Economic Consequences of Northeastern State Proposals to Limit Greenhouse Gas Emissions from the Electricity Sector

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Executive Summary

In April 2003, New York Governor George E. Pataki sent letters to the 11 governors from Maine to Maryland, inviting their states' participation in discussions to develop a regional cap-and-trade program covering carbon dioxide emissions from power plants within two years. By July 2003, the governor had received positive responses from governors from the following eight states: Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island, and Vermont. Currently, these states participate actively in the ongoing discussions. After discussions got underway, representatives from the Eastern Canadian Provinces Secretariat and the Province of New Brunswick began observing the process. The District of Columbia, Maryland, and Pennsylvania also send representatives to observe the process.[1]

The efforts of nine states to limit GHG emissions have been termed the Regional Greenhouse Gas Initiative (RGGI or "ReGGIe"). Currently the group is discussing the design of a regional cap-and-trade program with a market-based emissions trading system initially covering carbon dioxide emissions from power plants in the region. In the future, RGGI may be extended to include other sources of greenhouse gas emissions, and greenhouse gases other than CO2.

The group of states is still working on the details of the cap and trade program. For this study, we consider two alternatives based on the New England Governors and Eastern Canadian Provinces Climate Change Action Plan (CCAP) and the amended McCain-Lieberman bill (SA.2028). CCAP is an economy wide program that calls for greenhouse gas (GHG) emissions from the New England states and Eastern Canadian Provinces to return to 1990 levels by 2010, reduce the cap to 10% below 1990 levels by 2020, and then reduce emissions to between 75% and 85% below 2000 levels by about 2050. SA.2028, which covers most of the US economy, calls for covered U.S. greenhouse gas emissions to return to 2000 levels by 2010 and remain at this level through 2020.

In this study, we analyze the impact of the CCAP and SA.2028 limits applied only to the electricity sector. That is, the CCAP policy in this report looks into the impact on the northeast states and the rest of the U.S. economy if the northeast states were to cap carbon dioxide emissions from electric generators at 1990 levels of emissions from generators in 2010, 10% below 1990 levels by 2020, and 80% below 2000 levels by 2050. For the other policy, Cap 2000, emissions from electric generators are assumed to be capped at 2000 levels throughout the model horizon. To make these reductions in emissions, fossil energy consumption in electricity generation in the northeast would have to fall dramatically because carbon dioxide, the primary GHG covered by these proposals, is a necessary byproduct of the combustion of fossil fuels to produce electricity.

This report, based on an analysis commissioned by the American Council for Capital Formation's Center for Policy Research, summarizes the results of an in-depth analysis of the costs of capping carbon emissions from electric generators at the two different levels – CCAP and Cap 2000 – under a number of assumptions and scenarios designed to

[1] RGGI website: http://www.rggi.org/about.htm.

identify the likely range of costs, while acknowledging that these costs cannot be predicted precisely. Among the key impacts on northeastern states are the following:

- **Electricity prices rise significantly**: Electricity prices rise by 23% in 2010 and 34% in 2020 under CCAP. Under the Cap 2000's lower targets, electricity prices increase by 9.0% in 2010 and 14% in 2020.

- **Job losses are substantial**: Under the CCAP targets, job losses are 57,000 in 2010 and 83,000 in 2020; under the Cap 2000, job losses range from 18,000 to 33,000 in 2010 and 2020.

- **Burden of reducing carbon emissions falls most heavily on the poor and elderly**: In 2010 and 2020, the poorest 20% of households will bear an increased cost burden over 100% greater than the highest-income households due to the increased cost of energy. The elderly will face a burden 40% greater than the population under 65.

- **Purchasing power erodes because household income falls and prices rise**. A typical household in the northeastern states loses an average of $600 and $880 in purchasing power for the years 2010 and 2020, respectively, under the CCAP.[2] Under the Cap 2000, the emission reductions and impacts are smaller: the average northeastern household suffers a loss of $270 and $420 in 2010 and 2020, respectively.

- **Electricity Output decreases as costs rise.** Electricity generation decreases significantly under the examined policies. For the CCAP target, output from the electricity sector would fall by 10.5% and 16.2% for the years 2010 and 2020, respectively. Under the Cap 2000 policy, electricity output would fall by 4.7% and 7.8% in the years 2010 and 2020, respectively.

- **Regional economic output decreases**: The loss in northeastern gross regional product (GRP) grows over time. For the CCAP target, GRP would fall by 0.3% and 0.5% for the years 2010 and 2020, respectively. Under the Cap 2000 policy, GRP would fall by 0.1% and 0.2% in the years 2010 and 2020, respectively.

State tax revenues decline: Budget problems for the northeastern states would worsen. Lower wages and incomes lead to a loss in state income tax collections. In addition, reductions in gasoline tax collections and the linked loss in federal highway trust fund grants lead to a combined loss in state tax revenues of $421 million under the CCAP target and $174 million under the Cap 2000 for the northeastern region by 2010. Any increases in state outlays for electricity-related costs would further worsen these budgetary impacts.

[2] Throughout this report all dollars are 1999 dollars unless noted otherwise.

Introduction

Many of the governors of the northeastern and mid-Atlantic states view mandatory reductions in greenhouse gases (GHGs) as the preferred method to address climate change. In August 2001, the six New England states and five eastern Canadian provinces of the Conference of New England Governors and Eastern Canadian Premiers (NEG/ECP) signed an agreement to begin reducing greenhouse gas emissions in their region.[3] The governors and premiers adopted a Climate Change Action Plan (CCAP) that includes measures to increase energy efficiency, increase the use of renewable energy, and decrease the impact of transportation. To formalize the ideas behind the CCAP and therefore take concrete steps toward reducing emissions, nine northeastern states – Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont – created the Regional Greenhouse Gas Initiative, which calls for the creation of a cap and trade program to reduce CO2 emissions from electricity generation. Currently, the northeastern and mid-Atlantic states are working to formulate the levels of the caps and the rules of the system.. If the signatory states decide to implement this proposal, they will form their own regional emissions trading program, whereby their cumulative emissions from electricity generation must not exceed the sum of the caps for this group of states.

Assumptions in the Analysis

- **States Included**

The final set of signatory states has not been determined. Currently, nine states that include Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont are actively participating in the RGGI effort. In addition, Maryland, the District of Columbia, and Pennsylvania are observers in the process.[4] This analysis assumes either that nine states participate (Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont), or that eleven states participate (the preceding nine plus Pennsylvania and Maryland). While this report estimates the range of costs for GHG emission reduction for the group of nine and the group of eleven states, most of the data reported are for the case of all eleven states participating.

- **Emission Scenarios**

  Two different regional emission reduction targets for the northeastern states are used in this analysis. First, we analyzed the CCAP case: a return to 1990-level emissions in 2010, maintaining emissions at this level until 2020, when the cap drops to 10%

[3] NEG/ECP members are Governor of Connecticut, Governor of Maine, Governor of Massachusetts, Premier of New Brunswick, Premier of Newfoundland and Labrador, Governor of New Hampshire, Premier of Nova Scotia, Premier of Prince Edward Island, Premier of Québec, Governor of Rhode Island, and Governor of Vermont.

[4] http://www.state.ny.us/governor/press/year03/july24_03.htm

below 1990 emissions, then finally embarking on a trajectory to reduce emissions to 80% below 2000 levels by 2050 (CCAP Case). Second, we modeled a target of reducing emissions from electricity generation to 2000 levels and then holding to that level in perpetuity (Cap 2000 case). In addition, we considered the sensitivity of these policies to the cost-effectiveness of carbon sequestration technology. The rest of the United States is assumed not to commit to any mandatory reductions in GHG emissions.

To meet these emission targets, fossil energy consumption by electric generators must fall dramatically or integrated gasification combined cycle (IGCC) electric generators or similar technology must be developed. This will increase costs of electric generation. These changes would result in costs to both industry and households.

Detailed Results[5]

This section details the impacts of possible RGGI policies on the northeastern states under two different assumptions about targets. This section focuses on two possible targets in which all eleven states agree to cap their emissions from electric generators. The first case, "CCAP", assumes that the NEG/ECP emission targets are imposed on the electricity sector. In the CCAP scenario, we assume that the cost of the backstop technology declines over time – starting at a cost of $300/tonne in 2010 to reduce carbon, declining to $100/tonne by 2050.[6] In the second case, Cap 2000, we assume that the region's electricity emissions are capped at year 2000levels forever. In this case, the backstop cost is assumed to be $300/tonne for all time.

The impacts of these policies will vary by state. As mentioned above, these policies address the emissions from electricity generation, which equates to regulating the consumption of fossil fuels by electric generators. On a per MWh basis (adjusting for differences in heat rates), coal produces about twice as much carbon emissions as natural gas. Oil falls between coal and gas, but is somewhat closer to coal. Therefore the relative impact of these policies on any state depends in a large part on its generation mix. Table 1 reports the percentage of each state's electricity generated from the three fossil fuels and all other non-fossil fuels.

[5] These regional northeastern programs place no constraints on the amount of regional electricity production that may be replaced by electricity production from the rest of the U.S. that undertakes no commitment to reduce emissions. Thus, the region can maintain its level of electricity consumption while reducing emissions within the region dramatically by retiring many of its existing fired generators. However, this approach greatly reduces the efficacy of these proposals because emissions reduced in the northeastern region are generated in other regions when they produce electricity for export to the northeast. Therefore, assumptions about the ability of electricity exports (from the rest of the U.S. or Canada) to replace domestic production have a major effect on model results.

[6] In our model, the existence of a backstop technology is reflected as an exogenously specified price per tonne (denoted in $/tonne of carbon) at which CO_2 can be sequestered. We derive our cost estimates from estimates of carbon-capture technologies combined with integrated gasification combined cycle power generation.

Table 1. Electricity Statistics – Share of Generation by Fuel and Share of Industry Output (%)

State	Share of Generation by Fuel				Share of Industry
	Coal	Oil	Gas	Other	Output
Connecticut	10%	7%	28%	54%	1.1%
Delaware	58%	16%	24%	2%	0.8%
Maine	3%	5%	60%	32%	1.8%
Maryland	59%	5%	5%	31%	1.4%
Massachusetts	27%	16%	38%	19%	0.8%
New Hampshire	23%	4%	1%	71%	1.8%
New Jersey	16%	1%	31%	52%	0.8%
New York	17%	8%	28%	48%	1.0%
Pennsylvania	56%	1%	3%	40%	2.4%
Rhode Island	0%	1%	89%	10%	0.9%
Vermont	0%	0%	0%	100%	1.6%

Source: Energy Information Agency/State Electric Profiles 2002 and IMPLAN database.

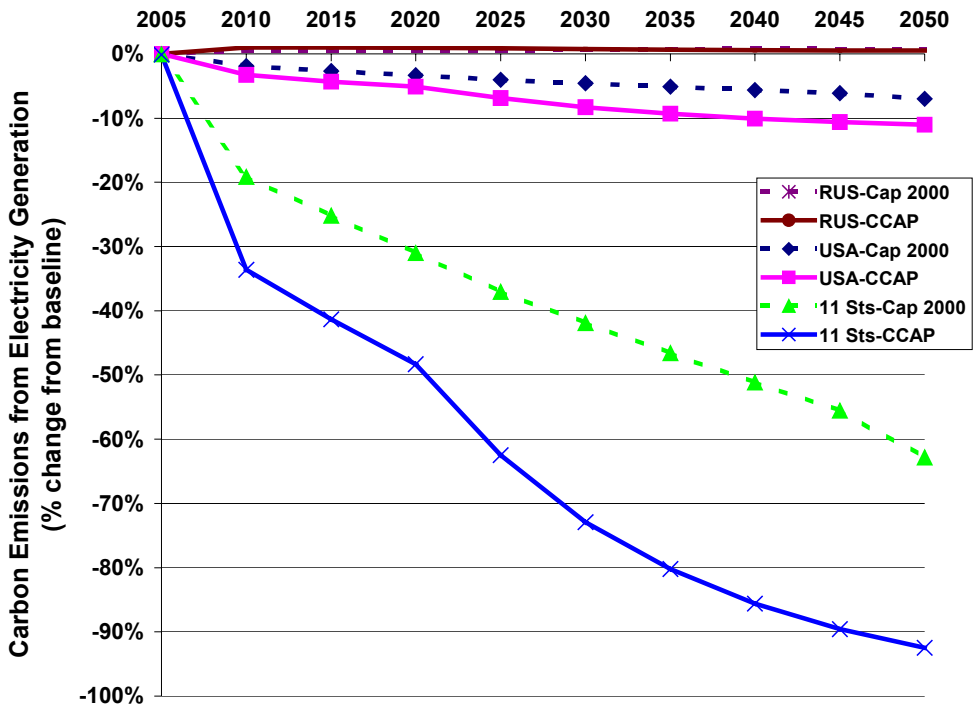
This table suggests that Vermont will be the least affected by these policies since it has the smallest share of generation by coal and by fossil fuels in general. Pennsylvania is likely to be harmed the most since over half of its generation comes from coal and electricity generation makes up 2.4% of its economy.

The next-to-last section of this report compares the economic effects on Maryland and Pennsylvania depending on whether they do or do not impose the carbon reduction targets on their states. The final section summarizes the impacts on all eleven states under these two cases. (See the Appendix on "Modeling Approach" for a more detailed discussion of the assumptions employed for each case.)

Impact of Targets on Carbon Emissions

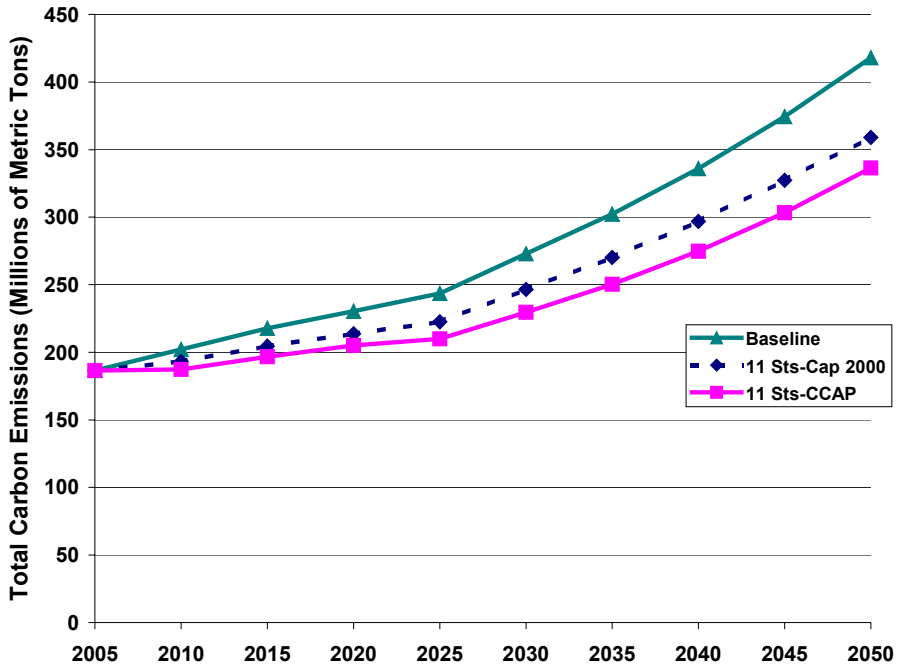
The two cases analyzed here (CCAP and Cap 2000) will cause very substantial reductions in carbon emissions from the growing levels of emissions expected under current policies. Figure 1 shows these reductions as a percentage change from the baseline emission. For example, in 2020 under the CCAP policy, emissions from electricity generation must be reduced by over 45% from the level they would have been in the baseline for the northeastern states to be in compliance with the policy's 2020 regional cap of 10% below 1990-level emissions. Figure 2 shows the total carbon emissions in the baseline and the net carbon emissions under the two policies. The net emissions in the policy scenarios equal the total emissions less the amount of carbon emissions captured and stored using carbon sequestration technologies on concentrated CO2 streams from electric generation technologies such as integrated gasification combined cycle (IGCC) electric generators. Sometime after 2020 for both policies, emissions increase above the caps. These excesses are offset through carbon sequestration, so that net emissions from the electricity sector meet the goals mandated under these policies. The cost of sequestering this carbon is determined by the assumption about the cost of the backstop technology. Therefore, the sequestration costs vary according to the case being examined.

Figure 1. Carbon Emissions from Electricity Generation for the Eleven States, the Rest of the US (RUS), and the US as a Whole for the Cap 2000 and CCAP Cases.[7]
(% Change from Baseline Forecast)



[7] The change in total emissions of the other 39 states is nearly zero, so this case does not show up.

Figure 2. Total Carbon Emissions for Eleven Northeastern States under the Baseline, and the Cap 2000 and CCAP Policies.
(Millions of Metric Tons of Carbon)



Targets Cause Carbon "Leakage" to Rest of the United States

If the northeastern (NE) states unilaterally adopt emission limits, some NE electricity production will relocate to other states where no emission limits exist. This outflow of generation leads to a reduction in NE emissions but causes an increase in emissions in the rest of the U.S. (RUS). The carbon leakage numbers below capture this regional shift in generation within the U.S. and measure the effectiveness of the policy to reduce GHGs. Because of the assumed relative ability of the NE states to increase electricity imports, these policies lead to carbon and economic leakage.

In 2010 for the Cap 2000 and CCAP cases, total carbon emissions in the capped states decrease by 16.6 MMTC and 31.5 MMTC, whereas total carbon emissions in the uncapped states increase by 3.6 MMTC and 6.6 MMTC. In other words, about 20% of the northeastern state carbon reductions from electricity generation would be offset by increases in other states for electricity sold to the northeast. These leakage numbers understate the total leakage under these policies since the NE region also increases its imports of electricity from Canada. These leakage numbers are highly dependent on the ease or difficulty in which the NE region can import electricity from the rest of the U.S. and Canada. If restrictions were placed on electricity imports, or it became difficult to build all the necessary transmission infrastructure to transmit electricity from the capped to the uncapped states, then leakage would decline sharply while the costs of complying with the policies would increase dramatically.

Table 2. Carbon Leakage under the Cap 2000 and CCAP Cases
(Millions of Metric Tons of Carbon)

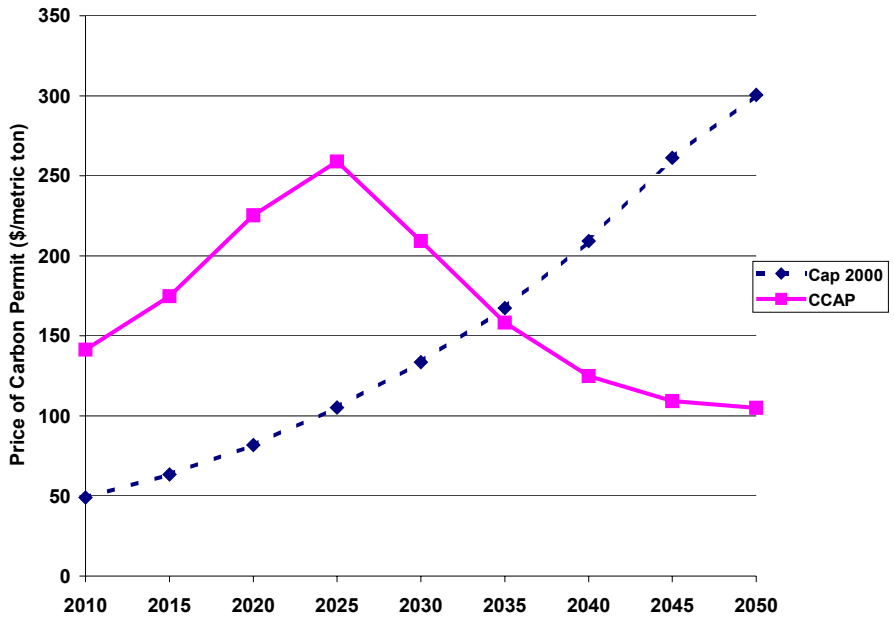
		Scenario	
	Year	Cap 2000	CCAP
Total Leakage in Carbon Emissions to the Rest of the U.S.	2010	3.6	6.6
	2020	4.7	7.6
Total Decrease in Northeast Carbon Emissions	2010	16.6	31.5
	2020	31.4	51.0

Price of Carbon Permits

As part of the program of reductions, CRA assumed that there is a region-wide permit trading program.[8] All carbon emissions from the burning of fossil fuels to generate electricity would require these permits. We assume that a perfectly functioning cap-and-trade program is established. These permits can be traded (bought and sold) freely across the electricity sector and states. Trade ensures that the marginal cost of abatement is equalized throughout the region. That is, permit trading will occur so that the cost to reduce one additional ton of emissions from New Jersey's electric sector would be the same as the cost to reduce one additional ton of emissions from Maine's electricity sector. Figure 3 displays this uniform carbon permit price under the Cap 2000 and CCAP cases.

The permit prices for Cap 2000 and CCAP are, respectively, $49 to $140 per tonne of carbon in 2010, increasing to $81 to $223 per tonne by 2020 (see Figure 3). These permit prices would raise the cost of generating electricity and hence force consumers to pay much more for electricity.

Figure 3. Marginal Cost of Abatement under the Cap 2000 and CCAP Cases.
($ per Metric Ton of Carbon)



[8] Permit trading systems fall into one of two categories: 1) Upstream system - suppliers of fossil fuels are required to hold permits equal to the embodied carbon in the fuels that they sell; and 2) Downstream system - the users of fossil fuels must hold permits equal to the amount of GHG emissions they produce. Since this program calls for capping only emissions from electric generators, it seems more natural to assume the cap and trade system is applied downstream at the generators.

Electricity Prices

RGGI's proposal would increase residential electricity prices. Consumers' energy bills would increase when counting the costs associated with carbon emissions associated with fuel use. These increases faced by a typical household in the eleven NE states are shown in Table 3. In addition, under the CCAP policy, industry will pay higher electricity prices, with an effective 23% increase in electricity prices in 2010. Electricity prices in the rest of the U.S. decline because the prices of input fuels – coal and gas – in this region decline.

Table 3. Electricity Prices at the Household Level for the CCAP States and the Rest of the U.S. (% Change from Baseline Forecast)

Sector	Year	11 Northeastern States		Rest of U.S.	
		Cap 2000	CCAP	Cap 2000	CCAP
Electricity	2010	9%	23%	-0.2%	-0.4%
(Residential)	2020	14%	34%	-0.2%	-0.4%

Household Electricity Taxes

Currently, the residents of the NE states pay taxes on electricity in the form of excise taxes and *ad valorem* tax based on gross receipts, consumption, or sales and use. Table 4 shows these existing taxes and expected taxes (including cost associated with carbon taxes) under the two different policy scenarios – Cap 2000 and CCAP in 2010 – for all eleven NE states as well as the average tax for the region. Current taxes on electricity for the NE states are based on 2002 electricity prices, which on average are 10.0 cents per kWh for residential electricity.[9] The examined policies would result in increases in electricity taxes with the introduction of carbon taxes or carbon permits.

Currently, New Jersey faces the highest taxes on electricity (1.01 cents per kWh) among the NE states, while households in these states on average face a tax of 0.36 cents per kWh. Under the CAP 2000 and CCAP policies, the average tax on electricity increases to 1.23 and 2.58 cents per kWh. This represents an increase of 242% and 618% from current taxes on electricity.

[9] Electricity prices are inclusive of taxes. Energy Information Administration.

The reason for the larger percentage increases in Table 4 compared to those in Table 3 is that the percent increase in taxes on electricity is much greater than the overall increases in total electricity prices. In other words, the data on tax increases shown in Table 4 is a "subset" of the increase in total electricity prices in Table 3.

Table 4. Residential Taxes on Electricity under Current Law, Cap 2000, and CCAP in 2010 (Cents per kWh)

													Northeast States	
		CT	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	Avg.	(% Δ)
Electricity	Current	0.47	0.00	0.00	0.21	0.50	0.06	1.01	0.23	0.34	0.42	0.05	0.36	
(cents/kWh)	Cap 2000	0.97	1.10	1.05	0.93	0.64	1.13	1.44	1.16	1.65	0.99	0.05	1.23	242%
	CCAP	1.77	2.80	2.47	2.05	0.87	2.97	2.10	2.65	3.98	2.22	0.06	2.62	629%

Cost per Household

The permit prices discussed above are indicators of the cost of meeting carbon emission limits. Meeting those limits will impose substantial economic costs on all signatory states. Purchasing power erodes as household income falls and prices rise. In general, costs per household ($/HH) rise over time as emission caps become more difficult to meet because of continued economic growth. Table 5 shows the reduction in consumption of all goods and services for the average household**.** Under CCAP, the impacts range from a gain in consumption of $108 for Vermont to a loss of $1,341 for Delaware in 2010; as the emission cap becomes tighter in 2020, household consumption decreases for the NE states, ranging from a gain of only $7 per household for Vermont to a loss of $1,585 for Pennsylvania. Census data indicate that a typical NE household has 2.6 members and an average income of $51,000 (in 1999 dollars). Therefore, the average household loss of $603 for a NE state's household under CCAP in 2010 and $881 in 2020 represent, respectively, 1.2% and 1.7% of the average household's income.

Table 5. Change in Household Consumption under the Cap 2000 and CCAP Cases ($ per Household)

	Cap 2000		CCAP	
	2010	2020	2010	2020
Connecticut	-$168	-$292	-$357	-$612
Delaware	-$609	-$674	-$1,341	-$1,374
Massachusetts	-$269	-$415	-$554	-$798
Maryland	-$327	-$468	-$735	-$966
Maine	-$10	-$42	-$22	-$100
New Hampshire	-$358	-$487	-$825	-$1,042
New Jersey	-$128	-$234	-$248	-$452
New York	-$236	-$380	-$512	-$790
Pennsylvania	-$502	-$727	-$1,186	-$1,585
Rhode Island	-$117	-$456	-$394	-$1,321
Vermont	$43	$4	$108	$7
Avg. of NE States	-$272	-$421	-$603	-$881
Rest of United States	$10	$5	$20	-$6

Even though the rest of the United States does not undertake GHG caps, households in the other states are affected by the actions of NE states in the following ways: on the negative side, they pay higher prices for goods produced in the NE states because production costs have risen in these states, and they experience a drop in the demand for energy resources (coal, natural gas, and refined petroleum products); on the positive side, the rest of the U.S. exports more electricity, their production costs decline relative to those in the northeast, which improves the competitive position of the rest of the U.S.

Cost Burden Falls Most Heavily on Poor and Elderly

The poor and elderly bear much harsher burdens under the RGGI's carbon emission reduction policies than do higher-income and younger households because they spend more of their budgets on electricity. The largest percentage increase in expenditures on electricity will occur for the lowest-income groups. According to the Census Bureau's 2002 Consumer Expenditure Survey, the average NE household in the lowest quintile (poorest households) allocates about 3.4% of its expenditures towards electricity whereas the average household in the highest quintile (wealthiest households) expends about 1.6% of its expenditures on electricity. Under these carbon abatement policies, electricity prices increase. Assuming NE households continue to buy the same quantity of electricity (no reduction in the quantity demanded as prices rise), expenditures on electricity by the poorest and richest fifth of households will represent 4.2% to 2.0% of their respective total expenditures (assuming no reduction in income) in 2010. Thus, the poorest households will devote an additional 0.8% of their total expenditures on electricity, while the wealthiest households would only dedicate an additional 0.4%. Figure 4 illustrates this disparity. Making the same computation for the elderly (over 65 years old) and non-elderly, we find the CCAP policy leads to the elderly paying out an additional 0.8% of total expenditures on electricity while the non-elderly's increase is less at 0.5% (see Figure 5).

Figure 4. Change in Percentage of Expenditures on Energy by Income Quintile for Region of Northeastern States
(Absolute Change in % of Expenditures on Energy)

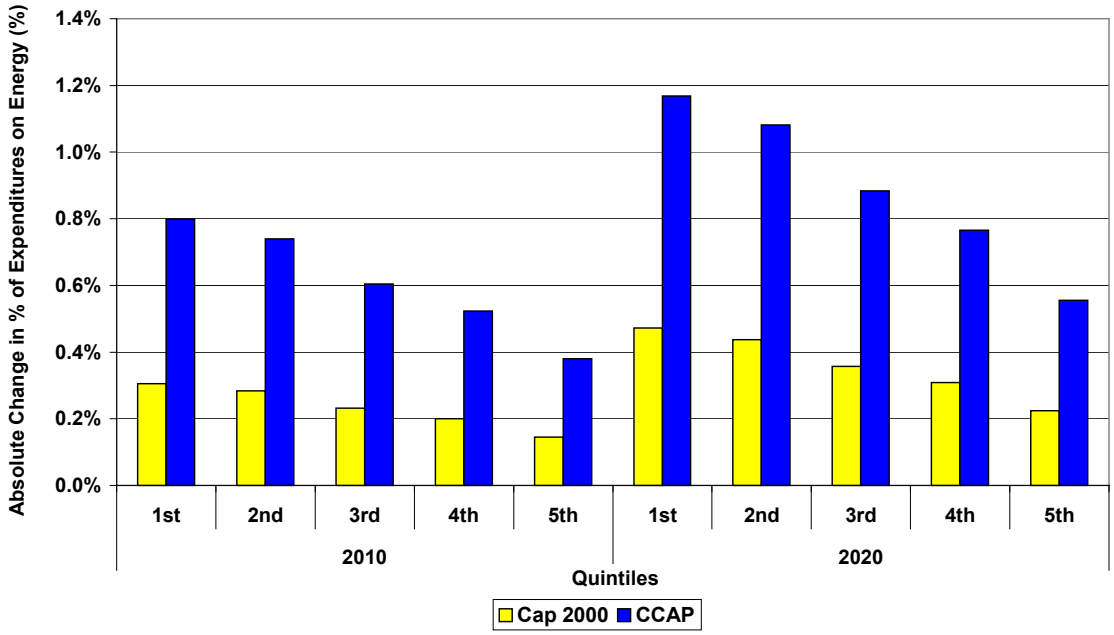
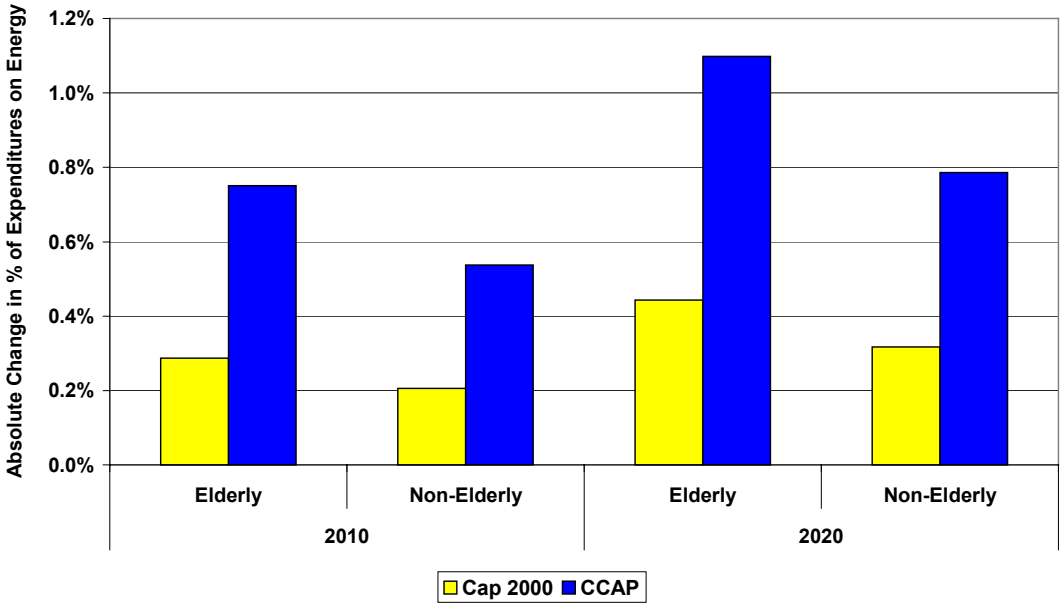


Figure 5. Change in Ratio of Expenditures on Energy to All Expenditures: Elderly vs. Non-Elderly for the Northeastern States
(Absolute Change in % of Expenditures on Energy)



Reduction in Economic Activity

Almost all the NE states show a loss in gross state product. In 2010 under CCAP, the change in gross state product (GSP) ranges from a gain for Rhode Island of 0.5% to a loss of 0.6% for Pennsylvania. Under CAP 2000, Rhode Island, Maine, and Vermont gain in 2010, while overall the losses for the NE states average about 0.3% of GSP. By 2020 under CAP 2000, all the NE states suffer losses. By 2020 under the CCAP, all states (except for Vermont with a small gain) see a decline in their GSP from 0.02% for Maine to 1% for Pennsylvania. After 2020, impacts depend on whether IGCC or carbon sequestration technology becomes available at a high or a moderate cost. Losses would continue to grow unless new technologies with falling cost became available over time.

Table 6. Change in Gross State Product under Cap 2000 and CCAP
(% Change Compared to Baseline Forecast)

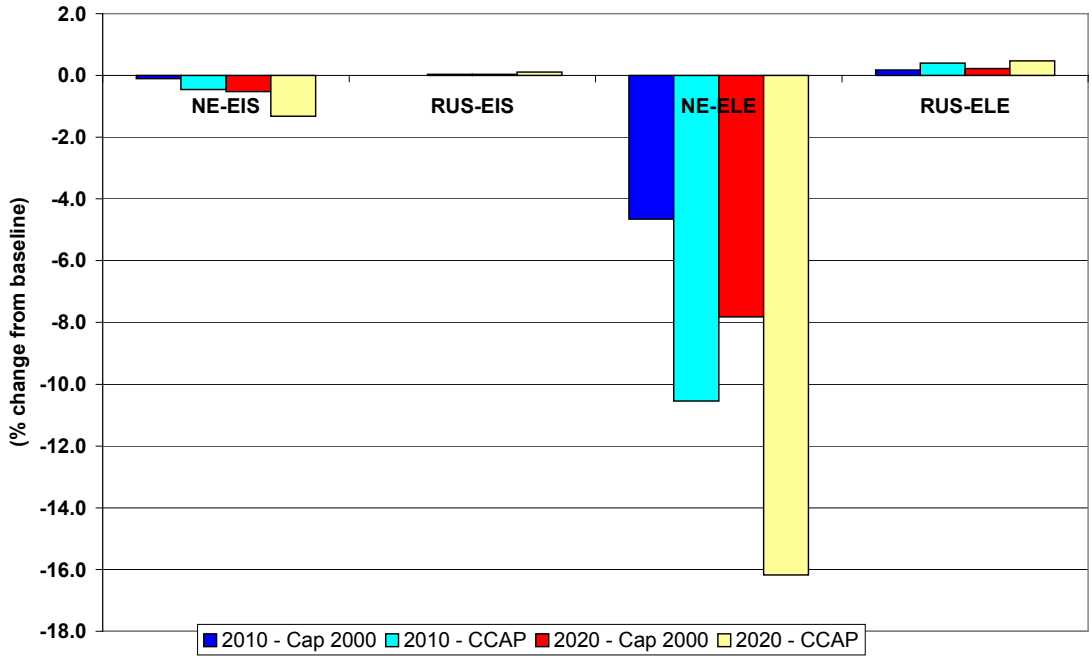
	Cap 2000		CCAP	
	2010	2020	2010	2020
Connecticut	-0.0%	-0.1%	-0.1%	-0.3%
Delaware	-0.1%	-0.3%	-0.3%	-0.8%
Massachusetts	-0.1%	-0.2%	-0.2%	-0.4%
Maryland	-0.1%	-0.2%	-0.3%	-0.5%
Maine	+0.0%	-0.0%	+0.1%	-0.0%
New Hampshire	-0.1%	-0.2%	-0.3%	-0.7%
New Jersey	-0.1%	-0.1%	-0.2%	-0.3%
New York	-0.1%	-0.2%	-0.3%	-0.5%
Pennsylvania	-0.2%	-0.4%	-0.6%	-1.0%
Rhode Island	+0.2%	-0.2%	+0.5%	-0.4%
Vermont	+0.0%	-0.0%	+0.0%	+0.0%
Avg. of NE States	-0.1%	-0.2%	-0.3%	-0.5%
Rest of United States	+0.0%	-0.0%	+0.0%	-0.1%

In the early years, the rest of the United States gains because of increased competitiveness relative to the NE states. By undertaking emission reduction commitments, the NE states must limit their use of electricity generation from fossil fuels, which drives up their cost of generation relative to the rest of the United States and raises industrial production costs in the northeast. Therefore, industries in the NE states are unable to sell as many of their products, which leads to layoffs in these states. With the gain in competitiveness, the other states are able to take market share away from the NE states; thus, there is an increase in output outside of the NE region. The decline in demand for products and services from the eleven states, however, eventually takes its toll, and the rest of the United States experiences a loss in gross product from 2020 onward.

Economic Growth Slows

Looking more in depth at the underlying factors that comprise the loss in GSP, we see that on average industrial output is down in all sectors throughout the region by 2020. Energy-producing sectors are the hardest hit as demand for their product falls most sharply. The impact on other sectors is directly correlated with electricity usage. Figure 6 compares the impact on the electricity sector (ELE) and the industrial sector[10] (EIS) for the NE states and the rest of the United States (RUS). On average, electricity generation in the NE states falls by 4.7% to 10.5% in 2010 and the drop worsens to 7.8% to 16.2% in 2020, with the largest impacts occurring under the CCAP policy. Output from industrial sectors falls by 0.1% to 0.5% in 2010 and by 0.5% to 1.3% in 2020. Because the other non-energy sectors use similar amounts of electricity per dollar of output, they experience similar losses. Output in the agriculture and motor vehicle manufacturing sectors decline by about 1.2% in 2020 under the CCAP policy (see Table 7). The non-energy sectors face losses for the following reasons: they must pay higher electricity prices; they become less competitive *vis a vis* industries in other states as well as in other countries that have no programs in place to abate carbon emissions; and the overall demand for goods and services declines in the region and the United States as a whole. Reduced activity in these sectors will cause a loss in jobs in these and related industries.

Figure 6. Change in Industrial Output and Electricity Generation under Cap 2000 and CCAP (% Change Compared to Baseline Forecast)



[10] The industrial sector includes energy-intensive industries such as aluminum, cement, chemicals, glass, iron and steel, mining, and pulp & paper.

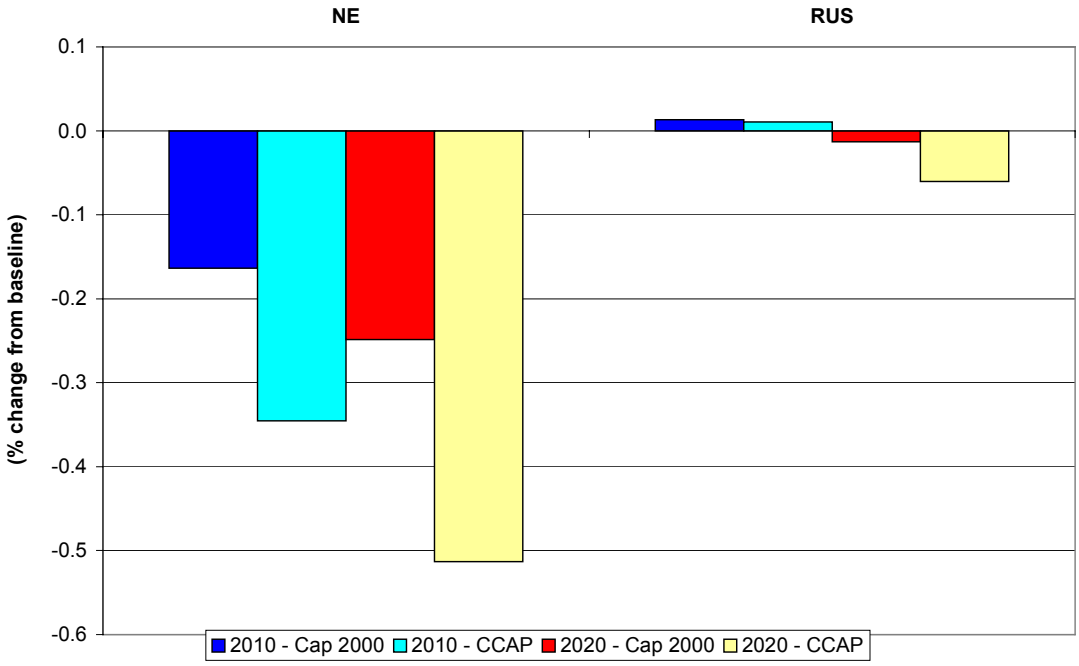
Table 7. Sectoral Output in the Northeast under Cap 2000 and CCAP (% Change from Baseline Forecast)

	Cap 2000		CCAP	
	2010	2020	2010	2020
Agriculture	-0.2%	-0.5%	-0.6%	-1.2%
Manufacturing	0.0%	-0.3%	-0.1%	-0.7%
Motor Vehicles	0.0%	-0.4%	-0.4%	-1.3%
Services	-0.1%	-0.3%	-0.3%	-0.7%

Impacts on Employment

Higher costs and reductions in output of the NE region's industries ultimately feed back to individuals in the form of lower wages and fewer jobs. Because of lower wages, labor supply is reduced, further trimming incomes and reducing the productive potential of the economy. Figure 7 shows the impacts on wages while Figure 8 and Table 8 display the effects on employment in the signatory states under the two cases.

Figure 7. Real Wage Rate for Northeastern States and Rest of U.S. (% Change from Baseline Forecast)



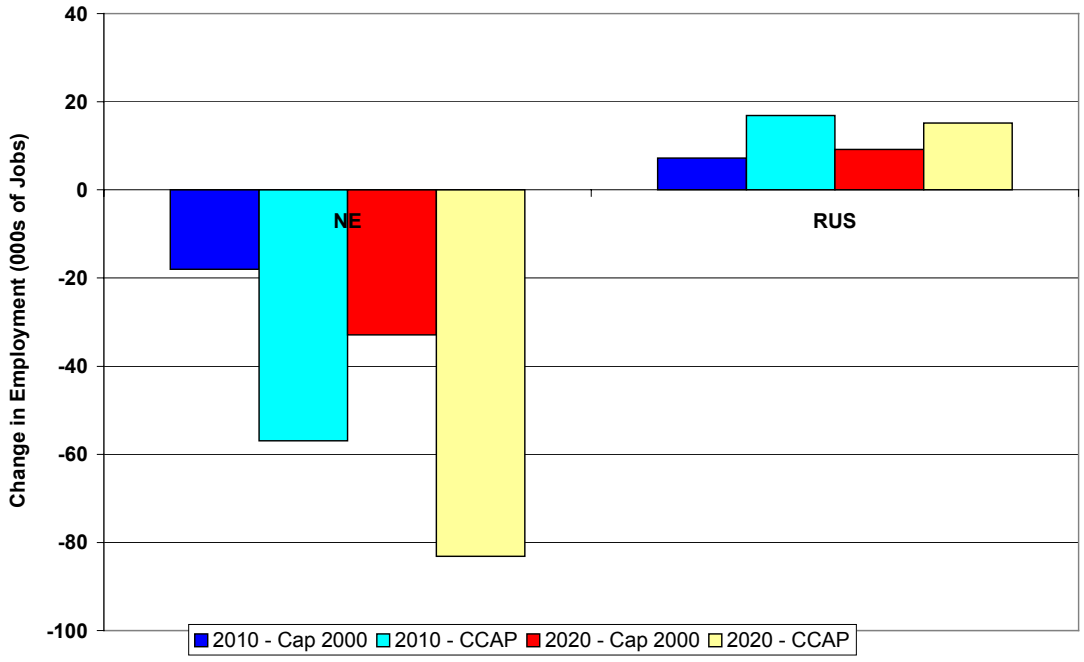
As production costs in the NE states increase, demand for their products falls, which in turn leads to a need for fewer workers and lower wages. The opposite occurs in the rest of the U.S., where production increases and, hence, the demand for workers, leading to higher wages. The NE region as a whole would lose between 18,000 and 57,000 jobs in 2010 and between 33,000 and 83,000 jobs in 2020 under the Cap 2000 and CCAP policy.

The rest of the U.S. will see an increase in jobs; however the overall increase is less than the loss in jobs in the NE states (see Figure 8).

Table 8. Impact on Employment under Cap 2000 and CCAP (Number of Jobs)

	Cap 2000		CCAP	
	2010	2020	2010	2020
Connecticut	-567	-1,385	-1,619	-3,249
Delaware	-312	-704	-1,020	-1,746
Massachusetts	-2,299	-4,122	-6,379	-9,045
Maryland	-2,131	-3,740	-6,120	-9,070
Maine	-20	-114	-29	-233
New Hampshire	-466	-934	-1,485	-2,397
New Jersey	-1,241	-2,128	-3,430	-4,679
New York	-4,539	-8,189	-14,235	-20,421
Pennsylvania	-6,005	-10,359	-21,462	-29,605
Rhode Island	-393	-1,269	-1,221	-2,821
Vermont	6	22	92	136
Avg. of NE States	-17,967	-32,921	-56,907	-83,131
Rest of United States	7,204	9,232	16,930	15,141

Figure 8. Impact on Employment under Emission Reduction Targets for the Northeastern States and the Rest of the U.S. (Thousands of Jobs)



State Budget Impacts

Lower wages and lower employment in the NE states will reduce income and spending, causing their excise, sales, and income tax revenues to fall. The drop in industrial production will also reduce state corporate income tax collections.[11] Furthermore, the impacts of these policies on wages and employment will affect the government's expenditures, increasing unemployment benefits and other transfer payments to affected workers. In addition, these policies will increase the government's electricity costs, particularly for the heating and cooling of public buildings, schools, and hospitals.

The group of signatory NE states could expect to see losses in revenue from many sources. For example, losses in personal income tax collections and reductions in state gasoline tax collections and the linked loss in federal highway trust fund grants will lead to a loss of state revenues of $174 million and $421 million dollars, for each program, respectively, in 2010 (see Table 9). Any increases in state outlays for electricity-related costs would increase these impacts. These outlays and lost revenues will require the states to choose between cutting programs or raising taxes or some combination of both. This will add to the burden caused by higher electricity prices on consumers.

Table 9. Change in State/Federal Budget Receipts in 2010 under Cap 2000 and CCAP (Millions of $):

	Cap 2000				CCAP			
	Motor Fuel Tax		Income Tax		Motor Fuel Tax		Income Tax	
	State	Federal	Revenue	Total	State	Federal	Revenue	Total
Connecticut	$0	$0	-$4	-$5	-$1	-$1	-$9	-$10
Delaware	-$1	-$1	-$3	-$5	-$1	-$1	-$9	-$11
Massachusetts	-$1	-$1	-$17	-$19	-$2	-$2	-$43	-$48
Maryland	-$2	-$2	-$12	-$17	-$5	-$4	-$31	-$39
Maine	$0	$0	$0	$0	$0	$0	-$1	$0
New Hampshire	$0	$0	$0	-$1	-$1	-$1	-$1	-$2
New Jersey	-$1	-$1	-$9	-$11	-$1	-$1	-$20	-$23
New York	-$1	-$3	-$55	-$59	-$2	-$6	-$133	-$141
Pennsylvania	-$10	-$7	-$39	-$56	-$23	-$15	-$103	-$142
Rhode Island	$0	$0	-$1	-$2	$0	$0	-$5	-$5
Vermont	$0	$0	$0	$0	$0	$0	$0	$1
Total for NE States	-$17	-$15	-$142	-$174	-$37	-$31	-$354	-$421
Rest of United States	$2	$2	$26	$30	$3	$3	$32	$38

Maryland and Pennsylvania: How Do They Fare If They Do Not Adopt Carbon Caps?

From earlier tables and figures that compare the impacts on the rest of the U.S. to the NE states, it is clear that the economic impacts of the policies on any state depend greatly on whether or not that state adopts emission limits. Therefore, it should come as no surprise that Maryland and Pennsylvania will fare much better economically if they do not sign on to reduce their carbon emissions from electricity generation. Tables 10 and 11 display the change in household consumption and GSP for Maryland, Pennsylvania, and the other nine NE states under CCAP and Cap 2000 when Maryland and Pennsylvania opt in and out of these policies.

[11] For this analysis, we assume that the permit trading system would be set up similarly to the one laid out in the McCain-Lieberman Senate Bill (SA.2028).

Maryland households experience a gain when they do not participate. In 2010 and 2020 the gain ranges from $16 to $13 and $22 to $11, for the case where only nine states agree to limit emissions to 2000 levels ("Cap 2000-9"), and in the New England Governor's plan ("CCAP-9"), respectively. Pennsylvania households also benefit when they do not participate, with gains ranging from $48 to $46 per household under Cap 2000-9 to $64 to $45 per household under the CCAP-9 scenario. Whether Maryland and Pennsylvania are in or out of the agreements has little impact on the other NE states, but obviously has a tremendous impact on these two states.

Table 10. Impact on Household Consumption with and without Maryland and Pennsylvania Participation in Carbon Caps Under Cap 2000 and CCAP
($ per Household)

MD & PA Status	Region	Cap 2000		CCAP	
		2010	2020	2010	2020
MD & PA In	MD	-$327	-$468	-$735	-$966
	PA	-$502	-$727	-$1,186	-$1,585
	NE-9	-$200	-$336	-$453	-$726
MD & PA Out	MD	$16	$13	$22	$11
	PA	$48	$46	$64	$45
	NE-9	-$177	-$268	-$432	-$628

The impacts on Maryland and Pennsylvania are not uniform. Comparing the impacts for these two states when they are in and out of the agreement illustrates this point (see Table 11). If Maryland were to sign on to the Cap 2000 or CCAP, it would experience losses in GSP ranging from 0.1% to 0.3% in 2010, respectively. However, if Maryland opted out of either of these policies, it would experience a gain in GSP. Because of its large industrial base and greater dependence on energy production, Pennsylvania would be hit the hardest among all the NE states if it adopted the policies. If, however, Pennsylvania declined to sign on, then its GSP would be up slightly under the Cap 2000 and would improve by between 0.05% and 0.06% under CCAP.

Table 11. Impact on Gross State Product with and without Pennsylvania and Maryland Participation in Carbon Caps under Cap 2000 and CCAP
(% Change from Baseline Forecast)

MD & PA Status	Region	Cap 2000		CCAP	
		2010	2020	2010	2020
MD & PA In	MD	-0.1%	-0.2%	-0.3%	-0.5%
	PA	-0.2%	-0.4%	-0.6%	-1.0%
	NE-9	-0.1%	-0.2%	-0.3%	-0.5%
MD & PA Out	MD	0.01%	0.02%	0.03%	0.03%
	PA	0.02%	0.03%	0.05%	0.06%
	NE-9	-0.1%	-0.1%	-0.2%	-0.4%

If Maryland and Pennsylvania decide not to sign on to either of the policies, the rest of the NE states (NE-9) experience slightly smaller losses because Maryland and Pennsylvania are net importers of carbon permits and because Maryland's and Pennsylvania's economies are better off. These two states have a great deal of coal fired generation and therefore, to ease their reduction in electricity production they demand more permits per GWh of electricity production than the other eleven states. Thus, when these two states opt out, the demand for permits is less and the burden on the other nine states falls. In addition, by opting out, Pennsylvania and Maryland's cost of electricity generation does not increase which means their export price for electricity does not rise, which in turn lowers the electricity price and production costs in the other nine states. These effects improve the economic conditions in these states relative to when Maryland and Pennsylvania opt in.

On average, losses in household consumption in the remaining NE states in 2020 improve from a loss of $336/HH to a loss of $268/HH under the Cap 2000 policy from the level it would have been if Maryland and Pennsylvania had signed on to this policy. The effects are greater under the CCAP policy, where NE-9 households would experience losses of $726/HH in 2020 if Maryland and Pennsylvania sign on. The loss decreases to $628/HH if Maryland and Pennsylvania opted out of the agreement. Therefore, the northeast would be relatively better off in 2020 without Maryland and Pennsylvania signing on as household consumption loss would be lower than with Maryland and Pennsylvania as member states..

Summary of Impacts on Each State

The following twelve tables provide a short summary of some of the key economic impacts on each of the NE states and the rest of the U.S. under the Cap 2000 and CCAP policies when all eleven NE states adopt the policies.

Table 12. Connecticut: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on Connecticut	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	0.0%	-0.1%	-0.1%	-0.3%
HH Consumption ($/HH)	-$168	-$292	-$357	-$612
Employment (# of Jobs)	-567	-1,385	-1,619	-3,249
Electricity Prices (%)	5.4%	9.3%	13.9%	22.9%
Electircity Sector Output (%)*	-3.0%	-6.3%	-7.3%	-13.8%

Table 13. Delaware: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on Delaware	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	-0.1%	-0.3%	-0.3%	-0.8%
HH Consumption ($/HH)	-$609	-$674	-$1,341	-$1,374
Employment (# of Jobs)	-312	-704	-1,020	-1,746
Electricity Prices (%)	14.8%	21.5%	37.9%	52.1%
Electircity Sector Output (%)*	-7.2%	-11.0%	-14.9%	-20.8%

Table 14. Maine: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on Maine	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	0.0%	0.0%	0.1%	0.0%
HH Consumption ($/HH)	-$10	-$42	-$22	-$100
Employment (# of Jobs)	-20	-114	-29	-233
Electricity Prices (%)	1.4%	2.3%	3.6%	5.7%
Electircity Sector Output (%)*	0.6%	-0.2%	1.4%	-0.8%

Table 15. Maryland: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on Maryland	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	-0.1%	-0.2%	-0.3%	-0.5%
HH Consumption ($/HH)	-$327	-$468	-$735	-$966
Employment (# of Jobs)	-2,131	-3,740	-6,120	-9,070
Electricity Prices (%)	10.9%	16.4%	27.9%	38.9%
Electircity Sector Output (%)*	-7.7%	-12.3%	-17.0%	-24.0%

* The change in the energy-intensive sector is referred to as the "industrial output" (%) in the tables.

Table 16. Massachusetts: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on Massachusetts	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	-0.1%	-0.2%	-0.2%	-0.4%
HH Consumption ($/HH)	-$269	-$415	-$554	-$798
Employment (# of Jobs)	-2,299	-4,122	-6,379	-9,045
Electricity Prices (%)	9.8%	15.2%	23.1%	34.9%
Electircity Sector Output (%)*	-7.6%	-12.4%	-15.5%	-23.7%

Table 17. New Hampshire: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on New Hampshire	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	-0.1%	-0.2%	-0.3%	-0.7%
HH Consumption ($/HH)	-$358	-$487	-$825	-$1,042
Employment (# of Jobs)	-466	-934	-1,485	-2,397
Electricity Prices (%)	10.0%	16.0%	27.2%	41.0%
Electircity Sector Output (%)*	-4.0%	-7.1%	-9.7%	-15.4%

Table 18. New Jersey: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on New Jersey	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	-0.1%	-0.1%	-0.2%	-0.3%
HH Consumption ($/HH)	-$128	-$234	-$248	-$452
Employment (# of Jobs)	-1,241	-2,128	-3,430	-4,679
Electricity Prices (%)	4.9%	7.1%	12.3%	16.7%
Electircity Sector Output (%)*	-2.3%	-3.8%	-5.2%	-8.1%

Table 19. New York: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on New York	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	-0.1%	-0.2%	-0.3%	-0.5%
HH Consumption ($/HH)	-$236	-$380	-$512	-$790
Employment (# of Jobs)	-4,539	-8,189	-14,235	-20,421
Electricity Prices (%)	7.7%	11.6%	20.0%	28.2%
Electircity Sector Output (%)*	-4.3%	-7.1%	-10.0%	-15.3%

Table 20. Pennsylvania: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on Pennsylvania	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	-0.2%	-0.4%	-0.6%	-1.0%
HH Consumption ($/HH)	-$502	-$727	-$1,186	-$1,585
Employment (# of Jobs)	-6,005	-10,359	-21,462	-29,605
Electricity Prices (%)	15.8%	24.9%	44.0%	65.7%
Electircity Sector Output (%)*	-5.3%	-9.1%	-12.4%	-19.1%

Table 21. Rhode Island: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on Rhode Island	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	0.2%	-0.2%	0.5%	-0.4%
HH Consumption ($/HH)	-$117	-$456	-$394	-$1,321
Employment (# of Jobs)	-393	-1,269	-1,221	-2,821
Electricity Prices (%)	5.5%	14.1%	17.3%	38.5%
Electircity Sector Output (%)*	-4.5%	-7.4%	-11.5%	-16.1%

Table 22. Vermont: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on Vermont	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	0.00%	0.00%	0.03%	0.02%
HH Consumption ($/HH)	$43	$4	$108	$7
Employment (# of Jobs)	6	22	92	136
Electricity Prices (%)	0.04%	0.08%	0.07%	0.17%
Electircity Sector Output (%)*	0.02%	-0.02%	0.06%	-0.01%

Table 23. Rest of the U.S.: Economic Impact of GHG Emission Reduction Targets in 2010 and 2020

Impacts on Rest of US	Cap 2000		CCAP	
	2010	2020	2010	2020
Gross State Product (%)	0.01%	-0.01%	0.02%	-0.05%
HH Consumption ($/HH)	$10	$5	$20	-$6
Employment (# of Jobs)	7,204	9,232	16,930	15,141
Electricity Prices (%)	-0.2%	-0.2%	-0.4%	-0.4%
Electircity Sector Output (%)*	0.2%	0.2%	0.4%	0.5%

Appendix: Modeling Approach

The American Council for Capital Formation Center for Policy Research commissioned Charles River Associates to analyze how the RGGI would affect the economic condition of the United States and, specifically, eleven northeastern states. Because this study focuses on the United States, we employed CRA's U.S. Multi-Region National (MRN) model, which includes the economic structure of each state.

To capture the effects of changes in the U.S. terms of trade with Canada and the rest of the world, we ran our Multi Sector Multi Region Trade model (MS-MRT) under the assumptions that the countries that ratified the Kyoto Protocol adhere to their Kyoto Caps and the United States either takes no action or the NE states act alone. MS-MRT fully tracks the physical flows of energy and their embodied carbon, so the impact of the state policies on the prices of U.S. imports and exports are included in the analysis. Utilizing MS-MRT insures that the domestic responses simulated within MRN are consistent with a broader global economic equilibrium. A key trading partner, Canada, is assumed to adhere to its Kyoto limits, as Canada has so committed by being a signatory.[12]

Emission Caps: Two possible emission caps on the electricity sector were considered. First, we analyzed the CCAP case: return to 1990-level emissions in 2010, maintaining emissions at this level until 2020, when the cap drops to 10% below 1990 emissions, finally embarking on a trajectory to reduce emissions to 80% below 2000 levels by 2050 (High Case). Second, we assumed the NE states (but not other states) agreed to cap their emissions from electricity generation at 2000 levels in perpetuity (Low Case). Table A.1 summarizes the emissions cap in specific time periods.

Table A.1 Emission Caps by Model Year and Scenario

	Model Year		
Policy	**2010-2020**	**2020-2025**	**2050-2070**
2000 Cap	2000 Levels	2000 Levels	2000 Levels
CCAP	1990 Levels	10% Reduction from 1990 Levels	80% Reduction from 2000 Levels

Backstop and Sequestration Assumptions: There is great uncertainty regarding the cost of carbon sequestration and carbon-free (or "backstop") technologies. Because of these uncertainties, we considered two cases: a flat $300 per metric ton of carbon and a declining cost. In the "Flat 300" scenario, we assume that the cost of sequestering carbon with a backstop technology[13] remains constant at $300/tonne of carbon. In the

[12] Canada's Kyoto targets are less stringent than those of the CCAP. Therefore, the impact on the eastern Canadian provinces will be smaller if they opt out of CCAP and instead adopt Kyoto. This creates a conflict of interest, as the rest of Canada appears to be signing on to the Kyoto limits.

[13] In the MRN model, the existence of a backstop technology is reflected as an exogenously specified price per tonne (denoted in $/tonne of carbon) at which CO_2 can be sequestered. This technology can be deployed in any sector that emits carbon dioxide and, for simplicity; we assume a uniform price across

"Declining" scenario, we assume that backstop technology could sequester carbon at $300/tonne of carbon in 2010, but that this cost would decline to about $100/tonne of carbon by 2050 (see Table A.2).

Table A.2 Assumed Carbon Removal Costs for Backstop Technology ($/tonne carbon-equivalent removed)

Scenario	Model Year				
	2010	2020	2030	2040	2050-2070
Flat 300	$300	$300	$300	$300	$300
Declining	$300	$275	$200	$125	$100

The assumptions about the backstop technologies may be optimistic, given the current unproven status of sequestration technology and lack of agreement on how carbon dioxide can be stored safely and permanently. In addition, we optimistically assume that this technology can be employed in all sectors. Therefore, costs could exceed those estimated in this study, especially in later years with more aggressive caps.

States Participating: As discussed above, two assumptions are made regarding state participation. First, it is assumed that all eleven of the states identified are covered by the emission caps. Second, it is assumed that only nine of the identified states participate – i.e., Maryland and Pennsylvania do not participate.

Relative Importance of Three Sets of Assumptions: The assumption about emissions caps has the greatest effect on the impacts. The backstop cost has a lesser effect on the results but is still a critical assumption. The choice of whether nine or eleven states adopt the climate change policy has little effect on the core group of nine states. Therefore, we focus our analysis on the eleven-state cases. Table A.3 lays out the cases that we considered; we chose to run these cases to avoid the extremes. That is, a case of 2000-level caps forever and a $300 price would have a smaller economic effect, whereas the case of the CCAP emission limits and the declining cost for backstop technology would be likely to have a larger impact.

Table A.3 Summary of Assumptions for All Cases in Order of Increasing Impacts for the Region.

Case	Emission Caps	Backstop Cost	MD and PA Sign On?
1 (Cap 2000-9)	2000 Cap Forever	Constant at $300	No
2 (Cap 2000)			Yes
3 (CCAP-9)	CCAP	Declining	No
4 (CCAP)			Yes

all sectors. Realistically, it will be much less costly to develop technology to sequester CO_2 emissions from large point sources and, therefore, the cost is likely to vary greatly across sectors. To be optimistic about the penetration of this technology, we derive our cost estimates from estimates of carbon-capture technologies combined with integrated gasification combined cycle power generation.

Glossary of Terms

Cap 2000	Policy to cap emissions of northeastern states at 2000 levels permanently.
Cap 2000-9	Policy to cap emissions where nine northeastern states agree to limit emissions at 2000 levels permanently.
CCAP	Climate Change Action Plan. Policy would cap greenhouse gas emissions at 1990 levels by 2010, reduce the cap to 10% below 1990 levels by 2020, and then reduce emissions to between 75% and 85% below 2000 levels by about 2050.
CCAP-9	Climate Change Action Plan. Policy, where nine northeastern states, would cap their greenhouse gas emissions at 1990 levels by 2010, reduce the cap to 10% below 1990 levels by 2020, and then reduce emissions to between 75% and 85% below 2000 levels by about 2050.
GHG	Greenhouse gases of which carbon dioxide is the most prevalent
GRP	Gross Regional Product
GSP	Gross State Product
HH	Household
kWh	Kilowatt Hour. Unit of electricity generation.
MMTC	Million Metric Tons of Carbon
NE	Northeast states that are considering the CCAP. These include Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and possibly Pennsylvania and Maryland.
NEG/ECP	New England Governors/East Canadian Premiers, which is the group that developed the CCAP.
RGGI	Regional Greenhouse Gas Initiative. States and Provinces participating in RGGI want to develop a regional cap-and-trade program to limit GHG emissions.
RUS	Rest of the United States
Tonne	Metric ton or 2200 pounds which is 10% more than a U.S. ton (2000 lbs.)