Analysis of the Climate Stewardship Act

A Study for

Natural Resources Defense Council

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Resource and Environmental Strategies

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This report is dedicated to the memory of Stephen Bernow, co-founder of Tellus Institute, inspiration and mentor to legions of energy and climate analysts around the world, exacting in rigor, generous in time and spirit, whose innovations in energy modeling and climate policy analysis leave a legacy for generations.

Acknowledgements:
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1. Executive Summary

This report presents the results of an analysis of the Climate Stewardship Act (S.139), conducted for NRDC by the Tellus Institute using a modified version of the Energy Information Administration's (EIA) NEMS model. The analysis finds that S.139 in conjunction with targeted complementary policies significantly reduces US emissions of heat-trapping gases while saving consumers billions of dollars. Important complementary policies that contribute to cost-effective implementation of S.139 include energy efficiency investments funded by allowance sales under the Act, oil savings of 1 million barrels/day by 2013, renewable energy standards, promotion of combined heat and power systems, caps on other power plant pollutants, and smart growth measures. Key findings include the following:

- Allowance prices increase from $8/tonne CO2-equivalent in 2010 to $22/tonne in 2020.
- Net savings to consumers accrue from 2013, reaching $48 billion annually in 2020.
- Household electricity bills decrease because of reduced demand, even though electricity prices rise slightly.
- There is no spike in natural gas prices because demand decreases relative to the base case, the result of efficiency policies and the emissions cap.
- A scenario analyzing a more aggressive policy to improve vehicle fuel efficiency showed lower allowance prices and higher net economic benefits.
- The allowance prices needed to achieve the emission limits in S.139 found in this analysis are lower than those projected by MIT and far lower than those projected by EIA. Welfare costs would be correspondingly lower than the very modest levels projected by MIT.

Table ES-1: Policy Measures Included in Modeling of S.139

McCain-Lieberman provisions	Caps on global warming pollution from covered sectors	
	Energy efficiency investments funded by allowance sales	
Energy bill provisions	1.0 million barrels/day oil savings by 2013 *(main policy case)*	2.1 million barrels/day oil savings by 2013 *(advanced policy case)*
	Renewable transportation fuels standard	
	Renewable portfolio electricity standard	
Other policies	Incentives and barrier removal for combined heat and power systems	
	Caps on other power plant pollutants – SO_2, NO_x, and mercury (as in S.843)	
	"Smart growth" measures that reduce VMT by 8% compared to the Base Case in 2020	

Table ES-2: Key Results for the Policy and Advanced Policy Cases

	2000	2010			2015			2020		
		Base	Pol.	Adv.	Base	Pol.	Adv.	Base	Pol.	Adv.
Allowance Price ($/tonneCO$_2$-eq)	---	---	8	7	---	18	9	---	22	15
Emissions (MMtCO2-eq)	5617	6486	5884	5884	7088	5677	5633	7703	5692	5656
Net Benefits (billion 2001$)	--	--	-6	7	--	15	55	--	48	98
Avg. Electricity Bill (2001$/Household)	943	939	1064	1051	962	1014	957	989	932	877
Avg. Electricity Price (2001cents/kWh)	6.9	6.4	7.4	7.3	6.5	7.6	7.1	6.6	7.5	7.0
Natural Gas Price (2001$/Mcf)	3.8	3.3	3.2	3.1	3.6	3.5	3.2	3.6	3.3	3.2
Electricity Generation (Terawatt-hours)	3631	4339	4239	4238	4759	4334	4326	5177	4443	4446
Oil Consumption (Quadrillion BTU)	39	45	43	42	49	45	42	53	47	43
Coal Consumption (Quadrillion BTU)	23	25	22	22	26	16	19	27	15	17
Gas Consumption (Quadrillion BTU)	24	28	27	27	30	29	28	33	32	30
Renewables Consumption (Quadrillion BTU)	6	7	8	8	8	10	10	8	12	12

Comparison to Other Studies

Some key results from this analysis are compared to recent analyses by MIT (Paltsev et al. 2003) and the Energy Information Administration (EIA, 2003b) in Table ES-3.

The MIT Joint Program on the Science and Policy of Global Change recently published *Emissions Trading to Reduce Greenhouse Gas Emissions in the United States: The McCain Lieberman Proposal* (Paltsev et al. 2003). Scenario 7 of that analysis resembles the scenario analyzed in this analysis, although the MIT analysis does not include complementary policies. The MIT results have allowance prices increasing from \$21/tonne CO_2 in 2010 to \$36/tonne CO_2 in 2020 (2001\$), higher than the values that we have shown. Even with the higher allowance prices, MIT calculates that welfare costs (the cost to the economy as measured by the impact on household purchasing power) would be only 0.09 percent to 0.13 percent of the reference case consumption levels. This suggests that if the complementary policies adopted in our analysis were included in the MIT analysis, the result would be to further reduce both MIT's estimate of allowance prices and welfare costs. As in this study, MIT finds that natural gas consumption would be lower under S.139 than under its reference case (both reference case and policy case natural gas consumption levels are significantly lower than the levels projected by both this study and by EIA).

The Energy Information Administration analyzed S.139 at the request of Senator Inhofe (and a subsequent request by Senator Lieberman). EIA used its NEMS model to conduct the analysis without the modifications applied here (see Section 5) and without the complementary policies considered in this analysis. In this form the NEMS model is well known to respond weakly to policy signals (Laitner et al. 2003), implying that higher allowance prices are needed to achieve the emission limits of S.139. Furthermore, EIA made a number of questionable assumptions in applying the model that further drive up allowance prices and welfare costs (Pew Center 2003). As a result the allowance prices forecast by EIA average more than twice as high as those forecast by this study. Welfare costs projected by EIA are also much higher than those found here or in the MIT study by a factor that greatly exceeds the difference in allowance prices. Another major difference is that EIA projects an increase, rather than a decrease, in natural gas consumption under S.139 relative to its reference case. This is due to the very weak demand response in the end-use sectors projected by EIA NEMS. As a result a much greater proportion of the total emission reductions must be achieved by fuel switching from coal to natural gas in the electric sector, driving up gas demand and prices (Pew Center 2003).

Table ES-3: Comparison of S.139 Analyses

	2010			2015			2020		
	Tel	**MIT**	**EIA**	**Tel**	**MIT**	**EIA**	**Tel**	**MIT**	**EIA**
Allowance Price (2001$/tonne$CO_2$-eq)	8	21	22	18	28	32	22	36	49
Cost per Household (2001$)	53	67	344	-124	91	630	-379	121	534
Gas Consumption (Quadrillion BTU)	27	21	28	29	23	31	32	23	37

Tel – Tellus Institute (this study) main Policy Case.
MIT – Paltsev et al.. (2003), Scenario 7.
EIA – EIA (2003b).
Allowance Price – MIT values inflated from 1997$ to 2001$ by a factor of 1.073.
Cost per Household – Tellus values represent net resource costs (see Section 4.2) divided by the number of households. MIT values represent welfare costs per household, defined as equivalent variation or loss in macroeconomic (personal) consumption. These values were inflated to 2001$ as above. EIA values represent differences in real consumption between the S.139 case and the Reference case (Table D21, EIA 2003b) divided by the number of households and inflated from 1996$ to 2001$ by a factor of 1.094. (Values for 2015 estimated from Figure 7.9, EIA 2003b).

1 Description of Bill

The Climate Stewardship Act (S.139), introduced by Senators Lieberman and McCain in January 2003, establishes a mandatory cap on emissions of six global warming pollutants (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) by electric generators, major industrial and commercial entities, and refiners of transportation fuels. Companies in these sectors that emit at least 10,000 tons of carbon dioxide (or an equivalent amount of other global warming pollutants) are required to report annual emissions and reduce emissions in two phases – reaching 2000 levels by 2010, and 1990 levels by 2016. The affected sectors account for approximately 85 percent of total U.S. emissions. The Climate Stewardship Act is expected to be offered as an amendment to the energy bill now under consideration in the Senate.

The Climate Stewardship Act creates a market-based cap-and-trade program to cost-effectively reduce global warming pollution, patterned after the highly successful acid rain program of the 1990 Clean Air Act. The program requires affected sources to turn in an emissions allowance at the end of each year to cover each ton of its emissions in that year. Refiners and importers of transportation fuels are required to turn in allowances based on the emissions that will occur when their fuels are consumed in transportation. Allowances will be allocated with a mix of approaches based on criteria specified in the Act. Some emission allowances will be given to companies without charge. The rest will be allocated to a non-profit Climate Change Credit Corporation created by the Act, which will use proceeds from the sale of allowances to promote new clean energy technologies and to protect consumers, dislocated workers and communities. The bill also provides incentives for firms to reduce emissions early or to take on more stringent emissions limits. The bill offers additional flexibility to help moderate costs by allowing the use of a limited number of "off-system credits" – up to 15 percent of a source's emission in 2010 and 10 percent in 2016 – derived from non-regulated sectors in the United States (such as forest and farm carbon sequestration), from emission reductions by smaller firms, and carbon reductions made in other nations that have adopted pollution caps.

In June 2003, the Natural Resources Defense Council (NRDC) contracted with the Tellus Institute to analyze the impacts of the Act. This report summarizes the results of that analysis.

2 Policy Scenarios

The policy scenario presented here is based on implementation of the Act introduced on January 9, 2003. Below we describe assumptions that we made in interpreting the Act. We also describe the other complementary policies that are included in this analysis that would enhance the efficacy of the Climate Stewardship Act and reduce its cost.

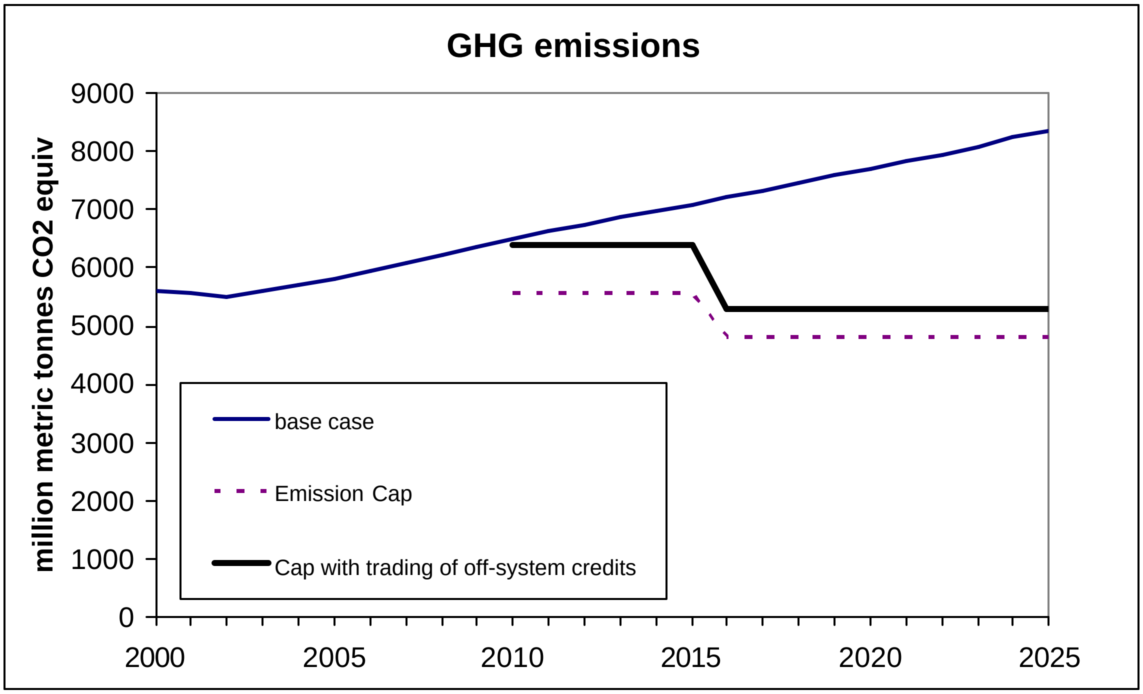
2.1 Covered Entities and Global Warming Pollutants

For this analysis we included all six heat-trapping gas emissions (carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons and sulfur hexaflouride; also called greenhouse gases (GHGs)) from the industrial, transportation and electric sectors, as defined by the U.S. Climate Action Report (U.S. Department of State 2002). We excluded the residential and commercial/institutional sectors to reflect the Act's exclusion of entities that emit less than 10,000 metric tons of CO_2 per year – most residences and commercial establishments emit below this level (Pizer and Kopp 2003, Paltsev et al. 2003). We included all of the industrial, transportation and electric sectors, regardless of entity size, for this estimate of the impacts.

2.2 Emission Caps and Off-Sector Credits

The Climate Stewardship Act limits emissions from covered entities to 2000 levels starting in 2010, and to 1990 levels starting in 2016. Figure 1 illustrates S.139's caps on national emissions of global warming pollution for covered entities (as defined in this analysis) as compared with Base Case emissions.

Figure 1 - Heat-trapping gas emissions for covered entities, Base Case and caps



The Act permits a covered entity to satisfy up to 15 percent of its allowance obligation with allowances derived from other sources: tradeable allowances from another nation's market in greenhouse gases, registered net increases in carbon sequestration, or registered emission reductions made by a person that is not a covered entity (S.139, Sec. 312). Starting in 2016, this amount would be reduced to 10 percent. According to our calculations, this would enable entities to acquire what we term "off-system credits" at a rate of 835 million metric tons CO_2 equivalent ($MMtCO_2$-eq) per year for the first six years, dropping to 482 $MMtCO_2$-eq per year thereafter, or a cumulative 9800 $MMtCO_2$-

eq across the 2010-2025 period of analysis. These additional amounts are also shown in Figure 1.

Our analysis assumes that entities will use the full amount of off-system credits allowed in the Act. Given the many potential sources of low-cost credits, it is quite plausible that the maximum allowable amount will be purchased throughout the entire period of analysis. The most likely near-term sources will be excess allowances available under the Kyoto Protocol, should it enter into force (based on den Elzen et al. 2002). The amount of international credits available over the longer term could be substantial, given the possibility of allowance sales by other developed countries that have established caps on their global warming pollution, the ability to tap very sizeable amounts of low-cost allowances from emission reduction projects in developing countries under the Clean Development Mechanism, and the probability that U.S. adoption of a concrete target under S.139 would spur future commitments by some developing countries (Grütter 2001). Domestic forest and agriculture sequestration is also a considerable resource for generating offsets, as are emission reductions from domestic emitters that are not covered entities under S.139 (e.g., increased capture of methane at landfills not covered by the landfill gas standard issued under the Clean Air Act). (U.S. EPA 1999).

2.3 Base Case

We use the Base Case from Annual Energy Outlook 2003 (AEO2003) to project energy-related CO_2 emissions from 2003 to 2025 (EIA 2003). Emission projections for non-CO_2 emissions and non-energy CO_2 emissions were derived from the Climate Action Report (U.S. Department of State 2002). These projections embody the following assumptions of the impacts of current policies:

- The AEO2003 projections “are based on Federal, State, and local laws and regulations in effect on September 1, 2002. The potential impacts of pending or proposed legislation, regulations, and standards (and sections of existing legislation requiring funds that have not been appropriated) are not reflected in the projections.” (EIA 2003).

- The U.S. Climate Action Report projections assume implementation of all voluntary measures. (Department of State 2002).

2.4 Policy Case

2.4.1 Climate Stewardship Act Provisions

Our Policy Case includes, first and foremost, provisions of the Climate Stewardship Act itself, the main provision being S.139’s two-phase caps on global warming pollution. Our Policy Case also includes a program of end-use energy efficiency investments (demand-side management) that could be funded by the sale of emission allowances allocated to the Act’s nonprofit corporation under Section 352 of the Act. The parameters of this program are described in Section 5.2. We did not attempt to model the impact of S.139’s provisions for awarding allowances to firms that take action before 2010.

Table 1: Policy Measures Included in Modeling of S.139

McCain-Lieberman provisions	Caps on global warming pollution from covered sectors	
	Energy efficiency investments funded by allowance sales	
Energy bill provisions	1.0 million barrels/day oil savings by 2013 *(main policy case)*	2.1 million barrels/day oil savings by 2013 *(advanced policy case)*
	Renewable transportation fuels standard	
	Renewable portfolio electricity standard	
Other policies	Incentives and barrier removal for combined heat and power systems	
	Caps on other power plant pollutants – SO_2, NO_x, and mercury (as in S.843)	
	"Smart growth" measures that reduce VMT by 8% compared to the Base Case in 2020	

2.4.2 Complementary Policies

The Policy Case also includes several proposals currently under consideration in the energy bill before the U.S. Senate. These are:

- Provisions to save one million barrels of oil per day by 2013 (rising to 1.5 million barrels per day by 2020);[1]
- A national renewable transportation fuels standard;[2] and
- A national renewable portfolio standard.[3]

The first two of these policies have already been incorporated in the Senate energy bill; the third is currently under consideration.

Although important details are not yet resolved, it is reasonable to anticipate that tighter limits on other power plant pollutants will be imposed in the same time period. To represent this likelihood, our Policy Case includes emissions caps for sulfur dioxide (SO_2), nitrogen oxides (NO_x) and mercury emissions from electric generating facilities, as proposed in S. 843, the Clean Air Planning Act of 2003.[4] We chose this proposal, over

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[1] The oil saving is to be achieved by reducing our petroleum consumption by at least 1 million barrels per day starting in 2013. If the oil reductions were to come solely from the light duty vehicle fleet, which would not be necessarily have to be the case, this translates to a new fleet average, including cars and light trucks, of 28 mpg in 2013 rising to 32 mpg by 2025.

[2] Under this legislation, NRDC estimated that ethanol consumption would increase to 5 billion gallons by 2013 and 10 billion gallons by 2020. About 1/3 of the ethanol will come from cellulosic sources in 2012 increasing to 100 percent in 2020. Cellulosic ethanol leads to greater net heat-trapping gas reductions than corn-based ethanol.

[3] We modeled the RPS in this legislation as 8 percent non-hydro renewables in 2020 – accounting for exclusions in the legislation, and we assumed the level would increase to 10 percent by 2025.

[4] The Clean Air Planning Act includes cap and trade policies for SO_2 (capped at 4.5 million tons in 2009, 3.5 million tons in 2013, 2.25 million tons in 2016), NOx (capped at 1.87 million tons in 2009, 1.7 million

other stronger and weaker alternatives, as indicative of possible new power plant emission controls.

Our Policy Case also includes measures to accelerate penetration of combined heat and power (CHP) systems in the commercial and industrial sectors. Provisions to give CHP sources more favorable treatment of plant depreciation for tax purposes are included in the Senate energy bill. Other policies to reduce barriers to CHP systems – including nationally standardized interconnection standards for small co-generators, reasonable access and pricing for back-up power, and improved plant siting and environmental permitting processes – are not currently in the bill.[5]

Finally, we assume that vehicle travel will be reduced slightly through policies such as smart growth.[6]

2.4.3 Advanced Policy Case

We also analyzed an advanced policy case that includes a more aggressive oil savings policy, one equivalent to a 1 mile per gallon (mpg) increase each year starting at 25 mpg in 2005 and increasing to 45 mpg in 2025.[7]

3 Approach

There are inevitable uncertainties in projecting exactly how the Act will be implemented, the implementation of related policies, behavioral responses to policy measures, economic growth, fuel prices, technology costs, and many other issues. We have explored one set of assumptions, which we regard as realistic based on results of other published research, model integrity, and expert judgment on this particular legislation.

This report analyzes the Policy Cases described above using a modified version of the Energy Information Administration's National Energy Modeling System (EIA NEMS) and additional analytical tools.

While NEMS provides detailed technology and policy options for modeling a carbon cap and trade policy in the electric sector, its representation of other sectors is much weaker. NEMS does not well characterize the industrial sector at the level of specific technologies

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tons in 2013), and mercury (capped at 24 tons in 2009, 10 tons in 2013). The Clean Air Planning Act also includes regulations on CO2 emissions, which we excluded since these are covered by the Climate Stewardship act.

[5] We assumed that enactment of these policies would trigger significant energy efficiency increases plus emission reductions and other benefits (Lovins et al. 2002, Casten and Collins 2002).

[6] Smart Growth and other transportation policy reforms are assumed to reduce vehicle miles traveled by 3 percent in 2010 and 8 percent in 2020 compared to the Reference case and is based on previous analysis conducted by NRDC and the Union of Concerned Scientists (Doniger et al. 2002).

[7] This is similar to a U.S. Senate proposal to increase fuel economy standards to 35 mpg (new fleet average including cars and light duty trucks) by 2015 and produces an oil savings of 2.7 million barrels per day in 2015. To extend the analysis to 2025, we assumed that fuel economy would continue to improve at the same rate from 2015 to 2025 as it would improve from 2005 to 2015.

and does not easily allow the modeling of specific transportation sector policies. For these other sectors, we used models developed by Tellus and the American Council for an Energy Efficient Economy (ACEEE), with relevant results incorporated into our version of NEMS.

Furthermore, EIA's NEMS model tends to limit the potential impact of new and innovative policies that differ from business as usual behavior. The model tends to overestimate future energy consumption and underestimate the impacts that technological change can have.

Methodological issues are addressed further in Section 5.

4 Results

Our results for the main and advanced policy cases analyzed here demonstrate that the Climate Stewardship Act is a cost-effective approach to managing U.S. emissions of global warming pollution, especially when partnered with sound energy policies that help increase energy efficiency and clean, renewable, sources of energy. Results are summarized in Table 2 and discussed below.

Table 2: Summary of results

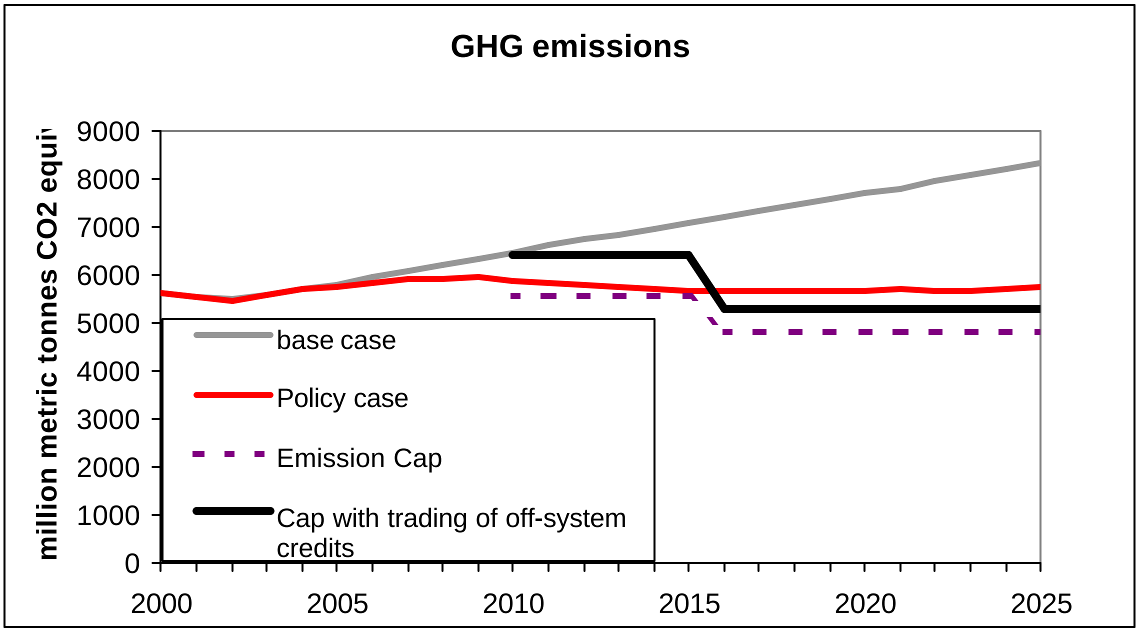
	2000	**2010**			**2015**			**2020**		
		Base	Pol.	Adv.	Base	Pol.	Adv.	Base	Pol.	Adv.
Allowance Price (\$/tonneCO_2-eq)	---	---	8	7	---	18	9	---	22	15
Emissions (MM #CO_2-eq)	5617	6486	5884	5884	7088	5677	5633	7703	5692	5656
Net Benefits (billion 2001\$)	--	--	-6	7	--	15	55	--	48	98
Avg. Electricity Bill (2001\$/Household)	943	939	1064	1051	962	1014	957	989	932	877
Avg. Electricity Price (2001cents/kWh)	6.9	6.4	7.4	7.3	6.5	7.6	7.1	6.6	7.5	7.0
Natural Gas Price (2001\$/Mcf)	3.8	3.3	3.2	3.1	3.6	3.5	3.2	3.6	3.3	3.2
Electricity Generation (Terawatt-hours)	3631	4339	4239	4238	4759	4334	4326	5177	4443	4446
Oil Consumption (Quadrillion BTU)	39	45	43	42	49	45	42	53	47	43

Coal Consumption (Quadrillion BTU)	23	25	22	22	26	16	19	27	15	17
Gas Consumption (Quadrillion BTU)	24	28	27	27	30	29	28	33	32	30
Renewables Consumption (Quadrillion BTU)	6	7	8	8	8	10	10	8	12	12

4.1 Emission Levels and Allowance Prices

Figure 2 presents the heat-trapping gas emissions for the covered entities under the Base Case and the main Policy Case. Figure 2 shows the nominal emission limits of S.139, and the amount allowed taking into account the availability of "off-sector credits." In our Policy Case, covered sources begin reducing emissions relative to the Base Case starting in 2005, five years in advance of the requirements of the Act. Action begins then partly in anticipation of the coming power plant pollutant caps, and partly in response to complementary policies (particularly the oil savings requirements and CHP policies). Some covered entities begin taking early actions as the most cost-effective manner to meet the future caps (e.g., replacing equipment that would be retired anyway with more efficient equipment, rather than waiting until the caps are in place to make the changes). Reductions before 2010 do not generate bankable allowances.

Figure 2 - Heat-trapping gas emissions for covered entities, Base and Policy Cases



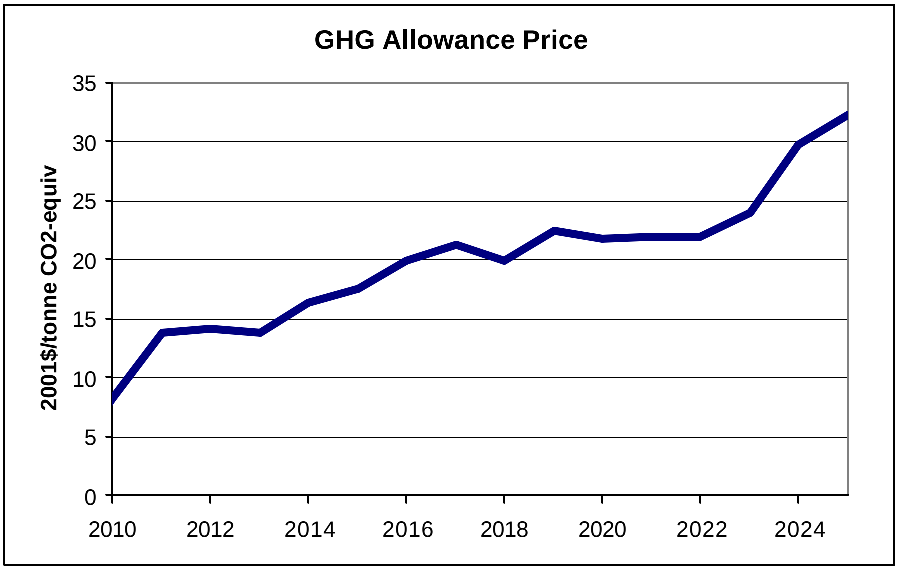
Allowance prices in our Policy Case increase over time, providing entities with an incentive to make extra emissions reductions during the 2010-2015 time period in order to bank unused allowances for use in the post-2016 period. We assumed entities would bank allowances following a strategy of rational economic expectations, and would bank appropriate amounts in anticipation of rising allowance. Section 4.6 describes the approach we used for estimating annual banking. Table 3 indicates the source of emissions (including purchased off-system credits).

Table 3 - Heat-trapping gas emissions and credits by source, Policy Case

	2010	2015	2020	2025
CO_2 Emissions from				
Industry	995	973	961	967
Electricity	2,244	1,861	1,630	1,406
Transportation	2,163	2,259	2,365	2,472
Non-CO_2 emissions	475	539	657	776
Off System credits	-835	-835	-482	-482
Banked allowances	527	771	-310	-319
Total	5,569	5,569	4,820	4,820

Figure 3 reports the allowance prices under the Act. The allowance price rises from about $8/tonne of CO_2-equivalent emissions in 2010 to $22/tonne in 2020 and $32/tonne in 2025. A price of $12/tonne CO_2-equivalent corresponds to increased fossil fuel prices of about 10 cents/gallon of gasoline, $0.65/thousand cubic feet for natural gas, and $1.00/million BTU for coal.

Figure 3 - Emission allowance prices



4.2 Societal Costs and Benefits

We calculated the costs and benefits of the Policy Case from a societal point of view, as shown in Table 4. The benefits assessed here do not include the benefits of less global warming or reductions in other pollution; rather, they include only such items as reductions in capital and fuel costs.

The Policy Case results in overall net benefits to society, as savings in fuel costs exceed the increased capital costs for more energy-efficient equipment. The electric sector experiences an increase in net costs in the 2000-2015 timeframe, as utilities invest in renewables, supply-side efficiency improvements, and cleaner plants and fuels. However, over the full 2000-2025 time period, the net cost of providing electricity services is reduced as end-use efficiency and CHP lead to lower investment and operation costs and fuel expenditures. Transfers of funds from trading activities (which are not societal resource costs) are also indicated in the table.

Table 4 - Resource cost of Policy Case, (cumulative present value – 5 percent discount rate, billion 2001$)

	2000-2015	2000-2025
Incremental Capital	$30	$155
Industry and Transportation Fossil Fuel Reductions	-$100	-$257
Electric sector costs		
Capital, imports	$76	$59
Fuel and Operating and Maintenance	-$24	-$171
Electric sector subtotal	$53	-$**112**
Non-CO2 gas costs	$1.9	$4.4
Off-system credits	$26	$43
Total	**$11**	**-$167**
Transfers from domestic trading activities	$238	$631

Notes:

Incremental capital – the incremental capital expenditures on more energy-efficient equipment and on CHP equipment in the residential, commercial, industrial and transportation sectors.

Industry and transportation fossil fuel expenditures – the savings in fossil fuel costs due to more efficient equipment (including cars) and increased on-site expenditures on fossil fuel for CHP use. This is an overall net benefit as the efficiency savings outweigh the CHP increases.

Electric sector costs – the costs minus benefits of the changes in the electric sector; costs include increased capital and fuel expenditures to meet tighter emission requirements, increased costs of renewable equipment, benefits accrue from lower electricity generation requirements (due to efficiency and CHP), lower fuel expenditures for renewables and from lower natural gas prices that result from lower natural gas demand.

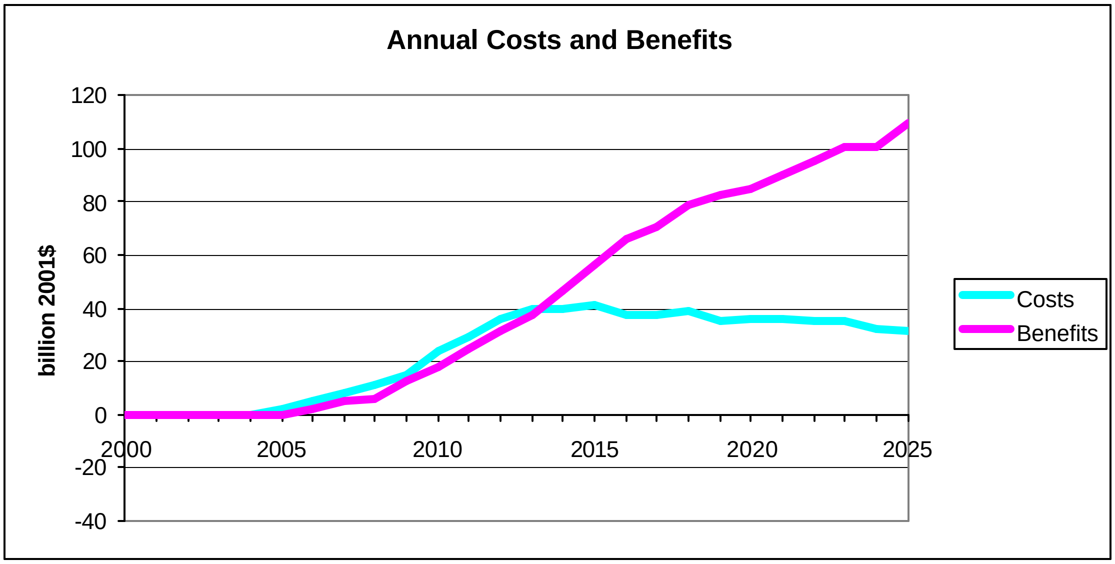
Non-CO_2 gas measures – the costs of measures taken to lower emissions of non-CO_2 gases such as methane from energy extraction and processing, nitrous dioxide from nitric and adipic acid production and hydroflorocarbon emission reductions.

Off-system credits – the cost of credits purchased from entities outside of those covered by the Act, including sequestration, methane from landfills and international credits. We estimated the cost of these credits based on $10/tonne CO_2-equivalent for each credit.

Transfers from domestic trading activities – the price of the allowances multiplied by the number of allowances. It is not an economic resource cost since it solely represents a *transfer* from those with initial allowance allocation to those who need allowances. The costs of changes to reduce emissions are all included in the total resource cost.

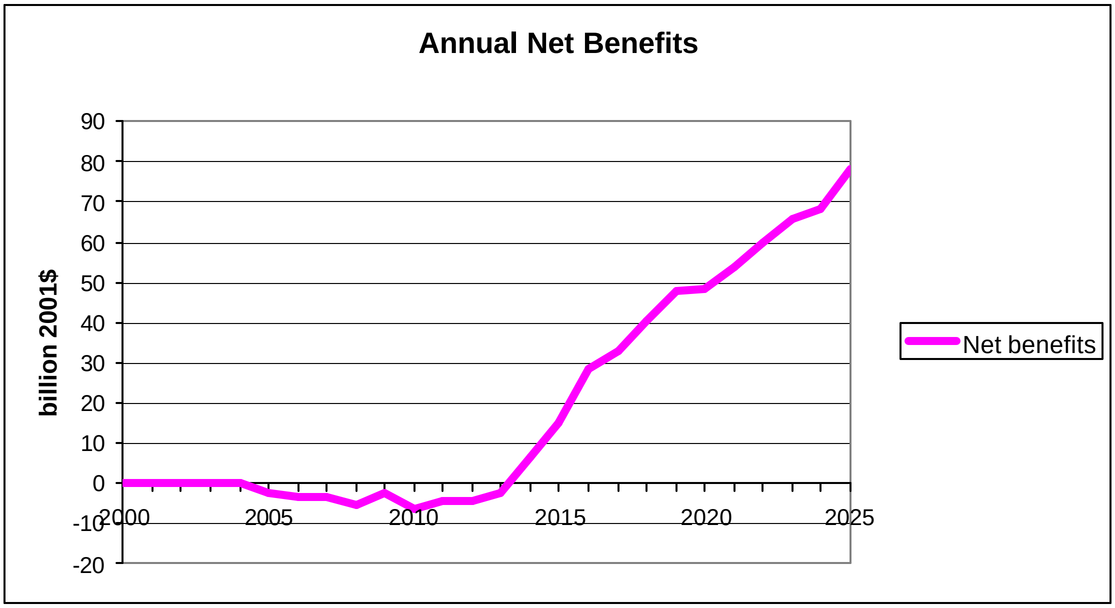
Figure 4 and Figure 5 represent annual costs and benefits and annual net benefits. These are based on the same information shown in Table but indicate annual amounts. From 2005 to about 2013, costs and benefits increase at close to the same rate. However after 2013, the costs flatten. Although there will be increased costs of more efficiency equipment in the demand sectors, the electric sector will have lower overall capital expenditures due to lower demand for electricity. The capital costs to the demand sectors are almost cancelled by the capital savings in the electric sector over time. Benefits (mostly savings from decreased fuel use, combined with lower fuel prices that result from the demand reductions) increase steadily over the entire period with the net benefits rising to $78 billion per year by 2025.

Figure 4 - Annual resource costs and benefits (billion 2001$)



Notes: Costs comprise incremental capital for the demand side plus electric sector capital and purchased power components + off-system credits + non-CO_2 gas costs
Benefits comprise fuel and operating and maintenance savings for all sectors including electric supply.

Figure 5 - Annual net benefits (billion 2001$)



Other analysts have also examined potential scenarios under the Climate Stewardship Act. The MIT Joint Program on the Science and Policy of Global Change recently published *Emissions Trading to Reduce Greenhouse Gas Emissions in the United States: The McCain Lieberman Proposal* (Paltsev et al. 2003). Scenario 7 of that analysis resembles the scenario analyzed in this analysis, although the MIT analysis does not include complementary policies. The MIT results have allowance prices increasing from \$21/tonne CO_2 in 2010 to \$36/tonne CO_2 in 2020,[8] higher than the values that we have shown. Even with the higher allowance prices, MIT calculates that welfare costs (the cost to the economy as measured by the impact on household purchasing power) increase by only 0.09 percent, to 0.13 percent above the reference case levels. This suggests that if the complementary policies adopted in our analysis were included in the MIT analysis, the result would be to further reduce both MIT's estimate of allowance prices and welfare costs.

4.3 Electricity Rates and Household Electricity Bills

Our results show that total household electricity bills incurred between 2005 and 2025 are *reduced* under the Climate Stewardship Act and accompanying policies, compared to the Base Case. Electricity prices in the main Policy Case are never more than 1.3 cents/kWh above Base Case prices. Although electricity prices are higher in the Policy Case, efficiency improvements reduce consumer electricity demand, resulting in overall *decreases* in household electricity bills of more than 13 percent by 2025. While total household electricity bills increase over the Base Case for the first few years, they are lower than Base Case bills starting in 2018. By 2025 the average U.S. household will save at least \$137 per year on its electricity bill.

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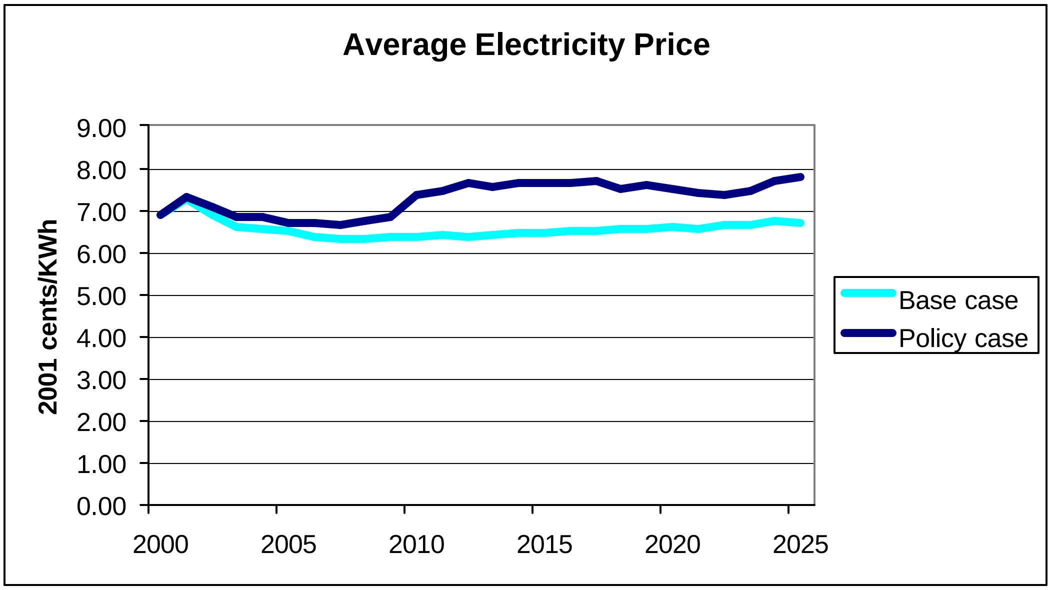
[8] Prices converted to 2001$ by Tellus for comparison to values in this report.

Figure 6 and Figure 7 show the average electricity price and average household electricity bills for all U.S. consumers for in the Base and Main Policy Cases. Electricity prices in the Policy Case are slightly higher than the Base Case from 2005 to 2009, owing to actions taken to meet the tighter NO_x, SO_2 and mercury emission caps and the renewable portfolio standard. In 2010, the emission caps of the Climate Stewardship Act begin to affect electricity prices. Although the allowance prices increase steadily from 2010 to 2025 (see Figure 2), the difference between electricity prices in the Base and Policy Cases narrows over this period. Electricity prices rise less than allowance prices both because electricity demand is lower in the Policy Case than in the Base Case and because more kilowatt-hours of electricity are produced for each ton of emissions.[9]

Figure 6 - Average electricity price



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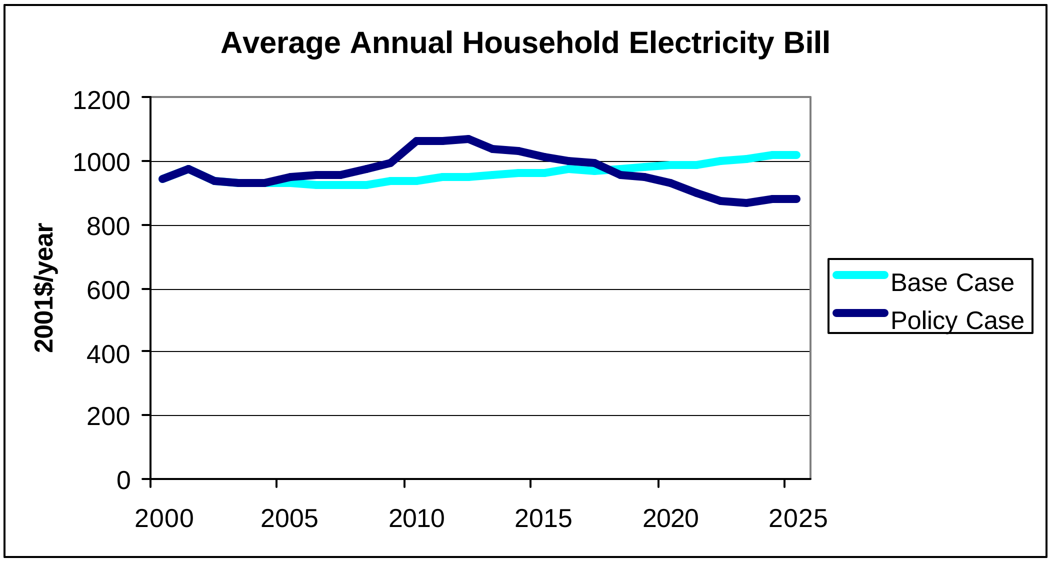
[9] Reduced electricity demand leads to reduced capital and fuel expenditures for generating electricity, reduced investment in renewables to meet RPS requirements (which is stated as a per cent of total electricity sales), and reduced natural gas prices (the reduced demand for natural gas for electricity generation leads to lower natural gas price). These components lead to lower electricity prices.

Figure 7 - Average annual household electricity bill



4.4 Energy Consumption

Figure 8 and Figure 9 present the energy consumption for the U.S. economy (including residential and commercial sector energy use) for the Base Case and the main Policy Case.

Our analysis shows that fears of increased natural gas prices under policies to cut global warming pollution are unfounded. Natural gas demand will increase at a slower rate under the Climate Stewardship Act than under business as usual, because the emission caps and complementary energy efficiency and renewable energy policies help decrease overall demand for future gas use. In our analysis, natural gas consumption in 2020 will be 3 percent below consumption under business as usual scenarios, resulting in a decrease in natural gas prices of 22 cents per thousand cubic feet.

Coal consumption shows the greatest change between the two cases – in 2020 coal consumption in the Policy Case is 44 percent lower than in the Base Case. This analysis is limited, however, in that we did not include any policies to incentivize advanced technologies for coal combustion such as integrated gasification combined cycle (IGCC) coupled with carbon capture and storage (CCS) in geologic repositories. Such technology offers great promise to allow continued coal consumption with dramatically reduced carbon emissions to the atmosphere. A share of the allowances allocated to the non-profit Climate Change Credit Corporation established under the Climate Stewardship Act could be dedicated to incentivizing this technology.

Petroleum consumption in 2020 is about 11 percent lower than in the Base Case. Renewables account for 11 percent of total energy consumption in the Policy Case by 2020, which is a 50 percent increase in the amount of renewable energy as compared to the Base Case. Use of nuclear energy does not change between the cases.

Figure 8 - U.S. Energy Consumption in Base Case

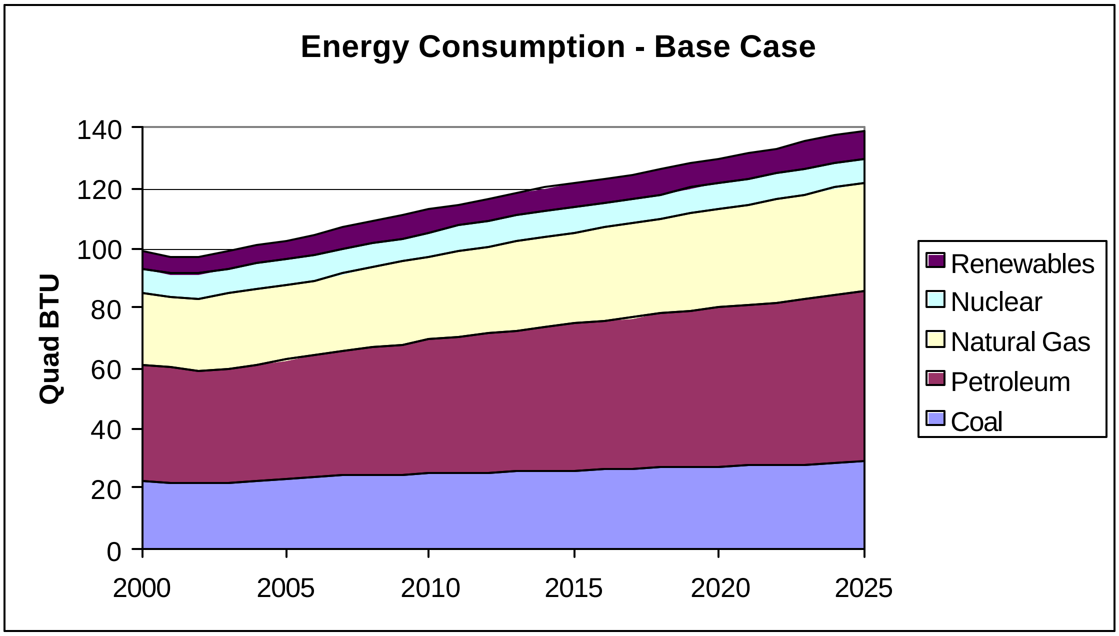


Figure 9 - U.S. Energy consumption in Policy Case

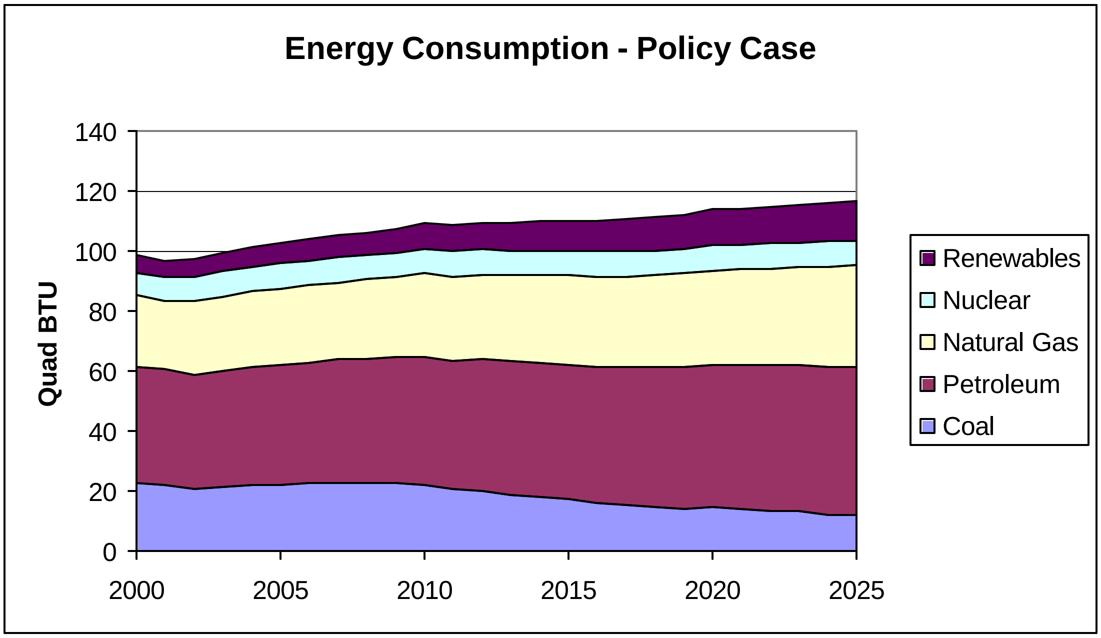


Figure presents the prices for natural gas under the Base and main Policy Cases. Demand for natural gas in the main Policy Case is lower than in the Base Case. The reason is that efficiency improvements that reduce total energy consumption more than offset an increase in natural gas market share. These demand reductions lead to natural gas price reductions, as seen in Figure 10, starting with a 2 percent reduction in natural gas wellhead price in 2015, and reaching a 6 percent reduction in 2020, as compared to the Base Case prices. Allowance prices are not included in the wellhead natural gas price.

Figure 10 - Wellhead Natural Gas Prices

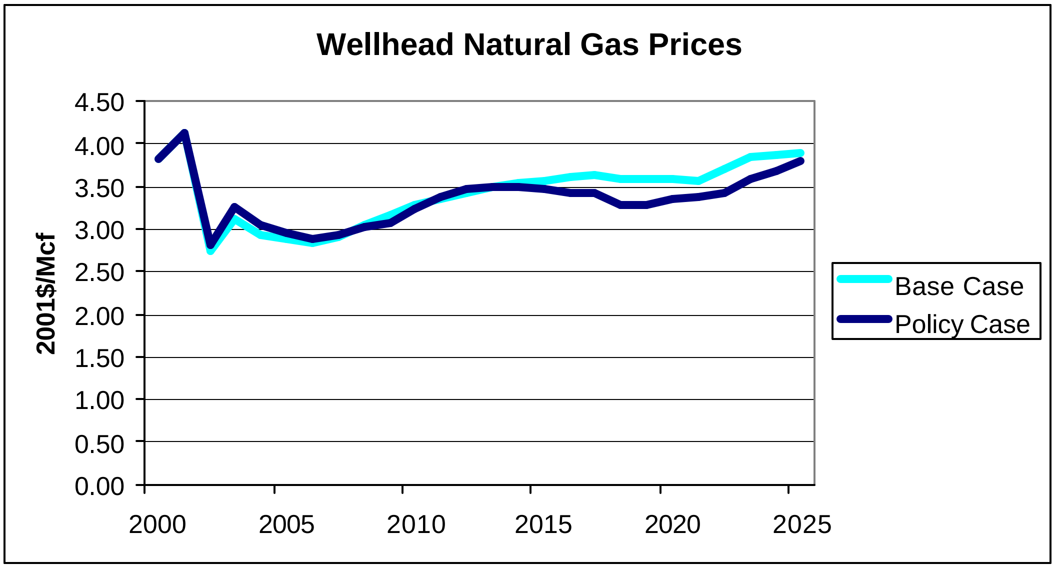
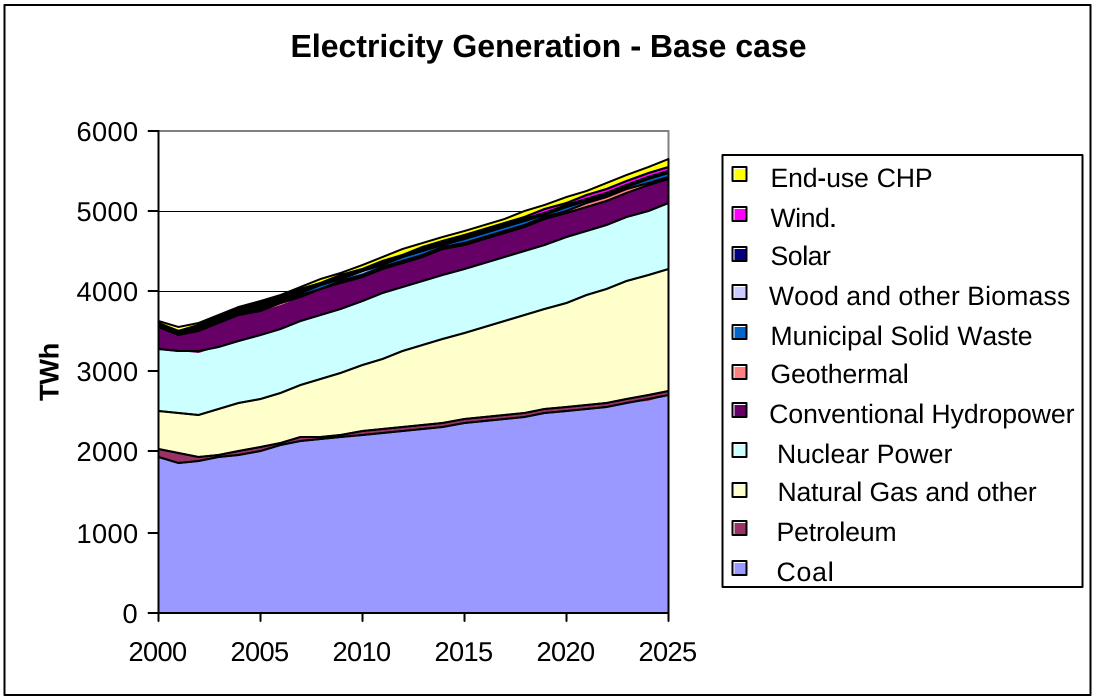


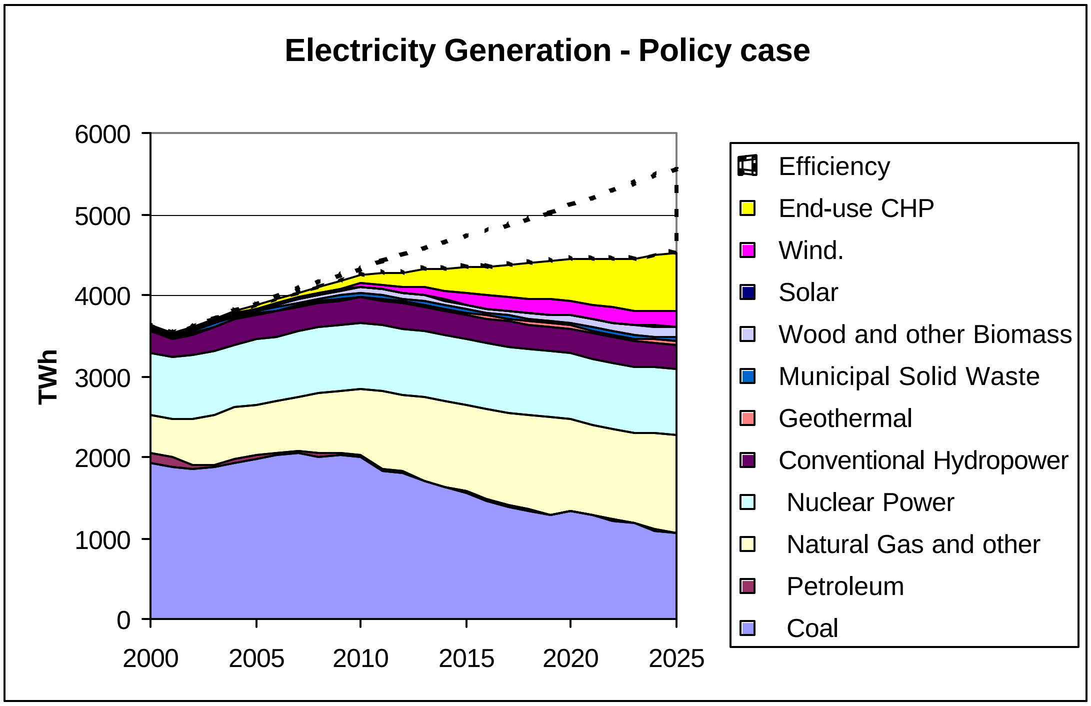
Figure 11 and Figure 12 report the mix of electricity generation for the Base and Main Policy Cases. In 2020, central station electricity generation is 23 percent lower in the main Policy Case than the Base Case, as a result of the end-use CHP and electricity efficiency measures. Coal generation experiences a 47 percent decrease and natural gas a 15 percent decrease in 2020, (Policy Case compared to Base Case). In 2020, wind generation is 4 times that of the Base Case, and accounts for 5 percent of total generation, while central station biomass increases 3 times and accounts for about 2 percent of total generation. Geothermal and landfill gas generation increase by 9 percent and 21 percent respectively, each accounting for about 1 percent of total generation. Solar generation remains small.

Figure 11 - Electricity generation in Base Case



Notes: End-use CHP refers to CHP in commercial and industrial sites whose main type of production is not heat or power. In the base case in 2025, end-use CHP generates 287 TWh of electricity and sells 81 TWh of electricity to the grid, 64 percent from natural gas, 20 percent from renewables, 8 percent from coal and 8 percent from other sources.

Figure 12 - Electricity generation in Policy Case



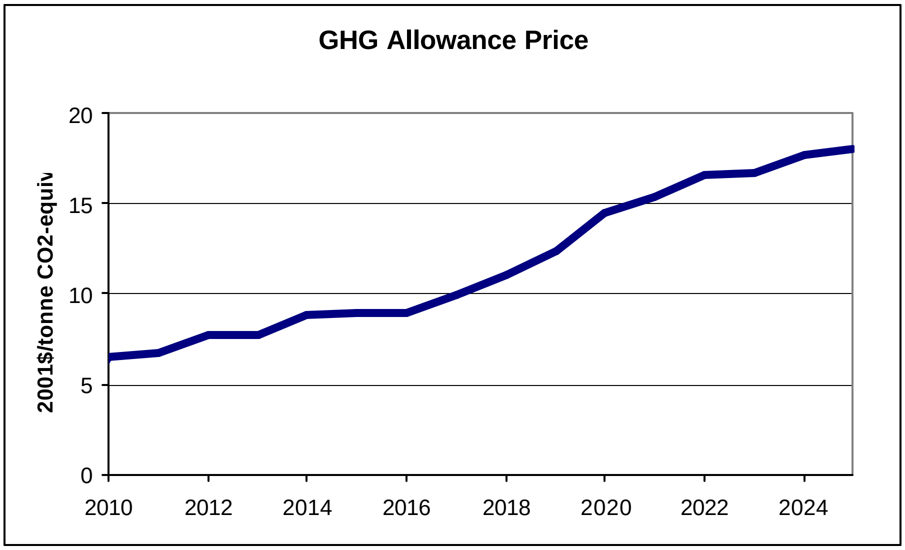
Notes: End-use CHP refers to CHP in commercial and industrial sites whose main type of production is not heat or power. In the policy case in 2025, end-use CHP generates 933 TWh of electricity (we did not analyze the amount sold to grid but assumed minimum losses for transmission and distribution for all CHP generation). The CHP generation mix is 83 percent from natural gas, 12 percent from renewables, and 2 percent from coal and 3 percent from other sources.

4.5 Advanced Policy Case Results

As previously mentioned, we analyzed an Advanced Policy Case with enhanced oil savings. We replaced the 1 million barrels per day reduction starting in 2013 with an increase in the new fleet average fuel economy (including cars and light duty trucks) of 1 mpg each year starting in 2005 at 25 mpg and increasing to 35 mpg in 2015 and 45 mpg by 2025. This translates to a savings of a little over 2 million barrels per day in 2013 rising to just over 4 million by 2025. With this somewhat more aggressive policy case we find that the requirements of the Climate Stewardship Act are significantly easier to achieve.

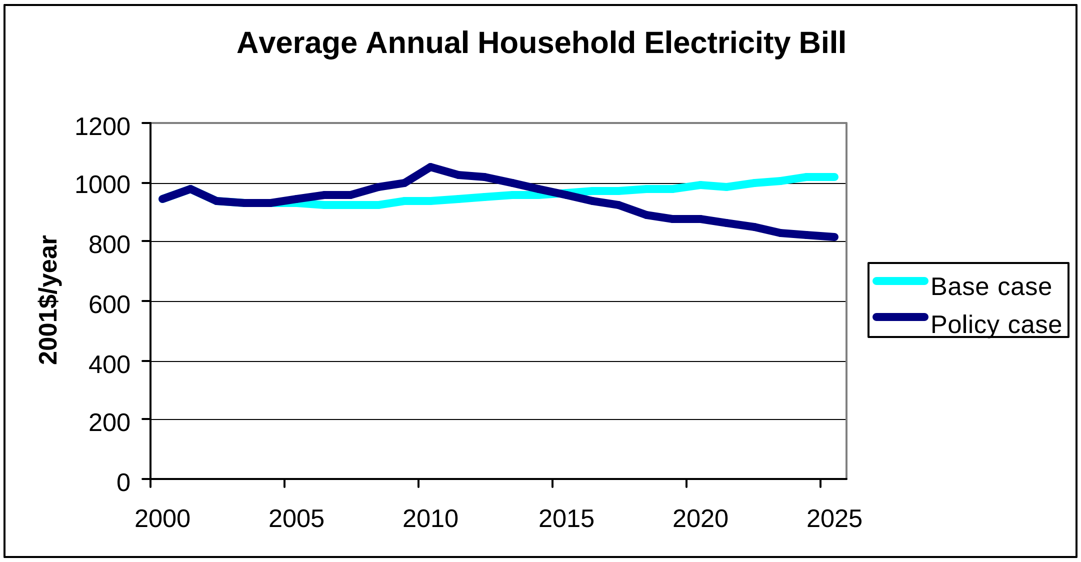
These greater oil savings reduce emissions of heat-trapping gases and result in lower allowance prices, particularly in the later years of the forecast. In this case projected allowance prices are $7/tonne of CO_2-equivalent emissions in 2010, $14/tonne in 2020, and $18/tonne in 2025 (Figure 13).

Figure 13 - Allowance prices for the Advanced Policy Case



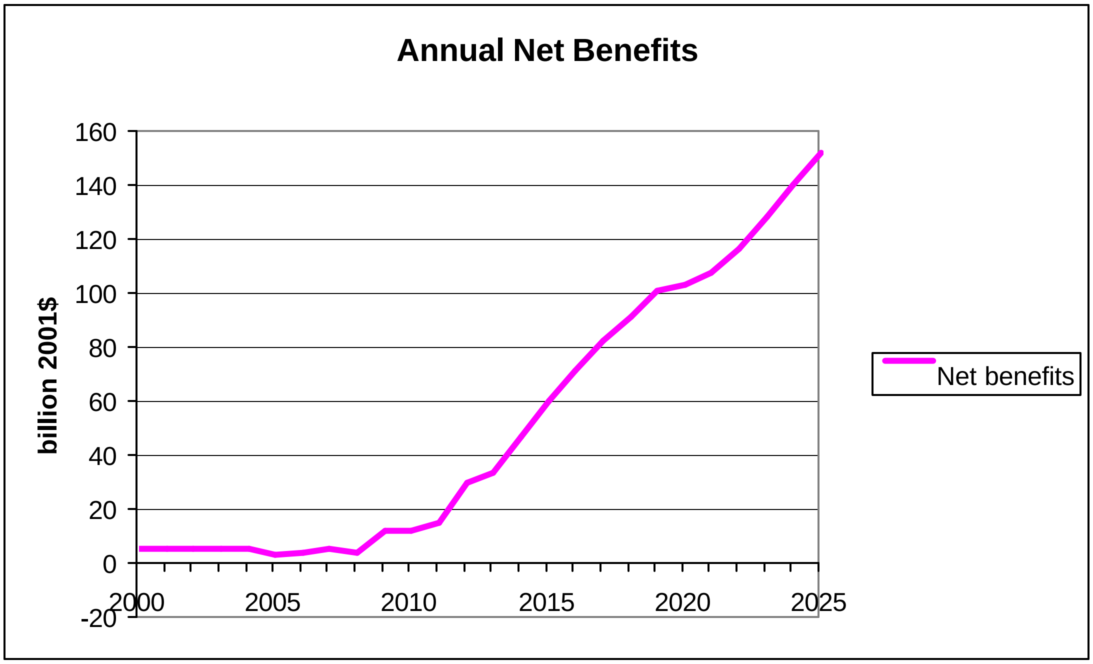
As a result of these lower allowance prices, electricity prices are also lower. Household electricity bills are even lower than in the main Policy Case, as shown in Figure 14. While average household electricity bills were projected at $883 in 2025 in the main Policy Case, they drop to $814 in the Advanced Policy Case as a by-product of greater oil savings. By comparison, the 2025 household electricity bill in the Base Case is estimated at $1020.

Figure 14 - Average annual household electricity bill for the Advanced Policy Case



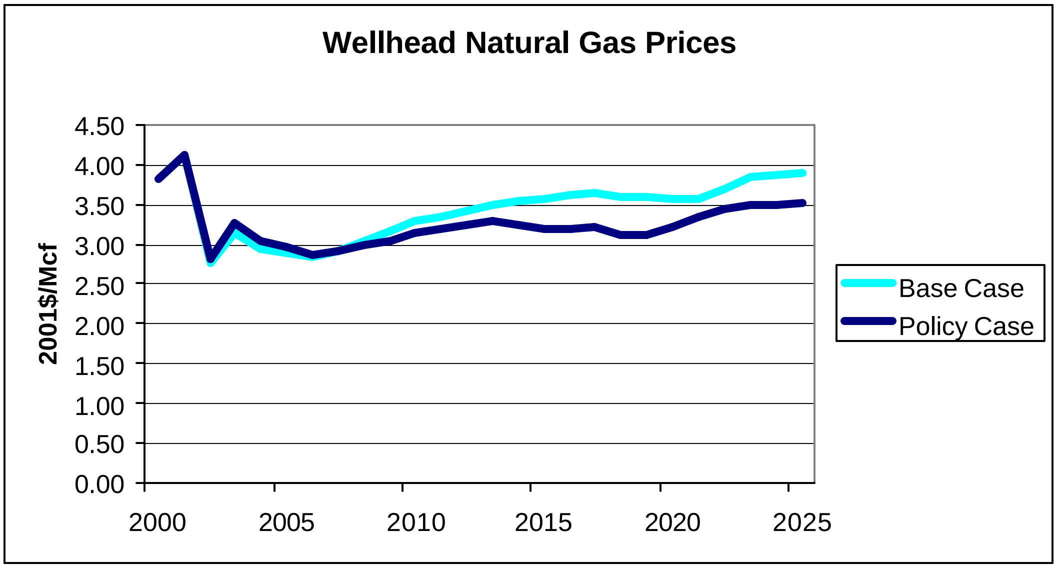
The evaluation of the societal costs and benefits trends are again similar, though here the benefits out weigh the cost 5 years earlier such that by 2025 the net benefit is $147 billion as compared to $78 billion (see Figure 15).

Figure 15 - Annual net benefits (billion 2001$) for the Advance Policy Case



Energy consumption also follows similar trends to those previously described, though this more aggressive transportation policy creates less need to reduce emissions by switching from coal to natural gas. As a consequence coal use declines less, as compared to the Base Case, and gas declines more. In 2020 coal consumption for the Advanced Policy Case is 37 percent lower than in the Base Case, petroleum consumption is 19 percent lower, and natural gas consumption is 9 percent lower. The larger decrease in natural gas demand leads to larger price reductions for natural gas as compared to the Base Case. As shown in Figure 16, we start with a 5 percent reduction in natural gas wellhead price in 2010, which reaches a 10 percent reduction by 2020 (as compared to the Base Case prices).

Figure 16 - Wellhead natural gas prices for the Advance Policy Case



4.6 Comparison to Other Studies

Some key results from this analysis are compared to recent analyses by MIT (Paltsev et al. 2003) and the Energy Information Administration (EIA 2003b) in Table 4.

The MIT Joint Program on the Science and Policy of Global Change recently published *Emissions Trading to Reduce Greenhouse Gas Emissions in the United States: The McCain Lieberman Proposal* (Paltsev et al. 2003). Scenario 7 of that analysis resembles the scenario analyzed in this analysis, although the MIT analysis does not include complementary policies. The MIT results have allowance prices increasing from \$21/tonne CO_2 in 2010 to \$36/tonne CO_2 in 2020,[10] higher than the values that we have shown. Even with the higher allowance prices, MIT calculates that welfare costs (the cost to the economy as measured by the impact on household purchasing power) would be only 0.09 percent to 0.13 percent of the reference case consumption levels. This suggests that if the complementary policies adopted in our analysis were included in the MIT analysis, the result would be to further reduce both MIT's estimate of allowance prices and welfare costs. As in this study, MIT finds that natural gas consumption would be lower under S.139 than under its reference case (both reference case and policy case

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[10] Prices converted to 2001\$ for comparison to values in this report.

natural gas consumption levels are significantly lower than the levels projected by both this study and by EIA).

The Energy Information Administration analyzed S.139 at the request of Senator Inhofe (and a subsequent request by Senator Lieberman). EIA used its NEMS model to conduct the analysis without the modifications applied here (see Section 5) and without the complementary policies considered in this analysis. In this form the NEMS model is well known to respond weakly to policy signals (Laitner et al. 2003), implying that higher allowance prices are needed to achieve the emission limits of S.139. Furthermore, EIA made a number of questionable assumptions in applying the model that further drive up allowance prices and welfare costs (Pew Center 2003). As a result the allowance prices forecast by EIA average more than twice as high as those forecast by this study. Welfare costs projected by EIA are also much higher than those found here or in the MIT study by a factor that greatly exceeds the difference in allowance prices. Another major difference is that EIA projects an increase, rather than a decrease, in natural gas consumption under S.139 relative to its reference case. This is due to the very weak demand response in the end-use sectors projected by EIA NEMS. As a result a much greater proportion of the total emission reductions must be achieved by fuel switching from coal to natural gas in the electric sector, driving up gas demand and prices (Pew Center 2003).

Table 4 - Comparison of S.139 analyses

	2010			2015			2020		
	Tel	**MIT**	**EIA**	**Tel**	**MIT**	**EIA**	**Tel**	**MIT**	**EIA**
Allowance Price (2001$/tonne$CO_2$-eq)	8	21	22	18	28	32	22	36	49
Cost per Household (2001$)	53	67	344	-124	91	630	-379	121	534
Gas Consumption (Quadrillion BTU)	27	21	28	29	23	31	32	23	37

Tel – Tellus Institute (this study) main Policy Case.
MIT – Paltsev et al.. (2003), Scenario 7.
EIA – EIA (2003b).
Allowance Price –MIT values inflated from 1997$ to 2001$ by a factor of 1.073.
Cost per Household – Tellus values represent net resource costs (see Section 4.2) divided by the number of households. MIT values represent welfare costs per household, defined as equivalent variation or loss in macroeconomic (personal) consumption. These values were inflated to 2001$ as above. EIA values represent differences in real consumption between the S.139 case and the Reference case (Table D21, EIA 2003b) divided by the number of households and inflated from 1996$ to 2001$ by a factor of 1.094. (Values for 2015 estimated from Figure 7.9, EIA 2003b)

5 Analytical Approach

We estimated the impacts of the Act and complementary policies through a combination of the National Energy Modeling System (NEMS) for the electric sector and other modeling approaches for the other sectors. While NEMS provides detailed technology and policy options for modeling a carbon cap and trade policy in the electric sector, its representation of other sectors is much weaker.

EIA's NEMS model reflects and reinforces the status quo, limiting the potential impact of innovative technologies and policies that differ from business-as-usual behavior. Historical analyses of the results from NEMS and similar energy-economic models have shown that NEMs has a strong tendency to over-estimate future energy consumption and underestimate the impacts that technological change can have on this consumption (Laitner et al. 2003). The systematic under-representation of impacts of new polices results in over-estimating compliance costs. In the case of cap and trade policies, this would be seen through over-estimates of both allowance prices and energy prices. Furthermore, the NEMS model assumes a reference case where most resources are fully employed and efficiently allocated.[11] Thus, by definition, any changes in the mix of resources made in order to protect the environment are predicted to lead automatically to a less efficient and more costly outcome. Yet, the assumptions that resources are fully efficiently allocated, and that there is always a trade-off between environmental and economic benefits, have been shown to be false (DeCanio 1997). For example, it has been shown repeatedly in the economic literature and through practical experience that energy efficiency measures can and do result in improved economic efficiency and net benefits to businesses and consumers.

We have addressed some of these shortcomings by refining aspects of the NEMS model (see section 5.4) and by employing other models for areas in which NEMS is particularly weak. NEMS does not well characterize the industrial sector at the level of specific technologies and does not easily allow the modeling of specific transportation sector policies. For these sectors we used models developed by Tellus and the American Council for an Energy Efficient Economy (ACEEE) that have been used for other similar policy contexts and incorporated the relevant results into our version of NEMS.

5.1 Residential and Commercial

Section 352 of the Act indicates the allowable uses for proceeds from allowance trading activities:

> (B) Use of Tradeable Allowances and Proceeds
>
> (1) IN GENERAL. — The Corporation shall use the tradeable allowances, and proceeds derived from its trading activities in tradeable allowances, to reduce costs borne by consumers as a result of the greenhouse gas reduction requirements of this Act. The reductions —
>
> > (A) may be obtained by buy-down, subsidy, negotiation of discounts, consumer rebates, or otherwise;

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[11] Some behavioral responses are included in NEMS to represent actions that are not strictly based on cost-minimization. However, the parameters for these responses tend to be based on historical data, which by definition would not represent an environment with innovative policies.

> (B) shall be, as nearly as possible, equitably distributed across all regions of the United States; and
> (C) may include arrangements for preferential treatment to consumers who can least afford any such increased costs.

To simulate the type of programs that could be enacted under this section of the Act, we used analysis provided by the American Council for an Energy Efficient Economy (ACEEE) that had been developed to simulate a public benefits fund. The analysis estimates the reductions in electricity demand that would result from a series of demand side management programs funded by a federal source. For the public benefit fund, the funding was from a small adder on electricity price; for the Climate Stewardship Act the funding would be drawn from proceeds from trading activities.

The key assumptions for this analysis are:

Start date of efficiency programs: 2011 using funds collected in 2010

Electricity reductions associated with programs: Four broad studies of 1990-1994 utility programs indicate a simple average of $0.036/kWh saved including utility and customer payments (Nadel and Geller 1996). A review of four market transformation efforts indicates a simple average of $0.021/kWh, again including utility, government, and end-user payments (Nadel and Latham 1998). Based on these studies, we estimate an average of $0.03/kWh for future programs. Support for this value is provided by the Northwest Energy Efficiency Alliance, which has found many productive ways to expend its nearly $30 million annual budget on programs below its cost ceiling of $0.03/kWh saved. (ACEEE 2001, notes from spreadsheet analysis).

Fraction of Investment Cost Covered by Government Funding: A review of utility lighting programs found that utilities paid an average of 56 percent of total costs including measure and administrative costs (Eto, et al. 1994). A review of large commercial programs found that utility costs averaged 76 percent of total costs (Eto et al. 1995). A review of five successful market transformation initiatives found that utility and government expenditures accounted for only 8 percent of total costs on a simple average basis. Given this wide disparity, and given a trend toward market transformation programs and other program approaches with lower utility cost shares, we estimate that in the future, the PBF share of total costs will average one-third. (ACEEE 2001, notes from spreadsheet analysis).

Allocation of Allowances from Trading Activities: We assumed 12 percent of allowances would be allocated to fund efficiency programs.

Allocation of Efficiency Programs: We assume programs will be designed to obtain equal *pro-rata* reductions in all regions in the country.

Electricity Reductions from the Efficiency Programs: The annual electricity demand reductions from the efficiency programs were estimated at 48 TWh in 2011, increasing to 274 TWh in 2016 and 731 TWh in 2025.

5.2 Industry Energy Efficiency

We estimated the potential reductions in the industrial sector that would result from the Climate Stewardship Act using analysis drawn from the American Council for an Energy Efficient Economy (ACEEE) study, *Smart Energy Policies: Savings Money and Reducing Pollutant Emissions through Greater Energy Efficiency* (Nadel and Geller 2001). That analysis estimated reductions based on a range of federal initiatives to motivate and assist industry to identify and exploit energy efficiency opportunities. We consider that the price signals sent by the Climate Stewardship Act's caps on global warming pollution would equal or exceed the incentives considered in the ACEEE analysis. Thus, our analysis treats the industrial emission reductions forecast by ACEEE to be the minimum response of the industrial sector to S.139. S.139's emissions caps take effect two years later than the policies assessed by ACEEE. To account for this later start up, we delayed the emission reductions forecast in the ACEEE analysis by two years but otherwise assumed the same these levels of reductions.

5.3 Combined Heat and Power

We estimated the increased penetration of CHP systems in the commercial and industrial sectors based on previous analysis (PowerSwitch 2003 and informed by Casten and Collins 2002 and Onsite Sycom Corp 2000) and personal communication with Neal Elliot, ACEEE (Elliot personal comm. 2003). While the Senate energy bill contains tax incentives for CHP, there is uncertainty about whether the bill will contain provisions to remove barriers to CHP (e.g., interconnection standards and reasonable back-up power requirements). Therefore, we assumed lower levels of CHP penetration in this analysis than we had in our previous PowerSwitch analysis. We assume an additional 55 GW of CHP capacity by 2020 and 80 GW by 2025 (above the AEO2003 estimates for CHP of 40 GW by 2020 and 45 GW by 2025).

5.4 Electric Sector

The modeling for this study was based primarily on the National Energy Modeling System (NEMS) of the U.S. Department of Energy, Energy Information Administration (DOE/EIA). The NEMS model version, data and assumptions employed in this study were those of EIA's *Annual Energy Outlook 2003* (EIA 2002), which also formed the basis for the Base Case. We refined the NEMS model with advice from EIA, based on their ongoing model improvements, and drawing on expert advice from colleagues at the ACEEE and the Union of Concerned Scientists, the National Laboratories and elsewhere. We refer to this refined version of the model as Tellus-NEMS.

For this study, we reduced electricity demand within Tellus-NEMS to reflect the efficiency and CHP programs described above. We also changed the parameters in NEMS to simulate the complementary electricity sector policies (the renewable portfolio standard and the NO_x, SO_2, and mercury cap and trade programs) as well as the CO_2 caps in the Climate Stewardship Act. We ran Tellus-NEMS to determine the new mix of electric capacity and generation (based on changes in both electricity demand and the electricity sector policies). The NEMS model takes account of the interactions between electricity supply and demand (aggregated residential, commercial and industrial) and the mix of competitive and still regulated pricing in the United States. It accounts for the feedback effects between electricity market and power plant construction decisions, the links between fuel demands, supplies and prices, and electricity purchases and sales between regions.

Our use of Tellus-NEMS for this project focused on the Electricity Market Module (EMM), complemented by the Oil and Gas Supply Module (OGSM). The EMM starts with the detailed fleet of existing power plants in the thirteen electric sector regions of the United States and also represents power imports from neighboring Canadian regions. It makes dispatch, construction, interregional purchase and retirement decisions based upon the regional electricity demands and the cost and performance characteristics of existing and new electric supply options, adhering to national pollutant caps and any state-level RPS requirements. It also takes account of cost reductions of new power plants with increased units in operation (learning and scale economies). The OGSM tracks changes in prices of natural gas and petroleum fuels based on changes in their demand. The electric generation, fuel and emissions savings plus electricity and natural gas price changes from these policies were obtained from Tellus-NEMS, thereby taking into account all of the interactive and feedback effects caused by the demand and electric sector policies implemented together.

Further information on NEMS is available from the Energy Information Administration's website, http://www.eia.doe.gov/bookshelf/docs.html.

5.5 Transportation

Our analyses of policy impacts in the transportation sector took account of vehicle stock turnover, fuel-efficiencies and travel indices, and were benchmarked to the structure, data and baseline projections of AEO2003. Following assumptions for light duty vehicle efficiency in ACEEE (2001) and other sources (DeCicco, Ross and An 2001), we accounted for both autonomous and policy-induced vehicle efficiency improvement, shifts between transport modes, and changes in demand for transport services. The analysis is based on the same approach used in WWF 2001.

Although the Act includes a provision for allowance trading by vehicle manufacturers that exceed fuel economy standards by 20 percent, we did not include this directly in our modeling. We estimated that the allowance prices would need to be about \$80/tonne CO_2 to provide manufacturers with an appropriate incentive to surpass current standards (27.5 mpg for cars, 20.7 mpg for light trucks). Our estimate of the required allowance price was based on incremental costs for vehicle efficiency from ACEEE 2001. We estimated much lower credit prices for other reductions options that provided sufficient reductions to meet the targets in the Act. So we did not assume that this provision of the Act would directly change the efficiency of light duty vehicles.

However, as described in section 2.4 on complementary policies, we did include the implementation of oil savings standards and increased levels of ethanol consumption. We also included the effects of modest "smart growth" policies to reduce vehicle travel.

5.6 Non-CO2 Gases

Sources of methane, nitrous oxide, and the so-called high global warming potential (high-GWP) gases – hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) – account for approximately 16 percent of current U.S. emissions of heat-trapping gases on a CO_2-equivalent basis (U.S. EPA 2003). Some of these sources are likely to be included as covered entities under the McCain-Lieberman legislation. For example, the current language clearly stipulates that producers and importers of the high GWP gases must hold allowances for each ton produced or imported.

Determining which sources of other non-CO_2 gases will be covered entities, however, is more difficult.[12] For the purposes of this analysis, the only other sources of non-CO_2 gases that we assume will be covered entities are natural gas, coal, and oil systems (releasing fugitive emissions of methane) and nitric and adipic acid production (releasing nitrous oxide). Together these sources account for about 33 percent of national methane emissions and 5 percent of nitrous oxide (N_2O) emissions.

To project non-CO_2 gas emissions from these sources, we used the Administration's 2002 Climate Action Plan, which assumes significant emissions reductions are achieved through voluntary programs, such as the Environmental Stewardship Initiative, which alone is estimated to reduce emissions by 94 $MMtCO_2$-eq (U.S. Department of State 2002). We then examined several opportunities to reduce emissions beyond this level:

- Upstream reduction of methane leaks due to reduced coal and natural gas consumption. Reduced natural gas use in the Policy Case results, to first order, in proportionately fewer methane emissions from leaks and venting. Similarly, reduced coal production leads to decreased underground mining and its associated emissions.[13]
- Improved technologies to reduce N_2O emissions from nitric and adipic acid production (U.S. EPA 2001).

These measures, available at no or very low cost (less than $1/tCO2), were included in the Policy Case. For all measures requiring active effort or investment, we assumed that only 80 percent of the economic potential found in technical studies would actually be achievable.

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[12] For instance, challenges in emissions measurement and attribution might make it difficult to account for nitrous oxide emissions from vehicles use, even though Sec. 311 states that petroleum refiners and importers are responsible for every ton of CO_2-equivalent emissions from the products they sell.

[13] We assume that coal production is proportional to coal use (i.e. we ignore net imports/exports). U.S.EPA expects that the marginal methane emissions rate will increase with production as an increasing fraction is expected to come from deeper underground mines. See U.S. EPA, 1999.

5.7 Banking

NEMS does not include subroutines to determine within the model the optimal, least cost levels of early "over-control" and allowance banking over time. We estimated levels of banking exogenously by analyzing output from a range of runs with different banking levels. From a rational economic point of view, an entity will bank emissions if the cost of reductions in future years is expected to exceed the cost of reductions in the current year by at least the entity's hurdle rate (usually the cost of capital plus some determination of risk aversion). The banking assumptions used in the chosen scenario reflect an average hurdle rate over the period of about 7%.

6 Conclusions

We have analyzed the impacts of the Climate Stewardship Act (S.139) by using EIA's NEMS model in conjunction with a variety of complementary polices to increase energy efficiency and renewable energy. We simulated a program to improve demand side management efficiency programs to reduce electricity demand using proceeds from trading activities as stipulated in the Section 352 of S.139. Complementary policies include measures currently under consideration in the U.S. Senate, such as a national renewable portfolio standard, an oil savings requirement, increased use of ethanol as transportation fuel, and caps on SO_2, NO_x, and Hg emissions from power plants (see footnotes 1- 4 for details). Additional policies were also included that would further complement the objectives of the Act and are well within the realm of feasibility as shown by past experience. We assume vehicle travel will be reduced slightly through policies such as smart growth, and that policies to eliminate barriers to the use of Combined Heat and Power (CHP) systems in the commercial and industrial sectors lead to increased penetration of these systems with the resulting significant energy efficiency increases, emission reductions and other benefits.

We estimated the impacts of these policies with a modified version of the National Energy Modeling System (NEMS) for the electric sector and other modeling approaches developed by Tellus Institute and ACEEE for the energy demand sectors.

Our results establish that the Climate Stewardship Act is a cost-effective approach to managing U.S. global warming pollution, especially when partnered with sound energy policies that help reduce energy consumption while increasing clean, renewable sources of energy. Our analysis shows that there can be substantial net economic benefits (upward of $150 billion per year by 2025), substantial household electricity bill savings (at least $57 per year by 2020, and $137 per year by 2025), and lower natural gas prices (6 percent less by 2020).

The window of opportunity to avoid the worst global warming impacts is rapidly closing. The Climate Stewardship Act *can* start curbing the serious hazard to our health and our environment that global warming presents and, at the same time, save the U.S. economy billions of dollars.

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