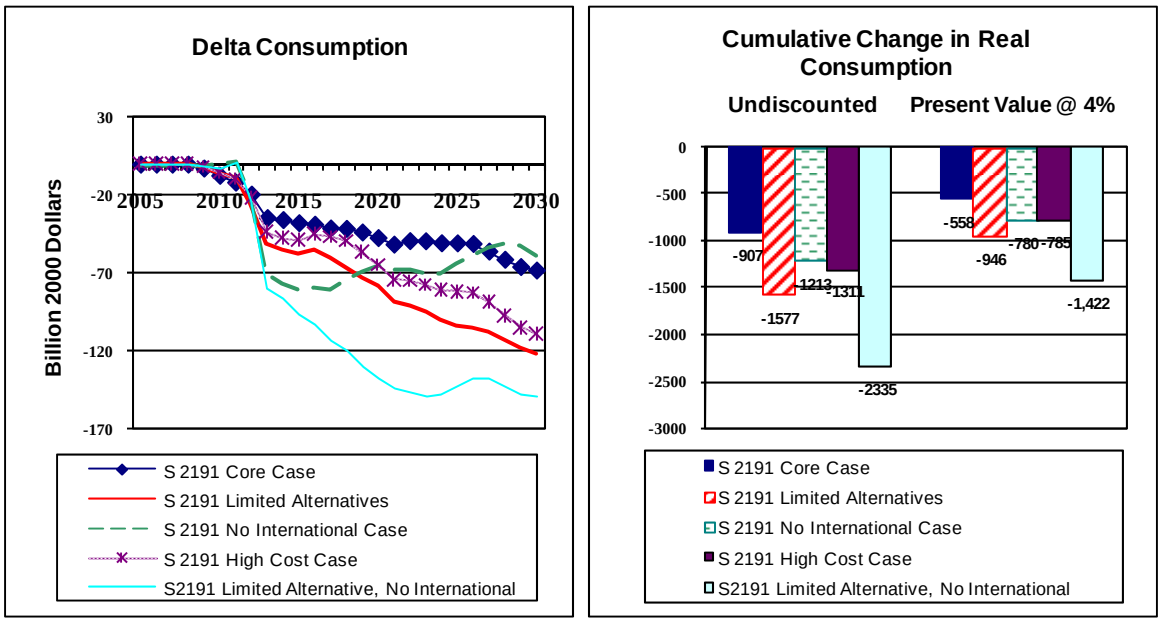
While real GDP is a measure of what the economy produces, the composition of GDP may change considerably between the major components: consumption, investment, government, and net exports. Consumer expenditures, one indicator of consumers' welfare, show larger relative losses compared to GDP. Figure 27 depicts consumption impacts over time and the cumulative discounted percent change in consumption over the 2009 to 2030 period compared to the Reference Case. The cumulative losses of real consumption are between $558 billion (0.4 percent) in the S. 2191 Core Case and $1.4 trillion (0.6 percent) in the Limited Alternatives/No International Case. By 2030, real consumption losses reach $68 billion (0.5 percent) in the S. 2191 Core Case. The Limited Alternatives/No International Case shows the highest consumption loss, reaching $149 billion (1.1 percent) in 2030.

Figure 26: Real GDP Impacts, Change from Reference Case



Source: National Energy Modeling System runs S2191d031708a; S2191BIVd031608a; S2191HCd031708a; S2191NOINTL.D032508a, S2191BIVNOI033108a relative to results in runs AEO2008d030208f.

Figure 27: Real Consumption, Change from Reference Case



Source: National Energy Modeling System runs S2191d031708a; S2191BIVd031608a; S2191HCd031708a; S2191NOINTL.D032508a, S2191BIVNOI033108a relative to results in runs AEO2008d030208f.

Table 4. Macroeconomic Impacts of S. 2191 Cases and S. 1766 Update Cases Relative to the Reference Case

(billion 2000 dollars, except where noted)

	S. 2191 Cases					S1766 Update
	Core	High Cost	Limited Alternatives	No International Offsets	Limited Alternatives No International	
Cumulative Real Impacts 2009-2030 (Present Value using 4 Percent Discount Rate)						
GDP						
Change	(444)	(729)	(912)	(546)	(1,306)	(66)
Percent Change	-0.2%	-0.3%	-0.4%	-0.2%	-0.6%	-0.03%
Consumption						
Change	(558)	(785)	(946)	(780)	(1,422)	(145)
Percent Change	-0.3%	-0.5%	-0.6%	-0.5%	-0.9%	-0.1%
Industrial Shipments (excludes services)						
Change	(1,340)	(1,723)	(2,031)	(2,430)	(3,684)	(722)
Percent Change	-1.3%	-1.7%	-2.0%	-2.4%	-3.6%	-0.7%
Nominal Revenue collected 2012-2030[a]	2,851	3,650	4,282	4,416	7,659	987
2020 Impacts (not discounted)						
GDP						
Change	(43)	(63)	(76)	(64)	(141)	(11)
Percent Change	-0.3%	-0.4%	-0.5%	-0.4%	-0.9%	-0.1%
Consumption						
Change	(47)	(65)	(78)	(65)	(137)	(14)
Percent Change	-0.4%	-0.6%	-0.7%	-0.6%	-1.2%	-0.1%
Industrial Shipments (excludes services)						
Change	(100)	(130)	(153)	(197)	(306)	(55)
Percent Change	-1.4%	-1.8%	-2.1%	-2.8%	-4.3%	-0.8%
Nominal Revenue collected[a]	113	144	168	158	300	45
2030 Impacts (not discounted)						
GDP						
Change	(59)	(120)	(136)	(27)	(163)	(12)
Percent Change	-0.3%	-0.6%	-0.7%	-0.1%	-0.8%	-0.1%
Consumption						
Change	(68)	(109)	(121)	(58)	(149)	(16)
Percent Change	-0.5%	-0.8%	-0.9%	-0.4%	-1.1%	-0.1%
Industrial Shipments (excludes services)						
Change	(233)	(313)	(354)	(319)	(589)	(139)
Percent Change	-2.9%	-3.9%	-4.4%	-4.0%	-7.4%	-1.7%
Nominal Revenue collected[a]	326	419	492	455	881	117

[a] Includes revenues from allowance auctions and revenues generated by the resale of allowances distributed to non-emitters. These values are not discounted.

Note: All changes shown are relative to the Reference Case.

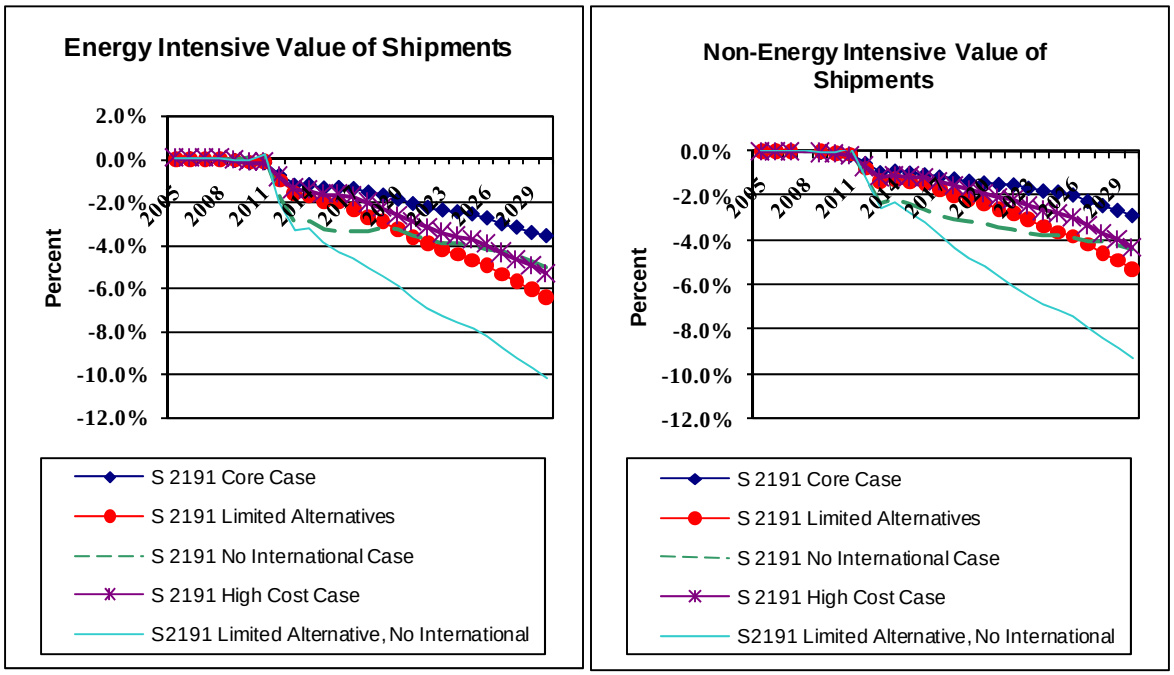
Source: National Energy Modeling System runs AEO2008.D030208F, S2191.D031708A, S2191HC.D031708A, S2191BIV.D031608A, S2191NOINT.D032508A, S2191BIVNOI.D033108A, and S1766_08.D031508A.

Industrial Impacts

Industrial energy prices increase more than consumer energy prices since 11 percent of the allowance revenue received by industry is aimed at ameliorating energy price impacts for consumers, 9 percent to electricity load-serving entities and 2 percent to natural gas distributors. As a result, industrial impacts show substantial losses. As energy prices increase, the energy-intensive sectors, including food, paper, bulk chemicals, petroleum refining, glass, cement, steel and aluminum, show greater losses compared to the rest of the industrial sectors, reaching 3.6 percent below the Reference Case by 2030 in the S. 2191 Core Case, and 5.0, 5.3, 6.4 and 10.2 percent in the No International Offsets, High Cost, Limited Alternatives, and Limited Alternatives/No International Cases, respectively. Figure 28 highlights manufacturing industries' impacts across the S. 2191 cases, separately showing the energy-intensive and non-energy-intensive manufacturing industrial sectors.

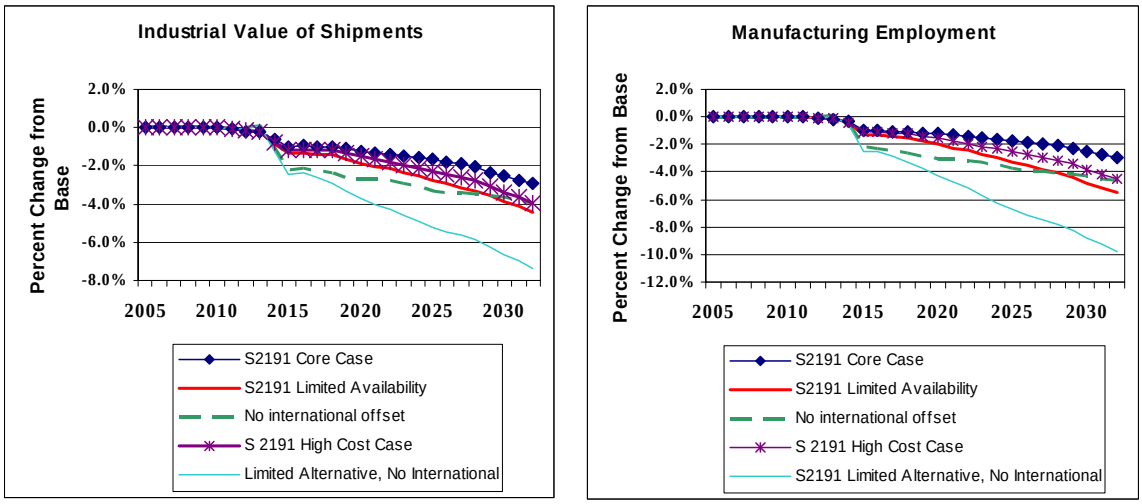
Figure 29 shows industrial sector (all non-service industries) and employment impacts for the S. 2191 Core, Limited Alternatives, No International Offsets, High Cost, and Limited Alternatives/No International Cases. In the S. 2191 Core Case, industrial output is down by 2.9 percent compared to the Reference Case in 2030 as higher prices and lower demand leads industrial output to fall. Manufacturing employment changes mirror industrial impacts.

Figure 28: Manufacturing Industrial Impacts, Percent Change from Reference Case



Source: National Energy Modeling System runs S2191d031708a; S2191BIVd031608a; S2191HCd031708a; S2191NOINTL.D032508a, S2191BIVNOI033108a relative to results in runs AEO2008d030208f.

Figure 29: Impacts on Industrial Value of Shipments and Manufacturing Employment
(percent change from Reference Case)



Source: National Energy Modeling System runs S2191d031708a; S2191BIVd031608a; S2191HCd031708a; S2191NOINTL.D032508a, S2191BIVNOI033108a relative to results in runs AEO2008d030208f.

Uncertainty

All long-term projections engender considerable uncertainty. It is particularly difficult to foresee how existing technologies might evolve or what new technologies might emerge as market conditions change, particularly when those changes are fairly dramatic. Under S. 2191, this analysis finds energy providers, particularly electricity producers, will increasingly rely on technologies that currently play a relatively small role or have not been built in the United States in many years. Sensitivity analyses suggest that the economic impacts can change significantly under alternative assumptions regarding the cost and availability of new technologies and the availability of offsets.

This analysis suggests that increasing the use of coal with CCS, nuclear, and renewable power is an economical compliance strategy, with coal with CCS capacity being driven by the bonus allowances provided in S. 2191. However, concerns about the time that it will take to commercialize this technology and its cost and performance characteristics add considerable uncertainty in this analysis. For nuclear, concerns about siting, waste disposal, and project risk could deter nuclear development. Similarly, there are questions about the potential development of a large-scale biopower industry. For example, a significantly increased mandate or breakthrough in the use of biofuels in the transportation sector could reduce the availability of biomass for electricity generation. With all three of these generating options, the industry will be relying on technologies about which there is considerable uncertainty.

Appendix A. Analysis Request Letter

United States Senate
WASHINGTON, DC 20510

November 9, 2007

The Honorable Guy F. Caruso
Administrator
Energy Information Administration
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dear Administrator Caruso:

We are writing to request that EIA estimate the economic impacts of S.2191, America's Climate Security Act of 2007. A similar request is being sent to the Environmental Protection Agency.

We ask that EIA begin this process by meeting with our staff as soon as possible to discuss the parameters, methods, and duration of the analysis. Please call David McIntosh in Senator Lieberman's office at (202) 224-5016 or Chelsea Maxwell in Senator Warner's office at (202) 224-6283.

Thank you for your assistance with this analysis.

Sincerely,

Joseph I. Lieberman
UNITED STATES SENATOR

John Warner
UNITED STATES SENATOR

Appendix B. Follow-Up Analysis Request Letter

United States Senate

WASHINGTON, DC 20510

November 16,2007

The Honorable Guy Caruso
Administrator
Energy Information Administration
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

Dear Mr. Caruso:

This is a supplemental request to our letter of September 18,2007 requesting additional analysis of S. 280. We are appreciative of your timely response to that letter.

Another proposal to limit greenhouse gas emissions, S. 2191, has been introduced. We understand that Senators Lieberman and Warner requested EPA analysis of their bill and we wanted to assure that your evaluation addressed all interests, and is as comprehensive as possible.

Therefore, in addition to the alternative scenarios outlined in our previous correspondence, we are requesting that your agency provide analysis of S. 2191 using some of the assumptions in your analysis of S. 280. The assumptions are as follows:

Non-Policy Cases

Reference: Reference case used in the S 280 analysis.

Low LNG Case and Global Carbon Constraint:

- LNG import terminals are limited to those operational by the end of 2008,
- GHG caps are implemented for ALL Kyoto Protocol Annex 1 signatory countries and are reduced to 20% below 1990 levels in 2020 and on a trajectory to 80% below 1990 levels in 2050; and
- A functioning natural gas cartel that can extract natural gas prices equivalent to the energy content parity with Low Sulfur Light imported crude.

Policy Cases

- The policy cases should include the Core S. 2191 case, the no international offsets case, and the 30 percent fixed offset case patterned after your S 280 analysis.

Alternative Policy Cases

Your analysis of S. 2191 should include an assessment of the factors outlined in the two following scenarios:

An Alternative Policy Case assuming:

- Nuclear power does not exceed AEO 2007 Reference Case growth through 2030; and
- Biomass power does not exceed AEO 2007 Reference Case growth through 2030.

Please refer to this alternative policy case as: Reference Nuclear and Biomass Power (RefNB).

An Alternative Policy Case assuming the Reference Nuclear and Biomass Power case above and assuming:

- Carbon capture and sequestration technology does not become commercially available until 2030;

Please refer to this alternative policy analysis as: Constrained CCS (RefNB+noCCS).

We have attached a table that summarizes these cases.

In addition, since the costs of greenhouse gas controls grow over time, an accurate account for the impacts between 2030 and 2050 is required. Therefore, in your analysis of S. 2191, please estimate economic impacts for the period 2030-2050 including the aggregate loss of GDP for the periods 2008-2030, 2030-2050, and 2008-2050. As you have indicated NEMS is not capable of providing any analysis beyond 2030. We assume that you can use NEMS through 2030 and use another validated model to estimate impacts between 2030 and 2050.

EIA should also provide natural gas, electricity, and economic impact data at the state and regional level.

An expedited process of this request is appreciated; we expect the results to be released in conjunction with the information provided in response to the request of Senators Lieberman and Warner. Todd Johnston (202-224-9325) and John Shanahan (202-224-8072) are available to work with you to clarify any issues. Thank you for your prompt attention to our request.

Sincerely,

James M. Inhofe
United States Senator

George V. Voinovich
United States Senator

John Barrasso
United States Senator

Case Name	Description and Assumptions
Non-Policy Cases	
Reference Case	Reference Case used in the S 280 analysis
Low LNG plus Global Carbon Constraint	LNG terminals expansion limited to those operational through 2008, and Kyoto signatories adopt additional reduction targets beyond 2012 leading to an 80% reduction below 1990 levels by 2050, and Natural gas pricing tied to imported LSL crude oil
Main Policy Cases	
S 2191 Core	Similar to S 280 assumptions
No International	Similar to S 280 assumptions
Fixed 30 Percent Offsets	Similar to S 280 assumptions
Alternative Policy Cases	
Constrained Nuclear	Nuclear expansion limited to AEO 2007 Ref through 2030
Plus	
Constrained Biomass	Biomass power plants limited to AEO 2007 Ref through 2030
Constrained CCS	CCS is not commercially available until after 2030 and nuclear and biomass are limited to AEO 2007 reference case through 2030

Appendix C. Detailed Summary of S. 2191 from Sen. Lieberman's Web Site

The Lieberman-Warner Climate Security Act (S. 2191)

(as reported from the Senate Environment and Public Works Committee on December 5)

A Summary of the Core of the Bill

The purposes of the Lieberman-Warner Climate Security Act (the CSA) are: "(1) to establish the core of a federal program that will reduce United States greenhouse gas emissions substantially enough between 2007 and 2050 to avert the catastrophic impacts of global climate change; and (2) to accomplish that purpose while preserving robust growth in the United States economy, creating new jobs, and avoiding the imposition of hardship on United States citizens."

Title I of the CSA places a declining cap on U.S. emissions of five primary greenhouse gases (CO_2, methane, nitrous oxide, sulfur hexafluoride, and perfluorocarbons – which the bill designates as Group I greenhouse gases) and on U.S. emissions of the sixth primary greenhouse gas (hydrofluorocarbons – which the bill designates at the Group II greenhouse gas) from one type of industrial activity.

Title X of the bill places a separate declining cap on U.S. emissions of hydrofluorocarbons from all other industrial activities that emit that gas.

For all six gases, the CSA uses a common unit of measurement, called a "CO_2 equivalent." A CO_2 equivalent is the quantity of a greenhouse gas that EPA determines makes the same contribution to global warming as one metric ton of CO_2.

Title I of the CSA requires owners and operators of the following types of facilities and entities to submit to EPA, at the end of each year, a number of emission allowances that accounts for all of the CO_2 equivalents that the facility emitted in that year:

- any facility that uses more than 5,000 tons of coal in a year;
- any facility that is a natural gas processing plant or that produces natural gas in the State of Alaska, or any entity that imports natural gas (including liquefied natural gas);
- any facility that in any year produces, or any entity that in any year imports, petroleum- or coal-based liquid or gaseous fuel, the combustion of which will emit greenhouse gas, assuming no capture and sequestration of that gas;
- any facility that in any year produces for sale or distribution, or any entity that in any year imports, more than 10,000 carbon dioxide equivalents of greenhouse gas, assuming no capture and destruction or sequestration of that gas; and
- any facility that in any year emits as a byproduct of the production of hydrochlorofluorocarbons more than 10,000 carbon dioxide equivalents of hydrofluorocarbons.

Title X of the CSA requires owners and operators of the following types of entities to submit to EPA, at the end of each year, a number of emission allowances that accounts for all of the CO_2 equivalents that the entities emitted in that year:

- any entity that produced hydrofluorocarbons in the U.S. for sale in the U.S. in 2005; and

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- any entity that imported hydrofluorocarbons or products or equipment containing hydrofluorocarbons into the U.S. in 2005.

The facilities and entities that are covered by either the Title I cap or the Title X cap currently are responsible for 87% of U.S. greenhouse gas emissions. The two declining caps bring those emissions down to the year 2005 level in 2012 and then gradually down to 70% below the 2005 level by 2050. The bill includes other measures to reduce the greenhouse-gas emissions of sources not covered by either cap.

A Subtitle-by-Subtitle Summary of the Bill

TITLE I CAPPING GREENHOUSE GAS EMISSIONS

Subtitle A Tracking Emissions

Subtitle A establishes an emissions monitoring and reporting system. It charges EPA with the task of running the system and making the data available to the public.

Subtitle B Reducing Emissions

Subtitle B directs EPA to establish a separate quantity of emission allowances, called an Emission Allowance Account, for each calendar year from 2012 through 2050. In a table, the subtitle identifies the size of each year's Account (i.e., the number of emission allowances issued for each year). The size of the 2012 Account is 5.775 billion allowances. That is the number of CO_2 equivalents of greenhouse gases that the facilities covered by Title I emitted in 2005. The number of allowances in any given year's account is 106 million fewer than the number in the immediately preceding year's account (106 million is 1.8% of 5.775 billion). The size of the 2050 Account is 1.732 billion allowances. That is 70% below the number of CO_2 equivalents of greenhouse gases that the facilities covered by Title I emitted in 2005.

EPA will create, at the inception of the program, all of the emission allowances that will exist over the entire 38-year life of the program. Each emission allowance will have a unique serial number that will include the calendar year for which it was created.

Subtitle B requires the owner or operator of each covered facility, at the end of each calendar year beginning in 2012 and ending in 2050, to submit to EPA one emission allowance for each CO_2 equivalent of:

- Group I greenhouse gas that was emitted by the use of coal by that covered facility during the preceding year;
- Group I greenhouse gas that will, assuming no capture and sequestration of that gas, be emitted from the use of any petroleum- or coal-based liquid or gaseous fuel that was produced or imported by that covered facility during the preceding year;
- Group I greenhouse gas that was produced for sale or distribution or imported by that facility during the preceding year;
- Group II greenhouse gas that was emitted as a byproduct of hydrochlorofluorocarbon production; and

- Group I greenhouse gas that will, assuming no capture and destruction or sequestration of that gas, be emitted –
  - from the use of natural gas that was, by that covered facility, processed, imported, or produced and not reinjected into the field, or
  - from the use of natural gas liquids that were processed or imported by that covered facility during the preceding year.

EPA is required immediately to retire all emission allowances submitted to it pursuant to the compliance obligation.

Owners or operators of covered facilities using coal are allowed to discount from their submission requirement the number of metric tons of CO_2 that they geologically sequester. Owners or operators of other types of covered facility are not allowed to perform such discounting. Instead, they receive an emission allowance back from EPA for each metric ton of CO_2 that they geologically sequester.

Entities also receive an allowance back from EPA for each carbon dioxide equivalent of greenhouse gas that they either destroy or use at as a feedstock in a matter that prevents its release to the atmosphere.

TITLE II MANAGING AND CONTAINING COSTS EFFICIENTLY

Subtitle A Trading

The CSA allows anyone to buy, hold, sell, and retire emission allowances.

Subtitle B Banking

The CSA allows the owners and operators of covered facilities to hold onto allowances as long as they wish. That way, an owner or operator will be able to maintain its own reserve of allowances.

Subtitle C Borrowing

Subtitle C directs EPA to promulgate regulations allowing the owner or operator of any covered facility to satisfy up to 15% of a given year's compliance obligation with allowances borrowed from future years. The CSA specifies a 10% annual interest rate on such "loans" and imposes a five-year limit on the term of any loan.

Subtitle D Offsets

Subtitle D directs EPA, in conjunction with the Secretary of Agriculture, to promulgate regulations allowing the owner or operator of any covered facility to satisfy up to 15% of a given year's compliance obligation with offset allowances generated within the United States.

Offset allowances are in addition to the emission allowances that comprise the annual Accounts (caps). Offset allowances come into being when EPA certifies that a non-covered facility has done something that either has reduced the number of CO_2 equivalents that the facility otherwise would have emitted in that calendar year or has increased the number of CO_2

equivalents that the facility otherwise would have captured from the atmosphere and stored in that calendar year.

Subtitle D specifies procedures and standards that EPA must use in certifying, monitoring, and enforcing offsets. The procedures and standards spelled out in the subtitle are intended to ensure that the activities certified as offsets by EPA will actually be verified, monitored, permanent, enforced, and additional.

Subtitle E International Emission Allowances

Subtitle E directs EPA to promulgate regulations allowing the owner or operator of any covered facility to satisfy up to 15% of a given year's compliance obligation with international allowances. An "international allowance" is an emission allowance purchased from a foreign greenhouse gas emissions trading market that EPA certifies as having comparable integrity to the U.S. market, and that exists by virtue of national emissions caps that EPA finds to be of comparable stringency to the caps established by the CSA.

Subtitle F Carbon Market Efficiency Board

Subtitle F establishes a Carbon Market Efficiency Board, comprising seven members serving staggered, fourteen-year terms, plus a scientific advisor to ensure that steps taken by the board are informed by expertise with climate change and its impacts on the environment. All members are appointed by the President with the advice and consent of the Senate. The Board is tasked with monitoring the emissions trading market and periodically reporting to the President and Congress on its operations.

In the first two years of the cap-and-trade program, the Board is authorized to increase – above the default 15% – both the percentage of a covered facility's annual compliance obligation that may be satisfied with borrowed emission allowances and the percentage that may be satisfied with offsets. The Board may only do that, however, in the event the average daily closing price of an emissions credit exceeds the upper end of the range predicted by the Congressional Budget Office prior to the start of the program.

In all subsequent years, the Board is authorized – but only as needed to avoid significant harm to the economy – to temporarily increase the amount that covered entities may borrow, lengthen the payback period of loans, and/or lower the interest rate on loans; and to loosen a given year's economy-wide emissions cap by as much as 5%, provided that subsequent years' caps are tightened sufficiently to ensure that the cumulative emissions reductions over the long term remain unchanged.

The Board is subject to the Freedom of Information Act. Each year, the Government Accountability Office reviews the Board's efficacy in fulfilling its purposes and duties.

TITLE III ALLOCATING AND DISTRIBUTING ALLOWANCES

Subtitle A Auctions

Subtitle A directs EPA, within 180 days of enactment, to take 5% of the allowances in the 2012 Account, 3% of the allowances in the 2013 Account, and 1% of the allowances in the 2014 Account and give them to the Climate Change Credit Corporation for early auctioning.

Subtitle A also directs EPA to allocate portions of each year's Emission Allowance Account to the Climate Change Credit Corporation for annual auctioning. A table in Subtitle A specifies the portions to be allocated for this purpose each year. The portion in 2012 is 21.5% (an additional 5% of the 2012 Account having been allocated for early auctioning). The portion rises steadily each year and then plateaus at 69.5% from 2031 through 2050.

Subtitle B Early Action

Subtitle B directs EPA, within 2 years of enactment, to take 5% of the allowances in the 2012 Account, 4% of the allowances in the 2013 Account, 3% of the allowances in the 2014 Account, 2% of the allowances in the 2015 Account, and 1% of the allowances in the 2016 Account and allocate them to owners and operators of covered facilities as reward for actions taken since January 1, 1994 to reduce greenhouse gas emissions. 1994 is the year in which the Rio Treaty took effect, thereby obligating the US to reduce its greenhouse gas emissions.

Subtitle B directs EPA to promulgate regulations setting forth procedures and criteria for distributing the early action allowances to individual owners and operators of covered facilities.

Subtitle C States

Subtitle C directs EPA each year to allocate 1% of that year's Account to state governments that have demonstrated that at least 90% of new buildings constructed in the state comply with the energy efficiency building codes established under Subtitle B of Title V;

The subtitle directs EPA each year to allocate an additional 2% of that year's Account to states that have adopted "decoupling" regulations for any electric and natural gas utilities in the state. Decoupling policies enable energy utilities to recover just as much money for investments in demand reduction measures as they recover for investments in satisfying demand.

Subtitle C directs EPA each year to allocate an additional 2% of that year's Account to state governments that have imposed on covered facilities within their borders greenhouse gas emissions limitations more stringent than those established by the CSA.

Subtitle C directs EPA each year to allocate an additional 4.5% of that year's Account to all state governments. EPA is directed to distribute the allowances to individual state governments based on the following formula: 1/3 based on Low Income Home Energy Assistance Program expenditures; 1/3 based on population; 1/3 based on "quantity of carbon dioxide embedded within coal that is mined, natural gas that is processed, and petroleum that is refined within the boundaries of a State, as determined by the Secretary of Energy."

States are directed to use for increasing recycling rates 5 percent of the allowances that they receice under Subtitle C.

States are directed to retire or use for the following purposes at least 90 percent of the allowances that they receive under Subtitle C:

- to mitigate impacts on low-income energy consumers;
- to promote energy efficiency (including support of electricity and natural gas demand reduction, waste minimization, and recycling programs);
- to promote investment in nonemitting electricity generation technology;
- to improve public transportation and passenger rail service and otherwise promote

reductions in vehicle miles traveled;

- to encourage advances in energy technology that reduce or sequester greenhouse gas emissions;
- to address local or regional impacts of climate change, including the relocation of communities displaced by the impacts of climate change;
- to collect, evaluate, disseminate, and use information necessary for affected coastal communities to adapt to climate change (such as information derived from inundation prediction systems);
- to mitigate obstacles to investment by new entrants in electricity generation markets and energy-intensive manufacturing sectors;
- to address local or regional impacts of climate change policy, including providing assistance to displaced workers;
- to mitigate impacts on energy-intensive industries in internationally competitive markets;
- to reduce hazardous fuels, prevent wildland fire, and suppress wildland fire;
- to fund rural, municipal, and agricultural water projects that are consistent with sustainable use of water resources; or
- to fund any other purpose that the states determine to be necessary to mitigate any negative economic impacts as a result of global warming or new regulatory requirements resulting from the CSA.

Subtitle C directs EPA each year to allocate an additional 0.5% of that year's Account to a Program for Tribal Communities to deliver assistance to those tribal communities within the borders of the U.S. that face disruption or dislocation as a result of global climate change.

Finally, Subtitle C directs EPA each year to allocate an additional 1% of that year's Account to states to operate, expand, and increase the efficiency of mass transit systems.

Subtitle D Electricity Consumers

Subtitle D directs EPA each year to allocate 9% of that year's Account to the load serving entities that have a regulatory or contractual obligation to deliver electricity to retail consumers. EPA is directed to distribute the allocated allowances to each individual load serving entity in proportion to the amount of electricity that the entity sells. The load serving entities are directed to use the value of the allowances for two purposes only: "(1) to mitigate economic impacts on low- and middle-income energy consumers, including by reducing transmission charges or issuing rebates; and (2) to promote energy efficiency on the part of energy consumers."

Subtitle E Natural Gas Consumers

Subtitle E directs EPA each year to allocate 2% of that year's Account to the natural gas local distribution companies that have a regulatory or contractual obligation to deliver natural gas to retail consumers. EPA is directed to distribute the allocated allowances to each individual natural gas local distribution company in proportion to the amount of natural gas that the entity sells. The natural gas local distribution companies are directed to use the value of the allowances for two purposes only: "(1) to mitigate economic impacts on low- and middle-income energy consumers; and (2) to promote energy efficiency on the part of energy consumers."

Subtitle F Bonus Allowances for Carbon Capture and Geologic Sequestration

Subtitle F directs EPA, within three years of enactment, to take 4% of the allowances in the Accounts for years 2012 through 2030 and place them into a Bonus Allowance Account. EPA is directed to allocate the allowances as reward for firms that actually inject CO_2 into geological formations. The number of bonus allowances that a firm receives for injecting a metric ton of CO_2 underground starts out at 4.5 in 2012 and gradually decreases.

Subtitle G Domestic Agriculture and Forestry

Subtitle G directs EPA each year to allocate 5% of that year's Account to the Secretary of Agriculture, who is directed to use the allowances to reward US farmers and foresters that adopt practices that increase the storage of CO_2 in plants and soils. The Secretary of Agriculture is directed to promulgate regulations to manage the distribution of allowances to farmers and foresters. The subtitle prohibits a single activity from both being certified as an offset and receiving allowances under this subtitle.

Subtitle G requires that 0.5 of the 5 percentage points of emission allowances allocated to this program be directed at projects to reduce nitrous oxide emissions through soil management or to reduce methane emissions from enteric fermentation and manure.

Subtitle H International Forest Protection

Subtitle H directs EPA each year to allocate 2.5% of that year's Account for reducing the rate of tropical deforestation in other nations. The subtitle sets out the structure of a distribution and verification program to be overseen by EPA, the State Department, the Department of Interior, and the Department of Agriculture.

Subtitle I Transition Assistance

Subtitle I directs EPA to allocate set percentages of each year's Account to facilities and entities within different industrial sectors. The subtitle sets forth the annual percentages in a table. In 2012, fossil fuel-fired electric power generating facilities receive 19%, rural electric cooperatives receive an additional 1%, energy intensive manufacturing facilities receive 10%, importers and producers of petroleum-based fuel receive 2%, and hydrofluorocarbon producers receive 2%. Those percentages eventually decline to zero in 2031.

Subtitle J Reducing Methane Emissions From Landfills and Coal Mines

Subtitle J directs EPA each year to allocate 1% of that year's Account to a program for achieving real, verifiable, additional, permanent, and enforceable reductions in emissions of methane from landfills and coal mines.

TITLE IV AUCTIONS AND USES OF AUCTION PROCEEDS

Subtitle A Funds

Subtitle A establishes seven new funds in the US Treasury: (1) the Energy Assistance Fund; (2) the Climate Change Worker Training Fund; (3) the Adaptation Fund, (4) the Climate Change and National Security Fund; (5) the Bureau of Land Management Emergency Firefighting Fund; (6) the Forest Service Emergency Firefighting Fund; and (7) the Climate Security Act Management Fund.

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Subtitle B Climate Change Credit Corporation

Subtitle B establishes the Climate Change Credit Corporation. The Corporation shall have a board of directors composed of five individuals appointed by the President, by and with the advice and consent of the Senate, for staggered five-year terms.

Each year, the Comptroller General reviews the efficacy of the Corporation's programs and expenditures, as well as the efficacy of the projects funded through the Corporation.

Subtitle C Auctions

Subtitle C directs the Corporation, within one year of enactment, to begin auctioning the allowances allocated to it for early auctioning under Subtitle A of Title III. It directs the Corporation to have completed auctioning the last of those allowances by the end of 2011. The subtitle directs the Corporation to devote all the proceeds of the early auctions to the Energy Technology Deployment Program established under Subtitle D of Title IV.

Subtitle C directs the Corporation, 330 days before the start of each calendar year, to auction all of the allowances allocated to it for annual auctioning under Subtitle A of Title III. Proceeds from the auction are first used: (1) to fund the activities that the CSA directs the Environmental Protection Agency and other federal agencies to undertake; and (2) to ensure adequate funds for emergency firefighting at the Bureau of Land Management and the Forest Service. It directs the Corporation to devote 52% of the remaining proceeds from those annual auctions, each and every year from 2012 through 2050, to the Energy Technology Deployment Program established under Subtitle D of Title IV. It directs the Corporation to deposit 2% of the proceeds each year into the existing Energy Transformation Acceleration Fund administered by the Advanced Research Projects Agency within the Department of Energy. It directs the Corporation to deposit 18% of the proceeds each year into the Energy Assistance Fund, 18% into the Adaptation Fund, 5% into the Climate Change Worker Training Fund, and 5% into the Climate Change and National Security Fund.

Subtitle D Energy Technology Deployment

Subtitle D spells out, in detail, a series of financial incentive programs designed to accelerate the development and deployment of sustainable energy technologies, low-carbon electricity technologies (including engineering integration costs), advanced bio-fuels such as cellulosic ethanol, CO_2 capture and storage systems, electric and plug-in hybrid electric vehicles, and high-efficiency consumer products.

Subtitle E Energy Consumers

Subtitle E directs that all funds deposited into the Energy Assistance Fund under Subtitle A of Title IV shall be made available to the Low Income Home Energy Assistance Program (LIHEAP) (50%), the Weatherization Assistance Program for Low-Income Persons (25%), and a new Rural Energy Assistance Program (25%).

Subtitle F Climate Change Worker Training Program

Subtitle E directs that all funds deposited into the Climate Change Worker Training Fund under Subtitle A of Title IV shall be used by the Department of Labor to fund a new workforce education, training, and placement program spelled out in the subtitle.

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Subtitle G Adaptation Program for Natural Resources in United States and Territories

Subtitle G directs that all funds deposited into the Adaptation Fund under Subtitle A of Title IV shall be used as follows:

- 35% shall be made available to the Interior Department, and subsequently made available to states and tribal governments, through the Wildlife Conservation and Restoration Account established under the Pittman-Robertson Wildlife Restoration Act.
- 19% shall be made available to the Interior Department for use in funding endangered species, migratory bird, and other fish and wildlife programs.
- 5% shall be made available to the Interior Department for adaptation activities carried out under cooperative grant programs.
- 1% shall be made available to Indian tribes to carry our adaptation activities through the tribal wildlife grants program of the Fish and Wildlife Service.
- 5% shall be made available to the Secretary of Agriculture for use in funding adaptation activities carried out on national forests and national grasslands under the jurisdiction of the United States Forest Service or pursuant to the cooperative Wings Across the Americas Program.
- 5% shall be made available to EPA for use in restoring large-scale freshwater and estuarine ecosystems and large-scale estuarine ecosystems.
- 10% shall be made available to the Army Corps for use in restoring large-scale freshwater and estuarine ecosystems.
- 10% shall be made available to the Commerce Department for use in funding adaptation activities to protect, maintain, and restore coastal, estuarine, and marine resources, habitats, and ecosystems.
- 10% shall be made available to wildlife adaptation through the Land and Water Conservation Fund.

Subtitle H International Climate Change Adaptation and National Security Program

Subtitle H directs that all funds deposited into the Climate Change and National Security Fund under Subtitle A of Title IV shall be made available to a program established by State Department and administered by the U.S. Agency for International Development, to:

- protect the national security of the United States where such interest can be advanced by minimizing, averting, or increasing resilience to potentially destabilizing climate change impacts;
- support the development of national and regional climate change adaptation plans in least developed countries;
- support the deployment of technologies that would help least developed countries reduce their greenhouse gas emissions and respond to destabilizing impacts of climate change;

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- provide assistance to least-developed countries and small island developing states with national or regional climate change adaptation plans in the planning, financing, and execution of adaptation projects;

- support investments and capital to reduce vulnerability related to climate change and its impacts, including but not limited to drought, famine, floods, sea level rise, shifts in agricultural zones or seasons, shifts in range that affect economic livelihoods, and refugees and internally displaced persons;

- support climate change adaptation research in or for least developed countries; and

- encourage the identification and adoption of appropriate low-carbon and efficient energy technologies in least-developed countries.

Subtitle I Emergency Firefighting Programs

Subtitle I directs that all auction proceeds deposited into the emergency firefighting funds established under Subtitle A shall be used to pay for Bureau of Land Management and Forest Service wildland fire suppression activities in excess of normal, non-emergency fire suppression.

TITLE V ENERGY EFFICIENCY

Subtitle A Appliance Efficiency

Subtitle A incorporates the strengthened energy efficiency standards for residential boilers, space heaters, and air conditioners that the House passed this summer as part of its energy bill.

Subtitle B Building Efficiency

Subtitle B incorporates the strengthened model energy efficiency rule for building codes that the House passed this summer as part of its energy bill. Adoption and enforcement of the strengthened model rule makes a state eligible for allowances under one of the 1% set-asides established under Subtitle C of Title III.

TITLE VI GLOBAL EFFORT TO REDUCE GREENHOUSE GAS EMISSIONS

Title VI closely tracks the international trade measure that appears in the Bingaman-Specter climate bill, S.1766.

Under this provision, the Executive Branch is directed, upon the CSA's enactment, to intensify its efforts to convince other nations to start reducing their greenhouse-gas emissions. If, eight years after the enactment of the U.S. program, it is determined that a given major emitting nation has not taken comparable action, the President at that time is authorized to require that importers of greenhouse-gas-intensive manufactured products (steel, aluminum, etc.) from that nation submit emissions credits of a value equivalent to that of the credits that the US system effectively requires of domestic manufacturers.

TITLE VII REVIEWS AND RECOMMENDATIONS

Title VII directs EPA to commission from the National Academy of Sciences (NAS) a report to be delivered to Congress every three years. The report will contain a broad review of the latest scientific information on the current and future: emissions and concentrations of greenhouse gases, temperature trends, and impacts of climate change. It will also examine the impact that the CSA's technology deployment programs are having, and to determine whether advanced climate-friendly energy technologies are deploying quickly enough to enable the US economy to comply with CSA's emissions caps without suffering hardship. It will analyze the performance of the CSA in ensuring that the Land and Water Conservation Fund receives funds sufficient to carry out its purposes, and whether the Bureau and Land Management and the Forest Service receive funds sufficient to suppress wildland fire effectively. Finally, it will address: (1) whether the cap-and-trade system is functioning properly; (2) whether the emissions trading market is liquid, transparent, and relatively free of dangerous volatility; (3) whether US emissions are coming down as projected; (4) whether atmospheric greenhouse gas emissions are stabilizing, on account of US and overseas emissions trends; (5) whether any of the allocations or uses of auction proceeds should be changed; (6) in particular whether there should be established for renewable electricity generation a bonus allowance system similar to the one established under Subtitle F of Title III for carbon capture and geological sequestration; (7) whether additional measures are required to protect low- and moderate- income Americans to cope with cost changes; and (8) in particular whether additional measures are required to reduce aviation emissions. NAS will be tasked with recommending additional measures to achieve the purposes of this act, based on its findings.

Title VIII also directs EPA to submit to Congress in 2012 the agency's own report indicating: (1) the latest scientific information and data relevant to the health effects of mercury emissions from coal-fired electric power generating facilities; (2) the state of the technology designed to reduce mercury emissions from coal combustion, including the efficacy of the technology with respect to each coal type; and (3) the extent to which the implementation of this Act is assisting in bringing concentrations of particulate matter and ozone into line with National Ambient Air Quality Standards.

Title VII then directs EPA to conduct and submit to Congress recommendations for further Congressional action based upon the NAS studies and the EPA study described above, including: (1) expansion of the definition of the term "covered facility" under the Act; (2) expansion of the scope of the Act's compliance obligation; (3) adjustment of the number of emission allowances comprising the Emission Allowance Account for 1 or more calendar years under the Act; (4) establishment of policies for reducing greenhouse gas emissions over and above those policies established under the Act; and (5) establishment of policies for reducing nationwide emissions into the atmosphere of sulfur dioxide, nitrogen oxides, and mercury in excess of the reductions resulting from the implementation of the Act.

Title VII directs the President to submit to Congress in 2020 a bill based on a consensus report that a task force of agency heads chaired by the EPA Administrator prepare based on the recommendations submitted by EPA in 2019.

Finally, Title VII directs EPA, in consultation with several other agencies, to perform regionally-specific analyses of the new infrastructure, safety, health, land-use planning, and coastal inundation prediction policies that will be necessary to enable the US to adapt to the degree of climate change that now is inevitable.

TITLE VIII FRAMEWORK FOR GEOLOGIC SEQUESTRATION OF CARBON DIOXIDE

Title VIII initiates a series of rulemakings, geological surveys, technical reviews, and panels of legal experts designed to pave the way for the rollout of a national infrastructure for taking CO_2 from power plants, through pipelines, to injection wells, and then deep underground.

TITLE IX MISCELLANEOUS

The first section of Title IX authorizes the President to suspend the provisions of the bill in the event of a national emergency.

The second section makes the actions that EPA takes pursuant to the CSA subject to the administrative procedures and judicial review provisions of the Administrative Procedures Act and the Clean Air Act.

The third section makes clear that states are not preempted from enacting and enforcing greenhouse gas emission reduction requirements that are at least as stringent as the federal ones.

TITLE X CONTROL OF HYDROFLUOROCARBON CONSUMPTION

Title X places a separate declining cap on the consumption and importation of hydrofluorocarbon (HFC) consumption and importation into the U.S. The first capped year is 2010. The 2050 cap is 70% below the 2010 cap.

HFC consumption allowances are allocated among U.S. importers and producers of HFCs starting in 2010, the first capped year. By 2031, however, all HFC consumption allowances are withheld for auction.

The proceeds of the auction are used to support the following purposes:

- a program to recover and destroy the maximum economically recoverable chlorofluorocarbons, halons, and other substances that have significant ozone depletion potential and global warming potential;
- a program of incentives for consumer purchases of refrigeration and cooling equipment that contains refrigerants with no or low global warming potential and that is energy efficient;
- a program to support the development and deployment of hydrofluorocarbons with low global warming potential, and energy efficient technologies, equipment, and products containing or using hydrofluorocarbons; and
- the programs receiving auction proceeds under Title IV.

HFC consumption allowances may not be traded with the emission allowances established under Title I.

TITLE XI AMENDMENTS TO CLEAN AIR ACT

Title XI includes two sections that extend to the greenhouse gas qualities of HFCs policies that Congress previously added to the Clean Air Act for the ozone-depleting qualities of

chlorofluorocarbons. The first such policy is a national recycling and emission reduction program for the chemicals. The second policy relates to the servicing of motor vehicle air conditioners.

The final section of Title XI amends the Clean Air Act to direct EPA to promulgate a low greenhouse gas fuel performance standard that will achieve a 5 percent reduction in aggregate lifecycle greenhouse gas emissions per unit of energy in US fuel by 2015, and a 10 percent reduction by 2020.

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