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Energy Market and Economic Impacts of S. 1766, the Low Carbon Economy Act of 2007

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Preface and Contacts

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The Office of Integrated Analysis and Forecasting prepared this report. General questions concerning the report can be directed to John J. Conti (john.conti@eia.doe.gov, 202/586-2222), Director of the Office of Integrated Analysis and Forecasting, and J. Alan Beamon (joseph.beamon@eia.doe.gov, 202/586-2025), Director of its Coal and Electric Power Division. Specific questions about the report can be directed to the following analysts:

Greenhouse Gas Analysis .... Dan Skelly (daniel.skelly@eia.doe.gov, 202/586-1722)
Macroeconomic Analysis .... Kay Smith (kay.smith@eia.doe.gov, 202/586-1132)
Transportation .... John D. Maples (john.maples@eia.doe.gov, 202/586-1757)
Electricity................................Robert Smith (robert.smith@eia.doe.gov, 202/586-9413)
Jeffrey Jones (jeffrey.jones@eia.doe.gov, 202/586-2038)

For ordering information and questions on other energy statistics available from EIA, please contact EIA's National Energy Information Center at:

National Energy Information Center, EI 30
Energy Information Administration
Forrestal Building
Washington, DC 20585

Telephone: 202/586-8800
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FAX: 202/586-0727
E-mail: infoctr@eia.doe.gov
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Background

This report responds to a request from Senators Bingaman and Specter for an analysis of S. 1766, the Low Carbon Economy Act of 2007 [1] S. 1766 establishes a mandatory greenhouse gas (GHG) allowance program to maintain covered emissions at approximately 2006 levels in 2020, 1990 levels in 2030, and at least 60 percent below 1990 levels by 2050. Gases subject to allowance requirements include carbon dioxide (CO_2) from fossil fuels, the fluorinated gases reported under United Nations' conventions (hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride), and nitrous oxide from adipic and nitric acid production. Other gases, including other sources of nitrous oxide and emissions of methane, are not subject to the allowance requirement directly, but reductions can be credited and applied as emissions offsets.

Initially, about three-fourths of the tradable emissions allowances are distributed for free to covered entities, carbon-intensive manufacturing industries, State governments, and as incentives for agricultural carbon sequestration, power plants with carbon capture and storage (CCS), and early actions. The remaining allowances are auctioned, with proceeds used to fund technology programs, climate adaptation programs, and low-income assistance.

A particularly important incentive under S. 1766 is the supplemental, or "bonus," incentive for CCS which provides additional allowances for sequestered CO_2 emissions at plants over their first 10 years of operation. The CCS bonus rate, a multiple of allowances given for each ton sequestered, ranges from 3.5 in 2012 to 0.9 in 2030 and is made available in addition to the standard offset credit for emissions reduced through CCS.

To control compliance costs, regulated entities may meet any portion of their allowance obligation with a "Technology Accelerator Payment" (TAP). The TAP price would effectively provide a ceiling on the allowance trading price. The TAP price is set at $12 per metric ton of CO_2 equivalent in 2012 and grows at 5 percent per year after accounting for inflation. Expressed in constant 2005 dollars–the price units used in this report–the TAP price would start at $10.42 in 2012 and rise to $25.07 in 2030.

As requested, this report analyzes S. 1766 under alternative technology assumptions and in combination with several other energy policies including a fuel economy standard for light-duty vehicles of 35 miles per gallon by 2020 and a 15-percent renewable portfolio standard (RPS) for electricity sellers (Table ES1). The impacts of alternative CCS bonus rates and assumptions about the potential limited availability of key carbon reduction technologies, including CCS, nuclear, biomass, and liquefied natural gas (LNG), are also examined. This analysis is based upon the Reference case from the *Annual Energy Outlook 20007* (*AEO2007*)[2], as requested by Senators Bingaman and Specter.

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[1] Request letters are provided in Appendices A and B.

[2] Energy Information Administration, *Annual Energy Outlook 2007*, DOE/EIA-0303(2007)(Washington, DC, February 2007)), web site: http://www.eia.doe.gov/oiaf/aeo/index.html.

Key Findings

S. 1766 significantly reduces projected GHG emissions compared to the AEO 2007 Reference case, but the use of the TAP provision results in emissions exceeding the 2030 target. While the timing varies, the projected allowance price eventually reaches the TAP price in all of the cases examined, triggering an alternative to allowance submission that enables emissions to exceed the cap. The TAP is triggered between 2017 and 2020 under Reference case technology assumptions, and between 2026 and 2027 under advanced technology assumptions.

Relative to the respective Reference and High Technology cases, projected covered emissions are between 12 percent and 26 percent lower in 2030. To meet the covered emissions target in 2030, a reduction of 38 to 43 percent from the High Technology and Reference case baselines, respectively, would be required. In the S. 1766 Core case, projected covered emissions, net of offsets, in 2030 are slightly below the 2005 level or about 26 percent above the 1990 level target of 4,818 million metric tons CO_2 equivalent (Table ES2).

The electric power sector accounts for the vast majority of the emissions reductions, with CCS serving as the key compliance technology in most cases. The electric power sector is projected to account for between 79 and 91 percent of the 2030 reduction in energy-related CO_2 emissions in the cases examined. The reductions are achieved through the deployment of new coal plants equipped with CCS, together with nuclear and renewable generating plants. Many existing coal plants without CCS are projected to be retired early because retrofitting with CCS technology is generally impractical. The projected reliance on new coal plants with CCS stems from the bonus incentive, but the modeling result is sensitive to the bonus rate assumed and technology improvements. In the S. 1766 Core case, nearly 300 gigawatts of coal-fired plants with CCS are added by 2030, almost as much coal capacity as exists currently. However, building this much of a yet-to-be-commercialized technology by 2030 would be extremely challenging.

In the Half CCS Bonus case, which reduces the CCS bonus to 50 percent of the levels specified in S.1766, 49 gigawatts of plants with CCS are added, while in the S. 1766 High Technology case, 128 gigawatts of CCS-equipped capacity is projected. In these cases, nuclear and renewable technologies play a bigger role in reducing power sector emissions. Projected nuclear capacity additions range from 24 to 107 gigawatts. In the Limited Alternatives case, where coal with CCS technology is assumed not to be available until after 2030, the power sector would instead turn to increased use of natural gas to replace coal generation while making even greater use of the TAP provision to comply.

Only modest emissions reductions are achieved in the residential, commercial, industrial, and transportation sectors without additional policies. Although some emissions reductions occur in the residential, commercial, industrial, and transportation sectors under S. 1766, the reductions in these sectors are small when compared to those in the electric power sector. The energy price increases resulting from the allowance program are generally not large enough to induce consumers to make large changes in their energy use. For example, motor gasoline prices in the S. 1766 Core case are only 19 cents per gallon, or 8 percent, higher than in the Reference case in 2030.

The S. 1766 High Technology Plus Policies case considered S. 1766 together with a 35-miles-per-gallon fuel economy standard for light-duty vehicles by 2020 and a 15-percent RPS for electricity sellers. Under these assumptions, the transportation and other end-use sectors make greater emissions reductions, but the electric power sector still provides the vast majority of the emissions reductions. The RPS has little incremental effect because the GHG allowance program in S. 1766 encourages an increase in renewable generation similar to what would be needed to comply with the RPS. The fuel economy standard leads to lower petroleum use and a reduction in the emissions associated with it. For example, 2030 transportation sector CO_2 emissions are 3 percent lower when only the provisions of S. 1766 are included, but they are 6 percent lower in the S. 1766 High Technology Plus Policies case.

The impact on coal use depends on the success of new coal plants with CCS. Projected coal use is lower in all of the policy cases examined, relative to the Reference and High Technology case baselines. In the Reference and High Technology cases without S. 1766, a large number of new coal plants without CCS are expected to be added to meet the growing demand for electricity while new coal-to-liquids plants are added to supply the transportation sector. However, S. 1766 makes it economically unattractive to continue to add these types of plants and a combination of new coal with CCS, nuclear, and renewable plants is generally added to supply electricity, and no new coal-to-liquids plants are added. When the availability of new coal with CCS, nuclear, and renewable generating technologies is limited, new natural-gas–fired combined-cycle plants are added instead of the coal plants without CCS.

If new coal plants with CCS can be successfully deployed rapidly enough to replace most of the generation expected from existing and projected new coal plants without CCS, total coal consumption would be expected to grow rapidly through 2030. In the Reference case, total coal use, on a Btu basis, is projected to increase 49 percent between 2005 and 2030. When the provisions of S. 1766, including the offset credits and full bonus allowances for CCS, are imposed, total coal consumption increases 37 percent between 2005 and 2030. However, this would require the addition of nearly 300 gigawatts of new coal plants with CCS by 2030, a difficult challenge.

In contrast, when the CCS bonus rate is cut in half or when the advanced technology assumptions are incorporated, the addition of new coal plants with CCS is reduced to between 49 and 128 gigawatts. As a result, projected coal use remains at approximately current levels (22 to 23 quadrillion Btu) through 2030 in these scenarios (Tables ES2 and ES3). In the S. 1766 Limited Alternatives case, coal use is projected to grow 16 percent between 2005 and 2030, compared to 49 percent in the Reference case.

The energy price impacts of S. 1766 are tempered by the TAP provision. The cost of using energy is increased by the requirement to submit allowances or pay the TAP price. Under S. 1766, most coal consumers and suppliers of natural gas and petroleum products must submit allowances, and the allowance costs will be reflected in their product prices. Relative to the Reference case, projected energy prices for petroleum, natural gas, coal, and electricity all increase, with the effect growing from 2010 through 2030 as the TAP increases (Tables ES-2 and ES-3). Across the primary cases examined (excluding the Limited Alternatives case), the increases in average delivered prices projected for 2030 range from 12 to 13 percent for natural gas, 7 to 10 percent for petroleum, 132 to 149 percent for coal, and 8 to 10 percent for electricity.[3]

The key uncertainties involve the potential for and the timing of the development, commercialization, and deployment of low-carbon electricity generating technologies. This analysis finds that energy providers, particularly electricity producers, will increasingly turn to technologies that play a relatively small role today or have not been built in the United States in many years, including coal with CCS, nuclear power, and renewable energy. However, new coal plants with CCS have not yet been commercially deployed and concerns about costs, feasibility, availability of reservoirs and pipelines, and other project risks could deter development. Similar concerns apply to nuclear power, as well as concerns about siting and waste disposal. Furthermore, the use of biomass for electric power could be affected if a biofuel mandate for transportation fuels larger than what currently exists were enacted.

The TAP provision in S. 1766 also limits the economic and energy price risks associated with technology development and deployment uncertainties. If carbon-free and low-carbon electricity technologies other than natural-gas-fired plants are not available for widespread deployment in a timeframe consistent with the provisions of S. 1766, use of the TAP would increase, and the level of emissions would rise above the level attained in the S.1766 cases where these technologies are available, tempering the economic consequences and energy price impacts that would otherwise occur under these circumstances. This is illustrated by the Limited Alternatives case, which holds deployment of nuclear and biomass generation and the availability of LNG to the Reference case level and further assumes that CCS is not available until after 2030. In this case, the electric power industry opts to rely more heavily on the TAP compliance option rather than reducing emissions. It also relies more heavily on natural gas, which leads to larger electricity price and economic impacts. For example, 2030 electricity sector CO_2 emissions in the Limited Alternatives case are roughly double the level seen in the S. 1766 Core case (Table ES-4). Electricity prices in 2030 in the Limited Alternatives case are 20 percent higher than in the Reference case, again, approximately double the impact seen in the S. 1766 Core case.

S.1766 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. The overall economic impacts as measured by changes in gross domestic product (GDP) and aggregate personal consumption are also tempered by the TAP provision. For example, total discounted GDP losses over the 2009 to 2030 time period range from $52 billion (-0.02 percent) to $163 billion (-0.07 percent) in the main S. 1766 cases. Similarly, the cumulative losses for personal consumption range from $157 billion (-0.09 percent) to $287 billion (-0.17 percent), in the same cases. The impacts are larger in the S. 1766 Limited Alternatives case, with cumulative GDP loses of $330 billion (-0.13 percent) and consumption loses of $344 billion (0.21 percent). The TAP provision plays an important role in mitigating the effects of the Limited Alternatives case assumptions on projected economic impacts.

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[3] The price increases are relative to either the Reference or High Technology case, as appropriate. The prices are the average of the delivered cost of energy on a physical unit basis, with coal including the cost of allowances.

Auction revenues and TAP payments are projected to provide a significant revenue flow to the Federal government. Government revenue from allowance auction revenues and TAP payments range from $81 to $101 billion in 2020 and from $149 to $165 billion in 2030, across the four main policy cases considered in this analysis. The Limited Alternatives case provides somewhat higher revenues to the Federal government, projected at $104 billion in 2020 and $187 billion in 2030, reflecting additional use of the TAP mechanism.

Table ES-1: Analysis Cases[4]

Case Name	Description and Assumptions
Non-Policy Cases	
Reference	• Updated *AEO2007* Reference case, which assumes a continuance of current laws and regulation • Non-CO_2 emissions growth based on EPA "no measures" and "no voluntary technology adoption" cases
High Technology	Updated *AEO2007* Integrated High Technology case (without S. 1766): • Includes more optimistic characteristics for energy technology, including a combination of earlier availability of advanced technologies, lower costs, and better performance • Assumptions apply to the residential, commercial, industrial, transportation, and electric power sectors
Main Policy Cases	
S. 1766 Core	Primary policy case. Key assumptions include: • Updated *AEO2007* Reference case assumptions • Cap and trade policy • Bonus credit incentives for CCS • TAP price establishes a limit on the allowance price, growing at 5 percent per year in real dollars • Nonenergy abatement supply, as a function of allowance costs, derived from information provided by the Environmental Protection Agency
Half CCS Bonus	S. 1766 Core with the bonus incentive rate for CCS halved.
S. 1766 High Technology	S. 1766 Core with High Technology case assumptions. Electricity generating technology cost and performance are reduced from the level achieved in the S. 1766 Core case
S. 1766 High Technology Plus Policies	S. 1766 High Technology case with additional supporting policies: • Fuel economy standards from H.R. 6 as amended by the Senate in June 2007 (35 miles per gallon average for light-duty vehicles by 2020) • A 15-percent renewable portfolio standard for the electricity sector by 2020
Sensitivity Cases	
S. 1766 Limited Alternatives	S. 1766 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 *AEO2007* Reference case level • LNG imports limited to *AEO2007* Reference case level
S. 1766 Plus Policies	S. 1766 Core case with additional supporting policies: • Fuel economy standards from H.R. 6 as amended by the Senate in June 2007(35 miles per gallon average for light-duty vehicles by 2020) • A 15-percent RPS for the electricity sector by 2020

[4] All of the cases examined in this analysis do not reflect the passage of the Energy Independence and Security Act of 2007, which was enacted on December 19, 2007. This law, which is expected to reduce oil consumption, increase production of alternative fuels, and increase energy efficiency, would affect the results contained in this report.

Table ES2: Summary Energy Market Results for the Reference, S. 1766 Core, and Half CCS Bonus Cases

(million metric tons CO_2 equivalent, except as noted)

	2005	2020			2030		
		Refer-ence	S. 1766 Core	Half CCS Bonus	Refer-ence	S. 1766 Core	Half CCS Bonus
Greenhouse gas emissions							
Energy-related carbon dioxide	5945	6886	6288	6375	7889	5770	6252
Other covered emissions	194	378	299	299	559	468	468
Total covered emissions	6140	7264	6588	6674	8448	6238	6719
Total greenhouse gas emissions	7147	8383	7598	7685	9673	7305	7787
Emissions reduction from Reference case							
Energy-related carbon dioxide		n.a.	597	510	n.a.	2119	1637
Carbon capture and storage		*n.a.*	*251*	*23*	*n.a.*	*1511*	*246*
Other covered emissions		n.a.	79	79	n.a.	91	91
Offset credits		n.a.	106	106	n.a.	153	153
Nonenergy carbon dioxide		n.a.	3	3	n.a.	5	5
Total emissions reduction			784	698		2368	1886
Biogenic carbon sequestration			171	171		479	479
Total (including carbon sequestration)			956	869		2847	2365
Compliance summary							
Allowances issued (cap)	n.a.	6189	6189	6189	4818	4818	4818
Covered emissions, less offset credits	6151	7264	6482	6569	8448	6085	6567
Net allowance bank change	0	0	0	0	0	0	0
TAP sales	0	0	293	380	0	1267	1749
Allowance price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	15	15	0	25	25
TAP price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	15	15	0	25	25
Delivered energy prices (2005 dollars per unit indicated)							
Motor gasoline, transport (per gallon)	2.32	1.97	2.09	2.09	2.21	2.39	2.40
Jet fuel (per gallon)	1.77	1.40	1.54	1.54	1.64	1.87	1.88
Diesel (per gallon)	2.41	2.09	2.24	2.24	2.35	2.60	2.60
Natural gas (per thousand cubic feet)							
Residential	12.80	10.85	11.36	11.67	11.69	12.48	12.67
Electric power	8.41	5.93	6.16	6.60	6.46	6.66	6.95
Coal, electric power sector (per million Btu)	1.53	1.57	3.01	2.97	1.70	4.11	3.87
Electricity (cents per kilowatthour)	8.10	7.90	8.18	8.36	8.06	8.88	8.75
Energy consumption (quadrillion Btu)							
Liquid fuels	40.7	46.5	45.5	45.3	52.0	50.2	50.0
Natural gas	22.7	27.1	25.7	26.8	26.9	23.1	24.5
Coal	22.9	27.1	25.1	23.0	34.1	31.3	22.2
Nuclear power	8.1	9.2	9.7	10.0	9.1	10.2	16.9
Renewable/Other	6.0	8.4	10.2	10.8	9.1	10.6	14.2
Total	100.3	118.4	116.1	116.0	131.2	125.3	127.8
Purchased electricity	12.5	15.5	15.3	15.3	17.6	17.3	17.2
Electricity generation (billion kilowatthours)							
Petroleum	141	120	64	65	124	52	56
Natural gas	752	1055	978	1129	923	528	733
Coal	2015	2475	2334	2073	3340	3382	2087
Nuclear power	780	885	928	960	869	981	1625
Renewable	350	505	684	741	541	717	1149
Total	4038	5039	4988	4968	5797	5661	5650

TAP: Technology Accelerator Payment

Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, and S1766ALTCCS.D103007A.

Table ES3: Summary Energy Market Results for the High Technology, S. 1766 High Technology, and S. 1766 High Technology Plus Policies Cases

(million metric tons CO_2 equivalent, except as noted)

	2005	2020			2030		
		High Tech	S. 1766 High Tech	S. 1766 High Tech & Policies	High Tech	S. 1766 High Tech	S. 1766 High Tech & Policies
Greenhouse gas emissions							
Energy-related carbon dioxide	5945	6531	6066	5960	7235	5739	5674
Other covered emissions	194	378	306	307	559	468	468
Total covered emissions	6140	6909	6372	6267	7793	6207	6142
Total greenhouse gas emissions	7147	8029	7386	7281	9020	7275	7210
Emissions reduction from Reference case							
Energy-related carbon dioxide		n.a.	465	571	n.a.	1495	1561
Carbon capture and storage		*n.a.*	*84*	*68*	*n.a.*	*586*	*486*
Other covered emissions		n.a.	72	71	n.a.	91	91
Offset credits		n.a.	103	103	n.a.	153	153
Nonenergy carbon dioxide		n.a.	3	2	n.a.	5	5
Total emissions reduction			643	747		1744	1809
Biogenic carbon sequestration			140	135		479	479
Total (including carbon sequestration)			783	882		2223	2288
Compliance summary							
Allowances issued (cap)	n.a.	6189	6189	6189	4818	4818	4818
Covered emissions, less offset credits	6151	6909	6268	6164	7794	6055	5989
Net allowance bank change	0	0	-79	25	0	0	0
TAP sales	0	0	0	0	0	1237	1171
Allowance price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	13	13	0	25	25
TAP price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	15	15	0	25	25
Delivered energy prices (2005 dollars per unit indicated)							
Motor gasoline, transport (per gallon)	2.32	1.95	2.04	2.01	2.14	2.32	2.18
Jet fuel (per gallon)	1.77	1.37	1.49	1.48	1.50	1.74	1.75
Diesel (per gallon)	2.41	2.05	2.18	2.21	2.21	2.47	2.53
Natural gas (per thousand cubic feet)							
Residential	12.80	10.73	11.32	11.25	11.67	12.50	12.44
Electric power	8.41	5.73	6.16	6.04	6.32	6.73	6.71
Coal, electric power sector (per million Btu)	1.53	1.53	2.77	2.72	1.61	3.89	3.88
Electricity (cents per kilowatthour)	8.10	7.65	8.05	8.08	7.83	8.43	8.44
Energy consumption (quadrillion Btu)							
Liquid fuels	40.7	44.2	43.1	42.2	48.3	46.6	45.2
Natural gas	22.7	26.2	25.6	25.2	26.3	23.4	23.3
Coal	22.9	25.3	22.5	21.9	29.9	23.2	22.4
Nuclear power	8.1	8.9	9.1	9.2	8.8	11.8	12.7
Renewable/Other	6.0	8.5	10.0	11.1	9.1	12.5	12.5
Total	100.3	113.1	110.2	109.7	122.4	117.4	116.0
Purchased electricity	12.5	14.7	14.5	14.5	16.3	16.0	15.9
Electricity generation (billion kilowatthours)							
Petroleum	141	117	58	59	120	53	54
Natural gas	752	1024	1100	1041	967	721	741
Coal	2015	2298	2058	1993	2911	2405	2275
Nuclear power	780	858	871	885	846	1131	1219
Renewable	350	512	664	772	543	956	976
Total	4038	4808	4752	4749	5387	5265	5264

TAP: Technology Accelerator Payment

Source: NEMS runs S1766HTBASE.D102307A, S1766HT.D110807C, and S1766POLRP.D120507B.

Table ES4: Summary Energy Market Results for the Reference, S. 1766 Reference Plus Policies, and Limited Alternatives Cases

(million metric tons CO_2 equivalent, except as noted)

	2005	2020			2030		
		Reference	S. 1766 Reference & Policies	Limited Alternatives	Reference	S. 1766 Reference & Policies	Limited Alternatives
Greenhouse gas emissions							
Energy-related carbon dioxide	5945	6886	6133	6572	7889	5627	7134
Other covered emissions	194	378	300	299	559	468	468
Total covered emissions	6140	7264	6433	6871	8448	6094	7602
Total greenhouse gas emissions	7147	8383	7445	7881	9673	7162	8667
Emissions reduction from Reference case							
Energy-related carbon dioxide		n.a.	753	314	n.a.	2262	754
Carbon capture and storage		*n.a.*	*237*	*0*	*n.a.*	*1379*	*0*
Other covered emissions		n.a.	77	79	n.a.	91	91
Offset credits		n.a.	105	106	n.a.	153	153
Nonenergy carbon dioxide		n.a.	3	3	n.a.	5	7
Total emissions reduction			938	502		2511	1006
Biogenic carbon sequestration			165	171		479	479
Total (including carbon sequestration)			1103	673		2989	1484
Compliance summary							
Allowances issued (cap)	n.a.	6189	6189	6189	4818	4818	4818
Covered emissions, less offset credits	6151	7264	6328	6765	8448	5942	7450
Net allowance bank change	0	0	-139	0	0	0	0
TAP sales	0	0	0	576	0	1124	2632
Allowance price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	15	15	0	25	25
TAP price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	15	15	0	25	25
Delivered energy prices (2005 dollars per unit indicated)							
Motor gasoline, transport (per gallon)	2.32	1.97	2.04	2.09	2.21	2.21	2.41
Jet fuel (per gallon)	1.77	1.40	1.54	1.54	1.64	1.87	1.87
Diesel (per gallon)	2.41	2.09	2.26	2.23	2.35	2.61	2.61
Natural gas (per thousand cubic feet)							
Residential	12.80	10.85	11.29	11.86	11.69	12.56	13.73
Electric power	8.41	5.93	6.09	6.88	6.46	6.74	8.53
Coal, electric power sector (per million Btu)	1.53	1.57	2.96	3.01	1.70	4.09	3.98
Electricity (cents per kilowatthour)	8.10	7.90	8.21	8.53	8.06	8.90	9.68
Energy consumption (quadrillion Btu)							
Liquid fuels	40.7	46.5	44.2	45.4	52.0	47.4	50.0
Natural gas	22.7	27.1	25.5	27.4	26.9	23.1	28.5
Coal	22.9	27.1	24.2	24.4	34.1	30.1	26.6
Nuclear power	8.1	9.2	9.7	9.2	9.1	10.2	9.3
Renewable/Other	6.0	8.4	11.3	8.8	9.1	11.7	11.7
Total	100.3	118.4	114.9	115.3	131.2	122.4	126.2
Purchased electricity	12.5	15.5	15.3	15.2	17.6	17.3	16.9
Electricity generation (billion kilowatthours)							
Petroleum	141	120	62	66	124	52	67
Natural gas	752	1055	952	1263	923	532	1383
Coal	2015	2475	2246	2208	3340	3226	2505
Nuclear power	780	885	933	885	869	974	896
Renewable	350	505	791	529	541	870	671
Total	4038	5039	4983	4952	5797	5654	5522

TAP: Technology Accelerator Payment

Source: NEMS runs S1766BASE.D102307A, S1766REFPOLS.D120507C, and S1766BIV.D102907A.

1. Background and Scope of the Analysis

This service report was prepared by the Energy Information Administration (EIA), in response to an August 1, 2007, request from Senators Bingaman and Specter.[1] The Senators asked EIA to estimate the economic impacts of S. 1766, the Low Carbon Economy Act of the 2007, a bill that would regulate emissions of greenhouse gases (GHGs) through an allowance cap-and-trade system.[2]

Under S. 1766, a cap for covered GHG emissions would be set at approximately 2006 levels in 2020, 1990 levels by 2030, and at least 60 percent below 1990 levels by 2050. Covered sources include carbon dioxide (CO_2) from fossil fuels, the fluorinated gases reported by United Nations conventions (hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride), and nitrous oxide from adipic and nitric acid production. Other anthropogenic GHG sources, including other sources of nitrous oxide and emissions of methane, would not be subject to the caps directly, but some reductions could be credited as emissions offsets.

S. 1766 requires regulated entities to submit allowances or qualifying domestic offsets that equal their emissions from covered sources. Each allowance represents a metric ton of CO_2-equivalent emissions. The allowance requirements for coal apply directly to large coal-consuming facilities, while other emissions are regulated on an "upstream" basis to reduce administrative costs. The upstream regulated entities include petroleum refiners, natural gas processors, importers of refined oil products and natural gas, and producers and importers of non-CO_2 GHGs. Energy-related allowance requirements are based on the CO_2 released, assuming complete combustion of the fuels supplied, and the bill provides offset credits to reimburse nonfuel uses that sequester the carbon, sequestration through carbon capture and storage (CCS), and exports. Offset credits are also provided for projects that reduce non-covered GHG emissions, such as methane captured at landfills and coal mines. While there are incentives to encourage agricultural carbon sequestration, it does not count as an offset.

Initially, about three-fourths of the emissions allowances are distributed for free to covered entities, carbon-intensive manufacturing industries, State governments, and as incentives for agricultural carbon sequestration, CCS, and early actions. The remaining allowances are auctioned, with the auction share growing over time. Of the shares auctioned, half are auctioned in the issue year and half are auctioned 4 years in advance.[3] Allowances are tradable and may be banked for future use if not used in the year for which they were issued. Proceeds of the auction are allocated for technology programs, climate adaptation programs, and low-income assistance.

To control compliance costs, regulated entities may meet any portion of their allowance obligation with a "Technology Accelerator Payment" (TAP). The TAP price would effectively

[1] Request letters are provided in Appendices A and B.
[2] The text of the bill is available at http://thomas.loc.gov/cgi-bin/query/z?c110:S. 1766:
[3] The first early auction in 2009 is an exception to the 4-year rule. Half of the 2012 allowance pool is auctioned that first year, along with half of the 2013 auction pool.

provide a ceiling on the price of allowances.[4] The TAP price is set at $12 per metric ton of CO_2 equivalent in 2012 and grows at 5 percent per year after accounting for inflation. Expressed in constant 2005 dollars–the price units used in this report–the TAP price would start at $10.42 in 2012 and rise to $25.07 in 2030.

The share of allowances auctioned ultimately depends on how many allowances are distributed for agricultural sequestration and CCS. The bill initially allots 5 percent of total allowances for agricultural sequestration and 8 percent for CCS. However, if these initial pools are oversubscribed and additional allowances are needed to provide these incentives, the allowances are taken from the auction pool, reducing the number of allowances that are auctioned. The supplemental, or "bonus" incentive for CCS provides additional allowances for sequestered CO_2 emissions at plants over their first 10 years of operation. The CCS bonus rate, which is multiplied by the number of tons sequestered to calculate the number of allowances to be granted in addition to the offset for sequestration, declines from 3.5 in 2012 to 0.9 in 2030. The attractiveness of these incentives and the initial level of the bonus rate suggest that the designated pool of 8 percent of the allowances could easily be oversubscribed, reducing the number of allowances that will be auctioned.

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 2007 (AEO2007)*.[5] 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. For this report, an updated Reference case based on the *AEO2007* assumptions was prepared using NEMS with some post-*AEO2007* modeling changes to support recent congressional analysis requests, as well as to reflect the baseline GHG coverage assumptions under S. 1766.[6] The *AEO2007* was published in February 2007; consequently, none of the cases examined in this analysis reflect the passage of the Energy Independence and Security Act of 2007, which was enacted on December 19, 2007. This law, which is expected to reduce oil consumption, increase production of alternative fuels, and increase energy efficiency, would affect the results contained in this report.

The EIA Reference case is deliberately designed to reflect only current laws and policies. Because analysis of alternative policies at the request of the Congress and/or the Administration

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[4] The term "Technology Adaptation Payment" implies the proceeds would be used to fund technology-related programs. However, there appears to be no explicit mechanism in the S. 1766 that allocates this revenue source. At the direction of Senate staff, we have assumed the proceeds are combined with auction proceeds to pay for technology programs, adaptation, and low-income assistance.

[5] Energy Information Administration, *Annual Energy Outlook 2007*, DOE/EIA-0383(2007) (Washington, DC, February 2007), web site: http://www.eia.doe.gov/oiaf/aeo/index.html.

[6] See Appendix C from the recent report, 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), for a discussion of updates to the *AEO2007* Reference case, web site: http://www.eia.doe.gov/oiaf/servicerpt/csia/index.html.

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.

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. Under S. 1766, the TAP price provides a ceiling on the allowance price. Because the 5-percent real growth in the TAP price is not expected to be high enough to induce allowance banking, allowance banking is assumed to end when the TAP price is attained.

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.

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.[7] For the analysis of the S. 1766, however, no international emission offsets were used, and several nonenergy emissions sources, notably, methane from natural gas systems and agricultural-related nitrous oxide, were assumed to be ineligible as offsets. For more information on the NEMS MAM and nonenergy emissions abatement assumptions, see the EIA's S. 280 analysis.

EIA is unable to directly model or estimate the effects of the energy technology incentives funded from the S. 1766 allowance auction revenue and the TAP programs. EIA also does not address the impacts of climate change adaptation programs, nor the potential benefits of S. 1766 in mitigating climate change.

Analysis Cases

The letter requesting this analysis specified that the impacts of S. 1766 should be estimated under two sets of assumptions, the EIA's *AEO2007* Reference case assumptions and the *AEO2007* High Technology case assumptions. The latter includes more optimistic assumptions regarding the availability, cost, and performance of new energy consumption and electricity production technologies.[8] The letter also requested an additional case be prepared, with the high technology assumptions, that includes several energy policies under consideration in recent energy bills, including a Corporate Average Fuel Economy (CAFE) standard for light-duty vehicles of 35 miles per gallon, as passed by the Senate in June 2007; a renewable fuels standard (RFS); and a 15-percent renewable portfolio standard (RPS) for electricity producers. A subsequent letter clarifying the analysis request (Appendix B) dropped the request for inclusion of the RFS as it would have delayed the analysis. The letter also requested a case where the bonus allowance incentive for CCS was halved.

In addition to the requested cases, two alternative cases were prepared. For comparison purposes, a case simulating the impacts of S. 1766 together with the CAFE and RPS policies using reference technology assumptions was prepared. The results from this case are not

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[7] 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: http://www.eia.doe.gov/oiaf/servicerpt/csia/index.html.

[8] In the policy cases with high technology assumptions, the cost and performance of new electricity generation technologies are reduced from the levels achieved in the policy case with Reference case assumptions, the S. 1766 Core Case.

discussed in the report, but they are useful when trying to separate the impacts of the technology assumptions and other policies from the impacts of S. 1766. EIA also prepared a "what-if" case with limits on several key carbon reduction technologies for electric power generation, as well as limits on the expansion of liquefied natural gas (LNG) imports. Earlier EIA analyses have shown that these technologies are likely to be important in reducing U.S. greenhouse gas emissions but there is considerable uncertainty about their future cost and performance; how fast they might reach commercialization; and whether other hurdles such as licensing, financing, and public acceptance might slow or block their market penetration. The assumptions for this case are based on a recent letter to EIA from Senators Barrasso, Inhofe, and Voinovich[9] who requested EIA to include scenarios assuming nuclear and biomass could not be expanded beyond the *AEO2007* Reference case levels, CCS technologies were unavailable through 2030, and the supply of imported natural gas was restricted, citing the uncertainty regarding technology availability and the adequacy of future natural gas supplies. This case examines what would happen if some of the key technologies found to be important in the S. 1766 policy cases were not widely available between now and 2030. The results of this case illustrate the effects of technology development and deployment uncertainties, and the full set of tables for this case, along with the others prepared for this analysis, are included on EIA's web site.

EIA has previously pointed out that the level of barriers to key technologies may be directly influenced by policy design choices.[10] For example, inclusion of a mechanism to relax compliance pressure that is tied to the level of compliance costs or other measures of economic impact is likely to discourage efforts by some stakeholders to raise barriers to particular technologies, such as nuclear power, that are attractive from a GHG emissions reduction perspective but are controversial for other reasons. With such a mechanism in place, these stakeholders will recognize that success in impeding particular GHG emission reduction options would increase the chances of triggering the mechanism and compromising the GHG target. In the absence of such a mechanism, these stakeholders might be more inclined to press their opposition to particular technologies once a GHG target is set, because they know the allowance price will increase to whatever higher level may be required to encourage deployment of the emission reduction options they prefer without compromising the GHG target.

To examine the impacts of S. 1766, simulations of NEMS were made with and without the provisions of the bill. The list of cases examined is shown in Table 1. Note that four of the policy cases (S. 1766 Core, the Half CCS Bonus, S. 1766 Limited Alternatives and S. 1766 Plus Policies) are based on Reference case assumptions, while the other two S. 1766 cases are based on the high technology assumptions. Because the technology development assumed in the High Technology case is not ascribed to the effects of the S. 1766 policies, the results of the two S. 1766 cases under high technology assumptions should be compared to the High Technology case under current policies, not the standard Reference case. While faster technology advancement could be induced under a GHG cap and trade bill, particularly with additional technology research and development programs funded with allowance proceeds, EIA is unable

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[9] For a copy of the letter and a related analysis, see *Supplement to: Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007*, web site http://www.eia.doe.gov/oiaf/servicerpt/biv/pdf/s280_1007.pdf.

[10] These two points are also made in the Executive Summary of the recent S.280 report. See SR/OIAF/2007-04, page xiii.

to link the proposed spending provisions under S. 1766 to the technology improvements suggested by the High Technology case.

Finally, all of EIA's analysis cases assume efficient policy implementation subject to whatever specific technology constraints and policies are modeled. To the extent that actual policies are implemented in a manner that degrades efficiency, allowance prices and energy and economic impacts can increase beyond the modeled levels. Economic impact results are also sensitive to the representation of the role of energy in the aggregate production function that is incorporated in the NEMS MAM.

Table 1: Analysis Cases

Case Name	Description and Assumptions
Non-Policy Cases	
Reference	• Updated *AEO2007* Reference case, which assumes a continuance of current laws and regulation • Non-CO_2 emissions growth based on EPA "no measures" and "no voluntary technology adoption" cases
High Technology	Updated *AEO2007* Integrated High Technology case (without S. 1766): • Includes more optimistic characteristics for energy technology, including a combination of earlier availability of advanced technologies, lower costs, and better performance. • Assumptions apply to the residential, commercial, industrial, transportation, and electric power sectors
Main Policy Cases	
S. 1766 Core	Primary Policy case. Key assumptions include: • Updated *AEO2007* Reference case assumptions • Cap and trade policy • Bonus credit incentives for CCS • The TAP price establishes a limit on the allowance price, growing at 5 percent per year in real dollars • Nonenergy abatement supply, as a function of allowance costs, derived from information provided by the Environmental Protection Agency
Half CCS Bonus	S. 1766 Core with the bonus incentive rate for CCS halved
S. 1766 High Technology	S. 1766 Core with High Technology case assumptions. Electricity generating technology cost and performance are reduced from the level achieved in the S. 1766 Core case
S. 1766 High Technology Plus Policies	S. 1766 High Technology case with additional supporting policies: • Fuel economy standards from H.R. 6 as amended by the Senate in June 2007 (35 miles per gallon average for light-duty vehicles by 2020)[11] • A 15-percent renewable portfolio standard for the electricity sector by 2020[12]
Sensitivity Cases	
S. 1766 Limited Alternatives	S. 1766 Core case with assumed limits on several carbon reduction technologies for electric power generation and limits on LNG imports:[13] • CCS not available by 2030 • Nuclear and biomass power plant additions limited to *AEO2007* Reference case level • LNG imports limited to *AEO2007* Reference case level
S. 1766 Plus Policies	S. 1766 Core case with additional supporting policies: • Fuel economy standards from H.R. 6 as amended by the Senate (35 miles per gallon average for light-duty vehicles by 2020)[14] • A 15-percent RPS for the electricity sector by 2020[15]

[11] The fuel economy provision is included in the text of H.R. 6 as amended by the Senate, June 2007, web site: http://energy.senate.gov/public/_files/HR6BillText.pdf.

[12] The RPS policy assumptions are those analyzed in a recent EIA analysis report, *Impacts of a 15-Percent Renewable Portfolio Standard*, SR/OIAF/2007-03 (Washington, DC, June 2007), web site http://www.eia.doe.gov/oiaf/servicerpt/prps/pdf/sroiaf(2007)03.pdf.

[13] For background on this scenario, see *Supplement to: Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007*, web site http://www.eia.doe.gov/oiaf/servicerpt/biv/pdf/s280_1007.pdf.

[14] The fuel economy provision is included in the text of H.R. 6 as amended by the Senate, June 2007, web site: http://energy.senate.gov/public/_files/HR6BillText.pdf.

2. Energy Market Impacts of Reducing Greenhouse Gas Emissions

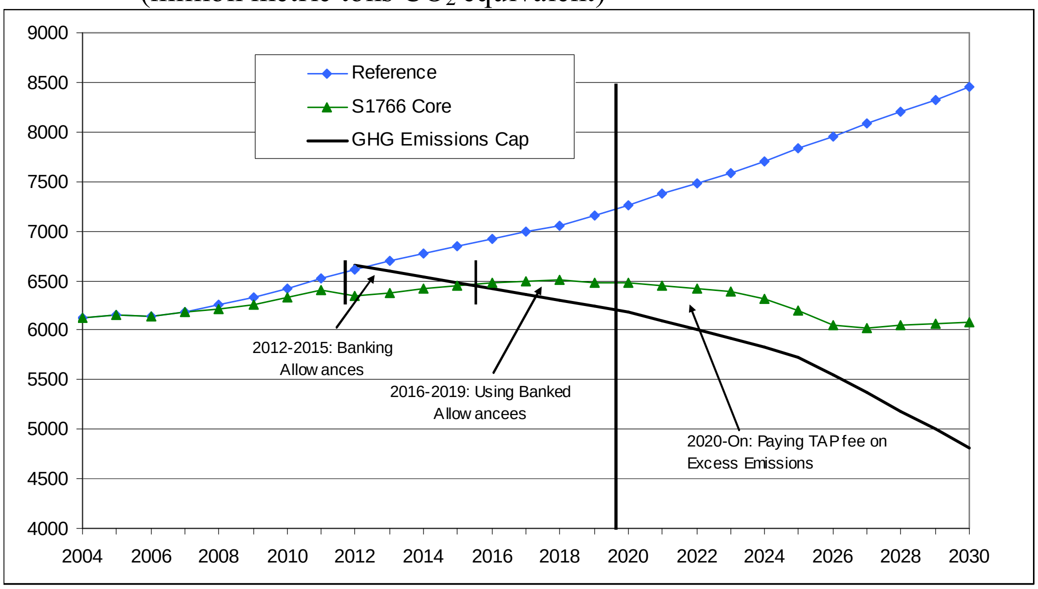
This section discusses the modeling results simulating the effects of S. 1766, comparing the results to a policy-neutral Reference case. The results under more optimistic technology assumptions will also be discussed. The impacts on GHG emissions, energy markets, and the economy are presented in turn. Table 2 compares the Reference case projections to the S. 1766 Core and Half CCS Bonus cases. Table 3 compares the High Technology case projections to the S. 1766 High Technology and S. 1766 High Technology Plus Policies cases. Table 4 compares the Reference case projections to the S. 1766 Plus Policies and Limited Alternatives cases.

Greenhouse Gas Emissions and Allowance Prices

Compared to the Reference case, GHG emissions are reduced under the S. 1766 cap and trade regulations, with the impact growing through 2030 (Figure 1).[16] Meeting the S. 1766 caps would require an absolute decline in emissions over time; however, the cap is implicitly relaxed if allowance prices reach the TAP level. In the S. 1766 Core case, the projected allowance price reaches the TAP level in 2020 (Figure 2), and covered emissions remain above the cap through 2030, stabilizing at about the 2000 level from 2026 to 2030.

Figure 1: Covered Greenhouse Gas Emissions Net of Offset Credits in the Reference and S. 1766 Core Cases

(million metric tons CO_2 equivalent)



Source: National Energy Modeling System runs S1766BASE.D102307A and S1766.D103007A.

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[15] The RPS policy assumptions are those analyzed in a recent EIA analysis report, *Impacts of a 15-Percent Renewable Portfolio Standard*, SR/OIAF/2007-03 (Washington, DC, June 2007), web site http://www.eia.doe.gov/oiaf/servicerpt/prps/pdf/sroiaf(2007)03.pdf.

[16] The figure plots covered GHG gas emissions, less offset credits, compared to the target. Emissions from covered emissions were about 86 percent of total GHG emissions in 2005. Not shown are the increases in biogenic carbon sequestration induced under the S. 1766 allowance allocation incentives.

Table 2: Summary Energy Market Results for the Reference, S. 1766 Core, and Half CCS Bonus Cases

(million metric tons CO_2 equivalent, except as noted)

	2005	2020			2030		
		Reference	S. 1766 Core	Half CCS Bonus	Reference	S. 1766 Core	Half CCS Bonus
Greenhouse gas emissions							
Energy-related carbon dioxide	5945	6886	6288	6375	7889	5770	6252
Other covered emissions	194	378	299	299	559	468	468
Total covered emissions	6140	7264	6588	6674	8448	6238	6719
Total greenhouse gas emissions	7147	8383	7598	7685	9673	7305	7787
Emissions reduction from Reference case							
Energy-related carbon dioxide		n.a.	597	510	n.a.	2119	1637
Carbon capture and storage		*n.a.*	*251*	*23*	*n.a.*	*1511*	*246*
Other covered emissions		n.a.	79	79	n.a.	91	91
Offset credits		n.a.	106	106	n.a.	153	153
Nonenergy carbon dioxide		n.a.	3	3	n.a.	5	5
Total emissions reduction			784	698		2368	1886
Biogenic carbon sequestration			171	171		479	479
Total (including carbon sequestration)			956	869		2847	2365
Compliance summary							
Allowances issued (cap)	n.a.	6189	6189	6189	4818	4818	4818
Covered emissions, less offset credits	6151	7264	6482	6569	8448	6085	6567
Net allowance bank change	0	0	0	0	0	0	0
TAP sales	0	0	293	380	0	1267	1749
Allowance price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	15	15	0	25	25
TAP price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	15	15	0	25	25
Delivered energy prices (2005 dollars per unit indicated)							
Motor gasoline, transport (per gallon)	2.32	1.97	2.09	2.09	2.21	2.39	2.40
Jet fuel (per gallon)	1.77	1.40	1.54	1.54	1.64	1.87	1.88
Diesel (per gallon)	2.41	2.09	2.24	2.24	2.35	2.60	2.60
Natural gas (per thousand cubic feet)							
Residential	12.80	10.85	11.36	11.67	11.69	12.48	12.67
Electric power	8.41	5.93	6.16	6.60	6.46	6.66	6.95
Coal, electric power sector (per million Btu)	1.53	1.57	3.01	2.97	1.70	4.11	3.87
Electricity (cents per kilowatthour)	8.10	7.90	8.18	8.36	8.06	8.88	8.75
Energy consumption (quadrillion Btu)							
Liquid fuels	40.7	46.5	45.5	45.3	52.0	50.2	50.0
Natural gas	22.7	27.1	25.7	26.8	26.9	23.1	24.5
Coal	22.9	27.1	25.1	23.0	34.1	31.3	22.2
Nuclear power	8.1	9.2	9.7	10.0	9.1	10.2	16.9
Renewable/Other	6.0	8.4	10.2	10.8	9.1	10.6	14.2
Total	100.3	118.4	116.1	116.0	131.2	125.3	127.8
Purchased electricity	12.5	15.5	15.3	15.3	17.6	17.3	17.2
Electricity generation (billion kilowatthours)							
Petroleum	141	120	64	65	124	52	56
Natural gas	752	1055	978	1129	923	528	733
Coal	2015	2475	2334	2073	3340	3382	2087
Nuclear power	780	885	928	960	869	981	1625
Renewable	350	505	684	741	541	717	1149
Total	4038	5039	4988	4968	5797	5661	5650

TAP: Technology Accelerator Payment

Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, and S1766ALTCCS.D103007A.

Table 3: Summary Energy Market Results for the High Technology, S. 1766 High Technology, and S. 1766 High Technology Plus Policies Cases

(million metric tons CO_2 equivalent, except as noted)

	2005	2020			2030		
		High Tech	S. 1766 High Tech	S. 1766 High Tech & Policies	High Tech	S. 1766 High Tech	S. 1766 High Tech & Policies
Greenhouse gas emissions							
Energy-related carbon dioxide	5945	6531	6066	5960	7235	5739	5674
Other covered emissions	194	378	306	307	559	468	468
Total covered emissions	6140	6909	6372	6267	7793	6207	6142
Total greenhouse gas emissions	7147	8029	7386	7281	9020	7275	7210
Emissions reduction from Reference case							
Energy-related carbon dioxide		n.a.	465	571	n.a.	1495	1561
Carbon capture and storage		*n.a.*	*84*	*68*	*n.a.*	*586*	*486*
Other covered emissions		n.a.	72	71	n.a.	91	91
Offset credits		n.a.	103	103	n.a.	153	153
Nonenergy carbon dioxide		n.a.	3	2	n.a.	5	5
Total emissions reduction			643	747		1744	1809
Biogenic carbon sequestration			140	135		479	479
Total (including carbon sequestration)			783	882		2223	2288
Compliance summary							
Allowances issued (cap)	n.a.	6189	6189	6189	4818	4818	4818
Covered emissions, less offset credits	6151	6909	6268	6164	7794	6055	5989
Net allowance bank change	0	0	-79	25	0	0	0
TAP sales	0	0	0	0	0	1237	1171
Allowance price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	13	13	0	25	25
TAP price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	15	15	0	25	25
Delivered energy prices (2005 dollars per unit indicated)							
Motor gasoline, transport (per gallon)	2.32	1.95	2.04	2.01	2.14	2.32	2.18
Jet fuel (per gallon)	1.77	1.37	1.49	1.48	1.50	1.74	1.75
Diesel (per gallon)	2.41	2.05	2.18	2.21	2.21	2.47	2.53
Natural gas (per thousand cubic feet)							
Residential	12.80	10.73	11.32	11.25	11.67	12.50	12.44
Electric power	8.41	5.73	6.16	6.04	6.32	6.73	6.71
Coal, electric power sector (per million Btu)	1.53	1.53	2.77	2.72	1.61	3.89	3.88
Electricity (cents per kilowatthour)	8.10	7.65	8.05	8.08	7.83	8.43	8.44
Energy consumption (quadrillion Btu)							
Liquid fuels	40.7	44.2	43.1	42.2	48.3	46.6	45.2
Natural gas	22.7	26.2	25.6	25.2	26.3	23.4	23.3
Coal	22.9	25.3	22.5	21.9	29.9	23.2	22.4
Nuclear power	8.1	8.9	9.1	9.2	8.8	11.8	12.7
Renewable/Other	6.0	8.5	10.0	11.1	9.1	12.5	12.5
Total	100.3	113.1	110.2	109.7	122.4	117.4	116.0
Purchased electricity	12.5	14.7	14.5	14.5	16.3	16.0	15.9
Electricity generation (billion kilowatthours)							
Petroleum	141	117	58	59	120	53	54
Natural gas	752	1024	1100	1041	967	721	741
Coal	2015	2298	2058	1993	2911	2405	2275
Nuclear power	780	858	871	885	846	1131	1219
Renewable	350	512	664	772	543	956	976
Total	4038	4808	4752	4749	5387	5265	5264

TAP: Technology Accelerator Payment

Source: NEMS runs S1766HTBASE.D102307A, S1766HT.D110807C, and S1766POLRP.D120507B.

Table 4: Summary Energy Market Results for the Reference, S. 1766 Reference Plus Policies, and Limited Alternatives Cases

(million metric tons CO_2 equivalent, except as noted)

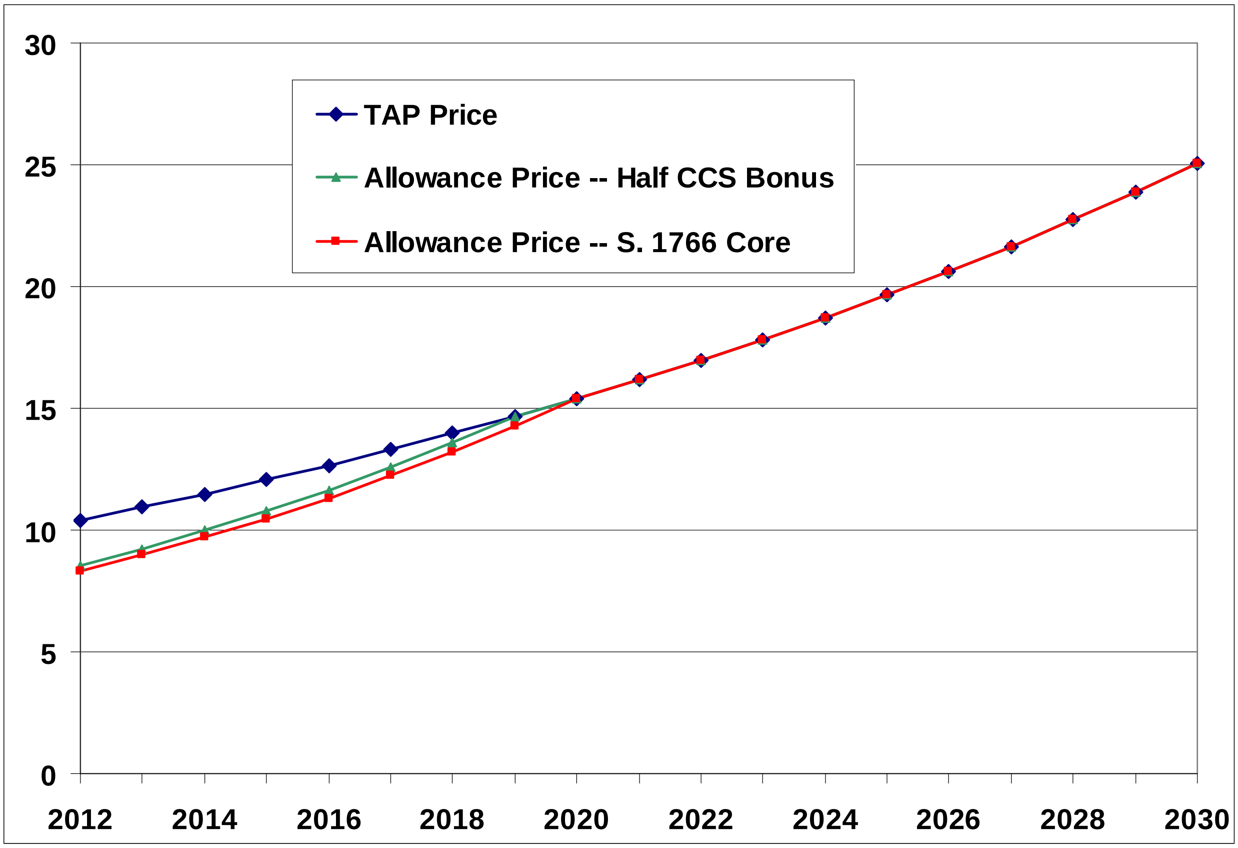
	2005	2020			2030		
		Reference	S. 1766 Reference & Policies	Limited Alternatives	Reference	S. 1766 Reference & Policies	Limited Alternatives
Greenhouse gas emissions							
Energy-related carbon dioxide	5945	6886	6133	6572	7889	5627	7134
Other covered emissions	194	378	300	299	559	468	468
Total covered emissions	6140	7264	6433	6871	8448	6094	7602
Total greenhouse gas emissions	7147	8383	7445	7881	9673	7162	8667
Emissions reduction from Reference case							
Energy-related carbon dioxide		n.a.	753	314	n.a.	2262	754
Carbon capture and storage		*n.a.*	*237*	*0*	*n.a.*	*1379*	*0*
Other covered emissions		n.a.	77	79	n.a.	91	91
Offset credits		n.a.	105	106	n.a.	153	153
Nonenergy carbon dioxide		n.a.	3	3	n.a.	5	7
Total emissions reduction			938	502		2511	1006
Biogenic carbon sequestration			165	171		479	479
Total (including carbon sequestration)			1103	673		2989	1484
Compliance summary							
Allowances issued (cap)	n.a.	6189	6189	6189	4818	4818	4818
Covered emissions, less offset credits	6151	7264	6328	6765	8448	5942	7450
Net allowance bank change	0	0	-139	0	0	0	0
TAP sales	0	0	0	576	0	1124	2632
Allowance price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	15	15	0	25	25
TAP price (2005 dollars per metric ton CO_2 equivalent)	n.a.	0	15	15	0	25	25
Delivered energy prices (2005 dollars per unit indicated)							
Motor gasoline, transport (per gallon)	2.32	1.97	2.04	2.09	2.21	2.21	2.41
Jet fuel (per gallon)	1.77	1.40	1.54	1.54	1.64	1.87	1.87
Diesel (per gallon)	2.41	2.09	2.26	2.23	2.35	2.61	2.61
Natural gas (per thousand cubic feet)							
Residential	12.80	10.85	11.29	11.86	11.69	12.56	13.73
Electric power	8.41	5.93	6.09	6.88	6.46	6.74	8.53
Coal, electric power sector (per million Btu)	1.53	1.57	2.96	3.01	1.70	4.09	3.98
Electricity (cents per kilowatthour)	8.10	7.90	8.21	8.53	8.06	8.90	9.68
Energy consumption (quadrillion Btu)							
Liquid fuels	40.7	46.5	44.2	45.4	52.0	47.4	50.0
Natural gas	22.7	27.1	25.5	27.4	26.9	23.1	28.5
Coal	22.9	27.1	24.2	24.4	34.1	30.1	26.6
Nuclear power	8.1	9.2	9.7	9.2	9.1	10.2	9.3
Renewable/Other	6.0	8.4	11.3	8.8	9.1	11.7	11.7
Total	100.3	118.4	114.9	115.3	131.2	122.4	126.2
Purchased electricity	12.5	15.5	15.3	15.2	17.6	17.3	16.9
Electricity generation (billion kilowatthours)							
Petroleum	141	120	62	66	124	52	67
Natural gas	752	1055	952	1263	923	532	1383
Coal	2015	2475	2246	2208	3340	3226	2505
Nuclear power	780	885	933	885	869	974	896
Renewable	350	505	791	529	541	870	671
Total	4038	5039	4983	4952	5797	5654	5522

TAP: Technology Accelerator Payment

Source: NEMS runs S1766BASE.D102307A, S1766REFPOLS.D120507C, and S1766BIV.D102907A.

From 2012 to 2020, covered emissions in the S. 1766 Core case match the cap on a cumulative basis, with allowance banking accounting for the year-to-year variations from the cap.[17] By 2030, projected covered emissions, net of offsets, in the S. 1766 Core case are 6,085 million metric tons (mmt) CO_2 equivalent, while the 2030 cap is 4,818 mmt. This implies the use of the TAP provision to pay for the excess emissions of 1,267 mmt in 2030.

Figure 2: Projected Allowance Prices in the S. 1766 Core and Half CCS Bonus Cases
(2005 dollars per metric ton carbon dioxide equivalent)



Source: NEMS runs S1766.D103007A and S1766ALTCCS.D103007A.

Due to the additional credits for CCS, the dominant compliance strategy in the S. 1766 Core case is the adoption of new coal-fired plants with CCS in the electric power sector. CCS is assumed to be an option for new coal and natural gas power plants, although it has higher capital and operating costs than conventional plants. S. 1766 provides a significant incentive to invest in and operate plants with CCS through a combined offset credit and multiple bonus credits. Under S. 1766, each ton of CO_2 emissions avoided through CCS qualifies for an offset credit, which can be used as an allowance. The value of the offset credit, which reflects the allowance price, provides an economic incentive for the CCS investment. In addition, S. 1766 further increases the economic attractiveness of CCS by offering an incentive bonus in the form of multiple

[17] Some impacts on emissions are evident before the 2012 regulation onset. The pre-2012 impacts result from the bill's early reduction incentives and the assumption that enactment would influence energy investment decisions immediately.

allowances for each ton reduced over the first 10 years of CCS plant operation. The bonus rate is 3.5 allowances per ton of CO_2 captured and stored in 2012. The bonus rate gradually drops to 1.9 allowances per ton in 2025 and to 0.9 in 2030. The combination of the offset credits and bonus allowances makes CCS an attractive compliance strategy at much lower allowance prices than it otherwise would be. The bonus makes CCS more competitive compared to nuclear and other carbon-neutral generating technologies at any given allowance price.

In the S. 1766 Core case, CO_2 reductions from CCS are projected to be 1,511 mmt in 2030, nearly all of which occur at coal-fired plants. Providing the bonus incentive for this sequestration at plants 10 years old or less requires an estimated 1,151 million allowances in 2030, or 24 percent of the total allowances created for 2030. Sec. 201 of S. 1766 initially allocates 8 percent of allowances for distribution as bonus CCS incentives, but additional allowances for CCS and agricultural sequestration can be drawn from the allowances in the auction pool if needed. In the S. 1766 Core case, the allowances for the CCS bonus incentive exceed the 8-percent allocation beginning in 2019. The maximum share of allowances for bonus CCS incentives in any year is 38 percent in 2026 in the S. 1766 Core case. This reduces the 2026 allowance auction share from 45 percent as initially allocated in Sec. 201 to14 percent after adjusting for the incremental allowances needed for CCS bonus and agricultural sequestration incentives.

As seen in Figure 1, covered emissions in the S. 1766 Core case stop declining after 2025, reflecting the reaction to a gradually declining CCS bonus allowance incentive and the slowing of the allowance price increase once the TAP price is reached. Initially, the bonus CCS rate provision provides a strong incentive to deploy CCS technology. Towards the end of the projection, however, the declining bonus rate eventually becomes insufficient to induce continued rapid growth in CCS investment, and the covered emissions level off after 2025.

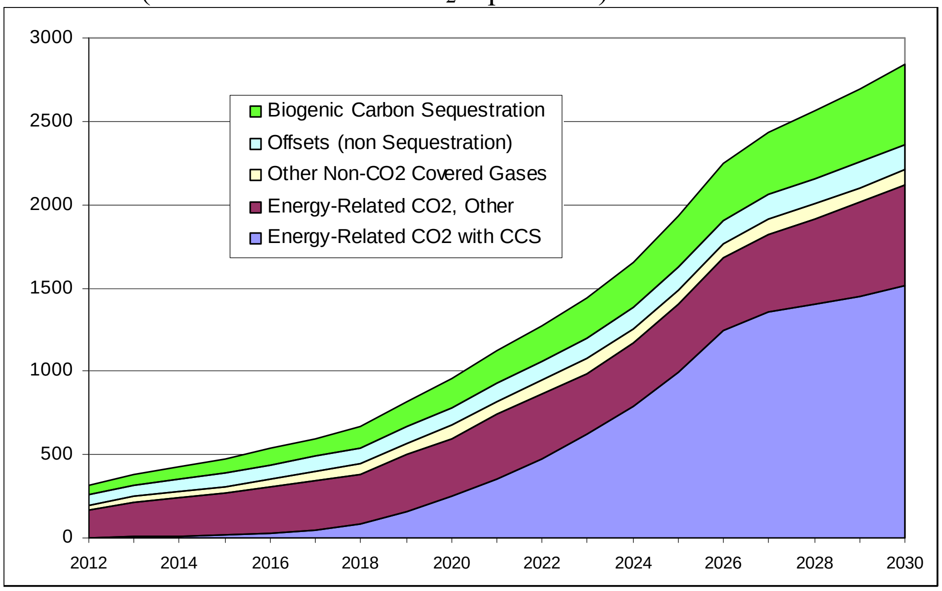
Of course, many factors could affect the potential success of the CCS bonus provisions and the results in the S. 1766 Core could overstate its potential contribution. For example, it could take many years to fully commercialize the technology and its cost and/or performance could turn out to be less attractive than expected. In the Half CCS Bonus case, with half the bonus rate of the S. 1766 Core case, substantially less penetration of CCS occurs. By 2030, the projected emission offset through CCS in the Half CCS Bonus case is 246 mmt, compared to 1,511 mmt in the S. 1766 Core case. The maximum share of allowances required for the bonus CCS incentive is 2 percent in the Half CCS Bonus case. As a result, the Half CCS Bonus case has a higher share of auctioned allowances than the S. 1766 Core case throughout the projection period.

Figure 3 breaks out the sources of emission reductions in the S. 1766 Core case, relative to the Reference case. In the first several years, CO_2 reductions, including those associated with CCS, constitute about half of the annual emissions impact. Once CCS begins to penetrate, the CO_2 share of reductions increases, reaching 75 percent by 2030. The overall contribution of CO_2 reductions in the Half CCS Bonus case also grows over time, but the CCS share is substantially reduced (Figure 4). The emissions reduction from CCS reaches a maximum of 10 percent by 2030, compared to 53 percent in the S. 1766 Core case.

In addition to the incentive for CCS, S. 1766 provides an incentive for carbon sequestration in agriculture, where allowances are exchanged for certified increases in carbon sequestration. Because the increase in carbon sequestration is not credited as an offset, the increases in carbon sequestration represent an additional impact of the bill, over and above the covered emissions reduction. In Figures 3 and 4, biogenic carbon sequestration is included among the emissions impact sources.[18] By 2030, biogenic carbon sequestration is projected to account for 17 percent of the total emissions impact in the S. 1766 core case and 20 percent in the Half CCS Bonus case.

Figure 3: Emissions Reductions and Offsets in the S. 1766 Core Case

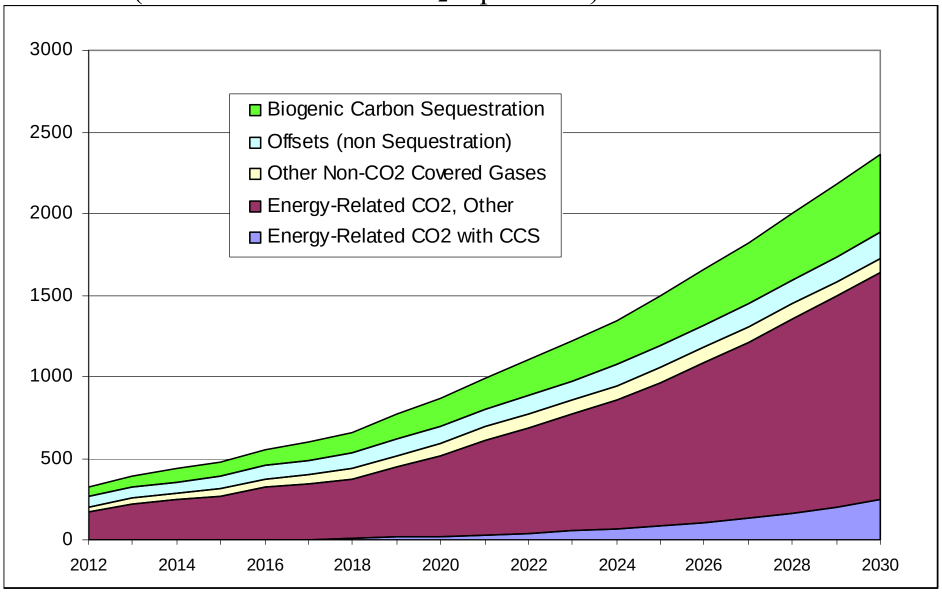
(million metric tons CO_2 equivalent)



Source: NEMS runs S1766BASE.D102307A and S1766.D103007A

[18] With the secondary information sources used, it was not possible to distinguish agricultural sequestration from forestry. As a result, all biogenic sequestration was assumed to be eligible for the incentive.

Figure 4: Emissions Reductions and Offsets in the Half CCS Bonus Case
(million metric tons CO_2 equivalent)

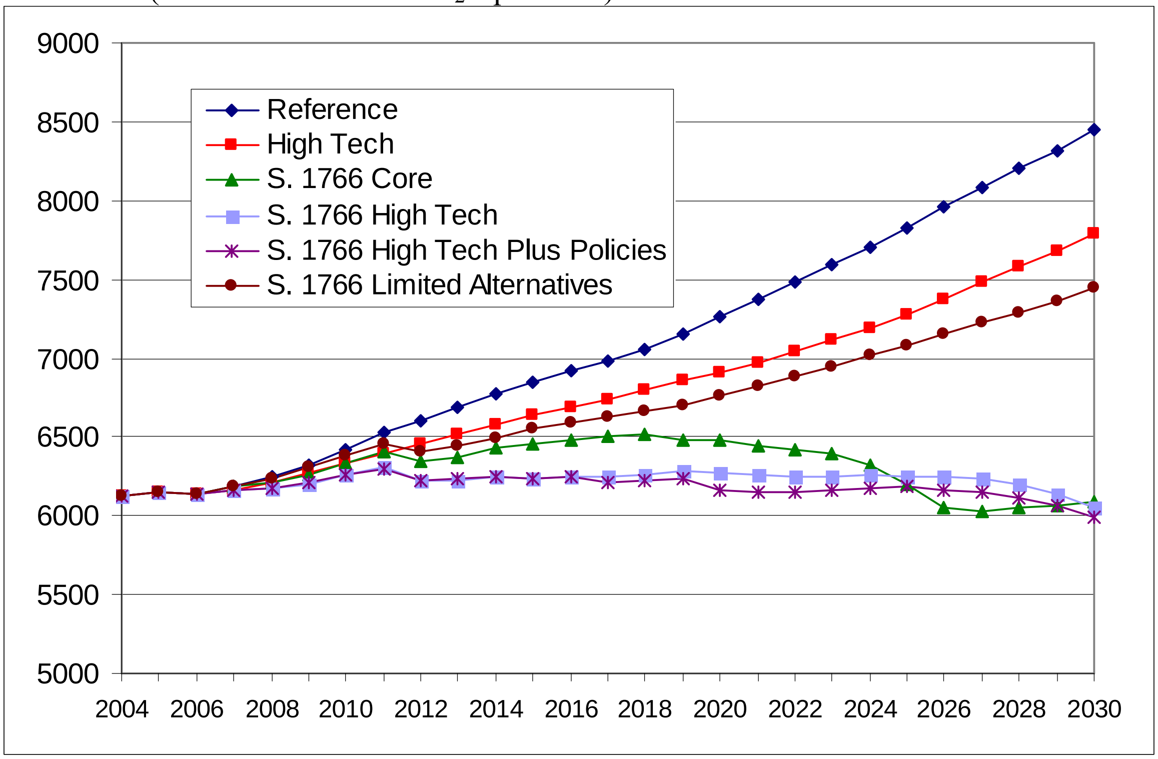


Source: NEMS runs S1766BASE.D102307A and S1766ALTCCS.D103007A.

In the S. 1766 High Technology case, projected emissions are initially lower than in the S. 1766 Core case, but ultimately converge to similar levels (Figure 5). The allowance price in the S. 1766 High Technology case is lower than in the S. 1766 Core case until 2026, when it reaches the TAP level (Figure 6). The lower early allowance prices in the S. 1766 High Technology case reduce the incentive to invest in CCS because their multiple bonus allowances are not as valuable. As a result, CCS plays a reduced role as a compliance strategy under the high technology assumptions, while nuclear and renewable plant alternatives become relatively more cost effective.

Figure 5: Covered GHG Emissions Net of Offset

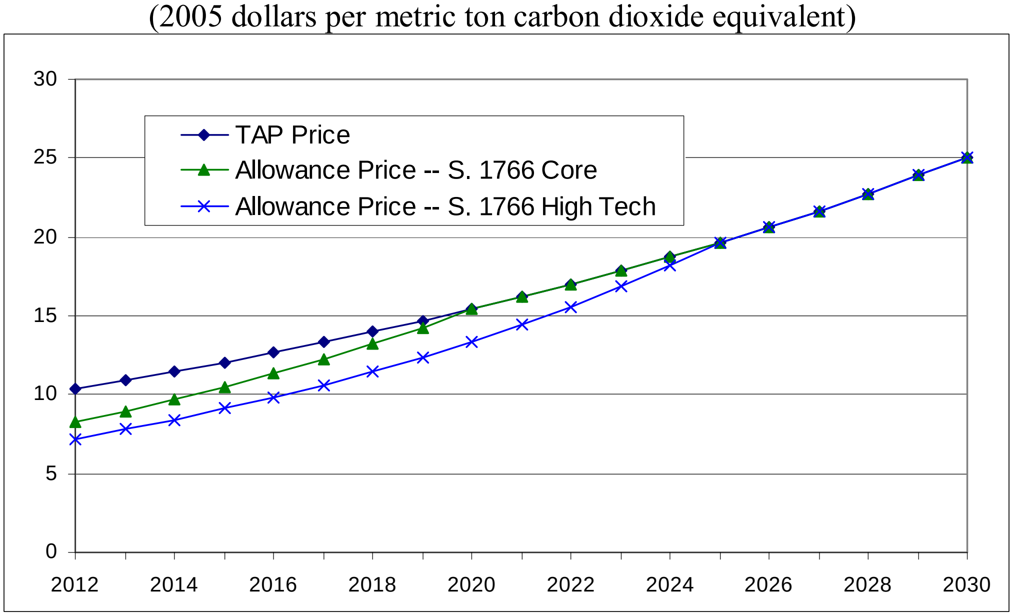
(million metric tons CO_2 equivalent)



Source: NEMS runs S1766BASE.D102307A, S1766HTBASE.D102307A, S1766.D103007A, S1766HT.D110807C, S1766POLRP.D120507B, and S1766BIV.D102907A.

Figure 6: Projected Allowance Prices in the S. 1766 Core and S. 1766 High Technology Cases

(2005 dollars per metric ton carbon dioxide equivalent)

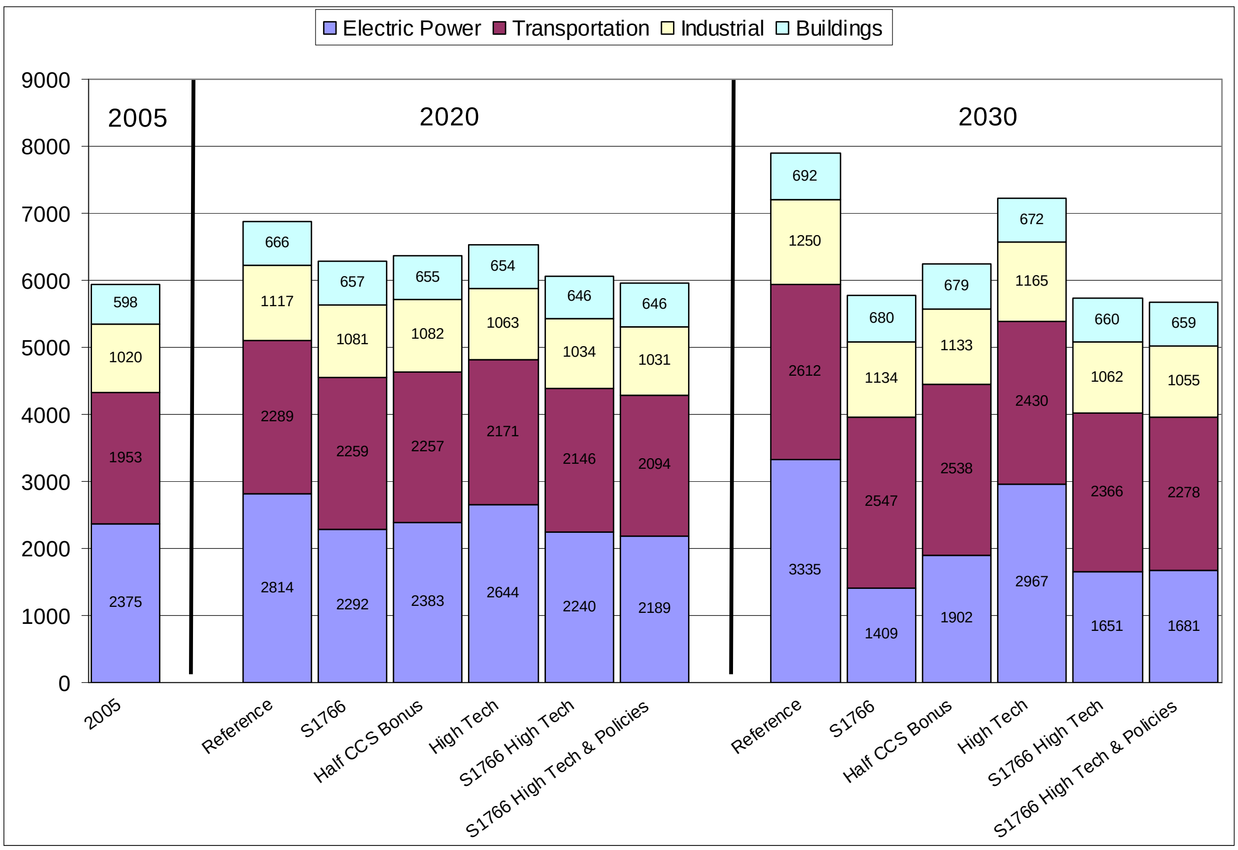


Source: NEMS runs S1766.D103007A and S1766HT.D110807C.

Energy Market Impacts

As discussed in the previous section, most of the energy-related CO_2 emissions reductions in the S. 1766 cases are associated with electricity generation (Figures 7 and 8).[19] Reductions in the industrial and transportation sector account for nearly all the remaining impact. In the Half CCS Bonus case, the pattern is similar, but the reductions come primarily from a shift away from coal use, rather than from CCS at new coal plants. Relative to the High Technology case, CO_2 reductions in the S. 1766 High Technology and S. 1766 High Technology Plus Policies cases also occur primarily in the electric power sector, but the share of emissions reductions from industrial and transportation sectors is greater.

Figure 7: Energy-Related CO_2 Emissions by Sector
(million metric tons CO_2)



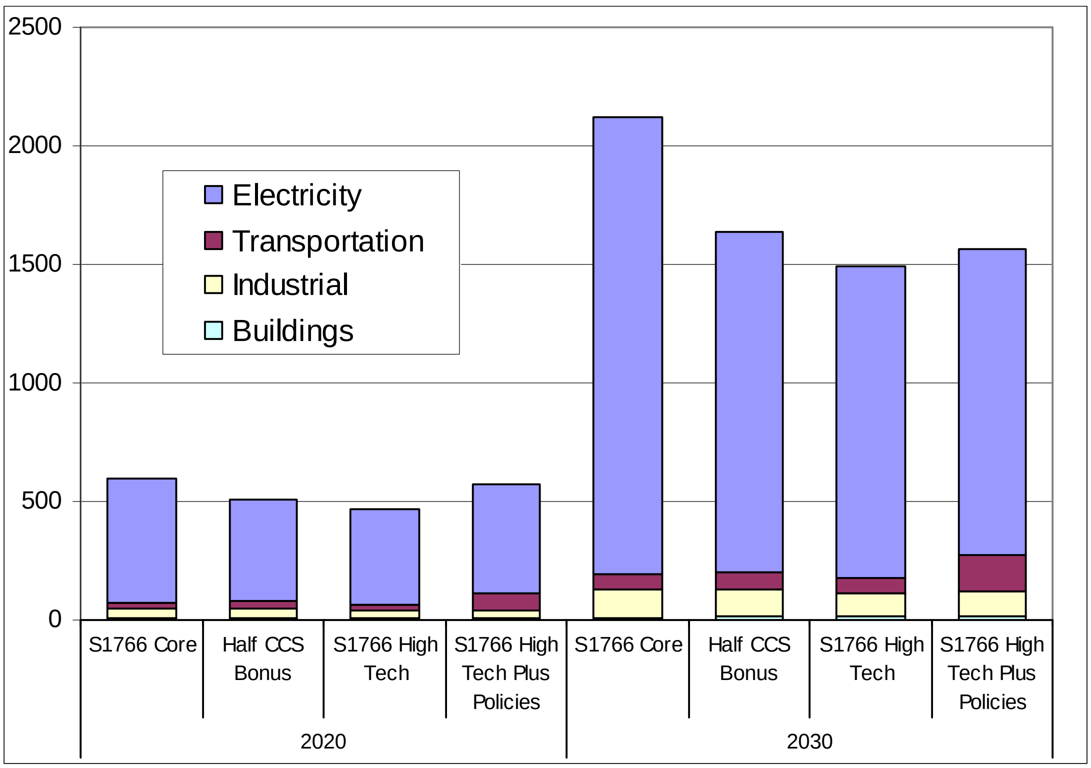
Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, S1766HTBASE.D102307A, S1766HT.D110807C, and S1766POLRP.D120507B.

In the S. 1766 High Technology Plus Polices case, the higher fuel economy standards bring about a somewhat greater reduction in emissions in the transportation sector than in the S. 1766 High Tech case. In the S. 1766 High Technology case, direct CO_2 emissions (excluding electricity-related) from transportation in 2030 are 2,366 mmt, compared to 2,278 in the S. 1766 High Tech Plus Policies case. Some of the lower emissions that would otherwise result from a

[19] In Figures 7 and 8, 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.

more efficient vehicle stock are offset by higher travel demand because vehicle miles traveled are 4 percent higher in 2030 than in the S. 1766 High Technology case--a so-called "rebound effect." Travel demand is influenced by the cost of driving, which is lowered with more efficient vehicles, as well as by slightly lower gasoline prices--15 cents per gallon less in 2030--compared to the S. 1766 High Technology case, which results from the greater market supply response to lower gasoline use.

Figure 8: Energy-Related CO_2 Emissions Reduction from Respective Baseline
(million metric tons)



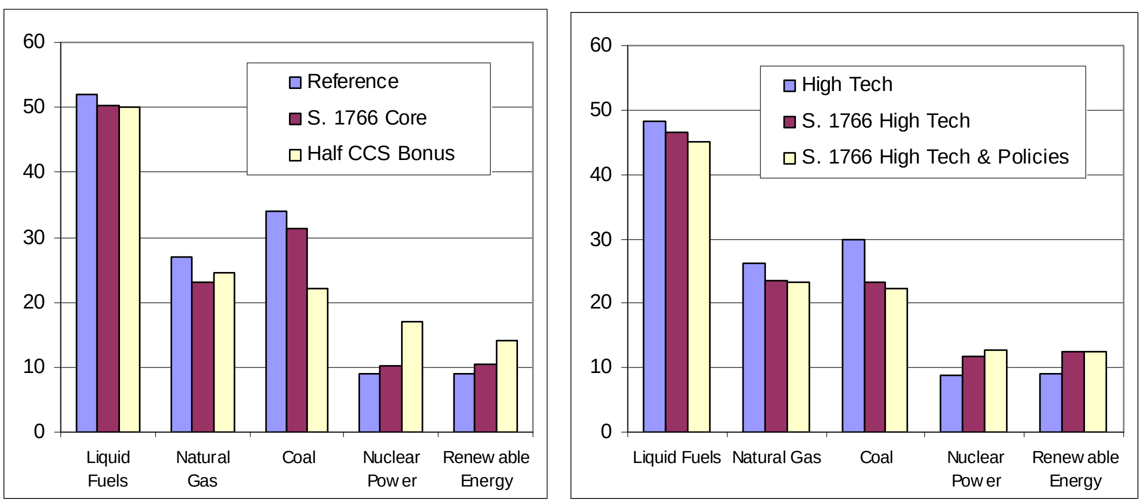
Note: Reductions for the S. 1766 Core and Half CCS Bonus cases are relative to the Reference case. Reductions for the S. 1766 High Technology and S. 1766 High Technology Plus Policies cases are relative to the High Technology case.
Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, S1766HTBASE.D102307A, S1766HT.D110807C, and S1766POLRP.D120507B.

In the four main policy cases considered, the overall impact of S. 1766 is to lower projections of coal, petroleum, and natural gas consumption compared to the Reference case, while increasing the use of renewables and nuclear energy (Figure 9). Through 2025, natural gas use is generally near or above Reference case levels because of fuel switching in the electric power sector. However, by 2030, new nuclear, renewable, and coal with CCS power generation is added and natural gas use falls below Reference case levels. In the cases based on Reference case technology assumptions, the results depend heavily on the amount of the CCS bonus. In the S. 1766 Core case, projected 2030 coal consumption is reduced by 8 percent relative to the Reference case level, while natural gas is reduced by 14 percent and liquid fuels are reduced 4 percent. In the Half CCS Bonus case, a much greater reduction in coal use is projected (35 percent), along with an 87-percent increase in nuclear energy and a 57-percent increase in renewable energy.

Under high technology assumptions, the allowance prices do not increase as fast, and all generating technology costs are assumed to be 10 percent lower than in the S. 1766 Core case. As a result, CCS does not penetrate the market as much as in the S. 1766 Core case, and the comparable reduction in coal use by 2030 is between 22 and 25 percent, relative to the High Technology case, compared to an 8-percent reduction in the S. 1766 Core case, relative to the Reference case.

The results under the S. 1766 Limited Alternatives case demonstrate the impacts if nuclear energy and biomass were restricted to *AEO2007* Reference case levels, CCS technology remained unavailable through 2030, and LNG imports were constrained. In this case, allowance prices would be driven to the TAP level by 2017, projections of natural gas consumption and wellhead prices would remain above Reference case levels after 2020, and much lower reductions in energy-related CO_2 emissions would be achieved: a 10-percent reduction from the Reference case in 2030, compared to a 27–percent reduction in the S. 1766 Core case.

Figure 9: Projected Energy Consumption by Source in 2030
(quadrillion Btu)



Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, S1766HTBASE.D102307A, S1766HT.D110807C, and S1766POLRP.D120507B.

Electricity Sector Emissions, Generation, and Prices

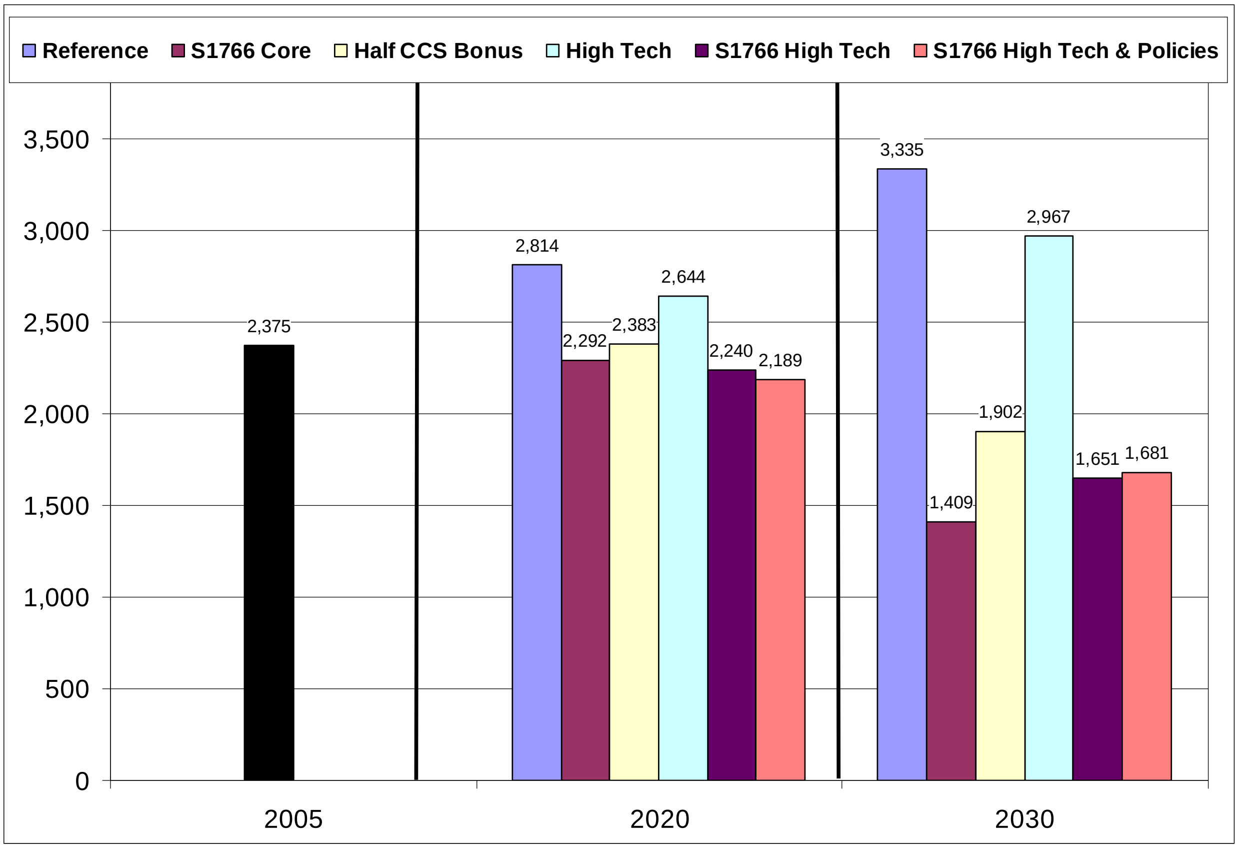
The provisions of S. 1766 alter electric power projections by favoring low-carbon technologies such as coal gasification plants that sequester CO_2, renewable facilities, and nuclear power. The impact of CCS technology is particularly pronounced because of the provisions that provide multiple allowances to these plants for each ton of CO_2 sequestered. In previous 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 offset credits and bonus allowances provided for CCS in S. 1766 significantly improve its relative economics. 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

As discussed, the electric power sector is expected to be the dominate source of U.S. emission reductions under S. 1766. In the S. 1766 Core case, CO_2 emissions from power stations fall below 2005 levels in 2018 and continue decreasing through 2030 (Figure 10). The pattern is similar in all the policy cases, though the power sector emissions do vary across the cases. In the Half CCS Bonus case, the reductions do not occur as quickly and are smaller than in the S. 1766 Core case. In the S. 1766 Core case, the 2030 CO_2 emissions are below the 2005 level and 58 percent below the Reference case level. The drop is caused largely by the decreasing generation from conventional coal plants which emit the largest amount of CO_2 per kilowatthour produced. The Half CCS Bonus case also has 2030 power sector CO_2 emissions that are below 2005 emissions, but they are only 43 percent less than the emission level projected in the Reference case. In all of the S. 1766 cases, nitrogen oxide and sulfur dioxide emissions from the power sector also fall well below the 2030 Reference case projections as the use of older coal plants declines.

In the High Technology cases, lower allowance prices and greater emissions reductions in the commercial, residential, industrial, and transportation sectors dampen the emissions reductions from the power sector. However, technology switching and lower electricity demand still cause a substantial drop in emissions in the S. 1766 High Technology case. Without S. 1766, CO_2 emissions in 2030 the High Technology case are 11 percent lower than in the Reference case. In the S. 1766 High Technology case, 2030 electric power sector emissions are 44 percent below the level projected in the High Technology case, but 17 percent higher than in the S. 1766 Core case.

Figure 10: Electric Power Sector Carbon Dioxide Emissions
(million metric tons)



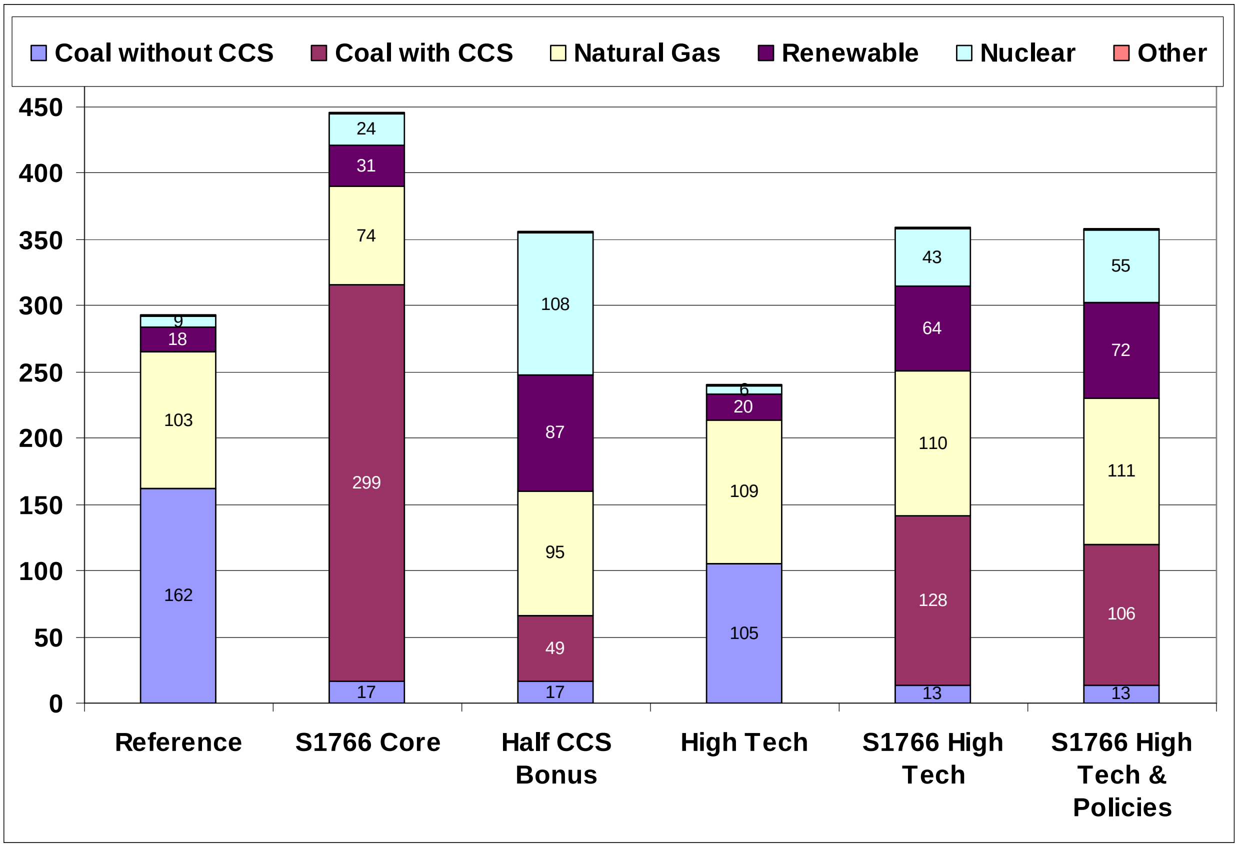
Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, S1766HTBASE.D102307A, S1766HT.D110807C, and S1766POLRP.D120507B.

Capacity and Generation

In the Reference case, coal plants without CCS meet a large share of new capacity requirements through 2030 (Figure 11). 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.

Under S. 1766, power plant choices are projected to shift to coal plants with CCS and, to a lesser degree, renewable and nuclear capacity. However, the projected mix of plants added under S. 1766 is sensitive to the CCS bonus rate and the level of allowance prices. In the S. 1766 Core case, nearly 300 gigawatts of new coal plants with CCS are added to meet growing electricity demand and replace electricity from coal plants without CCS that are retired or used less intensively. Overall, S. 1766 increases new capacity additions by approximately 40 percent above the level projected in the Reference case, because of the need to replace older coal, oil, and natural gas steam plants without CCS. While the incentives for CCS plants are expected to make them economically attractive, constructing the nearly 300 gigawatts of such capacity projected by 2030 would be extremely challenging. For example, if the technology were not fully commercialized until 2020, reaching nearly 300 gigawatts of capacity by 2030 would require the addition of 40 to 50 plants per year, a daunting challenge.

Figure 11: Cumulative Electricity Generating Capacity Additions
(gigawatts)



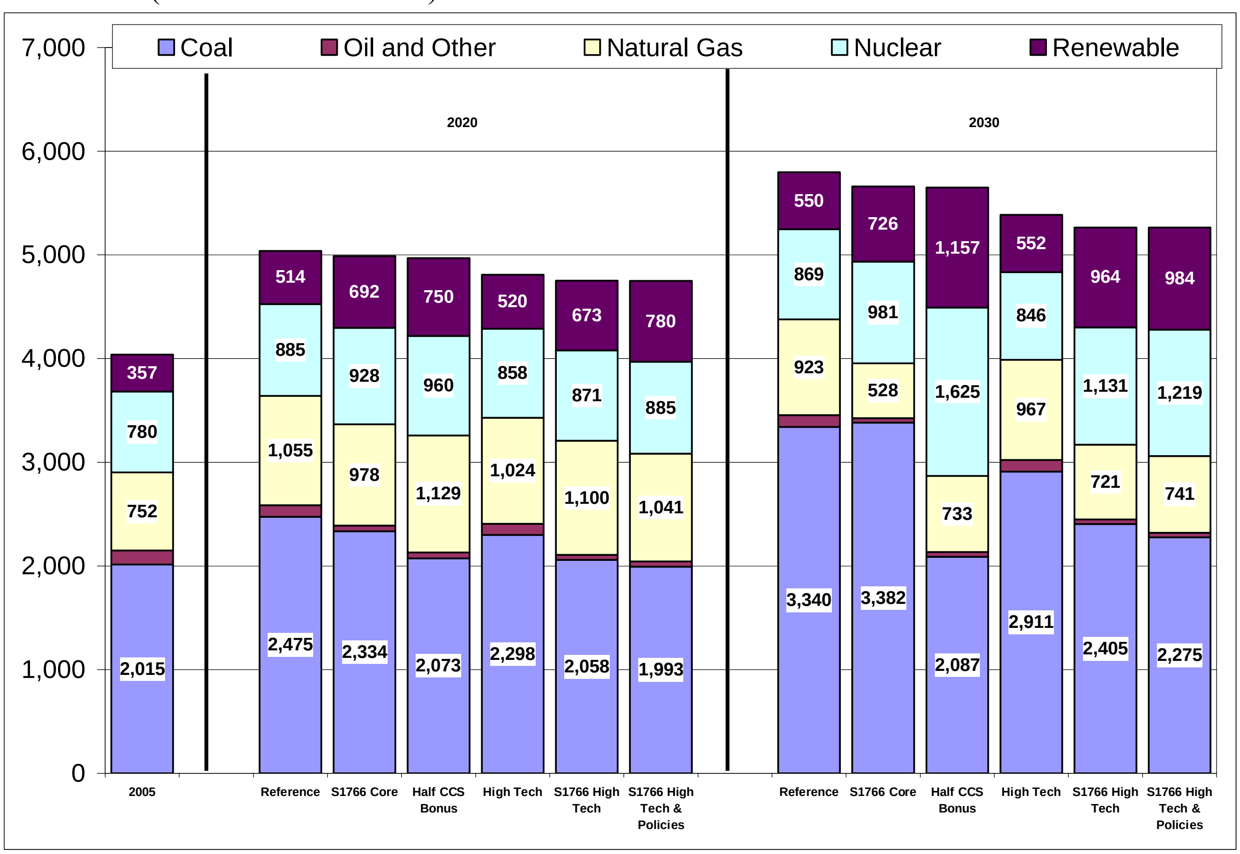
Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, S1766HTBASE.D102307A, S1766HT.D110807C, and S1766POLRP.D120507B.

When the number of allowances given to new plants with CCS for each ton sequestered is reduced in the Half CCS Bonus case, only 49 gigawatts of such CCS-equipped capacity is projected by 2030, and other low-carbon technologies including nuclear plants and renewable facilities play a larger role in lowering electric power sector emissions. However, electric power sector CO_2 emissions are significantly higher as a result (Figure 10) in this case than in the S. 1766 Core case, because power companies choose to pay the TAP earlier rather than further reduce their emissions.

More rapid technology improvement assumptions also lessen the penetration of new coal plants with CCS. The S. 1766 High Technology case still relies on this technology to meet emission reduction requirements, however the 128 gigawatts of projected capacity by 2030 is much more modest than the S. 1766 Core case despite the favorable credit environment. Relative to the S. 1766 Core Case, the combination of lower GHG allowance prices through 2025 and the lower electricity demand growth resulting from greater efficiency improvements in all sectors of the economy reduces the penetration of new coal plants with CCS in the S. 1766 High Technology case. By reducing the value of the CCS bonus, the lower allowance prices in the S. 1766 High Technology and S. 1766 High Technology Plus Policies cases also make new nuclear and renewable technologies relatively more attractive and they play a larger role in these cases than they do in the S. 1766 Core case. When compared to the results in the High Technology case, the power sector still adds substantially more capacity and turns to a mix of new coal plants with CCS, renewable, and nuclear plants in the two S. 1766 High Technology cases.

The projections of generation by fuel are consistent with the capacity choices and are influenced by allowance prices and the CCS bonus incentive (Figure 12). In the Reference case, coal generation reaches 3,340 billion kilowatthours by 2030, a 66-percent increase from the 2005 level. In the S. 1766 Core case, 2030 coal generation reaches a similar level, but two-thirds of it comes from new coal plants with CCS rather than from existing coal plants without CCS. In the Half CCS Bonus case projected coal-fired generation declines to 2,087 billion kilowatthours by 2030, similar to the 2005 level.

Figure 12: Generation by Fuel in Alternative Cases
(billion kilowatthours)



Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, S1766HTBASE.D102307A, S1766HT.D110807C, and S1766POLRP.D120507B.

Increases in nuclear and renewable power are projected in all of the policy cases, relative to the appropriate non-policy cases. The results are sensitive to the size of the CCS bonus, the allowance prices, and the assumptions about technology improvements. In the Reference case, nuclear capacity grows by 9 gigawatts through 2030. This growth is largely spurred by the incentives offered in the Energy Policy Act of 2005 (EPAct 2005). In the S. 1766 Core case, nuclear capacity is projected to increase, but its role is tempered by the growth of coal with CCS. The S. 1766 Core case projects an additional 15 gigawatts of nuclear capacity in 2030 over the Reference case projection. However, in the Half CCS Bonus case, 2030 nuclear capacity is 84 gigawatts higher than in the S. 1766 Core case and 99 gigawatts higher than in the Reference case. In the Half CCS Bonus case, nuclear generation in 2030 reaches 1,625 billion kilowatthours, 87 percent above the Reference case, and nuclear plants account for 29 percent of total electricity generated. Nuclear power also plays an important role in the S. 1766 High Technology cases, where lower allowance prices reduce the value of the bonus allowances to CCS and assumed technology improvements make nuclear power relatively more attractive than in the S. 1766 Core case.

Almost 80 percent of existing renewable capacity is comprised of hydroelectric plants, with wind, municipal solid waste, biomass, and geothermal energy accounting for virtually all of the remainder. In the Reference case, a 17-percent increase in renewable capacity is projected by 2030. Most of this growth comes from the addition of new wind and biomass plants.[20] While there are 13 gigawatts more renewable capacity and generation projected in the S. 1766 Core case, the potential is tempered by the bonus allowances given to CCS plants. Nearly all of the renewable capacity is from dedicated biomass. The remaining additions are wind and municipal solid waste plants. In the Half CCS Bonus case, projected renewable capacity, primarily dedicated biomass, is 56 gigawatts higher in 2030 than in the S. 1766 Core case. Since new biomass plants operate to meet baseload demand, they are a better replacement for retiring coal capacity than intermittently-operating wind or solar plants. Faster renewable penetration occurs under the High Technology policy cases than in the S. 1766 case, but not to the level seen in the Half CCS Bonus case. Still, 29 gigawatts of additional renewable capacity, mostly biomass, is added by 2030 in the S. 1766 High Technology case when compared to the S. 1766 Core case.

Changes in renewable generation, for the most part, follow the changes in capacity discussed above with one exception, biomass co-firing. Existing coal plants can be modified to co-fire with biomass. The costs of these modifications are much lower than building dedicated biomass capacity, but the share of fuel that can be supplied by biomass is limited. The Reference case projects approximately 60 billion kilowatthours per year of this generation in the last 10 years of the projection period, compared to 7 billion kilowatthours of co-firing in 2005. The S. 1766 Core case shows more rapid growth: by 2021, over 200 billion kilowatthours are generated through co-firing. This drops to 153 billion kilowatthours by 2030 as new dedicated biomass plants compete for biomass fuel and produce 104 billion kilowatthours of generation.

Price and Demand

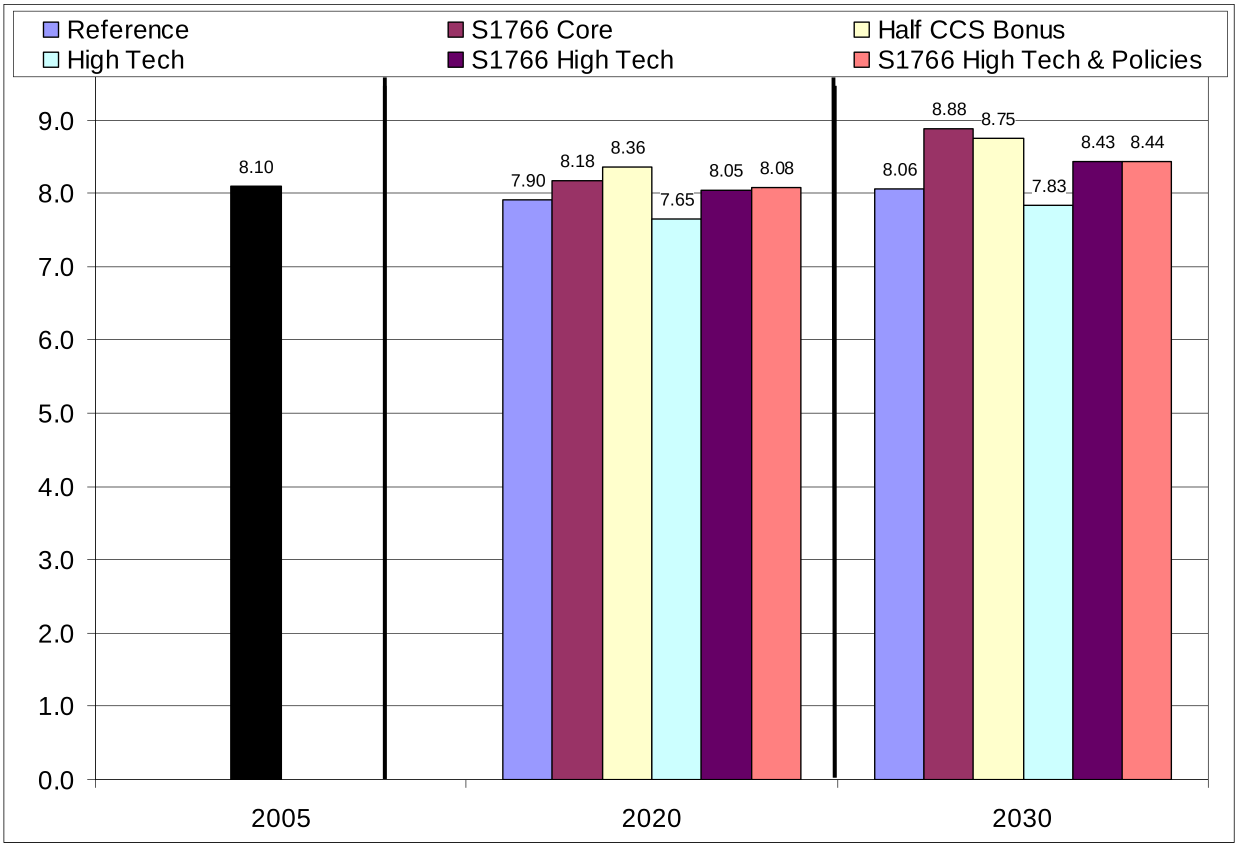
S. 1766 is expected to lead to higher electricity prices and lower electricity demand, with a lesser impact under the more rapid technology assumptions as in the High Technology cases. In the S. 1766 case, electricity prices reach 8.2 cents per kilowatthour in 2020 and 8.8 cents in 2030

[20] The capacity estimates for biomass facilities do not include the biomass co-fired at coal plants. This is counted in coal capacity projections.

(Figure 13). These prices are 4 percent and 10 percent higher, respectively, than the prices in the Reference case. The price increases are smaller in the S. 1766 High Technology cases, where the 2030 prices increase 8 percent above the price in the High Technology case.

Figure 13: Electricity Prices

(2005 cents per kilowatthours)



Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, S1766HTBASE.D102307A, S1766HT.D110807C, and S1766POLRP.D120507B.

Total consumer expenditures for electricity in the S. 1766 Core case, relative to the Reference case, are $71 billion greater over the 25-year projection period.[21] This added expenditure is a 1.7-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. The increase in consumer electricity expenditures ranges from $91 billion (2.3 percent) in the S. 1766 High Technology case to $81 billion (2.0 percent) in the S. 1766 High Technology Plus Policies case.

The higher electricity prices projected under S. 1766 (8 to 10 percent higher by 2030) are projected to result in a slight damping of electricity demand (2 percent by 2030). Projected total sales in the Reference case increase to 5,170 billion kilowatthours in 2030, a 41-percent increase from 2005. The S. 1766 Core case results in a 2030 aggregate demand of 5,073 billion

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[21] Costs accumulated from 2005 through 2030. All dollar values are 2005 dollars. Accumulated costs are discounted to 2005 using a 7-percent discount rate per guidance from OMB Circular A-94.

kilowatthours, 2 percent below the Reference case level. Because of the improvements in equipment efficiency, the High Technology cases show significantly lower electricity demand than in the Reference case, and the S. 1766 High Technology cases show still lower demand as consumers make additional investments in efficient appliances.

Effects of Limited Availability of Key New, Clean Generating Technologies

The results of the S. 1766 policy cases suggest that the power sector will turn to a combination of new CCS, renewable, and nuclear plants to reduce its emissions. However, there is substantial uncertainty about the potential pace and size of the expansion of these technologies. For example, new coal plants with CCS remain to be commercialized, renewable technologies other than hydroelectric continue to play a small role in overall electricity supply despite recent expansion, and new nuclear capacity has not been added in the United States for many years. It is certainly possible that the use of these technologies could expand rapidly if they are made economically attractive under the provisions of S. 1766. The existing fleet of approximately 100 gigawatts of U.S. nuclear capacity was nearly all brought on-line during the 20-year period from 1970 to 1990, despite the 1979 Three Mile Island accident and the 1986 accident at Chernobyl. Furthermore, the power industry demonstrated as recently as 2002, when nearly 60 gigawatts of capacity was brought on in a single year, that it can rapidly expand. However, given such uncertainties associated with developing, commercializing, and deploying these technologies rapidly, a prudent question to ask is what would happen under S. 1766 if the availability of these key technologies were limited. In the S. 1766 Limited Alternatives case it is assumed that:

- CCS is not available by 2030,
- Nuclear and biomass power plant additions are limited to Reference case levels, and
- LNG imports are limited to Reference case level.

The key finding in this case is that power producers choose not to reduce their CO_2 emissions as much as they do in the other policy cases (Figure 14). In fact, in the S. 1766 Limited Alternatives case, electric power sector CO_2 emissions continue to grow, albeit at a slower rate than in the Reference case. Instead of reducing their emissions sharply, power producers opt to pay the TAP.

Effects of Limited Availability of Key New, Clean Generating Technologies (cont'd)

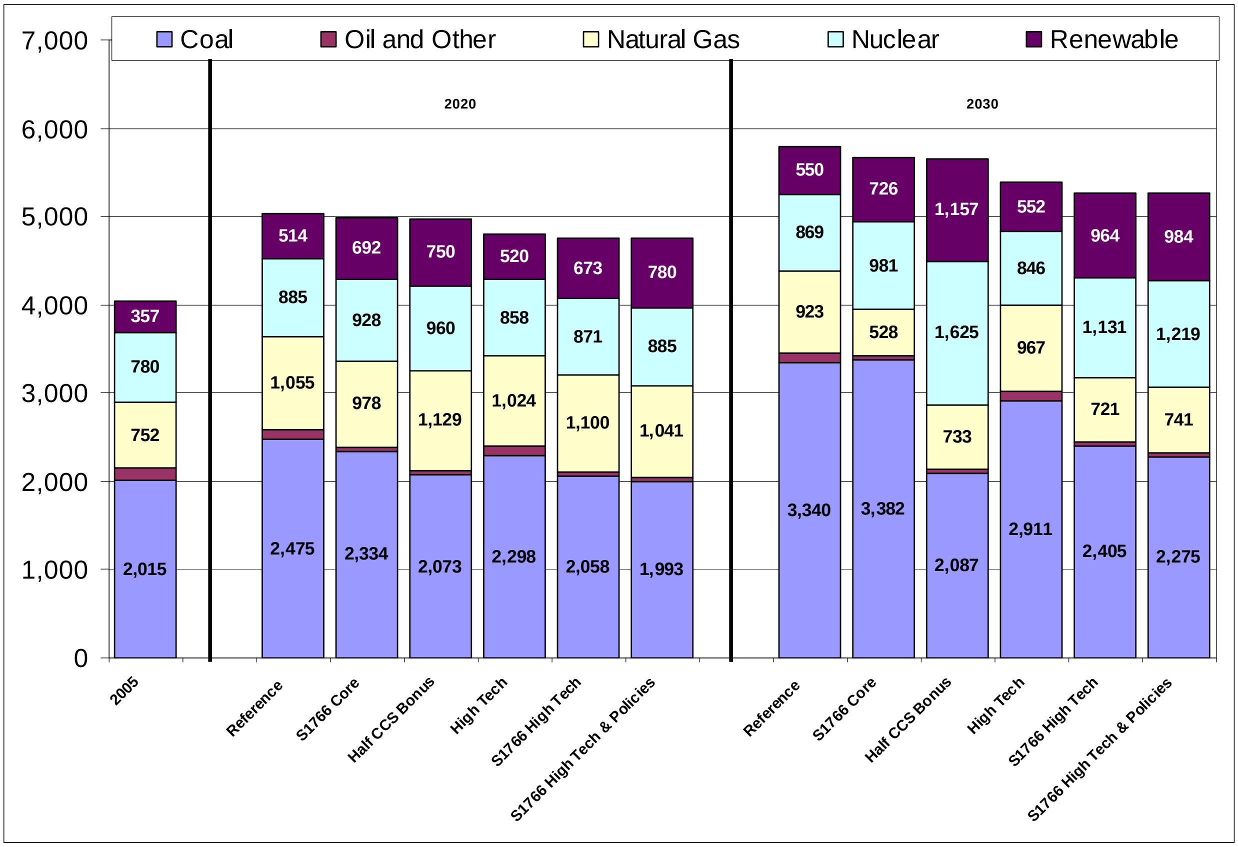
Figure 14: Electric Power Sector Carbon Dioxide Emissions
(million metric tons)

Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, and S1766BIV.D102907A.

Limiting the coal with CCS, nuclear, and biomass options also forces the electric power sector to rely more heavily on natural gas to reduce their emissions (Figure 15). In all other S. 1766 policy cases, total natural gas generation is projected to fall relative to Reference case levels as the power sector turns to coal with CCS, nuclear, and renewables. However, if these options have no or limited availability, shifting partially from coal to increased natural gas generation becomes an attractive emissions reduction option.

Effects of Limited Availability of Key New, Clean Generating Technologies (cont'd)

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

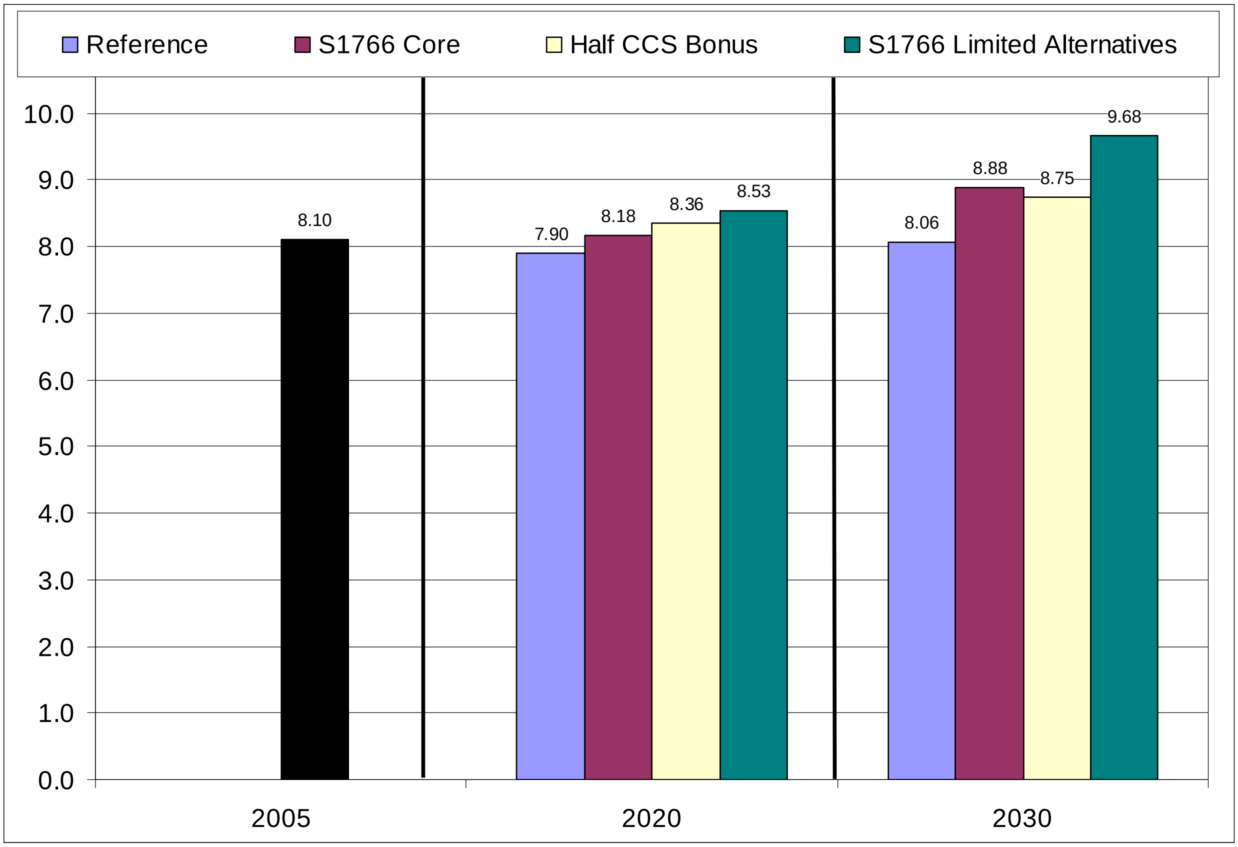


Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, and S1766BIV.D102907A.

The major consequence of the increased reliance on natural gas in the S. 1766 Limited Alternatives case is higher natural gas and electricity prices (Figure 16). Natural gas prices at the Henry Hub in the S. 1766 Limited Alternatives case are 10 percent higher in 2030 than in the Reference case, and 21 percent higher than in the S. 1766 Core case. Similarly, electricity prices in the S. 1766 Limited Alternatives case are 20 percent higher in 2030 than in the Reference case, and 9 percent higher than in the S. 1766 Core case. These combined effects increase the residential sector's total energy bill in 2030 by $35 billion (13 percent) relative to the Reference case and $15 billion (5 percent) relative to the S. 1766 Core case.

Effects of Limited Availability of Key New, Clean Generating Technologies (cont'd)

Figure 16: Electricity Prices
(2005 cents per kilowatthour)



Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, and S1766BIV.D102907A.

Transportation Fuel Use in Alternative Cases

The GHG cap-and-trade program in S. 1766 will lead to lower transportation sector CO_2 emissions as consumers modify their travel and vehicle purchase decisions in response to higher motor fuel prices. However, because the GHG cap-and-trade program in S. 1766 only increases 2030 motor gasoline prices by at most 20 cents per gallon (8 percent) in the various policy cases, the impacts on transportation sector fuel use and emissions are projected to be small. For example, by 2030 total transportation energy demand is reduced 2.4 percent between the High Technology and S. 1766 High Technology cases. An 80-percent share of this reduction in transportation energy is due to reduced travel from highway vehicles, a response to the higher projected fuel prices and reduced industrial output. Reductions in light duty-vehicle travel account for 60 percent of the total reduction in transportation fuel use between the S. 1766 High Technology case and the High Technology case. The remaining reductions in transportation energy demand between these cases can be attributed to reductions in rail coal shipments (9

Transportation Fuel Use in Alternative Cases (cont'd)

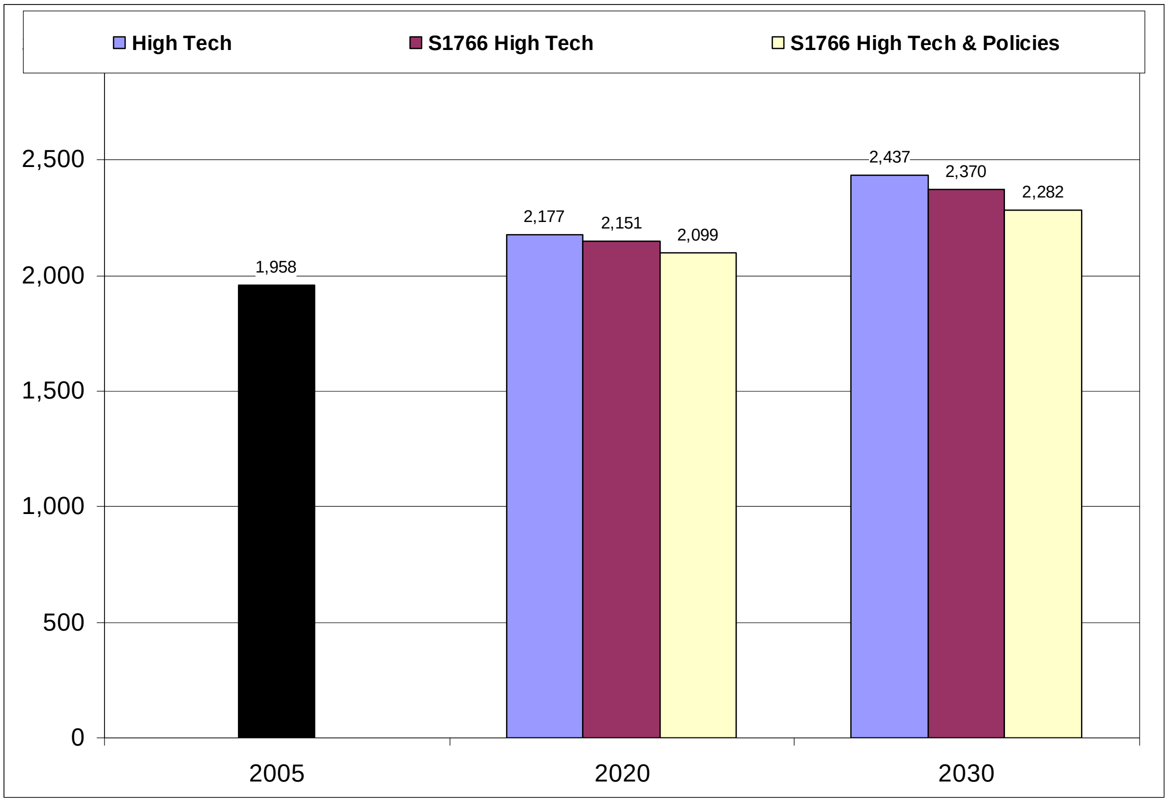
percent) and pipeline shipments (7 percent). Transportation sector CO_2 emissions between these two cases are reduced 2.7 percent by 2030 (Figure 17).

When the GHG cap-and-trade provisions in S. 1766 are combined with increasing fuel economy standards to 35 miles per gallon by 2020, the reduction in transportation sector fuel use and emissions are much larger. In the S. 1766 High Technology Plus Policies case, total transportation energy demand in 2030 is 6.5 percent lower than in the High Technology case. Total 2030 transportation sector CO_2 emissions are 6.4 percent lower in the S. 1766 High Technology Plus Policies case than in the High Technology case, a much larger change than occurred with S. 1766 alone.

While the increased CAFE standards reduce transportation sector energy demand and the associated GHG emissions, these reductions are achieved at a relatively high implicit allowance price. Test simulations with the NEMS transportation model were conducted to find an allowance price, beginning in 2012, that would induce consumers and manufacturers to change their behavior such that they achieve an average fuel economy for new light-duty vehicles of 35 miles per gallon by 2020. An allowance price of $325 a ton, more than 20 times the 2020 TAP limit and 13 times the 2030 TAP limit, was found to be the minimum that would achieve this objective. It should be noted, however, that higher CAFE standards may also advance other goals, such as reducing reliance on imported oil, and that consideration of such impacts may motivate policy action in this area despite the availability of lower-cost options for GHG reduction.

Transportation Fuel Use in Alternative Cases (cont'd)

Figure 17: Transportation Sector Carbon Dioxide Emissions
(million metric tons)



Source: NEMS runs S1766BASE.D102307A, S1766.D103007A, S1766ALTCCS.D103007A, S1766HTBASE.D102307A, S1766HT.D110807C, and S1766POLRP.D120507B.

Economic Impacts

Implementing the S. 1766 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 submit allowances or pay the TAP price. Second, the auctioning of allowances and the technology accelerator payments will generate revenue for the government, which, in turn, will spend these funds on programs designed to help businesses and consumers reduce their emissions or ameliorate the impacts associated with higher energy prices.

Allowance Revenues

The total value of allowances created under the S. 1766 allowance program depends on the quantity of allowances issued and the allowance price. Some allowances are auctioned, raising revenue directly, while others are distributed directly. The value of allowances allocated for free can also be considered a revenue transfer in the sense that recipients will use the allowances to cover their own emissions, thus avoiding the costs of buying them, or accrue revenue from the sale of the allowances to others. For simplicity in the following discussion, allowances allocated for free are treated as revenue transfers. All other allowances are auctioned and the revenue flows to State, local and Federal governments for disbursement (Table 5).[22]

Table 5. Allocation of Allowance Revenues in S. 1766

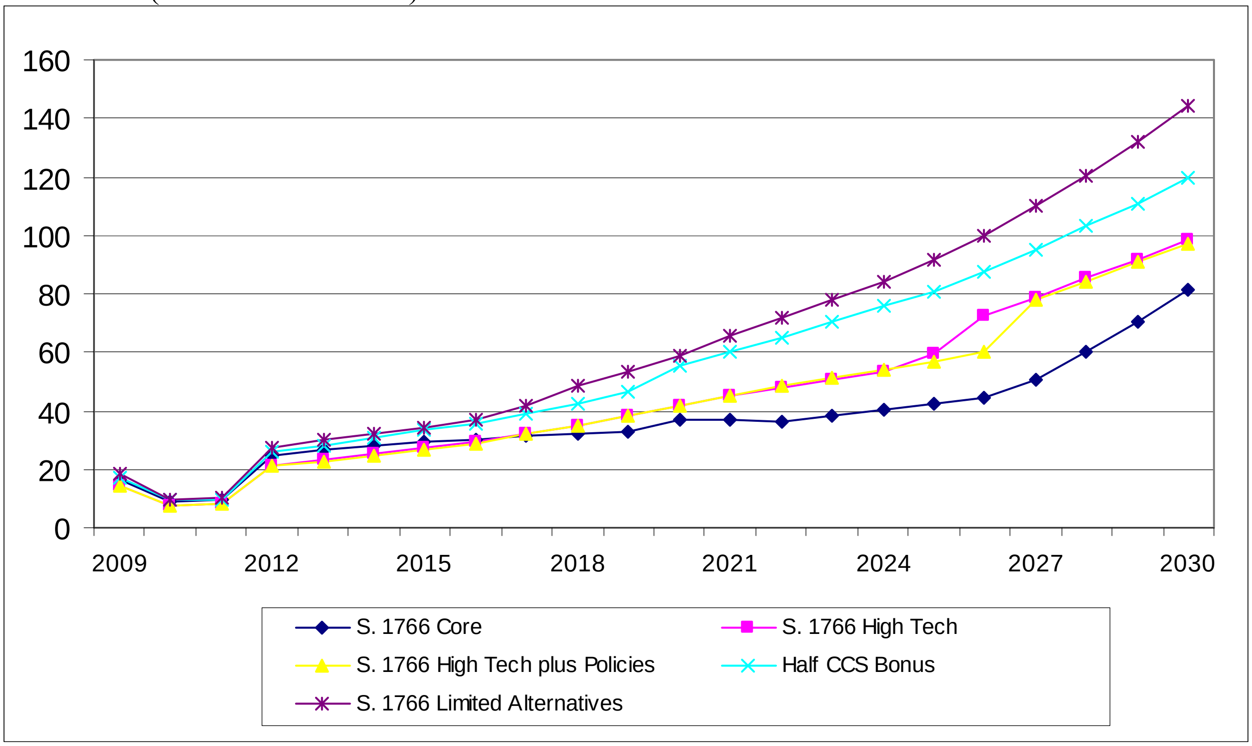
Revenue Source or Disposition	Share	Destination
Auctioned Allowances[1]	33 percent in 2012, increasing to 62 percent by 2030	See Below
Freely Allocated Allowances	67 percent in 2012, falling to 38 percent by 2030	Business
Disposition of Auction Revenue		
Technology Programs	12 percent in 2012, increasing to 26 percent by 2030	Government
Adaptation Programs	8 percent in 2012, increasing to 22 percent by 2030	Government
Low Income Assistance	4 percent between 2012 and 2020, 5 percent until 2030	Consumers
States	9 percent	State Government

[1] The share of allowances auctioned can differ from the values shown if the allowance pools set aside to provide incentives for CCS or agricultural sequestration are over-or under-subscribed.

The revenues collected for redistribution, including auction revenue and technology accelerator payments collected by the Federal government, as well as allowances allocated to the States, vary significantly across the cases (Figure 18 and Table 6). The major reasons for the difference in revenues are the variation in bonus allowances provided as incentives for CCS and the quantity of TAP sales. The CCS bonus is important because each CCS bonus allowance that is given out reduces the number of allowances auctioned, lowering the revenue to the government for redistribution. On the other hand, the revenue collected through the TAP increases the revenue to the government. Because of the CCS bonus differences, the maximum revenue collected by the government in the main S. 1766 cases occurs in the Half CCS Bonus case where the fewest new coal plants with CCS are built and more allowances are auctioned. In contrast, the smallest value occurs in the S. 1766 Core case, where the most new coal plants with CCS are built. The revenue collected by the government in 2030 ranges from $82 billion (2005 dollars) to $120 billion (2005 dollars) in the main S. 1766 cases. The cumulative government revenue collected from 2012 through 2030 in the main S. 1766 cases ranges from $770 billion to $1.2 trillion.

[22] Additional revenue is raised from TAP sales and is assumed to be allocated as though raised from allowance auctions.

Figure 18: Revenue Collected by Federal and State Governments
(billion 2005 dollars)



Source: NEMS runs S1766.D103007A, S1766ALTCCS.D103007A, S1766HT.D110807C, S1766BIV.d102907A, and S1766POLRP.D120507B.

Table 6. Allowance Value and TAP Revenues
(billion 2005 dollars, unless otherwise noted)

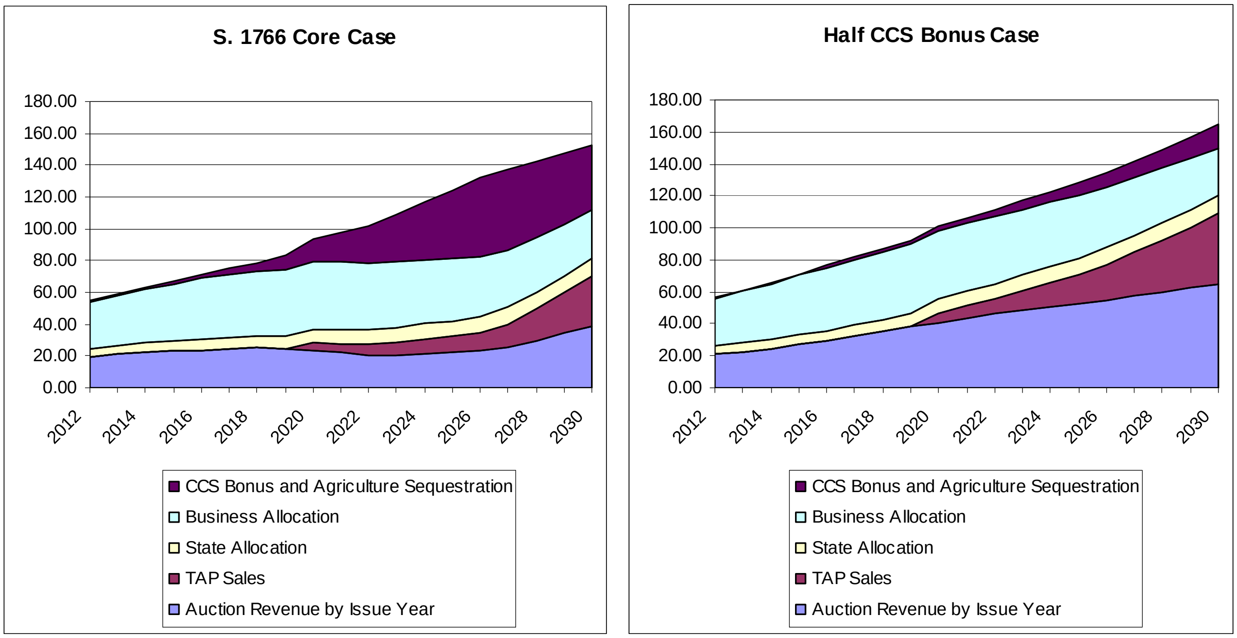
	2020					2030				
	S. 1766 Core	**Half CCS Bonus**	**S. 1766 High Tech**	**S. 1766 High Tech Plus Policies**	**S. 1766 Limited Alter-natives**	**S. 1766 Core**	**Half CCS Bonus**	**S. 1766 High Tech**	**S. 1766 High Tech Plus Policies**	**S. 1766 Limited Alter-natives**
Allowance Price (2005 dollars per ton)	15.4	15.4	13.4	13	15.4	25.1	25.1	25.1	25.1	25.1
Total Allowance Value	95.3	95.3	82.8	80.5	95.3	120.8	120.8	120.8	120.8	120.8
Allowance Distribution and TAP Value										
Value of Freely Allocated Allowances to Business	42.9	42.9	37.2	36.2	42.9	30.2	30.2	30.2	30.2	30.2
Government Revenue										
Allowance Auction Revenue	28.9	39.7	32.7	31.9	40.2	38.9	65.2	56.3	58.2	67.7
TAP Revenue	4.5	5.8	0	0	8.9	31.8	43.8	33.2	28.1	66
Value of allowances allocated to States	8.6	8.6	7.4	7.2	8.6	10.9	10.9	10.9	10.9	10.9
Subtotal Government	36.6	55.1	42.5	41.4	59	81.5	119.9	98.2	97.	144.6
CCS Bonus Allowance Value	11.3	0.5	3.3	2.6	0	28.8	2.5	11.4	9.5	0
Agriculture Sequestration Allowance Value	2.6	2.6	1.9	1.8	2.6	12	12	12	12	12
Total Allowance Value plus TAP	99.8	101.1	82.8	80.5	104.1	152.6	164.6	151.8	148.9	186.8

Source: NEMS Runs S1766.D103007A, S1766ALTCCS.D103007A, S1766HT.D110807C, S1766BIV.D102907A, and S1766POLRP.D120507B.

Figures 19 and 20 illustrate the flow of allowance-related funds and TAP revenue in the four main S. 1766 cases. Comparing the S. 1766 Core and Half CCS Bonus cases, the main differences are the levels of CCS bonus allowances and TAP revenue.

Figure 19. Revenues in the S. 1766 Core and Half CCS Bonus Cases

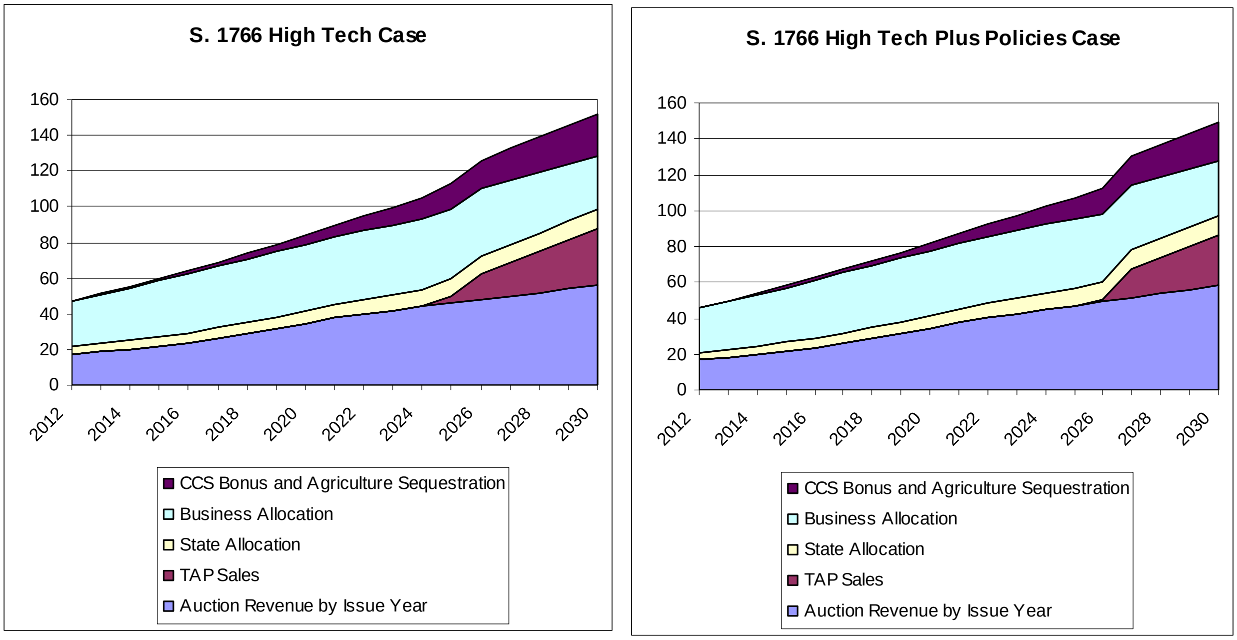
(billion 2005 dollars)



Note: Under S. 1766, half of the allowances are made available for auction 4 years in advance. Auction Revenue by Issue Year reports all the auction revenue as though it were raised in the allowance issue year.
Source: National Energy Modeling System runs, S1766.D103007A and S1766ALTCCS.D103007A.

Figure 20. Revenues in the S. 1766 High Technology and S. 1766 High Technology Plus Policies Cases

(billion 2005 dollars)



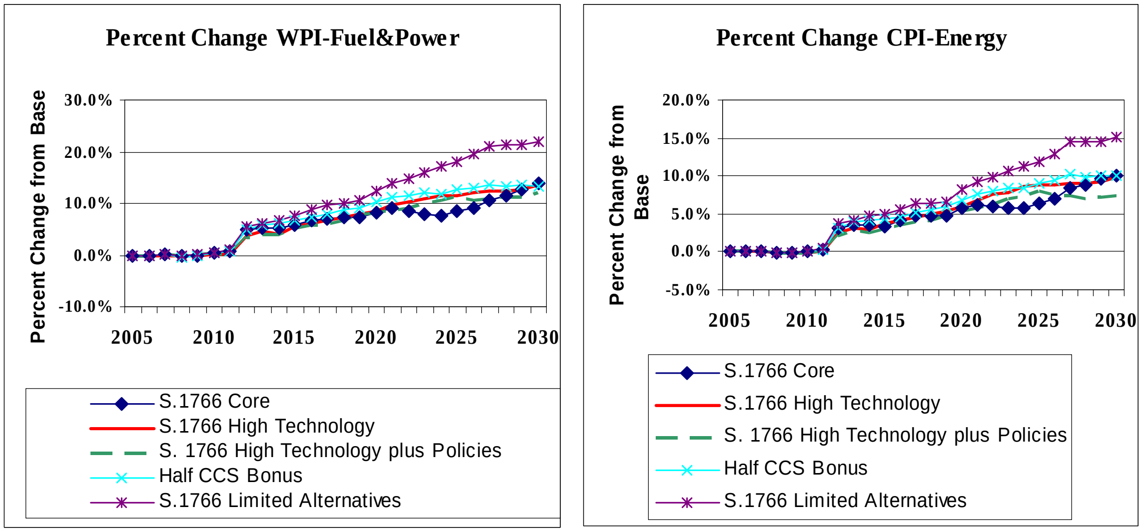
Note: Under S. 1766, half of the allowances are made available for auction 4 years in advance. Auction Revenue by Issue Year reports all the auction revenue as though it were raised in the allowance issue year.
Source: National Energy Modeling System runs S1766HT.D110807C and S1766POLRP.D120507B.

Impacts on Energy and Aggregate Prices

Rising energy costs influence the aggregate economy through their effect on prices and energy expenditures. Figure 21 shows the percentage changes in the both the consumer and producer indices for energy in the main S. 1766 cases. Figure 21 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 approximately 10 percent above the Reference case level by 2030 in the S. 1766 Core case. Ultimately, the consumer sees higher prices directly through final prices paid for energy-related goods and services, higher prices for other goods and services that result from the energy price changes and revenue flows, and changes in interest rates. Until 2020, all S. 1766 cases show very similar energy price paths in Figures 21 and 22. In the post-2020 period, energy prices moderate initially and begin to return to the Reference case level. After 2025, the prices increase and diverge from the Reference case level.

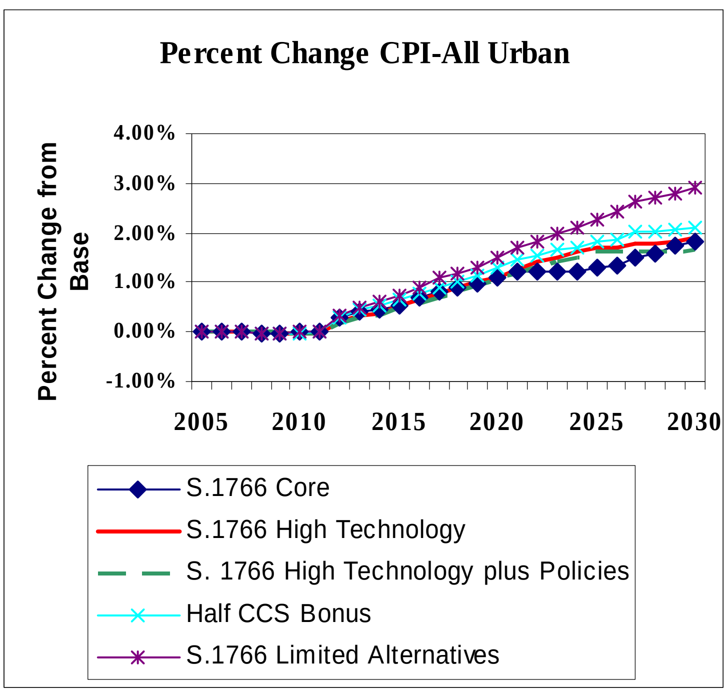
Figure 21: Consumer and Producer Energy Prices

(percent change from reference case)



Source: National Energy Modeling System runs S1766.D103007A, S1766ALTCCS.D103007A, S1766BIV.D102907A, S1766HT.D110807C, and S1766POLRP.D120507B relative to results in runs S1766BASE.D102307A and S1766HTBASE.D102307A.

Figure 22: Consumer Prices

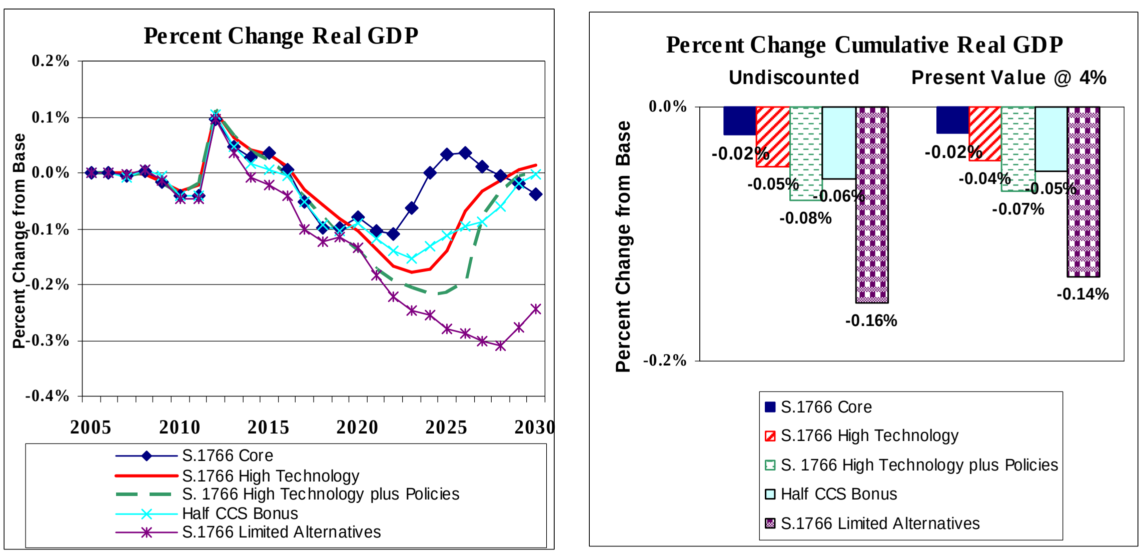


Source: National Energy Modeling System S1766.D103007A, S1766ALTCCS.D103007A, S1766BIV.D102907A, S1766HT.D110807C, and S1766POLRP.D120507B relative to results in runs S1766BASE.D102307A and S1766HTBASE.D102307A.

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 23). Relative to the Reference case, real GDP in 2030 is between 0.07 percent below to 0.01 percent above base in 2030. Total discounted GDP losses over the 2009 to 2030 time period are $52 billion (-0.02 percent) in the S. 1766 Core case and range from $104 billion (-0.04 percent) in the S. 1766 High Technology case to $163 billion (-0.07 percent) in the S.1766 High Technology Plus Policies case[23]. Projected GDP impacts generally begin to return to baseline as redistributed revenues offset the effect of steady increases in energy prices. In the S. 1766 High Technology Plus Policies case, fuel economy standards are increased, forcing a change in the optimal mix of factor inputs of capital, labor, and energy. Moving to this new factor input mix involves dislocations, idling of the old capital stock, and accumulation of new capital stock with the requisite technologies. As a result, losses in potential output are greater in the S. 1766 High Technology Plus Policies case.

Figure 23: Real GDP Impacts



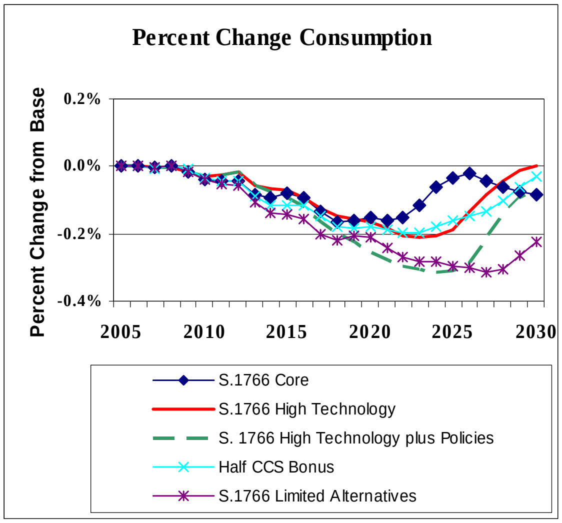
Source: National Energy Modeling System runs S1766.D103007A, S1766ALTCCS.D103007A, S1766BIV.D102907A, S1766HT.D110807C, and S1766POLRP.D120507B relative to results in runs S1766BASE.D102307A and S1766HTBASE.D102307A.

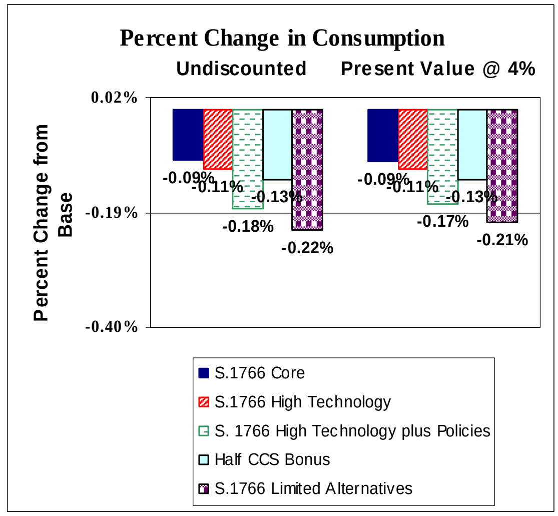
While real GDP is a measure of what the economy produces, the composition of GDP may change considerably between the major components: consumption, investment, government and net exports. Consumer expenditures, one indicator of consumers' welfare, show larger relative losses compared to GDP, although both start to return to baseline by 2025. Figure 24 depicts consumption impacts over time and the cumulative discounted percent change in consumption over the 2009 to 2030 period compared to the appropriate Reference case. The cumulative losses of consumption are $157 billion (-0.09 percent) in the S. 1766 Core case and $215 billion (-0.13

[23]All dollar values reported in this section and beyond are expressed in real 2000 dollars unless otherwise stated

percent) in the Half CCS Bonus case, $181 billion (-0.11 percent) in the S. 1766 High Technology case, and $287 billion (-0.17 percent), in the S. 1766 High Technology Plus Policies case.

Figure 24: Real Consumption Impacts





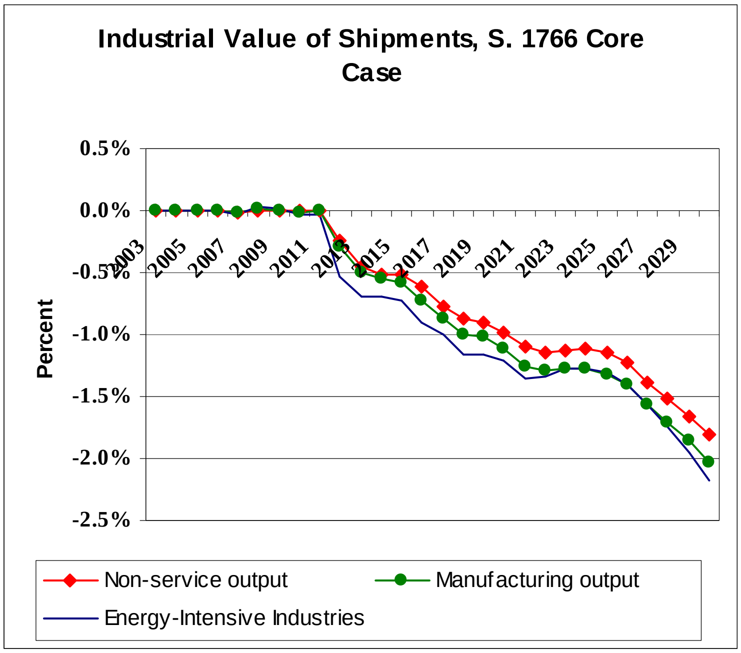
Source: National Energy Modeling System runs S1766.D103007A, S1766ALTCCS.D103007A, S1766BIV.D102907A, S1766HT.D110807C, and S1766POLRP.D120507B relative to results in runs S1766BASE.D102307A and S1766HTBASE.D102307A.

Industrial Impacts

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 2.2 percent below the Reference case by 2030 in the S. 1766 Core case. Figure 25 depicts impacts by industry in the S. 1766 Core case while Figure 26 shows the change in total industrial output in the S. 1766 Core, Half CCS Bonus, S. 1766 High Technology, and S. 1766 High Technology Plus Policies cases. In the S. 1766 Core case, the industrial sector (all non-service industries) output is 1.8 percent lower than the Reference case, as higher inflation and lower demand impact industrial activity. As with real GDP and consumption, industrial activity losses are similar across all S. 1766 cases.

Figure 25: Impacts on Industrial Output, S. 1766 Core Case

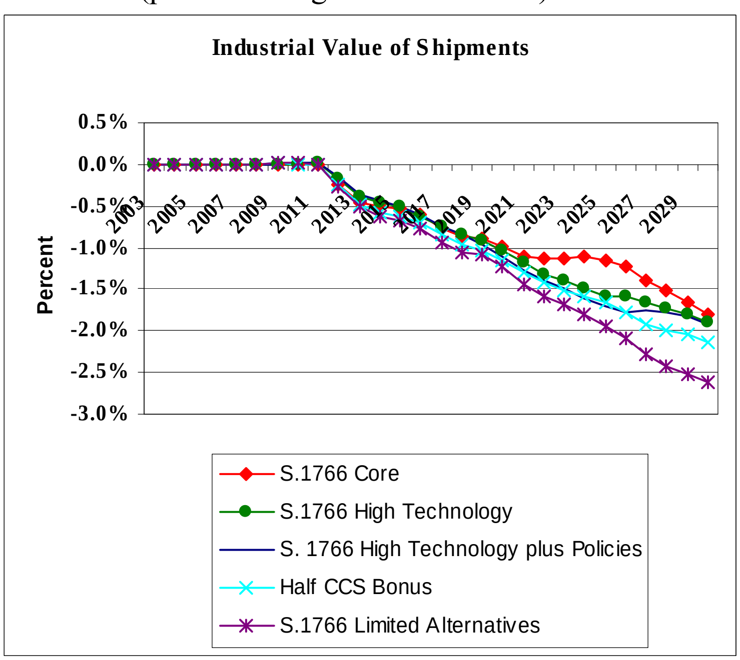
(percent change from reference)



Source: National Energy Modeling System run S1766.D103007A relative to results in run S1766BASE.D102307A.

Figure 26: Impacts on Industrial Output

(percent change from reference)



Source: National Energy Modeling System S1766.D103007A, S1766ALTCCS.D103007A, S1766BIV.D102907A, S1766HT.D110807C, and S1766POLRP.D120507B relative to results in runs S1766BASE.D102307A and S1766HTBASE.D102307A.

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. 1766, 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. However, under S. 1766, the economic impacts would be tempered by the TAP which acts as a ceiling that limits the potential increase in allowance and energy prices that might occur if new clean technologies were not available in a timeframe consistent with the requirements of S. 1766 or their cost or performance was not as promising as expected.

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. 1766. 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, the analysis does not assume enactment of a significant new mandate for the use of biofuels in the transportation sector, which would tend to 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.

The S. 1766 Limited Alternatives case examines the implications of these technologies not being available. As discussed, under these conditions, the industry would opt to pay the TAP shortly after the 2012 starting date of the program and turn to natural gas to partially reduce the growth in coal generation that would have otherwise been expected.

Appendix A. Analysis Request Letter

United States Senate

WASHINGTON, DC 20510

August 1, 2007

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

Dear Mr. Caruso:

We are writing to request that EIA estimate the economic impacts of the "Low Carbon Economy Act" of 2007 (S.1766), which we introduced on July 11th. We would like EIA to analyze our bill under two sets of assumptions: (1) EIA's AEO 2007 reference case assumptions used for its analysis of the "Climate Stewardship and Innovation Act" of 2007 and (2) a scenario using EIA's AEO 2007 "high-technology" assumptions. We feel that the latter case better reflects the complementary measures that we see as necessary and beneficial to reduce greenhouse gas emissions and reflects the substantial funding that our program provides to the development and deployment of advanced energy technologies.

In addition, we ask that you analyze a scenario that includes, along with the high-technology assumptions, the fuel economy standards and renewable fuel standards recently passed by the Senate (H.R. 6, as amended by the Senate), and a 15% renewable portfolio standard for the electric generation sector.

We believe EIA's analysis of the "Low Carbon Economy Act" would prove useful to us and other members of the Senate as we craft measures to combat global climate change. We anticipate that the Senate will vote on climate change legislation this fall, and ask that the economic impact assessments be completed as soon as possible.

Given the tight timeline, 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 Jonathan Black with the Senate Committee on Energy and Natural Resources at (202)224-6722 or Tom Dower with Senator Specter at (202)224-9027.

Thank you for your assistance with this analysis.

Sincerely,

Jeff Bingaman

Arlen Specter

Appendix B. Follow-Up Letter

United States Senate

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, DC 20510–6150

ENERGY.SENATE.GOV

October 25, 2007

Dr. Howard K. Gruenspecht
Deputy Administrator
Energy Information Administration
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, DC 20585

Dear Dr. Gruenspecht:

In a letter dated August 1, 2007, Senators Bingaman Specter requested that the Energy Information Administration (EIA) estimate the economic impacts of the "Low Carbon Economy Act" of 2007 (S.1766), which was introduced on July 11th.

In response to our letter request, we have been asked by EIA staff to provide guidance on specific aspects of the analysis. It is our understanding that in order for the EIA analysts to complete our request, some additional guidance is required to formulate assumptions for input into the NEMS model. In accordance with your staff's request, we are submitting this letter. As regards specific assumptions, we recommend the following:

1. Renewable Fuel Standard: Because the renewable fuel standard will considerably lengthen the time needed for the analysis, we ask that you not include it in the analysis as originally requested.

2. CAFE: We hope to improve our understand of the interaction of an emission trading program and higher CAFE standards. While we understand that you are not able at this time to model an attribute-based CAFE standard, we ask that you model the fuel economy improvements outlined in the original request letter.

3. Offsets: For the core scenarios, please assume that the only offset projects that are eligible to receive credits are those that are listed in Section 303 of the legislation. In these scenarios, treat biogenic carbon sequestration as an allowance set-aside, as these reductions are over and above reductions needed to meet the cap. This treatment is consistent with EIA's January 2007 analysis titled "Energy Market and Economic Impacts of a Proposal to Reduce Greenhouse Gas Intensity with a Cap and Trade System." We understand that EIA has updated its offset cost curves, including the economic assumptions regarding biogenic sequestration, and will use the updated economic assumptions for this analysis.

4. Bonus Allowances for Carbon Capture and Storage: We ask that you model an additional sensitivity scenario that awards bonus allowances at half of the rate stated in Section 207 of the legislation.

Please do not hesitate to contact me if there are any questions on this request.

Sincerely,

Jonathan Black