FINAL REPORT

Prepared For:

Partners for Affordable Energy
and a coalition of Minnesota trade associations, organizations and utilities

Economic Analysis of the Impact of a Midwest Regional Climate Policy on Minnesota

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Date: December 2008

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EXECUTIVE SUMMARY

Minnesota's Next Generation Energy Act of 2007 launched the state to the national forefront in terms of aggressive energy policies to address climate change. This policy, combined with other state energy policies and Minnesota's participation in the region-wide Midwest Regional Greenhouse Gas Accord, demonstrates Minnesota's desire to take a leading role in the climate debate. However, as this report shows, Minnesota's aggressive steps toward environmental goals will have economic consequences in terms of increased energy costs that will flow into all energy-consuming activities in residential, commercial and industrial sectors within the state. This study, conducted by CRA International (CRA) on behalf of Partners for Affordable Energy along with several Minnesota trade associations, organizations and utilities, explains and quantifies some of the impacts that can be expected in various sectors of Minnesota's economy.

The policy analyzed in this study was based on elements of the Next Generation Energy Act of 2007 (NGA), passed by the Minnesota Legislature, with a specific focus on carbon emissions within the greenhouse gas emission goals outlined in the Act. A CO_2 emissions cap was formulated based on the reduction schedule outlined in the NGA: reduction goals of 15% below 2005 emissions by 2015, 30% below by 2025 and 80% below by 2050. However, there are a number of reasons why the analysis in this report reflects a policy that is less stringent than the actual NGA requirements. These reasons are fully explained in Section 2 of the report ("Analytical Approach"), but they include how offsets and non-CO_2 gases were addressed in modeling the reduction goals listed in the NGA.

In this analysis, the percentage reductions goals stated in the NGA were applied to emissions from five states that are signatories to the Midwest Regional Greenhouse Gas Accord (Minnesota, Wisconsin, Illinois, Iowa and Kansas), as a single, region-wide cap, with trading allowed among the five states.[1] Emissions from the generation of electricity imported into the five covered states are also counted against the regional cap. This policy scenario will be referred to as the "regional climate policy" or "RCP" throughout this report. The analysis that does not include the RCP will be referred to as the "baseline model."

CRA analyzed the RCP policy using CRA's proprietary MRN-NEEM model, which was developed over the past ten years specifically for assessment of regional impacts of US climate policies. First, the baseline model was established including Minnesota's existing energy policies, such as the Renewable Energy Standard and the Mercury Emissions Reduction Act. Once the baseline model was established, the same model was then run but also including the provisions of the RCP described above. This policy scenario shows the

[1] Michigan and Manitoba were also signatories to the Midwest Governor's Accord. However, the model used in this analysis does not include Manitoba. Michigan was not included because of the difficulty of counting electricity imports into the state towards the cap. We do not believe that the exclusion of these areas has a material impact on the study results.

economic responses to the RCP within the covered region. From these responses, a cost of compliance is determined. The primary signal of this compliance cost is in the form of a carbon price. This price signal filters throughout the economy and increases costs on everything from electricity rates to gasoline prices to state industrial output,[2] and affects all industrial sectors and Minnesota households. The MRN-NEEM model traces all of these impacts.

Because the baseline model includes several recently enacted policies that will also have an effect of reducing greenhouse gas emissions, the economic impacts estimated in this analysis for the RCP are only those *incremental* costs that will arise from the policies and regulations not included in the baseline model.

The NGA does not specify any provisions for distributing the CO_2 allowances.[3] Although allowance distribution decisions will have a huge impact on which businesses and individuals are financial winners and losers as a result of a carbon cap, the actual distribution method may have very little impact on the net cost of the policy to the economy as a whole. In this analysis we did not make any assumptions about how allowances would be distributed among specific businesses and consumers. We did, however, assume that each of the covered states would be able to allocate the allowances under its own cap in a manner that would cause the value associated with those allowances to remain in that same state's economy. The costs that we report for each state thus reflect only the *net* cost of the policy to the *average* state resident, after accounting for the incremental resource expenditures for meeting the cap, any changes in inter-state economic competitiveness, *plus* an offsetting credit for the value of the allowances that the state distributes. Without further information on the intended allowance distribution method, nothing further can be said about what entities will be winners and losers around that average net impact estimate.[4]

[2] For this analysis, no safety valve or other cost containment measures were applied. Carbon prices therefore rise until the level of emissions is reduced down to the level of the cap. If a safety valve set at CO_2 prices below those projected for the RCP cap had been applied, the RCP emissions levels would have exceeded the RCP cap levels.

[3] The typical options are to allocate allowances for free to different groups (usually based on either historical or future emissions or operations), to auction the allowances, or some combination of these two options.

[4] How exactly the state chooses to distribute its allowances, however, can produce extremely different sets of financial winners and losers within the state, because the value of these allowances is very large. For example, the Minnesota government would have $2 billion in 2015 (2008$) and almost $3 billion in 2030 (2008$) to hand out (or spend) as it sees fit. If none of these allowances is allocated to the businesses that will be bearing the most direct costs of compliance, their net financial losses are likely to be severe (particularly in the case of businesses that have little or no ability to pass their higher costs through to their customers). Thus, pockets of severe financial harm could be created within the state's economy even while the net cost to the state's economy (which is all that this report presents) may appear to be *relatively* moderate. Similarly, Minnesota's decisions on how to distribute this annual $2 billion to $3 billion-worth of allowances could – either purposefully or inadvertently -- create some very large financial winners even while the average resident will bear a net cost from the policy. Substantial questions of fairness ride on this allowance distribution decision. This study has made no attempt to assess the mix of winners and losers because there is no information available on what allowance distribution decisions Minnesota will make, yet almost any pattern of major winners and losers can be constructed with alternative feasible distributional formulas.

Given the additional economic and technology assumptions that are detailed in Section 2 of the report, this analysis finds that the *net* cost to the Minnesota economy of the RCP is a present value of $42 billion (2008$). On a per-household basis, this implies a reduction in consumption (or loss of spending power) for the average Minnesota household of about $575 in 2015 (2008$) rising to $720 in 2030 (2008$). As noted above, the net cost may be borne disproportionately by some businesses and households than others. However, it is not possible to assess who the winners and losers will be, or what the depth of their respective losses or gains might be, without more information about how Minnesota will choose to distribute the allowances under the NGA cap.

An economic analysis of a policy using standard types of macroeconomic models such as MRN-NEEM will necessarily allow for the successful achievement of that policy, regardless of the cost of doing so. However, in the real world, if costs and disruption of a policy become large, political hindrances to successful achievement of the targets may emerge. It is therefore important to consider the nature and rate of changes in economic activity to assess the viability of a particular policy, and not just whether a model determines that the policy "can be achieved." To achieve the goals of the policy, Minnesota (as well as the other participating states) will have to undertake certain steps in regard to its energy profile – and based on this analysis, the resulting conditions represent a very different Minnesota than the one that exists today. Key assumptions underlying these changes are:

- Projection of a doubling of Minnesota/Iowa[5] electric generation from nuclear power;[6]
- An assumption that Minnesota/Iowa's existing transmission infrastructure can adequately handle the large quantities of imported renewable energy sources;
- An assumption that large-scale investments in carbon sequestration and capture technology (and the necessary infrastructure to support it) will be available and economical; and,
- A projection that a very large quantity of demand reduction/energy efficiency will be achieved and households will undertake significant behavioral changes to produce the required level of energy conservation.

Nevertheless, it remains a very important question that should be analyzed in greater depth before allocation decisions are made by Minnesota's policy makers.

[5] Minnesota and Iowa are grouped in the results as a single region for electricity market modeling purposes because the model creates regional groupings based on similar market characteristics.

[6] Minnesota's current law prohibiting new nuclear units has been maintained going forward in this analysis, so the new nuclear generation is physically located in Iowa, but available to serve both states.

While it is difficult to predict the future, the following is a snapshot of what this shift in Minnesota's energy landscape might look like over the next 40 years (all comparisons relative to the baseline):

Minnesota in 2015 under the Regional Climate Policy

- Compliance with the Renewable Energy Standard (as part of the Midwest Renewable Energy Tracking System, 12% of power from renewable resources)
- 962 MW of currently existing Minnesota coal-fired generators have been retired
- 41% of Minnesota/Iowa electricity comes from low/zero carbon resources[7]
- Electricity demand in Minnesota/Iowa is 5% lower as a result of demand reduction and energy efficiency[8]
- Net loss of 21,000 jobs in Minnesota

Minnesota in 2025 under the Regional Climate Policy

- Minnesota/Iowa are generating 18% of their power from renewable sources (and 15% of their power from low/zero carbon emitting imports)
- 1,049 MW of currently existing Minnesota coal-fired generators have been retired
- 47% of Minnesota/Iowa electricity comes from low/zero carbon resources
- Electricity demand in Minnesota/Iowa is 12% lower as a result of demand reduction and energy efficiency
- Net (cumulative from 2010) loss of 30,000 jobs in Minnesota

[7] Low/zero carbon generation includes nuclear, renewables, hydro, coal with carbon capture and sequestration and imports.

[8] Examples of demand reduction include people choosing to set their thermostats at a higher temperature in summer and businesses that shut down and move their operations to other states/countries. Examples of energy efficiency include households installing new, energy efficient windows that keep a house warmer in winter or businesses that spend capital to purchase newer, less energy-intensive machinery.

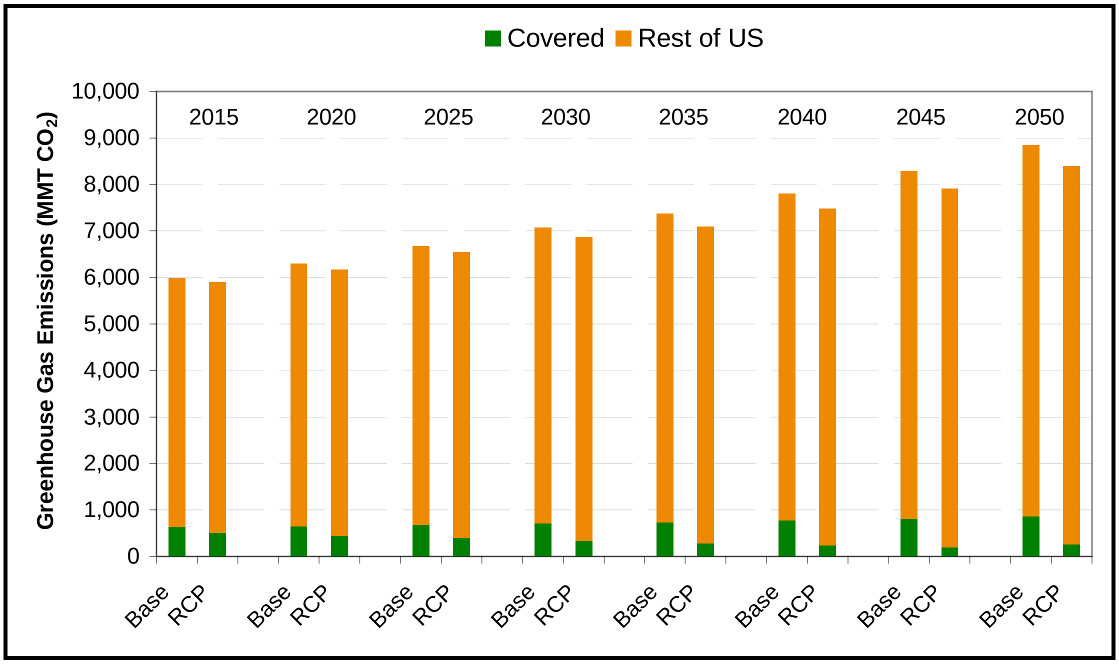
Minnesota in 2050 under the Regional Climate Policy

- Minnesota/Iowa are generating 30% of their power from renewable sources (and 17% of this power is from low/zero carbon emitting imports)
- Nuclear generation has doubled from current levels within Minnesota/Iowa
- Coal with carbon capture and sequestration provides 15% of Minnesota/ Iowa electricity demand
- 88% of electricity in Minnesota/Iowa comes from low/zero carbon resources
- 3,600 MW of currently existing Minnesota coal-fired generators have been retired
- Electricity demand in Minnesota/Iowa is 23% lower as a result of demand reduction and energy efficiency
- Net (cumulative from 2010) loss of 54,000 jobs in Minnesota

There are many other types of economic impact measures than those listed above. The following is a summary of several of the other key impacts that were projected to result from the RCP scenario that was analyzed in this study:

- CO_2 emissions in Minnesota/Iowa are reduced by 23 million metric tons carbon dioxide ($MMTCO_2$) in 2015 and 52 $MMTCO_2$ in 2030; in the covered region CO_2 emissions are reduced by 134 $MMTCO_2$ in 2015 and 385 $MMTCO_2$ in 2030. Overall U.S. emissions are reduced as well (92 $MMTCO_2$ in 2015 and 221 $MMTCO_2$ in 2030), but emissions are actually higher in the areas immediately surrounding the covered region as those states make up for exporting their low emission generation into the capped stated by building new fossil fuel plants that exhibit superior economics absent carbon constraints, for use in their own states. The CO_2 emissions in the covered states and the non-covered states are shown in Figure 1 for all years.
- The carbon permit price increases from $23 to $126 per metric ton CO_2 over the timeframe of the scenario analysis (2015 through 2050).
- Household electricity prices in Minnesota increase 17% by 2015 and 28% by 2030, relative to the baseline prices in those respective years. Industrial electricity prices increase 33% by 2015 and 50% by 2030, relative to the baseline.
- Household natural gas prices in Minnesota increase 11% by 2015 and 21% by 2030, relative to the baseline. Industrial prices increase 15% by 2015 and 24% by 2030, relative to the baseline.

Figure 1: U.S. CO_2 Emissions



- The "pump prices" of motor fuel in Minnesota increase 4% in 2015 and 9% in 2030, relative to the baseline.

- Even with projected increases in "green jobs," Minnesota will experience net job losses because of job losses in other sectors of the economy, particularly in non-energy sectors.

- Coal-fired generation drops significantly within the covered states compared to projections with no carbon constraint. Within these five states, coal use in electric generation falls by 30% in 2015 and 65% in 2030, relative to the baseline.

The impacts of the RCP are felt throughout Minnesota's economy, but they have varying effects on the different industry sectors. The magnitude of the effect on Minnesota's specific industries varies based on several key factors, such as energy intensity, level of competition (regional, national and international), cost drivers, reliance on transportation, substitutability of products/services, and the ability to shift operations to non-covered regions.

An Addendum to this report provides qualitative analyses of the likely effects of the RCP on several specific sectors of importance to the Minnesota economy: paper manufacturing, agriculture (crops, food processing and ethanol production), mining, commercial transportation, wholesale trade and logistics, technology manufacturing/biotech, tourism, corporate management and financial services. The sectoral analysis is in an addendum to this report because the MRN-NEEM model does not produce detailed quantitative results for these sectors. Thus, the sectoral analysis is more qualitative in nature, providing a discussion of how the market fundamentals faced by businesses in each sector determine the nature of their responses to the changes in energy markets and macroeconomic conditions that have been projected by the MRN-NEEM model, as summarized above.

Not surprisingly, the most energy-intensive industries make up the sectors that are projected to experience the most significant consequences of a regional carbon policy. The following are a few examples of how some of Minnesota's most critical industries will be affected by the RCP (more details are included in the Addendum):

- **Paper Manufacturing** – Minnesota's paper manufacturing plants are vulnerable to increased electricity and natural gas prices due to their reliance on these inputs and the fact that their products lack differentiation versus their competitors'. They will likely not be able to pass their increased costs through to customers because of the commodity nature of the products.
- **Taconite Mining** – Electricity, natural gas, and motor fuels combine to represent nearly one-quarter of iron ore production costs. While almost all U.S. taconite production occurs in the covered states, there is significant competition from iron ores from countries that do not have carbon cap plans, and that already enjoy lower production costs. Increased costs for Minnesota companies will place them at a significant competitive disadvantage against foreign competition from countries such as Brazil, China and India, because taconite customers (i.e., iron and steel manufacturers) whether located inside or outside of the capped region, are themselves subject to stiff cost-based competition for much of their output, and cannot continue to use taconite from Minnesota if it becomes more costly than alternative raw inputs.
- **Commercial Transportation** – The obvious effect on commercial transportation is the increase in the price of motor fuels. High levels of capital will be required to make fleets more fuel efficient and less efficient forms of transportation will lose market share to other forms of transport, such as rail supplanting trucking in some cases.
- **Agriculture (crops)** – Crop production will be affected by the rise in energy costs, which will be manifested in both planting/harvesting costs and fertilizer/chemical costs. As prices rise, the case for consolidation of farm operations increases to take advantage of economies of scale.
- **Agriculture (food processing)** – As an energy-intensive industry, food processing operators will face a triple threat: production cost increases (electricity/gas), transportation cost increases (fuels) and raw materials cost increases (crops), significantly altering costs of operations compared to non-covered competitors. A likely result would be declining market share, to the extent that their products already compete with the same foods produced in uncapped states.

While Minnesota takes a leadership position in confronting carbon emissions at a regional level in lieu of a Federal policy, the state is well advised to examine the economic impacts of its policy choices. The RCP, as it is currently designed, has significant economic consequences for households and industries as they adjust their energy-related activities to meet the emissions caps. Different sectors will respond differently based on their respective exposure to prices and their business fundamentals. This study is the first step in gaining a more complete understanding of the economic impacts of this RCP on Minnesota households, Minnesota employers and the Minnesota economy as a whole.

1. INTRODUCTION

CRA has prepared this report on behalf of Partners for Affordable Energy and a coalition of industry associations and utilities to evaluate the economic impacts associated with implementation of a Midwest regional climate policy (RCP). This analysis characterizes some of the expected impacts on both Minnesota consumers and Minnesota businesses. This report includes a quantification of the effects of the RCP on Minnesota consumers and some of the likely changes to the Minnesota energy landscape. A separate Addendum to this report characterizes the effects of the RCP on specific business sectors of importance to the Minnesota economy. The qualitative analysis in the Addendum relies on the quantitative results in this report and applies them to the businesses' outcomes.

Section 2 of this report includes a discussion of the analytical approach that has been used to evaluate the impacts of the policy. This includes a description of the modeling methodology using CRA's MRN-NEEM model, as well as a listing of the key assumptions in the baseline case and the RCP case -- a scenario that layers a Midwest regional climate policy onto the baseline case.

Section 3 summarizes the key results from the analysis. These results include the energy price increases on Minnesota households for their consumption of electricity, natural gas and motor fuels. Other important results are the change in CO_2 emissions that result from the RCP and the CO_2 allowance prices that motivate those reductions.

The three Appendices include further discussion of some of the key assumptions and their implications in this analysis, more details of the model results, and more detailed information about the MRN-NEEM model.

2. ANALYTICAL APPROACH

This section describes the analytical approach that CRA employed to analyze the five-state regional climate policy that is labeled as the RCP. The regional cap for the RCP was based on the numerical percentage reduction targets delineated in the Next Generation Energy Act of 2007 (NGA), passed by the Minnesota Legislature: reduction goals of 15% below 2005 emissions by 2015, 30% below by 2025 and 80% below by 2050. However, there are at least three reasons why the analysis presented in this report should be viewed as understating the costs of meeting the NGA itself:

- The cap analyzed in this report was applied only to CO_2 emissions and did not include emissions of non-CO_2 greenhouse gases, whereas the NGA actually limits *all* the greenhouse gases. Further, this analysis allowed CO_2-offsetting reductions to be provided by some of the non-CO_2 greenhouse gas emission sources in the region. Therefore, this analysis reflects an emissions cap that is actually less stringent than that of the NGA.[9]

- This analysis also assumed that offsets from regional biosequestration projects (i.e., reforestation, afforestation, forest management changes, and agricultural soil management changes) would be acceptable alternatives to actual CO_2 emissions reductions for purposes of compliance. If these biosequestration offsets are not actually allowed during implementation of the NGA, then the NGA will be even more costly than the current analysis suggests.[10]

- This analysis assumed implementation of the NGA will provide for unlimited allowance banking. As a result, the projected cumulative reductions of CO_2 over the entire 40-year period modeled (i.e., from 2010-2050) are equal to the cumulative reductions required by these goals, although projected annual emissions may differ from the annually-stated goals.[11]

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[9] That is, under the NGA, these reductions from non-CO_2 greenhouse gases would be needed just to help meet the reduction requirements for those other gases that were not required in this analysis, and thus would not be available to offset the portion of the cap that applies to CO_2 emissions. This would mean that even more CO_2 reduction would be needed under the NGA than is required in this analysis, and hence meeting even the CO_2 cap alone would be more costly than estimated in this analysis. About 7% of the required cumulative reductions in CO_2 are met with offsets from non-CO_2 greenhouse gas emissions sources in this analysis. Thus costs of the NGA targets when applied to all greenhouse gases would be at least 7% greater than this analysis estimates (probably more than 7%, given that the last few percent of reductions under a cap are always more costly than the average).

[10] The analysis projects that about 20% of the total required reductions of CO_2 would be met through biosequestration offsets over the 40-year period. If these offsets were to be disallowed by regulators, the NGA cap would be another 20% tighter than the one analyzed in this study, which would result in much higher costs and economic impacts than those presented in this report.

[11] Optimal banking behavior results in somewhat greater-than-required reductions in the earlier years of the policy, followed emissions above the annual targets in later years of the policy. However, total emissions over the full 40-

Additionally, this is an analysis of a regional climate policy (i.e., the "RCP"), albeit with each of the five states taking on the same percentage emissions reductions goals stated in Minnesota's NGA. The five states capped in the RCP case that was analyzed in this study are signatories to the Midwest Regional Greenhouse Gas Accord (Minnesota, Wisconsin, Illinois, Iowa and Kansas). They are treated as a single, region-wide cap, with trading allowed among the five states.[12] Emissions from the generation of electricity imported into the five covered states are also counted against the regional cap.

While the policy modeled in this study follows the direction of the NGA, there are a number of analytical complications in extending this law to apply it on a regional level. We lack specific legislative direction not only on how a regional policy would be implemented, but also how emissions from imported electricity would be accounted for. We also do not know the baseline level of non-CO_2 emissions for each of the states subject to the policy. CRA created the regional policy scenario to reflect the spirit of Minnesota's law, with accommodations for the limited information, in order to assess the implications of the policy.

In developing the analysis, CRA has assumed achievement of the CO_2 reduction goals of the NGA, where CO_2 in Minnesota is estimated to account for approximately 78% of Minnesota's total greenhouse gas emissions in 2005.[13] In measuring against this CO_2 cap, the study counted only CO_2-emitting sources (including emissions associated with imported electricity). The NGA also calls for limitations on non-CO_2 greenhouse gases (e.g., methane) but there is no reliable data available on these emissions for all of the states subject to the RCP, and so they were not included in the analysis.

To account for these limitations and other aspects of the policy that are not clearly defined, CRA developed additional assumptions to create the full set of information required for the evaluation of the RCP. These assumptions include:

- Lacking available data, non-CO_2 gases were not included in the setting of the cap, nor were the non-CO_2 emissions counted against the modeled cap. (These emissions account for approximately 22% of Minnesota emissions, but it is not clear if this percentage is indicative of the other covered states).

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year period are completely compliant with the sum of the annual targets. Inclusion of optimal banking results in a lower projected present value of policy costs than if the analysis were not to include banking. Banking is likely to be allowed under the NGA, as it is accepted in most current climate cap proposals, so this particular assumption adds relatively little to the likely understatement of costs associated with the two points above. However, it is important for understanding some of the temporal patterns in projected emissions reductions that are presented in this report.

[12] Michigan and Manitoba were also signatories to the Midwest Governor's Accord. However, the model used in this analysis does not include Manitoba. Michigan was not included because of the difficulty of counting electricity imports into the state towards the cap. We do not believe that the exclusion of these areas has a material impact on the study results.

[13] *DRAFT Minnesota Greenhouse Gas Inventory and Reference Case Projections 1990-2020*, Center for Climate Strategies, July 2007. While this data is available for Minnesota it is not available in a comparable form for the other covered states.

- The model allowed for reductions from non-CO_2 gases and increases in CO_2 sinks (such as reforestation) to count as offsets.[14] The effect of including these offsets is to lower CO_2 allowance prices and hence lower cost impacts on Minnesota households.

- The model allowed for "banking" of emissions, such that early reductions beyond the level required by the cap would allow for fewer reductions to be undertaken in later years. In total, however, the required reductions with or without banking are identical – only the timing of the reductions changes. The NGA does not comment on banking, but most Federal cap and trade bills allow for banking and it is a generally accepted provision.

- As the policy is a regional policy this means that there will be active trading of allowances among the states such that there is a single CO_2 allowance price. This approach ensures that the least expensive reductions will occur regardless of their location (among the covered states). This means that some states may make greater reductions than other states, but in total the combined reductions among the covered states will be those specified by the CO_2 cap.

- While states under the RCP may be able to count emissions associated with imported electricity toward the cap, they cannot force emitting electric generators operating in other states to cease operating if they can still sell their power to uncapped entities in their own state. Therefore, there is going to be some "leakage" whereby emission declines in the covered states will be paired with emission increases in non-covered bordering states.

Before turning to the details of the scenario specifications and numerical modeling assumptions, we also comment on the important impact of provisions for how to distribute allowances under any cap-and-trade system. The NGA did not specify any provisions for distributing the CO_2 allowances.[15] Although allowance distribution decisions will have a huge impact on which businesses and individuals are financial winners and losers as a result of a carbon cap, the actual distribution method may have very little impact on the net cost of the policy to the economy as a whole. In this analysis we did not make any assumptions about how allowances would be distributed among specific businesses and consumers. We did, however, assume that each of the covered states would be able to allocate the allowances under its own cap in a manner that would cause the value associated with those allowances to remain in that same state's economy. The costs that we report for each state thus reflect only the *net* cost of the policy to the *average* state resident, after accounting for the incremental resource expenditures for meeting the cap, any changes in inter-state economic competitiveness, *plus* an offsetting credit for the value of the allowances that the state

[14] Offsets are reductions in the emissions of non-covered greenhouse gases or increases in carbon sinks.

[15] The typical options are to allocate allowances for free to different groups (usually based on either historical or future emissions or operations), to auction the allowances, or some combination of these two options.

distributes. Without further information on the intended allowance distribution method, nothing further can be said about what entities will be winners and losers around that average net impact estimate.[16]

2.1. SCENARIO SPECIFICATION

The approach to evaluating the impacts of a policy is to use an economic model to evaluate a ***baseline case*** and then a case with a ***Midwest regional climate policy (RCP)***. The baseline or business as usual (BAU) case includes current Minnesota rules and regulations, such as the Minnesota Mercury Emissions Reduction Act and the Minnesota Renewable Energy Standard. The RCP case layers onto these existing policies and assumptions the policy to be evaluated, in this case the provisions of the RCP, which in this analysis, takes Minnesota's percentage emission reduction goals and applies them to a broader, five-state region (but applied to CO_2 emissions only, for the reasons explained above). A comparison of the two modeled scenarios then yields estimates of the incremental impacts of the policy.

To follow this approach we used the MRN-NEEM model that CRA has developed specifically for US regional climate policy analysis over the past ten years. MRN-NEEM is further described in Appendix C. We modeled the baseline using the existing policies described below. As shown in Figure 2, *the only input change in the RCP is the addition of a Midwest regional climate policy*. This policy caps CO_2 emissions in five states and also counts emissions associated with electricity imported into these states against that cap.

[16] How exactly the state chooses to distribute its allowances, however, can produce extremely different sets of financial winners and losers within the state, because the value of these allowances (given the caps and the projected CO_2 allowance prices) is very large. For example, in 2015, the projected annual value of the allowance to be distributed under the five-state RCP is projected to be more than $12 billion (2008$), which increases to almost $18 billion in 2030 (2008$). Minnesota accounts for approximately 17% of the regional cap so it would receive 17% of the allowance value, or $2 billion in 2015 (2008$) and almost $3 billion in 2030 (2008$), to hand out (or spend) as it sees fit. If none of these allowances is allocated to the businesses that will be bearing the most direct costs of compliance, their net financial losses are likely to be severe (particularly in the case of businesses that have little or no ability to pass their higher costs through to their customers). Thus, pockets of severe financial harm could be created within the state's economy even while the net cost to the state's economy (which is all that this report presents) may appear to be *relatively* moderate. Similarly, Minnesota's decisions on how to distribute this annual $2 billion to $3 billion-worth of allowances could – either purposefully or inadvertently -- create some very large financial winners even while the average resident will bear a net cost from the policy. Substantial questions of fairness ride on this allowance distribution decision. This study has made no attempt to assess the mix of winners and losers because there is no information available on what allowance distribution decisions Minnesota will make, yet almost any pattern of major winners and losers can be constructed with alternative feasible distributional formulas. Nevertheless, it remains a very important question that should be analyzed in greater depth before allocation decisions are made by Minnesota's policy makers.

Figure 2: Summary of Key Minnesota Provisions in Baseline and Regional Climate Policy Case

Provision	Baseline	Regional Climate Policy
Minnesota Renewable Energy Standard	Increase from 12% of utility retail sales in 2012 to 25% by 2025; modeled as part of regional renewable portfolio standard (RPS) with other Midwestern states	
Minnesota Mercury Emissions Reduction Act	90% reduction by 2015 on the following coal plants: Sherco, Allen S. King and Clay Boswell	
Minnesota Energy Efficiency Goals	Not included (But these goals are achieved anyway in the RCP case, in response to the higher prices of electricity created by cap)	
Regional Climate Policy	**Not included**	**Next Generation Energy Act of 2007 applied to CO_2 emissions and extended to 5 states to reflect NGA's intent to be part of a regional cap (covered states are MN, IA, WI, IL and KS)**

Two Minnesota policies are in place in the baseline case. Minnesota's Renewable Energy Standard (RES) calls for 12% of utility retail sales to be sourced from renewable resources by 2012. This standard increases to 17% in 2016, 20% in 2020 and 25% in 2025. The Minnesota RES has been modeled as part of a region-wide RPS program called the Midwest Renewable Energy Tracking System (M-RETS). Requirements for other Midwestern states including Illinois and Wisconsin are also included in the program. Additionally, the Minnesota Mercury Emissions Reduction Act of 2006 will result in a 90% reduction in mercury emissions from six generating units at Minnesota's three largest coal-fired power plants (Sherco, Allen S. King, and Clay Boswell).

Minnesota's Energy Efficiency goals were not modeled directly because these goals and indications on how to measure them are not well defined in Minnesota law. However, the conservation goals are likely to be met in the RCP as a response to higher electricity rates that are projected to result from the RCP. Therefore, the projected electricity demand growth in Minnesota in the RCP case is significantly lower than in the baseline due to energy efficiency and demand reduction in response to higher electricity prices.

This study's representation of the RCP relies on Article 5 of Minnesota's Next Generation Energy Act of 2007 (NGA) with a focus only on CO_2 emissions. The reduction goals are based on reductions from 2005 CO_2 emissions levels. Emissions for the baseline year of 2005 by state are from the Energy Information Administration (EIA), which had data for 2004. The 2004 state-level emissions were escalated to estimated 2005 emissions by applying the national percentage change in emissions from 2004 to 2005, with the results provided in Table 1.[17] The reduction goals of 15% below 2005 emissions by 2015, 30% below 2005 by 2025 and 80% below by 2050 were used to define the CO_2 cap for the entire covered region, which included Minnesota, Wisconsin, Iowa, Illinois and Kansas (see Table 2).[18] CO_2 emissions from all sectors of the economy were subject to the cap, in addition to emissions associated with electricity imported into the covered region.

Table 1: 2005 Baseline CO_2 Emissions (MM Metric Tons of CO_2)

State	2005 Estimated CO_2 Emissions
MN	103
WI	109
IL	246
IA	82
KS	78
Total	618

Table 2: CO_2 Cap (MM Metric Tons of CO_2)

Year	Cap (MM Metric Tons)	% Reduction from 2005
2015	526	15%
2020	479	23%
2025	433	30%
2030	371	40%
2035	309	50%
2040	247	60%
2045	185	70%
2050	124	80%

There was not sufficient information available on non-CO_2 greenhouse gases at the state level to merit their inclusion in the cap used in the model. Regional non-CO_2 offset supply curves and supply curves for increases in CO_2 sinks ("biosequestration")[19] were developed from national offset supply curves originally developed by the U.S. Environmental Protection Agency. Using allocation factors, we determined an estimated quantity of the offsets for each of the covered states. Only the offsets supplies estimated *within the covered states* were

[17] Source: http://www.eia.doe.gov/oiaf/1605/ggrpt/excel/tbl_statetotal.xls for 2004 totals, grown from 2004 to 2005 using percentage change in total U.S. emissions (available at http://www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html). Note that these figures do not include CO_2 emissions associated with imported electricity because this data is not available for all of the states. However, in the RCP the emissions associated with imported electricity do count against the cap. These figures do not include emissions of non-CO_2 greenhouse gases.

[18] Michigan and Manitoba were also signatories to the Midwest Governor's Accord. However, the MRN-NEEM model does not include Manitoba. Michigan was not included because of the difficulty of counting electricity imports into the state towards the cap. We do not believe that the exclusion of these areas has a material impact on the study results.

[19] Carbon sinks are typically natural sources that absorb CO_2 and therefore reduce the concentration of CO_2 emissions in the atmosphere. Examples include trees, soil and oceans. Increasing forestry therefore reduces the concentration of CO_2 in the atmosphere and is equivalent to a reduction in CO_2.

allowed to be applied toward meeting the CO_2 cap. (Also, the quantity of offsets relied on in any one year was not allowed to exceed the level of the cap for that year.) Essentially, the offsets serve as way to manage emissions within the entire region while still adhering to the designated CO_2 cap.

Minnesota has estimated its CO_2 and non-CO_2 emissions in 2005.[20] The estimated greenhouse gas emissions of 151.5 million metric tons in 2005 includes 14.3 million metric tons of CO_2 emissions associated with imported electricity, leaving in-state emissions of 137.2. Therefore, the exclusion of non-CO_2 emissions from the cap results in approximately 22% of greenhouse gas emissions not being covered by the cap (assuming the Minnesota data is comparable to other states). If these emissions had been included in the cap, the cap would have been higher, but emissions would also have been higher. Further, reductions in these non-CO_2 gases would not have been available as offsets, but would instead have been needed to help meet the added limit on the non-CO_2 gases.[21]

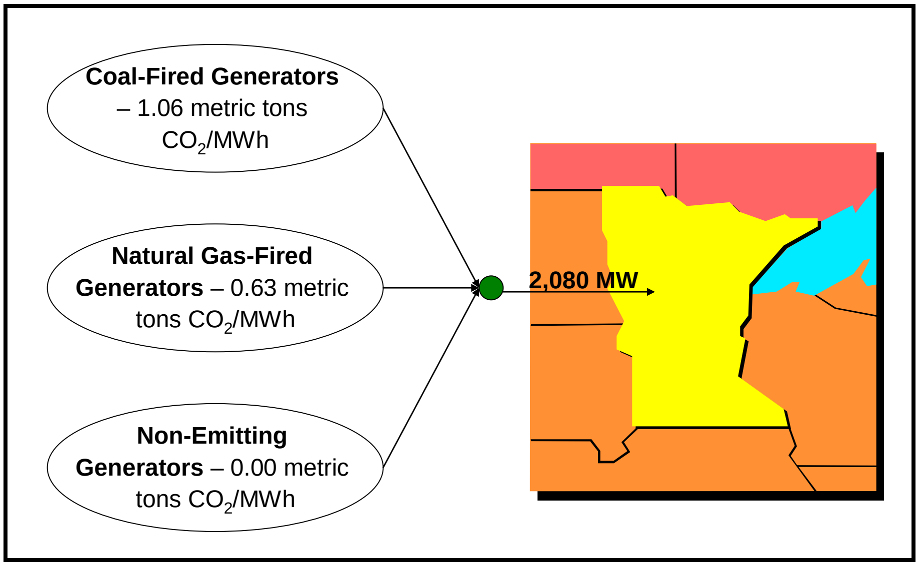
Minnesota law does not explain how Minnesota plans to implement the provision of the Next Generation Energy Act of 2007 that counts towards the cap emissions associated with electricity imports. If load serving entities in the covered region enter into contracts with generators outside of the covered region, the emissions can be tracked. However, if load serving entities purchase power in the wholesale electricity markets, it is not clear how emissions will be tied to these purchases.

To address this issue in the modeling effort, sets of similarly emitting types of generation units (both existing and new) were grouped in the model (*e.g.*, coal, natural gas and non-emitting generators). This allowed for the model to track the types of generation being imported into the covered regions. In the illustrative example in Figure 3, there is a maximum of 2,080 MW that can be imported into Minnesota in each hour from North Dakota. In this case, the group of the coal-fired generators in North Dakota has an average CO_2 emission rate of 1.06 metric tons of CO_2 per MWh, natural gas-fired generators have an emission rate of 0.63 metric tons of CO_2 per MWh, and non-emitting resources have no emissions. These emission rates were held constant over time. We built a feature into the model to track the sources of the imported generation with their respective CO_2 emission rates. The total emissions were then counted under the CO_2 cap.

[20] *DRAFT Minnesota Greenhouse Gas Inventory and Reference Case Projections 1990-2020*, Center for Climate Strategies, July 2007. While this data is available for Minnesota it is not available in a comparable form for the other covered states.

[21] The analysis projects that about 7% of the required CO_2 reductions come from non-CO_2 gas offsets (gradually declining from about 14% in 2015 to about 5% by 2050). Given that about 22% of total emissions in Minnesota are from the non-CO_2 gases, it seems likely that the non-CO_2 reductions projected in our RCP case would not be sufficient to meet the additional reduction requirements for those non-CO_2 gases that are in the RCP, if they had been included. Thus, the RCP cap analyzed here is probably looser than the actual RCP policy by more than 7%. However, the exact degree of difference cannot be ascertained without information on the share of non-CO_2 gases in the other four states in our RCP scenario, and without information on the baseline growth for those other greenhouse gases.

Figure 3: Illustrative Example of Accounting for Imported Electricity Emissions



There is no Federal carbon policy in place – states not covered by the RCP were assumed not to face any Federal carbon policy and therefore do not experience any of the increases on their direct costs nor limitations on their CO_2 emissions that are incurred by businesses operating in the five RCP states.

Finally, no large-scale electrification is assumed in the analysis, as might occur for example with widespread adoption of plug-in hybrid electric vehicles.

The imposition of the limits on CO_2 emissions in the covered states leads to economic responses that are reflected in commodity prices, electricity demand and a CO_2 allowance price. Also, because the RCP counts emissions from imported electricity against its own CO_2 cap, the policy leads to some changes (although relatively minor ones) outside of the covered region. These changes flow all the way through the economy to impact the operations of businesses and the financial position of households. Several of these changes are described in the summary results section (i.e., Section 3).

2.2. Key Assumptions

Working with PAE and collaborating Minnesota trade associations, CRA developed a set of input assumptions for this analysis. Some of the most important modeling assumptions are highlighted in Figure 4, and then detailed below the figure.

Figure 4: Summary of Key Assumptions in Baseline and Regional Climate Policy Case

Assumption	Baseline	Regional Climate Policy
Natural Gas Commodity Prices	NYMEX Henry Hub future through 2020; then based on growth rates in Henry Hub prices from U.S. Department of Energy's *Annual Energy Outlook 2008 (AEO 2008)*	
Crude Oil Commodity Prices	NYMEX futures through 2016; then based on growth rates in AEO 2008 prices	
Electricity Demand	MN: grows at 1.6%/year from 2010-2015, 0.8%/year 2015-2050	
New Generation Capacity Costs and Characteristics	Based on AEO 2008 with additional cost adders to reflect run-ups in commodity and labor costs[22]	
Regional Electricity Transmission	Hourly transmission limit of 2,080 MW from North Dakota to Minnesota; import limit from Manitoba increases from 500 MW to 750 MW starting in 2020; no other changes in regional transmission limits	Same as in baseline; CO_2 emissions associated with electricity imported into the covered region count towards the CO_2 cap (see example below)
CO_2 Offsets	Not applicable	Offset opportunities in covered states estimated from national offset curves
Federal Carbon Policy	No Federal carbon policy	
Large-Scale Electrification	No large-scale electrification (*e.g.*, widespread adoption of plug-in hybrid electric vehicles)	

While the assumptions in the baseline and RCP case are the same with the exception of the regional climate policy caps themselves, the changes that result from the imposition of the limits on CO_2 emissions lead to changes in fuel prices and in demand for electricity. While not inputs to the model, these changes are discussed below, along with other details about key policies and assumptions.

The baseline natural gas prices at Henry Hub relied on a combination of NYMEX futures prices and growth rates in annual prices from the U.S. Department of Energy's Annual Energy Outlook 2008 (AEO 2008). Actual NYMEX futures prices from July 29, 2008, were used for 2010 through 2020. From 2021 through 2030, the respective annual percentage change in natural gas prices from AEO 2008 was applied to the prior year's prices (e.g., the

[22] Included in the capital costs are costs associated with necessary transmission to connect the new unit with the existing transmission grid. Other upgrades to the transmission grid are not captured in these costs.

annual change in 2021 from AEO 2008 was applied to the 2020 futures price on NYMEX). After 2030 (when the AEO 2008 projection ends), the compound annual growth rate from AEO 2008 for 2015 through 2030 was applied. The result is a baseline input assumption for natural gas prices from 2010 through 2050.

The baseline crude oil prices were developed in a manner similar to that of the natural gas prices. NYMEX futures prices were available for 2010 through 2016. Thereafter the respective annual percentage change from AEO 2008's crude oil prices was applied through 2030. After 2030, the AEO 2008 compound annual growth rate in crude oil prices for 2015 to 2030 was applied.

The addition of the RCP to the baseline policies and assumptions results in changes to demand (and supplies) for commodities such as natural gas and crude oil prices. However, since the greenhouse gas policy is only regional (not national or even global), the demand changes for both natural gas and crude oil are relatively small and have little impact on the commodity prices for these fuels. The baseline and RCP prices are shown in Table 3 and Table 4.

Table 3: Natural Gas Commodity Prices (2008$/MMBtu)

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Baseline	$8.16	$6.83	$7.02	$7.54	$8.52	$9.13	$9.78	$10.49	$11.23
RCP	$8.18	$6.84	$7.04	$7.47	$8.39	$8.94	$9.59	$10.29	$11.15
% Change (Baseline to RCP)	0%	0%	0%	-1%	-2%	-2%	-2%	-2%	-1%

Table 4: Refined Oil Commodity Prices (2008$/MMBtu)

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Baseline	$21.85	$19.29	$19.79	$21.33	$22.72	$23.88	$25.16	$26.57	$28.14
RCP	$21.90	$19.29	$19.77	$21.28	$22.66	$23.81	$25.08	$26.47	$28.02
% Change (Baseline to RCP)	0%	0%	0%	0%	0%	0%	0%	0%	0%

In the baseline, regional electricity demand grows at a rate based on forecasts of the North American Electric Reliability Corporation Electricity Supply & Demand (NERC ES&D) through 2014. Starting in 2015 (where the NERC forecasts end), regional electricity demand grows based on rate in the AEO 2008 forecast. As a result, the Minnesota/Iowa long-term electricity demand growth rate is 0.8% per year. The higher cost of electricity in Minnesota under the RCP scenario (and other covered states) leads to two separate responses that result in an electricity demand growth rate in Minnesota/Iowa of 0.2% per year in the RCP case (as shown in Table 5):

- The first response is increased energy efficiency, where investments are increased in productive sectors so that for each dollar of economic output, there is less electricity (and other energy) usage needed.
- The second response is loss of electricity demand due to demand reduction.[23]

Table 5: Electricity Demand (TWh)

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Baseline – US	4,199	4,562	4,774	5,081	5,462	5,698	6,057	6,404	6,783
RCP – US	4,197	4,550	4,738	5,039	5,422	5,627	5,972	6,321	6,680
% Change	0%	0%	-1%	-1%	-1%	-1%	-1%	-1%	-2%
Baseline – MN	120	129	135	141	149	152	158	164	172
RCP – MN	120	123	124	124	126	122	125	127	132
% Change	0%	-5%	-7%	-11%	-14%	-19%	-21%	-22%	-23%

CRA's MRN-NEEM model contains a representation of all existing electric generators. In addition, all units currently under construction are added to the model in the years in which they are currently planned to be on-line. All other electric generator additions in the model are based on the model's projected needs for new capacity and the relative economics of different types of new generators that can serve those needs. CRA continuously monitors reports on costs of new capacity additions to ensure that assumptions in its models represent up-to-date data. This analysis starts with capital costs from AEO 2008, but increases them to account for missing cost items such as owners' costs, transmission, natural gas pipeline connections and rail spurs. In addition, these cost inputs reflect the increased cost of labor and steel that has been evident over the last several years, but which is not yet reflected in the AEO 2008 cost estimates. The capital cost assumptions used in this analysis are presented in Table 6 and Table 7.

The analysis assumed that several technologies not available today will become available over time. New nuclear units have a delayed availability date due to their regulatory and construction lags, with the first ones possible to come on-line in 2020. Carbon capture and storage (CCS) becomes available and is phased in starting at the same date, but at a slower rate before about 2025, reflecting current industry views on large-scale availability. The analysis also assumed that costs for most generation technologies decline over time. The cost decrease is most pronounced for new technologies such as CCS, which are expected to have steeper learning curves.

This analysis also assumed an open and accessible transmission system that will allow for the import of non-emitting sources (e.g., renewables and nuclear) up to the interconnection

[23] Demand reduction can be thought of in two different ways. One could be the loss of demand from industry that leaves the state. The second explanation could be households choosing to use less electricity by decreasing the setting on their thermostat in the winter, for example.

limits between the regions. It is not clear that these non-emitting sources would actually be deliverable into Minnesota without upgrades to the existing transmission system. However, the analysis did not that that any costs would be needed to upgrade the transmission system in order to meet the new levels of transmission projected under the RCP.

Table 6: Fossil Fuel Unit Capital Costs (2008$/kW, before financing costs)

Year	Pulverized Coal	IGCC	IGCC with Capture & Storage	Combined Cycle	Peaker
2010	$2,442	$3,256	NA	$835	$661
2015	$2,152	$2,872	NA	$821	$633
2020	$1,718	$2,424	$3,864	$821	$633
2025	$1,718	$2,021	$3,176	$821	$633
2030	$1,718	$2,021	$2,998	$821	$633

Table 7: Non-Fossil Fuel Unit Capital Costs (2008$/kW, before financing costs)

Year	Nuclear	Biomass	Landfill Gas	Wind	Geothermal
2010	NA	$2,686	$2,222	$1,905	$3,249
2015	$4,579	$2,686	$2,222	$1,905	$3,249
2020	$4,579	$3,246	$2,222	$1,905	$3,249
2025	$3,527	$3,134	$2,222	$1,905	$3,249
2030	$2,984	$3,134	$2,222	$1,905	$3,249
2035	$2,984	$3,134	$2,222	$1,905	$3,249
2040	$2,984	$3,134	$2,222	$1,905	$3,249
2045	$2,984	$3,134	$2,222	$1,905	$3,249
2050	$2,984	$3,134	$2,222	$1,905	$3,249

Costs are for a generic region of the U.S. Costs in Minnesota are 7% higher.

Based on information from utilities operating in Minnesota, the transmission limit between Minnesota and Manitoba in 2020 was set to allow for imports of 750 MW of hydroelectric power, reflecting recent agreements with Manitoba Power. (This is higher than it has been in prior years, where the limit was 500 MW). For this analysis, CRA split the MAPP/MRO NERC region of its MRN-NEEM model into two regions (one that was subject to the RCP and one that was not). An interconnection limit of 2,080 MW was assumed from North Dakota into the Minnesota, and was held at this magnitude throughout the study period.

Appendix A includes a further discussion of some of the key assumptions and the implications associated with these assumptions.

3. SUMMARY RESULTS

This section summarizes key results and trends from CRA's integrated macroeconomic and electric sector model, MRN-NEEM. These results show impacts on Minnesota's economy as a whole, and on Minnesota households.

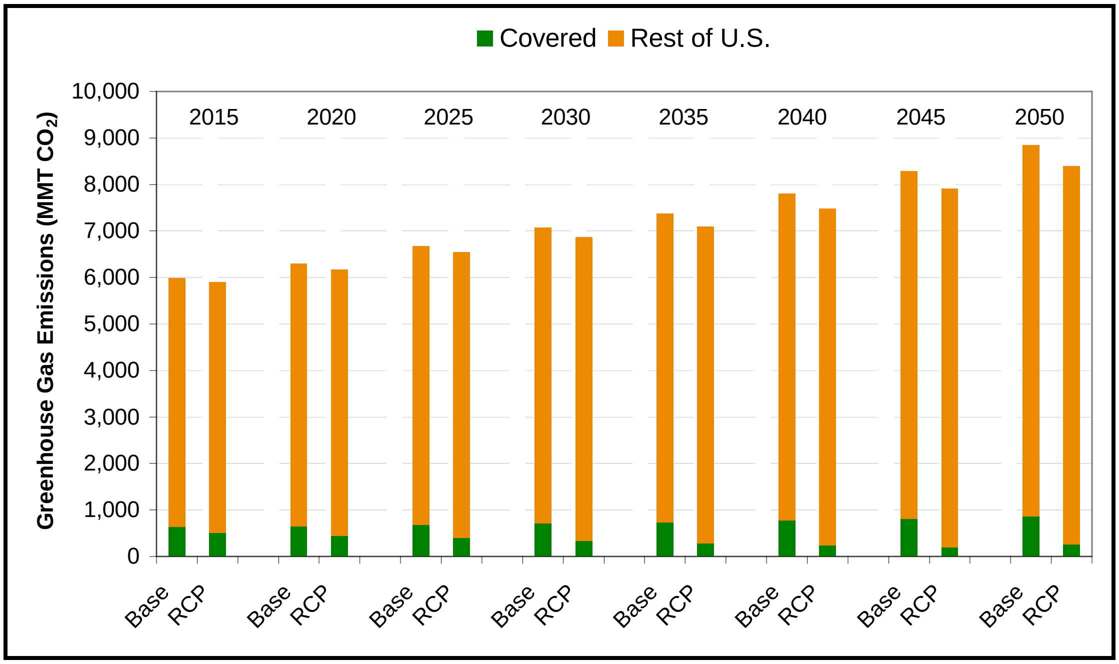
The following information also demonstrates some of the significant changes that will need to occur in Minnesota's energy landscape if Minnesota expects to achieve the aggressive greenhouse gas emission goals in the Next Generation Energy Act of 2007 (NGA) as part of a regional climate policy (RCP). These results suggest an energy dynamic that will not only include substantial loss of currently-existing baseload sources (through coal retirements) but the need for considerably higher use of nuclear power and heavy dependence on imports of renewable sources (and the transmission to bring that power into Minnesota).

3.1. GREENHOUSE GAS EMISSIONS

The RCP places a limit on the amount of CO_2 that can be emitted, thus imposing a cost on carbon. As illustrated in Figure 5, CO_2 emissions (net of any reductions attributable to offsets) in the United States decrease relative to the baseline. In 2015 and 2030, Minnesota emissions decrease by 92 and 221 million metric tons of carbon dioxide (MMT CO_2), respectively. In the covered states, CO_2 emissions in 2015 and 2030 are reduced by 134 and 385 MMT CO_2, respectively. However, emissions in *uncovered* U.S. regions increase under the RCP. Uncovered emissions increase by 42 and 164 MMT CO_2 in the years 2015 and 2030, respectively. Net U.S. emissions are reduced, but not by as much as the RCP regions attempt to contribute on their own.

This phenomenon is not uncommon under regional climate policies because the balance of non-emitting and emitting sources is shifted among the states. Much of the bordering states' non-emitting generation can serve the covered area, leaving a greater demand for generation from the non-covered states; their *net* demand increase is met by fossil-fired resources even though they nominally export only their low-carbon generation to the neighboring covered states.

Figure 5: U.S. CO_2 Emissions

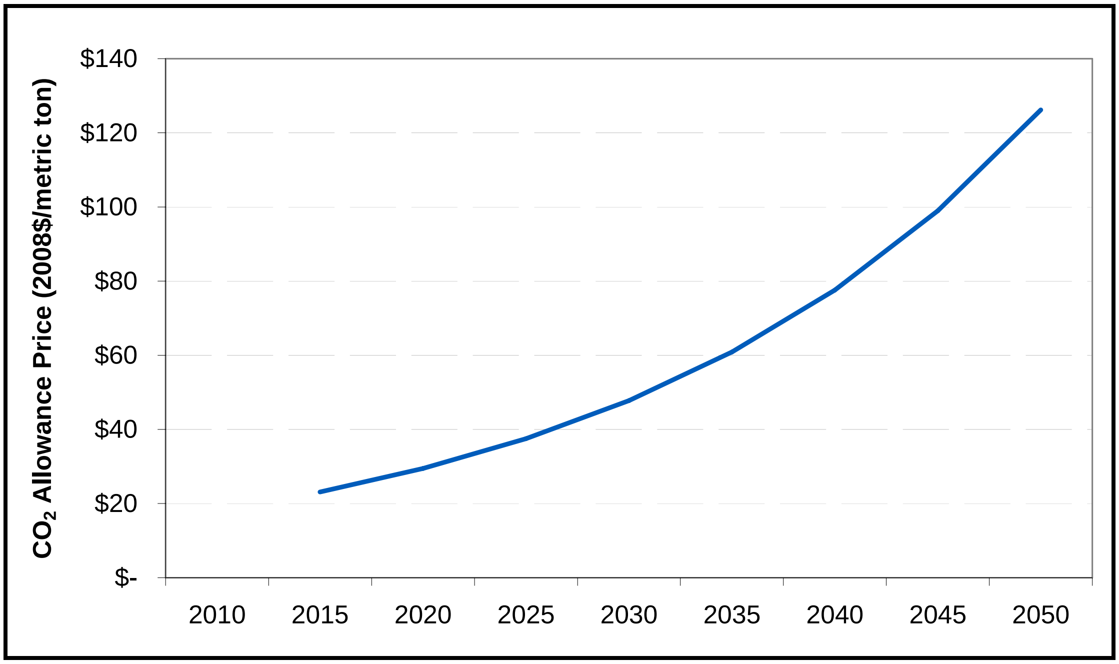


While this study did not include non-CO_2 emissions under the cap analyzed (as discussed in detail in the previous section and in the Executive Summary), there were reductions in these emissions in the covered states in the form of projected offsets projects. In 2015, emissions of these gases were reduced by 18 MMT CO_2 in the covered states (primarily from methane, nitric/adipic acid and high global warming potential gases such as HFCs, PFCs, and SF_6). The exclusion of non-CO_2 emissions from the cap and the availability of reductions from these non-CO_2 gases (and from increases in CO_2 sinks), both result in a looser cap than is actually represented by the Minnesota NGA. This analysis has therefore produced lower CO_2 reductions, and hence lower allowance prices, than would otherwise be expected if a system for counting non-CO_2 emissions at a regional level is developed and implemented as part of the cap.

3.2. CO_2 ALLOWANCE PRICES

Carbon-intensive generation technologies like coal that are physically located within states that are subject to the RCP cap are projected to be retired or operated at lower capacity factors to support electric system reliability because a limit on carbon emissions effectively imposes a price on the ability to emit carbon until such sources are used less. Emissions decline as the price of emitting carbon makes it uneconomic to continue operations that are relatively carbon-intensive. Over the timeframe of the RCP analysis, the permitted price of emitting carbon is projected to increase from $23 to $126 per metric ton of CO_2 (Figure 6). These are the projected prices that will be necessary to achieve the CO_2 reduction goals specified in the RCP.

Figure 6: CO_2 Allowance Prices under Midwest Regional Climate Policy



3.3. Impacts on Minnesota Consumers

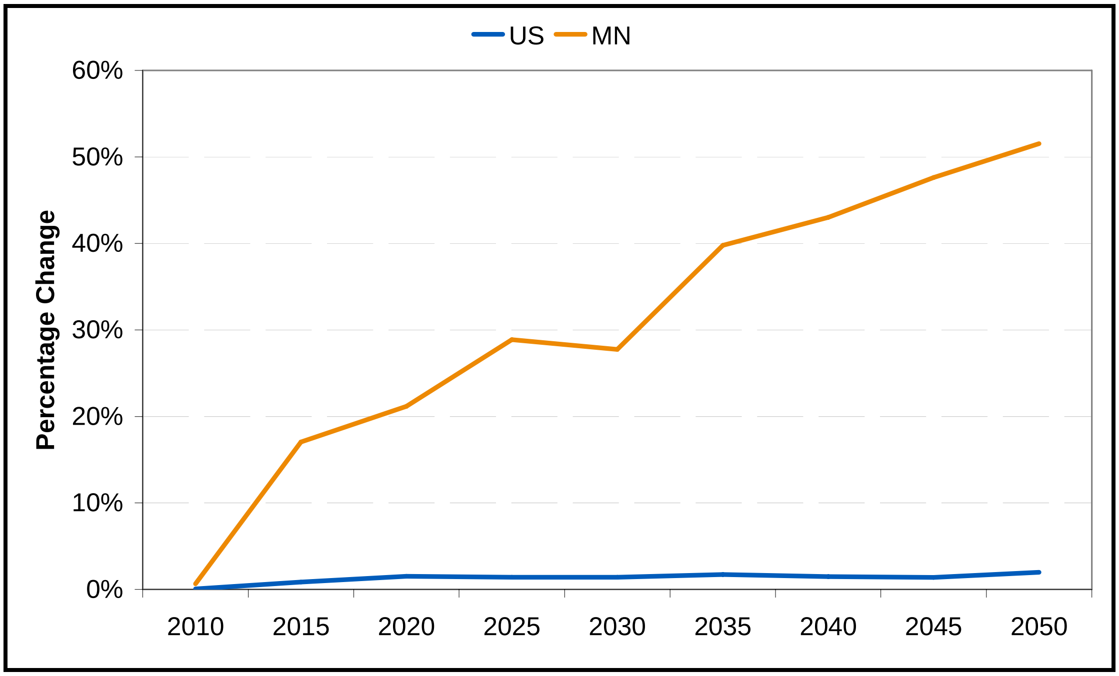
Minnesota households are projected to incur significant price increases on all of their energy needs, including electricity, natural gas and motor fuels. These increases for Minnesota households (and households of other covered states) occur while energy prices outside of the covered region remain nearly unchanged relative to the baseline. The energy price increases also translate into higher costs for those goods and services that are produced within the five-state capped region, thus reducing spending power.

The net effect is that Minnesota residents are projected to reduce their consumption of goods and services by a present value of $42 billion through 2050 (2008$). On a per-household basis, this implies a reduction in consumption (or loss of spending power) for the average Minnesota household of about $575 in 2015 (2008$) rising to $720 in 2030 (2008$). As noted above, the net cost may be borne disproportionately by some businesses and households than others. However, it is not possible to assess who the winners and losers will be, or what might be the depth of their respective losses or gains, without more information about how Minnesota will choose to distribute the allowances under the NGA cap.

3.3.1. Household Energy Prices

While average electricity prices for the U.S. remain relatively flat over the study timeframe, electricity prices in Minnesota are projected to increase 17% by 2015 and 28% by 2030 (see Figure 7).

Figure 7: Percentage Change in Household Electricity Prices (Relative to Baseline) as a Result of a Midwest Regional Climate Policy



3.3.2. Household Natural Gas Prices

Minnesota households experience similar increases in natural gas prices as a result of the RCP. As illustrated in Figure 8, by 2015 household natural gas prices are projected to increase by 11% and rise to 21% in 2030 relative to price levels in the baseline.

3.3.3. Motor Fuel Prices

Likewise, consumers experience significant increases in the price of motor fuel. The "pump price" of motor fuel is projected to increase 4% in 2015 and 9% in 2030 relative to price levels in the baseline (see Figure 9). Outside of the covered region, energy prices remain nearly unchanged from the baseline.

Figure 8: Percentage Change in Household Natural Gas Prices (Relative to Baseline) as a Result of a Midwest Regional Climate Policy

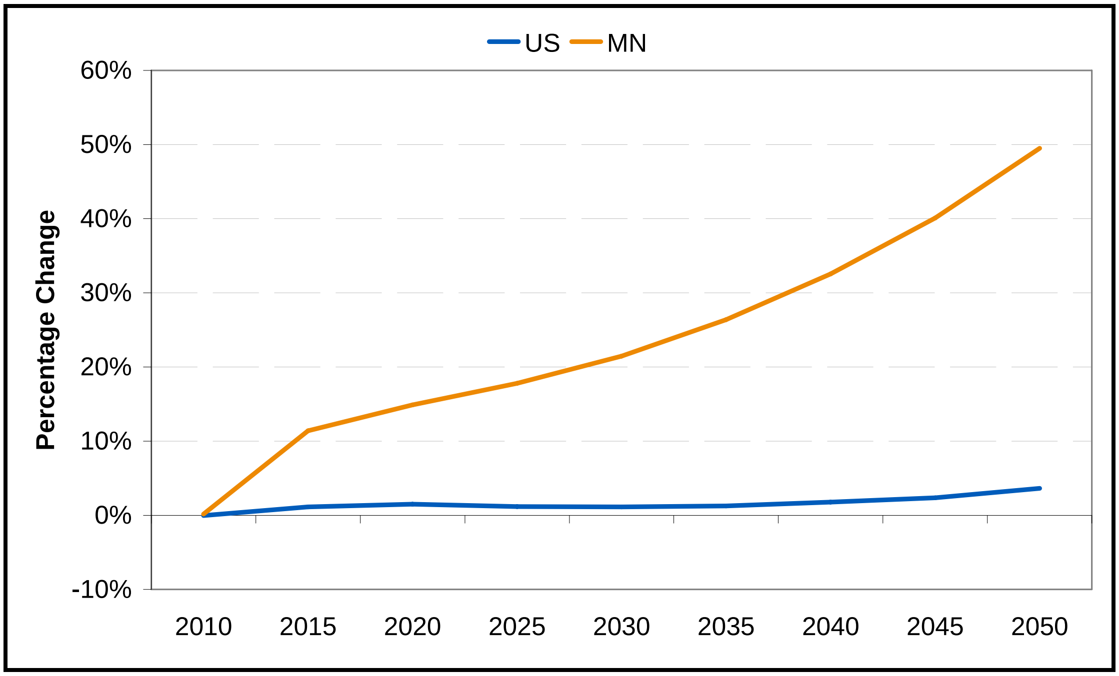
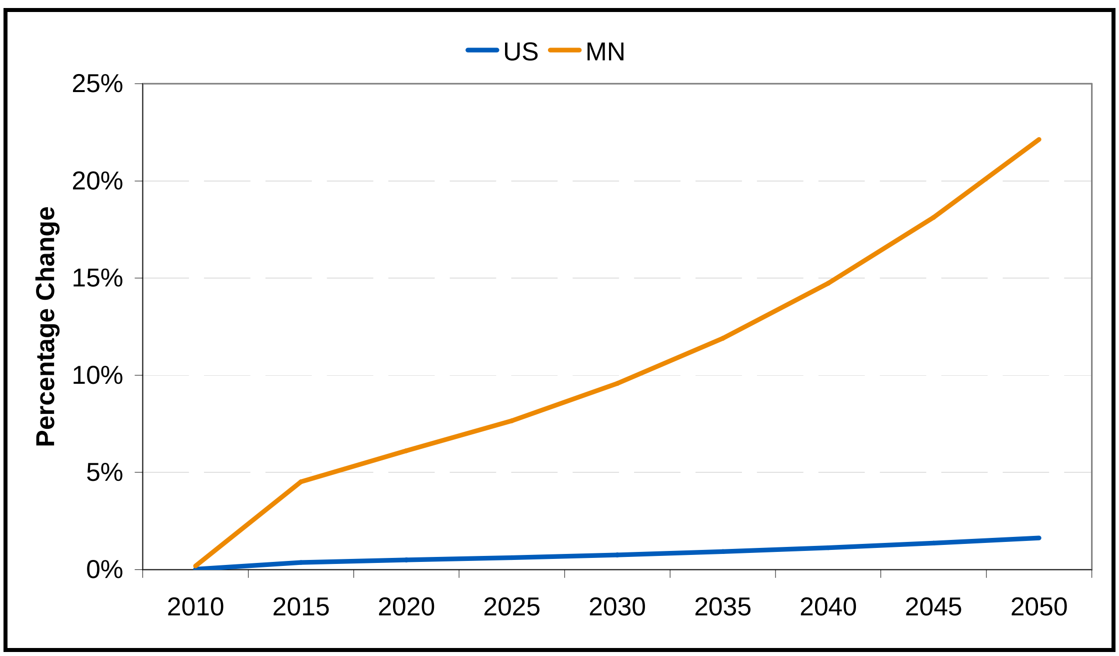


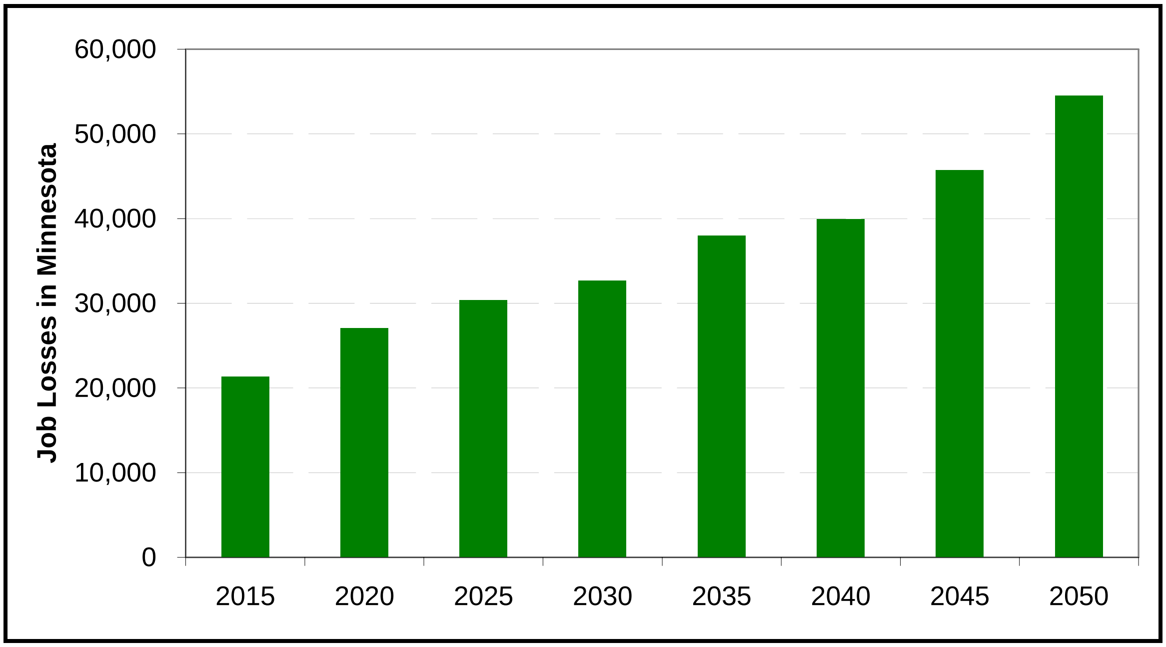
Figure 9: Percentage Change in Motor Fuel Prices (Relative to Baseline) as a Result of a Midwest Regional Climate Policy



3.3.4. Jobs

The higher costs associated with the RCP are also projected to lead to net job losses. While there would be increases in "green" jobs associated with increased investments in renewables generation and energy efficiency in the region, these gains would be more than offset by job losses in other sectors of the economy.[24] Figure 10 shows projected net job reductions in Minnesota.

Figure 10: Net Job Reductions in Minnesota Relative to the Baseline as a Result of the Midwest Regional Climate Policy



3.4. Energy Sector Impacts

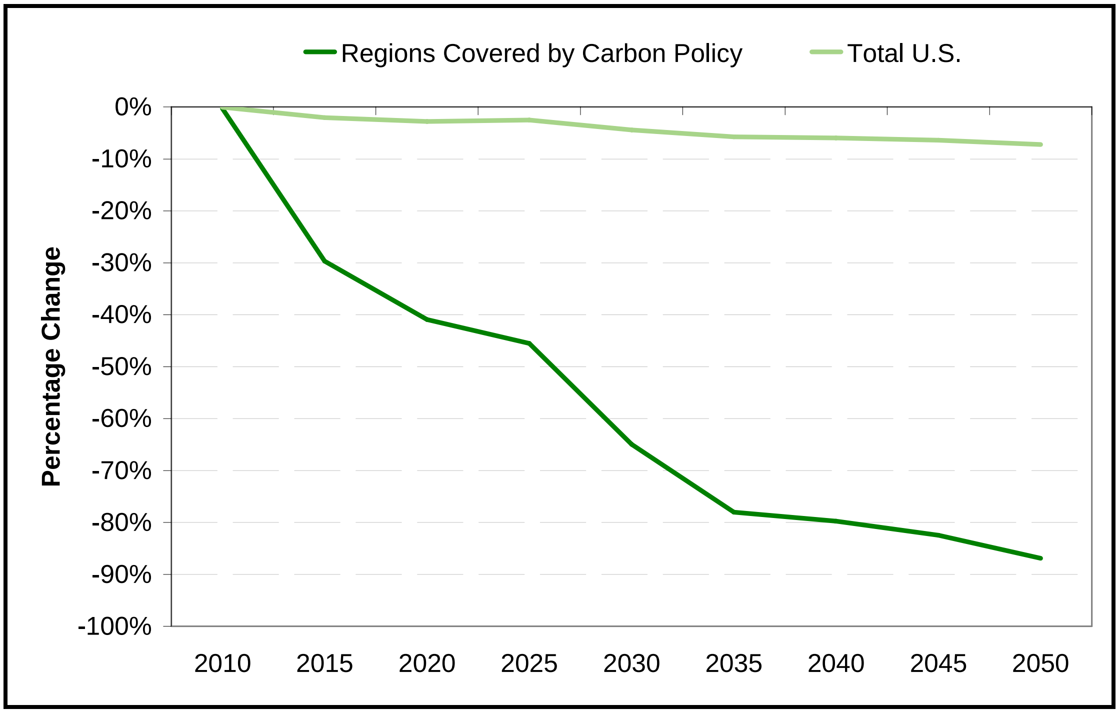
3.4.1. Coal Consumption

Another result of the price on CO_2 emissions is the decline in coal-fired generation within the covered states. In the covered states, coal use in electric generation is projected to fall by 30% in 2015 and 65% in 2030, relative to the baseline. Coal use in uncovered regions is not

[24] The model estimates jobs aggregated across all sectors, using a "sticky wage" model that assesses how changes in the economy-wide real wage rate alter the supply-demand balance for total labor Thus, we do not calculate changes in jobs by type of economic activity, which is what others do when they attempt to estimate "green jobs." If the model were to disaggregate the job figures, then the increased investments in certain sectors (such as renewables generation) would lead to increased jobs in these sectors. However, the model would also demonstrate that the decline in investments in other economic sectors would lead to declines in the number of jobs in those sectors. The net job loss estimate implies that across the entire economy more jobs are lost due to the higher cost of energy than are created in by spending on those higher-cost energy sources, such as renewable generation.

significantly affected by the policy and therefore national coal use is weighted down by the covered region but otherwise flat (Figure 11). Only the most efficient coal-fired power plants continue to operate under the cap imposed by the RCP. Decline in coal use arises as much of the current fleet in the covered area is retired, necessitating other technologies to replace this lost electric energy. This gap is projected to be filled with increases in nuclear generation (from outside of Minnesota) and increases in renewable generation, which is assumed to be deliverable with the current transmission system

Figure 11: Percentage Changes in Coal Consumption in the Electric Sector (Relative to Baseline)[25]

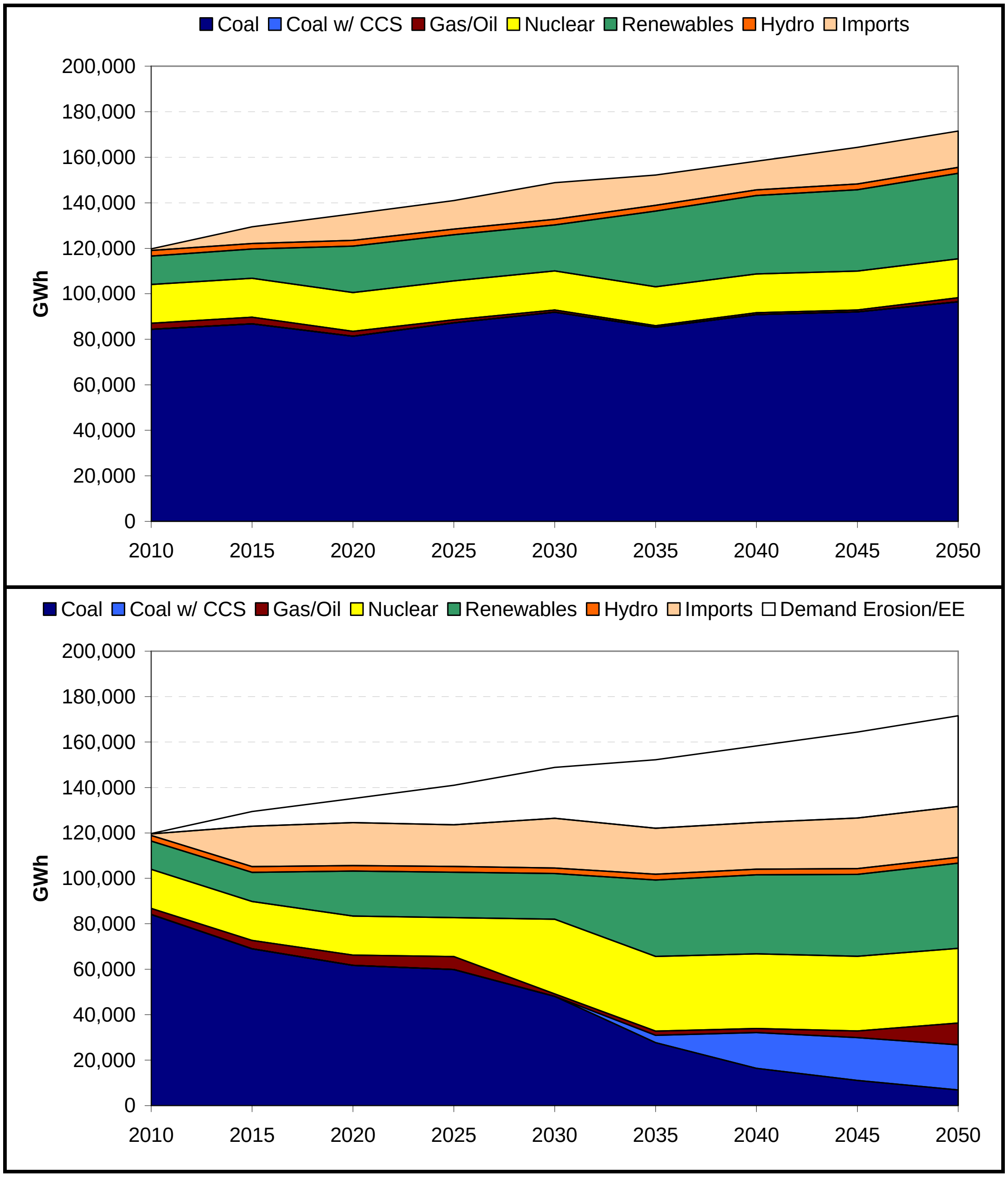


3.4.2. Electricity Generation

As illustrated in Figure 12, successful execution of the RCP will dramatically change the dynamics of energy production in Minnesota. This assumes certain steps will be taken to meet the emissions reduction goal that would lead to the following: a significant increase in nuclear generation, much higher importation of low- and zero-carbon generation, major investment in carbon sequestration for coal plants and considerably higher availability of renewables. Figure 12 also reveals that Minnesota is projected to experience significant demand reduction (coupled with significant investments in energy efficiency).

[25] Includes coal use from traditional pulverized coal, as well as from coal with carbon capture and sequestration (CCS).

Figure 12: Generation Mix in Minnesota/Iowa – Baseline and Midwest Regional Climate Policy[26]



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[26] Minnesota and Iowa are grouped in the electric sector modeling and it is not possible to separate out new units into those in Minnesota as opposed to those built in Iowa. The only exception is new nuclear builds, which are not allowed in Minnesota.

3.5. Sectoral Impacts

The imposition of prices on CO_2 emissions as a result of the RCP has implications for industries and other businesses within Minnesota. The MRN-NEEM model aggregates impacts into six non-energy sectors and five energy sectors.

The five non-energy sectors that are relevant in Minnesota are:

1. Agriculture (e.g., beet farming);
2. Commercial Transportation (e.g., commercial airlines);
3. Energy-Intensive Sectors (e.g., mining);
4. Manufacturing (e.g., electronic component manufacturing); and
5. Services (e.g., tourism).

The two energy sectors relevant in Minnesota are:

1. Electric Power; and
2. Refined Petroleum Products.

Table 8 shows the percentage change in the value of output from these sectors within Minnesota. The non-energy sectors are projected to have declines in the value of their output relative to the baseline, but the energy sectors are projected to see significant declines in the value of their output.

Table 8: Percentage Change in Value of Sectoral Output in Minnesota (Relative to Baseline)

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Agriculture	0%	-1%	-2%	-2%	-3%	-3%	-3%	-4%	-4%
Commercial Transportation	0%	-2%	-2%	-2%	-3%	-3%	-4%	-5%	-5%
Energy-intensive Sectors	0%	-1%	-1%	-2%	-2%	-2%	-2%	-2%	-3%
Manufacturing	1%	0%	0%	0%	0%	-1%	0%	-1%	-1%
Services	0%	0%	0%	0%	0%	0%	0%	0%	0%
Electric Power	0%	-17%	-18%	-22%	-26%	-32%	-34%	-35%	-35%
Refined Petroleum	0%	-2%	-3%	-4%	-5%	-7%	-8%	-13%	-20%

The small percentage changes for the non-energy sectors in Table 8 may be deceiving due to their high degree of aggregation. Some industries within these aggregate sectors may experience much larger percentage output reductions due to their inability to pass prices through to consumers based on the average of the sector. Thus, sector-specific impacts may be a substantial concern for sectors defined at a more disaggregated level. An Addendum to this report provides a discussion of the potential nature of impacts to several of these more disaggregated sectors based on the quantitative results reported above for the costs of energy, and overall demand changes.

APPENDIX A: Further Discussion of Assumptions

In developing the models for this analysis, CRA (working with Partners for Affordable Energy and collaborating associations and organizations) made assumptions that were deemed to be as reasonable as possible. Below is a discussion of some of the assumptions, and why we feel that they have contributed to an overall tendency to *understate projected costs* to Minnesota's economy.

- In the RCP, imports of non-emitting resources from outside of the covered region are assumed to be able to be imported into the covered region. This may not be a sound assumption for several reasons. First, these resources may not have access to the necessary transmission to be physically deliverable into the covered region. Also, if these are existing resources, utilities/municipalities outside of the covered region could contract for them, making them unavailable to the region covered under the RCP. If fewer non-emitting resources could be imported into the covered region, then the electricity generation that these resources are projected to provide would need to be replaced with additional generating resources (possibly fossil fuel-fired generation), which would be more costly and potentially require additional emission reductions outside of the electric sector.

- Minnesota's Next Generation Energy Act of 2007 specifies that non-CO_2 greenhouse gases are to be counted under the cap. However, reliable estimates of the non-CO_2 gases for all of the states in the covered region were not available. As such, these emissions did not count toward the cap in this analysis (nor were they included in setting the cap). Opportunities for reducing these non-CO_2 emissions were made available in the modeling as offsets. In addition, increases in carbon sinks were also made available as offsets. Both of these assumptions have the result of loosening the cap and therefore lowering the cost of compliance.

- The analysis assumes Minnesota will achieve a level of conservation beyond the present 1.5% goal in response to the higher energy prices that result from the RCP. In the presence of higher energy costs, the model allows a substitution toward more capital investment in return for less energy usage. In addition, there are elasticities associated with energy usage for households such that when energy prices increase, energy usage declines from the levels that would otherwise occur, due to conservation behavior. If the degree of energy efficiency response (the trade-offs between capital and energy usage) and demand reduction assumed possible in the MRN-NEEM analysis were not realistic, then it would be more costly to meet the carbon cap than estimated in this study.

- A limit is placed on the quantity of wind generation that can be used within each region. This limit is that no more than about 20% of total generation can be met with intermittent resources such as wind while maintaining reliability within the transmission system, even with back-up from natural gas reserves. While the cost of new wind capacity includes some additional costs for transmission (for interconnection to the grid) it is not clear that the existing transmission system could reliably accommodate such a quantity of wind generation. If 20% level of wind generation is too optimistic for maintenance of system reliability, then there would either be increased costs associated with upgrading the existing transmission system or there would be tighter limits on the quantity of wind generation. In either case this would result in higher costs to Minnesota consumers and businesses than projected in this analysis.

- In this analysis, the value of all allowance allocations is distributed back to the covered states. It is up to those states to determine how that revenue will be used to mitigate the costs of the carbon policy. The value of the allowances (given the caps and the projected CO_2 allowance prices) is large. In 2015, the annual value of the allowances is more than $12 billion (2008$), which increases to almost $18 billion in 2030. Minnesota accounts for approximately 17% of the cap so it would receive 17% of the allowance value, or $2 billion in 2015 and almost $3 billion in 2030, to use as it sees fit. The value of the allowances is fully reflected in the net regional and net per-household cost numbers presented in this report. However, this does not in any way capture the potential for there to be significant winners and losers if the allowance values are distributed in an inequitable manner. This question of potential pockets of winners and losers under alternative possible allocation formulas merits a detailed analysis in its own right, relying on the overall impacts projected in this analysis. While such an analysis would not likely dramatically alter the overall net economic costs and net energy system impacts projected in this study, it could reveal some important concerns for fairness of the policy.

APPENDIX B: Detailed Results

Table 9: Allowance Prices for CO_2 (2008$/metric ton)

	2015	2020	2025	2030	2035	2040	2045	2050
CO_2 prices	$23	$30	$38	$48	$61	$78	$100	$127

Table 10: Delivered Natural Gas Prices in Minnesota (2008$/MMBtu)

		2010	2015	2020	2025	2030	2035	2040	2045	2050
Residential	Base	$11.87	$10.59	$10.33	$10.85	$11.46	$11.89	$12.36	$12.85	$13.37
	RCP	$11.89	$11.79	$11.87	$12.78	$13.92	$15.03	$16.38	$18.01	$19.99
	Pct	0%	11%	15%	18%	21%	26%	33%	40%	49%
Industrial	Base	$9.12	$7.78	$7.97	$8.50	$9.48	$10.08	$10.73	$11.44	$12.19
	RCP	$9.13	$9.03	$9.56	$10.43	$11.89	$13.14	$14.68	$16.53	$18.84
	Pct	0%	16%	20%	23%	25%	30%	37%	44%	55%

Table 11: Electricity Prices in Minnesota (2008 ¢/kWh)

		2010	2015	2020	2025	2030	2035	2040	2045	2050
Residential	Base	9.66	9.75	10.23	10.15	10.46	10.05	10.06	10.24	11.98
	RCP	9.72	11.41	12.39	13.08	13.37	14.05	14.39	15.11	18.15
	Pct	1%	17%	21%	29%	28%	40%	43%	48%	52%
Industrial	Base	4.99	5.17	5.64	5.56	5.87	5.46	5.46	5.63	7.37
	RCP	5.05	6.85	7.83	8.53	8.81	9.50	9.83	10.56	13.60
	Pct	1%	33%	39%	53%	50%	74%	80%	87%	84%

Table 12: Covered States' CO_2 Emissions (Metric tons CO_2)

		2010	2015	2020	2025	2030	2035	2040	2045	2050
Base-line	Electric	282	309	304	326	342	344	363	380	400
	Non-Electric	324	333	345	358	375	394	416	440	468
	Total	606	642	649	684	717	738	779	820	867
RCP	Electric	280	216	173	157	98	59	42	34	31
	Non-Electric	324	322	328	334	339	347	357	355	348
	Total	604	508	444	402	332	286	239	204	256

APPENDIX C: Description of MRN-NEEM

C - 1. MODEL DESCRIPTION

In conducting this analysis, CRA used an integrated model that combines two of its widely accepted state-of-the-art economic models: the Multi-Region National (MRN) model and the North American Electricity and Environment Model (NEEM).[27] The integrated model approach makes it possible to understand the economy-wide impacts of specific energy policies, while examining the specific impacts on the U.S. electric sector in detail.

MRN is a model of the U.S. economy that incorporates the national-level impacts of environmental policies. NEEM evaluates the national electricity sector. CRA has mathematically integrated NEEM's bottom-up representation of wholesale electricity supply and demand with MRN's representation of all other sectors of the economy, and household/consumer decisions to save, work, and consume goods and services.

The MRN-NEEM modeling system was developed by CRA and is proprietary software. It is based on commercial optimization software (GAMS), and typically uses Excel for input and output of data. The model's components have individually and jointly been tested in numerous assignments for private and public sector clients.

C - 2. OVERVIEW OF THE MRN SUB-MODEL

MRN is a computable general equilibrium model of the U.S. economy that simulates patterns of investment and consumption behavior that maximize consumer welfare over time. MRN captures changes in electricity demand, natural gas and oil prices that cannot be evaluated without modeling the entire U.S. energy sector. MRN is a necessary component when potential carbon regulations are being evaluated, because MRN captures changes in electricity demand and fuel prices across the entire U.S. energy sector. Linking MRN with NEEM allows for the analysis of unit-level impacts while accounting for the economy-wide impacts of carbon regulation resulting from climate change policies.

MRN is calibrated to a baseline macroeconomic forecast (usually the EIA Annual Energy Outlook Reference Case) and projects *changes* from that baseline. As shown in Figure 13, MRN updates NEEM's regional electricity demands, natural gas prices and carbon prices.[28]

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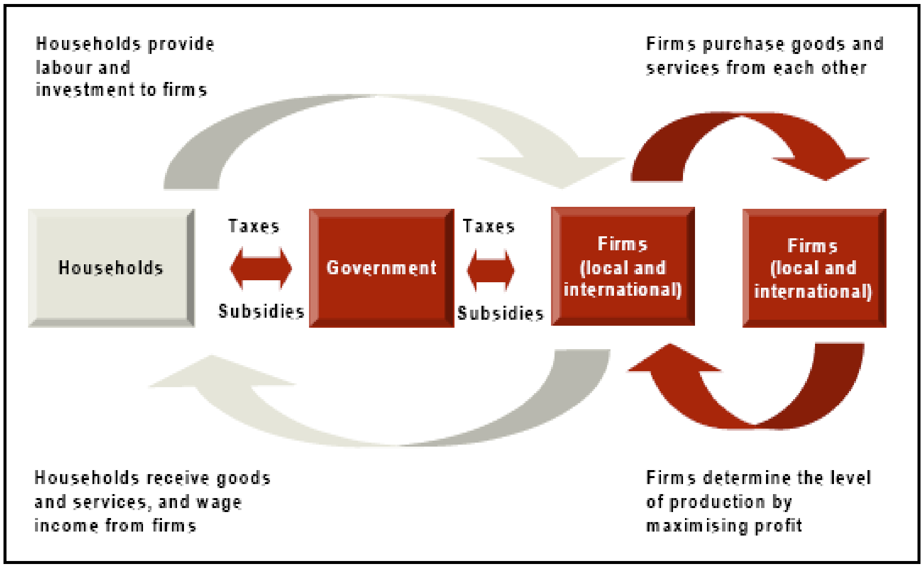
[27] A complete model documentation is available at: http://www.crai.com/uploadedFiles/RELATING_MATERIALS/Publications/BC/Energy_and_Environment/files/MRN-NEEM%20Integrated%20Model%20for%20Analysis%20of%20US%20Greenhouse%20Gas%20Policies.pdf

[28] Actually, MRN passes electricity demand curves, natural gas supply curves and non-utility carbon demand curves to NEEM rather than point estimates.

Figure 13: Circular Flow of Goods and Services and Payment Figure



The representation of electricity, coal and natural gas markets in MRN makes it possible to address feedback effects of changes in electricity costs or generation on the price of fuels and electricity and on the demand for electricity. The electricity sector in MRN is calibrated to match the results of detailed modeling with NEEM, which takes electricity demand and fuel prices as given. The supply and demand relationships in MRN then are used to forecast changes in fuel prices and electricity demand, which are then used as inputs to NEEM in order to produce a new electricity forecast. This process is iterated until NEEM and MRN produce the same electricity forecast with the same inputs for fuel prices and electricity demand.

Natural gas and coal prices, as well as industry competitiveness and therefore demand for electricity, are also influenced strongly by world markets. MRN is an open economy model, taking as inputs world prices for all traded goods and determining on this basis U.S. imports and exports. When there is reason to expect that changes in world prices are important to the outlook, MRN is used in conjunction with CRA's related Multi-Sector Multi-Region (MS-MRT) model, which models the U.S. economy in the context of global trade.

MRN represents the investment and production decisions of businesses and the labor supply, and saving and consumption behavior of households in an optimizing framework. It is a fully dynamic model, in which saving and investment decisions are made based on rational expectations of future prices. The time horizon is flexible, and for long-term studies has been set to 2070. This framework makes macroeconomic behavior consistent with the planning basis used in NEEM, which also bases investments on expectations of fuel and electricity prices and costs of alternative technologies over the life of an investment.

MRN has been peer reviewed, with both documentation and results published in peer-reviewed publications. It has been used in a series of widely recognized studies of the economic impacts of proposed climate change policies.

MRN is typically modeled with 9 regions in the United States. For this analysis, we added three additional regions to be able to effectively break out those regions that would be subject to the RCP.

Regional and sectoral information for the entire United States within the MRN model is built upon the IMPLAN economic impact modeling system, which was initially developed at the University of Minnesota. The IMPLAN data provides social accounting matrices and multiplier models that allow for detailed analysis of state and regional economies.[29]

C - 3. Overview of the NEEM sub-model

NEEM was designed to model new capacity, retirements, environmental compliance, and fuel choice at the national level. NEEM models coal units in detail as these are most affected by environmental regulation, and incorporates as inputs fuel prices and electricity demands from MRN.

NEEM models the U.S. electric power system and portions of the Canadian system, with 31 geographical regions that reflect the interplay of transmission constraints and environmental regulations. In NEEM, there is some level of unit aggregation for non-coal units; however, all but small coal units are modeled at a unit level. NEEM also models the dynamics of coal supply and transportation.

A particular aspect of NEEM is the detail included for modeling the coal sector. Major coal units are individually represented in NEEM, and NEEM includes coal supply curves that represent 21 coal supply regions and coal types. These coal supply regions are linked to the generation units by a coal transportation matrix with unit-specific transportation costs.

In NEEM, this means that different levels of coal use in different periods lead to different average coal prices; effectively, coal prices are an output of NEEM, not an input. This approach ensures internal consistency between allowance prices and coal prices, unlike other models in which coal prices are effectively fixed regardless of rate of consumption.

The coal supply curves in NEEM were developed by CRA staff with the assistance of Mr. J. Heller (Hellerworx) and Norwest Corporation, two specialists with significant knowledge of the U.S. coal industry and of overseas coal markets.

The output from NEEM is average peak and off-peak electricity price by region, emission allowance prices, coal prices, unit retirements, resource additions, unit retrofits and the associated cost data over a 30- to 50-year time horizon.

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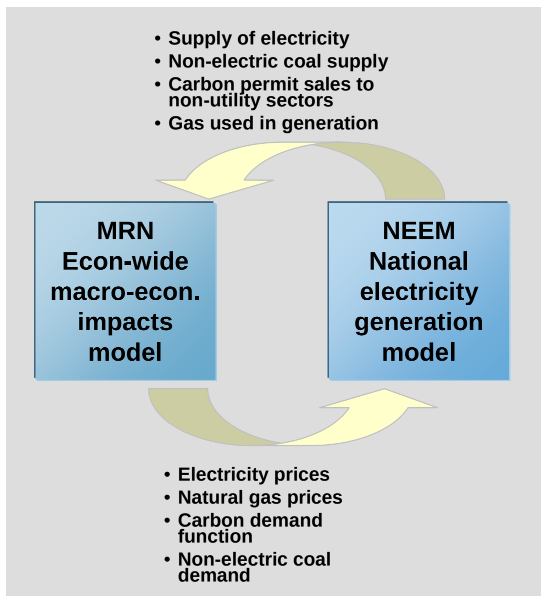
29 For more information on IMPLAN go to http://implan.com/.

C - 4. MRN-NEEM INTEGRATION METHODOLOGY

The MRN-NEEM integration methodology follows an iterative procedure to link the top-down and bottom-up models.[30] The method utilizes an iterative process where the MRN and NEEM models are solved in succession, reconciling the equilibrium prices and quantities between the two. The solution procedure, in general, involves an iterative solution of the top-down general equilibrium model given the net supplies from the bottom-up energy sector sub-model followed by the solution of the energy sector model based on a locally calibrated set of linear demand functions for the energy sector outputs. The two models are solved independently using different solution techniques but linked through iterative solution points (see Figure 14).

Figure 14: MRN-NEEM Iterative Process



30 Combining Top-Down and Bottom-up in Energy Policy Analysis: A Decomposition Approach, Christoph Böhringer and Thomas F. Rutherford, Discussion Paper No. 06-007 ZEW (Zentrum fur Europaische Wirtschaftsforschung GmbH Centre for European Economic Research).