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Cap-and-Trade Technical Work Group

Summary List of Draft Priorities for Analysis

Option No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value (Million $)	Cost-Effectiveness* ($/tCO_2e$) 2025	Permit Price† ($/tCO_2e$) 2025	Level of Support
		2015	2025	Total (2008–2025)				
C&T-1 Cap and Trade Program	MGA Partners C&T – *High Cost Case* (All Sectors)		77.24			$3.37	$45.68	
	MGA Partners C&T – *Low Cost Case* (All Sectors)		77.19			$1.19	$40.58	
	MGA Partners+Observers C&T – *High Cost Case* (All Sectors)		80.33			$5.08	$49.85	
	MGA Partners+Observers C&T – *Low Cost Case* (All Sectors)		80.15			$3.43	$44.23	
	MGA plus WCI Partners C&T – *High Cost Case* (All Sectors)		72.56			$0.85	$39.60	
	MGA plus WCI Partners C&T – *Low Cost Case* (All Sectors)		74.79			$0.75	$37.71	
	MGA and WCI Partners+Observers C&T – *High Cost Case* (All Sectors)		79.42			$4.58	$48.61	
	MGA and WCI Partners+Observers C&T – *Low Cost Case* (All Sectors)		81.51			$4.13	$45.94	
	MGA Partners C&T – *High Cost Case* (Power Sector)		22.41			$1.64	$32.14	
	MGA Partners C&T – *Low Cost Case* (Power Sector)		22.41			$1.22	$23.93	
	MGA Partners+Observers C&T – *High Cost Case* (Power Sector)		22.99			$2.43	$33.98	

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	MGA Partners+Observers C&T – *Low Cost Case* (Power Sector)		22.99			$1.81	$25.30	
~~C&T-2~~	MN-Only C&T (merged into C&T-1)		80.83			$8.35	$50.10	
~~C&T-3~~	National C&T (merged into C&T-1)							
C&T-4	Carbon Tax							
C&T-5	Market Advisory Group (Formerly CC-11)							
C&T-6	Regional and Multi-State GHG Reduction Efforts (Formerly CC-7)							
C&T-7	Carbon Credit System for Minnesota (Formerly CC-10)							

Note: MGA C&T partners include Iowa, Illinois, Kansas, Michigan, Minnesota, Wisconsin, and Manitoba; MGA C&T observers include Indiana, Ohio, and South Dakota; WCI partners include Arizona, California, New Mexico, Oregon, Utah, Washington, British Columbia, and Manitoba; WCI observers include Colorado, Idaho, Montana, Nevada, and Wyoming. In order to run simulations including both MGA and WCI states in year 2025, we used 2020 marginal cost curves for WCI states for the year 2025. The emission cap for both MGA and WCI states (or provinces) is assumed to be 30% below the 2005 level in Year 2025.

* This represents the average cost per tCO_2e mitigated/sequestered for Minnesota.

† This represents the marginal cost of the last tCO_2e mitigated/sequestered, and applies to all states involved in a trading arrangement.

Results are subject to change. We have limited data on mitigation/sequestration options for Midwestern States. Preliminary results given here may change when better data is available.

It is anticipated that future model runs will include the following:

- All RGGI states of the Northeast
- Updated MN specific cost curves from the MCCAG process, and new cost curves for other states in the Midwest
- Cost curve modifications to address sensitivity analysis and alternate assumptions
- Other design assumption modifications based on MCCAG feedback

C&T-1. Cap-and-Trade Program

Policy Description

Cap-and-trade programs limit emissions by first placing a 'cap,' or limit, on the total number of pollutant tons that will be permitted to be released from regulated, or 'covered,' sources within a specified geographic area and interval of time. The cap is enforced by the issuance of permits, or 'allowances,' which must be surrendered by each covered source in an amount equal to its emissions. By setting the total number of allowances equal to the overall cap, total emissions are limited. Moreover, the number of allowances issued over time can be decreased, thereby further reducing total emissions.

Since the government regulates only the total emissions, the means by which the reductions are achieved is left to the individual covered sources (although many reduction activities may be covered by other polices). Sources would individually identify their least-cost options, but creating a market gives these allowances a financial value, which encourages the covered sources to collectively implement the least-cost measures at different levels of mitigation to achieve the capped emissions reductions. Through trading, participants with lower costs of compliance can choose to over-comply and sell their additional reductions to participants for whom compliance costs are higher. In this fashion, overall costs of compliance are lower than they would otherwise be.

It should be noted that the least cost approach for some sectors or sources may not be cap and trade; it may instead be for technology forcing or incentive policies that address specific market barriers. Cap and trade will not necessarily remove market barriers or lead to the fastest or broadest adoption of new technologies and practices that save money or stimulate economic performance.

Policy Design

To assist in the evaluation of policy options, the Cap and Trade TWG created the following Principles and Guidelines, which are listed in no particular order. The Cap and Trade Program:

- Must be cost-effective; that is, it has to meet GHG reductions targets at a cost comparable to or better than alternative measures;
- Should be open to consideration of other (non-Cap and Trade) measures;
- Should encourage collective actions;
- Should be transparent;
- Should offer covered entities a degree of certainty regarding outcomes;
- Should strive for full coverage of participants;
- Should be fair in the distribution of allowances;

- Should strive for simplicity;
- Should be enforceable;
- Should be administratively efficient; and,
- Should reward early actions.

Emission Reduction Goals: The law requires the MCCAG to "recommend the parameters of a cap-and-trade system that includes a cap that would prevent significant increases in greenhouse gas (GHG) emissions above current levels with a schedule for lowering the cap periodically to achieve the goals in subdivision 1 and interim goals recommended under paragraph (a)." Minn. Stat. 216H.02, subd. 5(b). Accordingly, the cap-and-trade should set an initial cap at 2007 emission levels, with gradual annual reductions to achieve the statutory goals of at least 15% below 2005 levels by 2015, 30% below 2005 levels by 2025, and 80% below 2005 levels by 2050. (The cap may need to be adjusted from these levels to compensate for emissions from non-covered sectors if projections show those sectors are likely to fall short of or exceed the target reductions.)

Timing: The cap-and-trade should be implemented as soon as possible, to prevent significant increases above current emissions in the meantime and to maximize the time available to meet the 2015 target. In the event that good historical emissions data are available from some but not all covered sectors, a phased approach can be used, or other policies can be used to address these other sectors and sources (such as transport).

In phased approaches traditionally regulated stationary sources with good emissions data are included in the first phase of the program, which also includes mandatory reporting from sources planned to be covered in future phases. This allows a relatively quick program start and a ramp-up of the administrative, governance and financial functions of the program. It also achieves greater emissions reductions progress over time by capping a limited number of large sources early.

Complimentary policies play a critical role in reducing the level of emissions that need to be covered by a cap and trade program, and by reducing emissions directly (e.g. appliance efficiency standards, vehicle efficiency standards, etc.). In the process they can also reduce the costs of cap and trade compliance by encouraging low cost emissions reductions through removal of non-price or price barriers to energy efficiency, renewables and other actions. Cap and trade programs are typically considered a means of ensuring full attainment of sector-based or economy wide caps on emissions, or as enhanced methods of providing flexibility to compliance.

The feasibility of specific program start dates has not been closely examined here. The MCCAG recommends further study of the cap and trade option at the state level and regionally through the MGA initiative. Program timing will need to be examined by both groups. The MCCAG encourages an early program start for first phase sources, such as 2010, to allow time for emitters and regulators to prepare for the program, and still allow five years under the program to achieve reductions toward the 2015 goal.

Other Key Design Variables:

Geographic Coverage: The MCCAG recommends that geographic scope of the program be at a minimum Midwest regional, including the Partners in the MGA initiative (MN, WI, IL, KS, IA, MI and Manitoba). The MCCAG further recommends that linkages with other regional programs such as WCI and RGGI be encouraged and inter-regional program mergers be studied.

The MCCAG recommends against the creation of a Minnesota-only cap and trade program. The MCCAG found that as a general rule larger programs broaden access to lower-cost emission reductions opportunities, thereby reducing the overall cost of achieving the targeted reductions.

The MCCAG has found that Minnesota can achieve its GHG cap and trade reduction goals at lower cost through a Midwest regional approach than as a single state. The MCCAG also sees other benefits through regional action, including significantly greater overall emission reductions, a more powerful voice during deliberations on a potential national program and an early opportunity to work out these complex issues in a manner that is most supportive of the special needs of the Midwest prior to the implementation of a federal program. However, the MCCAG has also found that the implementation of a national program could be far preferable to a state or regional program. The Minnesota goal should be to work fervently toward the quick passage of an appropriate national program that would assimilate the regional effort.

The Cap and Trade TWG studied a Minnesota-only program, consistent with the requirements of Subd. 5(b) of Minnesota Statute 216H.02. Modeling indicates that the cost of CO_2 emission reductions sufficient to meet the state goals across all economic sectors under a Minnesota-only cap and trade program in 2025 compares unfavorably with all regional programs studied.

The Cap and Trade TWG is also examining the impact of a likely national program on Minnesota, pursuant to the requirements of statute.

Sectors and Sources Covered: The MCCAG recommends that the electric power sector, large industrial boilers and processes, transportation fuels and landfills be included in the cap and trade program. The Cap and Trade TWG also favors the inclusion of municipal waste incinerators and fossil fuel for residential and commercial use, however at least one member strongly objects to the inclusion of natural gas for residential and commercial use. The TWG is still considering whether large livestock operations (CAFOs) ought to be included in the program.

Information provided by the PCA indicates that the 700 currently-regulated stationary sources in the power generation, industrial and commercial sectors release approximately 54 million tons of CO_2 annually. Within these sectors the electric power (41.5M tons) and industrial (11M tons) sectors are by far the largest contributors. But across all three sectors the largest ten percent of all sources – 70 facilities – release approximately 95 percent of the total emissions. The annual emissions threshold above which these 70 facilities operate is 44,000 tons per year. If fossil fuels are part of the program as proposed by the TWG, the remaining 630 regulated sources and all unregulated sources would also be included indirectly.

A cap-and-trade program that limited and reduced emissions from the recommended sectors could make substantial progress toward achieving the state's goal. In addition, the scope of

coverage of a cap and trade program is substantially affected by the level of existing and future policies and measures using other mechanisms. It also will be affected by numerous interactions of design feasibility and performance (see later discussion).

Pollutants Covered: Most attention in other cap-and-trade programs has been focused on carbon dioxide, which represents 84% of all GHG emissions in the United States from human sources. Of this all but 2% are released as a direct result of the combustion of coal, petroleum and natural gas. Other gases, such as methane, tend to be sector-specific. Landfills and agricultural operations release significant quantities of methane, which ton-for-ton is 21 times as powerful a GHG as CO_2 over a 100-year time span. Much work has been done to standardize the greenhouse effect-forcing potential of the major gases so it is possible to regulate more than one gas under the same cap-and-trade program. The program should cover all six GHGs listed in the statute (CO_2, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) from the covered sectors. It also can include carbon sequestration as a part of CO2 emissions.

Flexibility and cost containment mechanisms: These could include any combination of offsets, banking, borrowing, credit for early action, baseline protection, adjustment of cap levels or timing, safety valves, price caps, or other means. Offsets are of particular importance, potentially. Offsets are out-of-sector emissions reductions or carbon sequestration projects that are recognized by the program as qualifying for allowance credit. By definition offsets must be measures that are not required by the program and in most cases they cannot be required by any emissions reduction program. They provide an incentive for low-cost investments in emissions reductions as an alternative to higher-cost in-sector reductions or allowance purchases. Offsets should be subject to stringent standards to ensure their environmental integrity, and limited to ensure that the overwhelming majority of emission reductions come from covered sectors.

Integration with complementary policies and measures: As noted above the level and type of complimentary measures and the means by which they are integrated can substantially affect the performance of a cap and trade program.

Point of Regulation: The point of regulation is the entity responsible for acquiring and surrendering allowances for emissions. In some sectors, such as major industrial emissions, this is simply the entity operating the facility from which the emissions are released. But for other sectors it is either impractical or undesirable to use this approach. The MCCAG recommends the following point of regulation for each covered sector. 1) Electric Power Sector: A load-based, 'first-seller' or some other hybrid system is recommended in order to capture the substantial emissions resulting from in-state consumption of imported electricity. 2) Large Industrial Boilers and Processes, Waste Incinerators and Landfills: A production-based system regulating direct emissions from each source is recommended. For waste incinerators the regulated emissions would be limited to the fossil fuel component of the emissions. 3) Transportation Fuels and Fossil Fuels for Residential and Commercial Buildings: An indirect or 'upstream' system is recommended, requiring allowances from the entity importing the fuel into the Minnesota market. If a fuel used by a facility that is regulated on a production basis has been covered 'upstream', any allowance applied upstream should be credited against the facility operator's obligation.

Distribution of Allowances: There are two basic models: 1) free distribution to covered sources on some basis such as historical emissions (grandfathering); or 2) auction at the market price, requiring covered sources to purchase the allowances. It should be pointed out that these options are not mutually exclusive, and a blend of both auction and free distribution is possible. The Cap-and-Trade TWG is modeling using both methods. If allowances are auctioned, with proceeds collected by the state, these funds could be used to a) finance energy efficiency programs, b) promote development of sustainable low-carbon energy sources, c) assist low-income energy consumers, d) help any workers harmed by the transition away from high-carbon technologies, and e) provide rebates to consumers to offset the cost of the program. **[TBD]**

Implementation Mechanisms

Market based programs include a variety of potential approaches that stimulate market demand for emissions reductions, market supply of emissions reduction actions, and implementation flexibility. Cap and trade is one such program. It is designed to create market demand for emissions reductions by establishing a regulatory limit on emissions, stimulating market supply by providing trading opportunities among entities, and providing various flexibility mechanisms to contain costs. The Cap and Trade TWG is also examining performance-based market approaches in addition to the cap and trade.

Related Policies/Programs in Place

A wide array of existing policies and measures are in place in Minnesota. New and expanded policies and measures are being recommended through this effort. These will have a substantial interactive effect on a cap and trade program and vice versa. The MCCAG views the cap and trade and the other recommended policies and measures within each capped sector as 'overlapping.' The role of the cap and trade program is therefore seen as reinforcing the implementation of policies needed to reach the target, or expanding the level of effort needed to reach the target. These policy areas include efficiency and conservation, renewable energy, transportation fuels and efficiency, waste management, and industrial process.

Type(s) of GHG Reductions

All 6 statutory GHGs (CO_2, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride).

Estimated GHG Reductions and Net Costs or Cost Savings

Model scenarios for multi state options include:

- MGA Partners C&T
  (All Sectors)
- MGA Partners+Observers C&T
  (All Sectors)

- MGA Partners plus WCI Partners C&T
  (All Sectors)
- MGA Partners+Observers plus WCI Partners+Observers C&T
  (All Sectors)
- MGA Partners C&T
  (Power Sector)
- MGA Partners+Observers C&T
  (Power Sector)
- Minnesota only
  (All Sectors)
- All 50 states (TBD)

Currently, we have limited data on mitigation/sequestration options for other Midwestern States. Preliminary results given below may change significantly when better data are available.

The preliminary cap-and-trade simulations yield the following model outputs and results:

Model outputs:

- Permit price, volume and distribution on states and sectors
- Total cost and per ton cost of compliance
- Cost savings for each state of joining the Cap and Trade mechanism
- Comparison of the scenario effects of: Targets, timing, state coverage, sectoral coverage, allocation methods, flexibility mechanisms, cost curves, emissions baselines, trade/no trade, level of complimentary measures, and market concentration

Summary of model results:

1. The factors that have the greatest influence on all simulations are the absolute levels and the relative levels of the marginal mitigation/sequestration cost curves. The former has the greatest influence on the potential for cost savings, while the latter has the greatest influence on the variation across states, including whether each state is a permit buyer or seller.

2. The power sector scenario indicates a lower per unit cost of compliance compared with the economy-wide scenario for MGA states simulations. This is reflected in relatively lower permit prices of trading in the power sector only simulations. One possible explanation is that economies of scale in mitigation of carbon in the electric power are greater than found in other sectors for these states.

3. For both the economy-wide and power sector only scenarios, the permit price goes up if the three observer states join the MGA cap and trade program, since on average the observers have higher mitigation costs compared with the MGA partner states.

4. Minnesota is a permit buyer in the simulations of all the geographic configurations except for the low cost case simulation with all MGA and WCI partners and observers. However, in this simulation case the amount of permit Minnesota sells is minimal. The biggest seller in the WCI simulations is California. The biggest seller in the MGA States simulations is Illinois. California is also the biggest seller in the simulations that include both WCI and MGA states. Kansas is the biggest permit buyer among the MGA states.

5. In the economy-wide simulations, the permit price is lowest for the case of trading among MGA and WCI partners. Including WCI observer states will increase the permit price. These results indicate that MGA states (not including the observers) have overall higher mitigation/sequestration costs than the WCI partners, but lower costs than the WCI partners plus observers. As a permit buyer, Minnesota would be better off joining the WCI trading market with only the eight partners, because it can buy permits at a lower price than in other configurations.

6. In the Minnesota only simulation, the model was run for trading among four major sectors within Minnesota (Power Sector, Transportation Sector, Sequestration Sector, and Other Sector). The simulation results show that Power Sector and Other Sector will buy permit from the Transportation Sector and Sequestration Sector. The sectoral trading equilibrium permit price is $50.10/tonCO2e, which is consistent with the marginal cost level if MN undertakes all mitigation on its own.

Table of Model Results for Multi State and MN-only Cap and Trade Scenarios

Option No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value (Million $)	Cost-Effectiveness* ($/tCO2e) 2025	Permit Price† ($/tCO2e) 2025	Level of Support
		2015	2025	Total (2008–2025)				
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~~C&T-2~~	MN-Only C&T (merged into C&T-1)		80.83			$8.35	$50.10	
~~C&T-3~~	National C&T (merged into C&T-1)							

Data Sources:

Marginal cost curves for states and provinces are developed directly based on assessment of: 1) state level actions developed through state and provincial planning processes in: Arizona, Colorado, Montana, New Mexico, and Washington (developed based on mitigation costs of individual policy options presented in CCS reports or other assessments of the respective State Climate Change Action Plans) or 2) by approximation methods for other states using a parametric shift method based on cost curves from states with actual data. We developed the marginal cost curves of other Western states based on New Mexico actual cost data. We developed the marginal cost curves of Midwestern states based on Minnesota actual cost data. No direct cost curve data is available for other Midwestern states at present.

Emission projections data comes from: 1) CCS inventory and forecast studies of respective states, or 2) publicly available data from EIA *Annual Energy Outlook 2007* and Natural Resources Canada *Canada's Energy Outlook 2006* for states lacking detailed bottom up assessments.

Quantification Methods:

In this study, a non-linear programming model of emission allowance trading is used. This model is based on the well established principles of the ability of unrestricted permit trading to achieve a cost-effective allocation of resources in the presence of externalities.[1] The model requires equalization of marginal cost of all trading participants with the equilibrium permit price. This ensures minimization of total net compliance costs for each state and minimization of total abatement costs for the cap-and-trade program as a whole.[2]

Key Assumptions:

The purpose of this study is to illustrate the economic impacts of a cap and trade program to Minnesota under particular design scenarios. It does not intend to define the final details of a prospective cap and trade regulatory program, but rather stands ready to model any design configuration proposed by the TWG.

Current assumptions and results are draft and preliminary.

All emissions considered are consumption-based and are gross emissions (excluding sinks).

The economic modeling conducted in this study helps to analyze the potential GHG reductions and associated cost for Minnesota under several scenarios of different design configurations

[1] See, for example, T. Tietenberg, 1985. *Emissions Trading: An Exercise in Reforming Pollution Policy*, Washington, DC, Resources for the Future.

[2] See, for example, B. Stevens, and A. Rose, 2002. "A dynamic analysis of the marketable permits approach to global warming policy: A comparison of spatial and temporal flexibility," *Journal of Environmental Economics & Management* 44(1):45–69; A. Rose, T. Peterson, and Z. Zhang, 2006. "Regional Carbon Dioxide Permit Trading in the United States: Coalition Choices for Pennsylvania," *Penn State Environmental Law Review* 14(2):203–229.

using following variables: targets, timing, state coverage, sectoral coverage, allocation methods, flexibility mechanisms, cost curves, emissions baselines, trade/no trade, level of complimentary measures, market concentration.

A full discussion of all the assumptions is underway within the TWG, and will continue as the model and data are refined.

Key Uncertainties

A number of design variables and the quality of data for cost curves and emissions projections can affect permit prices, volume and distribution including: targets, timing, state coverage, sectoral coverage, allocation methods, flexibility mechanisms, cost curves, emissions baselines, trade/no trade, level of complimentary measures, market concentration.

Additional Benefits and Costs

In addition to direct cost of compliance and GHG emissions reductions other potential impacts are possible on labor, value added, income, market share of industries, energy independence, energy prices, air quality, and other environmental or economic outcomes.

Feasibility Issues

A number of technical feasibility issues relate to cap and trade program implementation, including transaction cost, point of regulation, etc.

Status of Group Approval

Pending—[until MCCAG moves to final agreement at meeting #6 or #7]

Level of Group Support

TBD—[blank until MCCAG meeting #6 or #7]

Barriers to Consensus

TBD

C&T-4. Carbon Tax

Policy Description

A carbon tax sets a fee, or tax, for the release of carbon to the atmosphere. It does not set a limit, reduce or otherwise control the tons of carbon released. The tax raises the cost of carbon-based emissions and therefore encourages investment in low-carbon or no-carbon alternatives. It also generates revenue for the government which could be directed toward energy efficiency, the development and use of renewable energy, climate change adaptation investments and other measures to mitigate or address the impacts of climate change. A carbon tax could be implemented as a tax on fossil fuels according to the amount of CO_2 emitted by their combustion. One of the benefits is that it can be more easily applied across all sectors.

It is assumed that the cost of the tax would be passed down to the ultimate consumer, such as residential and commercial utility ratepayers for electricity. In order to achieve the stated goal, the amount of the tax must be high enough to trigger financial and behavioral decisions toward conservation or a shift to lower emitting fuels.

Policy Design

Goals: Make the cost of inefficient or higher CO_2 emitting activities more expensive than alternatives, thereby creating a financial incentive to change behavior away from activities that result in CO_2 emissions. The tax should include safety valves to reduce low-income impact and minimize detrimental economic consequences. One option is to make the tax "revenue neutral," (an equal amount of other state taxes would be reduced so that the "net" to the state is zero); or the revenue from the tax could be used to develop or promote alternatives that reduce CO_2 emissions. The amount of the tax should be high enough to contribute to the reduction targets specified in statute.

Timing: TBD—[as needed and approved by the TWGs]

Parties Involved: Major payers would be utilities that generate or distribute electricity in Minnesota; refiners or distributors of transportation and heating fuels in Minnesota; and commercial and industrial sources creating energy for production or other commercial use.

Other: N/A

Implementation Mechanisms

This option requires legislation and the creation or expansion of administrative tax collection and enforcement capabilities.

Related Policies/Programs in Place

None.

Type(s) of GHG Reductions

Reductions in emissions of carbon dioxide from combustion sources.

Estimated GHG Reductions and Net Costs or Cost Savings

TBD—[as needed and approved by the TWGs]

Data Sources:
TBD—[as needed and approved by the TWGs]

Quantification Methods:
TBD—[as needed and approved by the TWGs]

Key Assumptions:
TBD—[as needed and approved by the TWGs]

Key Uncertainties

TBD—[as needed and approved by the TWGs]

Additional Benefits and Costs

TBD—[as needed and approved by the TWGs]

Feasibility Issues

TBD—[as needed and approved by the TWGs]

Status of Group Approval

Pending—[until MCCAG moves to final agreement at meeting #6 or #7]

Level of Group Support

TBD—[blank until MCCAG meeting #6 or #7]

Barriers to Consensus

TBD

C&T-5. Market Advisory Group (Formerly CC-11)

Policy Description

The CC TWG recommends that Minnesota create a "Market Advisory Group" consisting of experts to provide guidance to the state on the design of market-based compliance programs to manage GHG emissions. The State of California has formed a Market Advisory Committee (MAC) to help formulate a GHG cap-and-trade system in California. The California MAC has formulated a set of guiding principles and has developed an initial set of recommendations for a California Cap-and-Trade program. It is recommended that Minnesota convene a similar "Market Advisory Group" to receive the policy recommendations of the MCCAG and provide expert guidance to the state on the design of a Minnesota market-based compliance program to manage GHG emissions.

Policy Design

Goals: The Cap-and-Trade TWG and the MCCAG expect to recommend the creation of a cap-and-trade program to help manage GHG emissions. This recommendation will contain policy guidance in the areas of jurisdictional coverage, sector coverage, timing, allowance distribution, safety valve, offsets and possibly others. Before a program can be implemented, however, this guidance must be refined into a detailed program design. The appointment of a Market Advisory Group is recommended for this purpose.

Timing: In order to provide the earliest possible guidance to covered sectors the Market Advisory Group should be appointed as soon after the MCCAG recommendation for a cap-and-trade program is accepted by policy makers.

Parties Involved: Unlike the MCCAG, which is stakeholder-driven, the Market Advisory Group should be comprised of individuals with particular expertise in key areas such as economics, markets, climate science and policy, cap-and-trade programs in other jurisdictions or for other pollutants, key covered sectors, finance, etc.

Other: The committee should encourage public comment throughout their deliberations.

Implementation Mechanisms

The Market Advisory Group could be created by executive order or by legislative act, and should serve for a limited time. The product of the Market Advisory Committee's deliberations should be a report or reports recommending in some detail the scope, design and plan for implementation of the Minnesota cap-and-trade program.

Related Policies/Programs in Place

None currently; however, MCCAG Policy Options C&T-1, Cap-and-Trade Program, CC-7 (Participate in Regional or Multi-State GHG Reduction Efforts), CC-10 (Facilitate the Development of an Effective Carbon Credit System for Minnesota), and possibly C&T-4 (Carbon Tax) could all be related to the creation of a Market Advisory Group.

Type(s) of GHG Reductions

TBD—[as needed and approved by the TWGs]

Estimated GHG Reductions and Net Costs or Cost Savings

TBD—[as needed and approved by the TWGs]

Data Sources:

TBD—[as needed and approved by the TWGs]

Quantification Methods:

TBD—[as needed and approved by the TWGs]

Key Assumptions:

TBD—[as needed and approved by the TWGs]

Key Uncertainties

TBD—[as needed and approved by the TWGs]

Additional Benefits and Costs

TBD—[as needed and approved by the TWGs]

Feasibility Issues

TBD—[as needed and approved by the TWGs]

Status of Group Approval

Pending—[until MCCAG moves to final agreement at meeting #6 or #7]

Level of Group Support

TBD—[blank until MCCAG meeting #6 or #7]

Barriers to Consensus

TBD

C&T-6. Participate in Regional and Multi-State GHG Reduction Efforts (Formerly CC-7)

Policy Description

Regional approaches undertaken in collaboration with partner states or other organizations can offer broader and more economically efficient opportunities to reduce GHG emissions across Minnesota's economy. There are several options for regional, market-based GHG reduction strategies which should be considered in Minnesota such as: joining the Western Climate Initiative (WCI), joining the Northeast States RGGI, or instituting a new Midwestern states GHG initiative. Additional examples might include consideration of the California vehicle standards, cost sharing on multistate initiatives, etc.

Policy Design

Goals: Ensure the cost effective reduction of GHG emissions to at least the reduction levels set forth in Minnesota statute, in a manner that maximizes public benefits and induces innovation in energy efficiency and sustainable energy technologies and avoids inequitable impacts.

Timing: By February 1, 2008, the Administration must report to the legislature on its investigation into regional GHG reduction opportunities. By August 1, 2009 Minnesota should either join an existing GHG reduction initiative or institute and join a new Midwestern states GHG initiative that will ensure that Minnesota achieves the goal, as stated above.

Parties Involved: The Governor and administration staff should implement the legislative directive (see below) and inform the chairs and ranking minority members of the legislative committees with jurisdiction over energy and environmental finance and policy.

Other:

Implementation Mechanisms

Next Generation Energy Act, S.F. No. 145, Article 5, Sec. 2, Subd. 6 (Regional activities). The state must, to the extent possible, with other states in the Midwest region, develop and implement a regional approach to reducing GHG emissions from activities in the region, including consulting on a regional cap-and-trade system.

Related Policies/Programs in Place

Next Generation Energy Act, S.F. No. 145, Article 5, Sec. 2, Subd. 6 (Regional activities). See above.

Type(s) of GHG Reductions

Not applicable.

Estimated GHG Savings and Costs per $MtCO_2e$

Not applicable.

Key Uncertainties

Joining another regional entity should not compromise the achievement of Minnesota's goal.

Additional Benefits and Costs

There will be additional environmental and economic co-benefits associated with the state's participation in a regional GHG emission reduction initiative that meets Minnesota's goals, including: the opportunity to reduce GHG emissions in economically efficient manner, the identification of additional areas for cooperation within specific sectors (e.g., transportation), and the reduction of other non-GHG pollutants associated with the production and use of energy.

Feasibility Issues

None cited at this time.

Status of Group Approval

Pending – [until MCCAG moves to final agreement at meeting #6 or #7]

Level of Group Support

TBD – [blank until MCCAG meeting #6 or #7]

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]

C&T-7. Facilitate the Development of an Effective Carbon Credit System for Minnesota (Formerly CC-10)

Policy Description

GHG reductions from a wide variety of sources and actors could potentially be undertaken in order to participate in offset programs or markets. Minnesota could develop an offset program as a state-led or private effort. Under this policy, the preferred approach is for entities to participate in an official state-recognized registry. However, for entities not covered by the registry, the policy should allow for offsets to be submitted as a way to opt in to GHG emission allowance markets or trading systems. Such offsets would be registered using approved protocols or (in the absence of protocols) an application for approval of specific projects on a case-by-case basis. The effectiveness of such offsets is likely to help determine their value and utility for participants. In particular, concerns about measurement, permanence, additionality, and enforceability must be resolved in the protocol-setting process; measures such as categorical exclusions and temporary credits for certain types of emission-reducing actions should be considered. However, the administrative burden and/or transaction costs that could be imposed could have a countervailing (dampening) effect, leading to an overall increase in costs.

Policy Design

Goals: Enable a wide range of quality offsets to be generated, preferably in Minnesota, with the applicability of such offsets to be determined as state, regional, national and international GHG reduction efforts continue to develop. Criteria for such an offset system in Minnesota might include those described in the cap-and-trade webinar (real, surplus (additional), verifiable, permanent and enforceable).

Timing: By January 1, 2009, establish an offset program including at least the major sectors for which existing GHG emission reduction protocols exist or are developed for use by Minnesota entities. To the extent that Minnesota's participation in *The Climate Registry* will enable certain sectors and/or entities to participate in offset creation, those sectors and/or entities would not be included in the separate offset program under this policy.

Parties Involved: Minnesota Department of Commerce and Minnesota Pollution Control Agency along with other appropriate partners. The offset program tracking and administration could be formed with the same agency structure as envisioned for the State's participation in the Climate Registry. A stakeholder and public comment process should be employed during 2008 to determine types of offsets and relevant protocols for inclusion.

Other: Consider a State purchase of offsets using an RFP process to jump start the market, versus strong advocacy for rapid development of national or regional offset systems.

Implementation Mechanisms

Legislative authorization for the agency-based offset program including funding for staff and associated stakeholder process. Consider need for protocol development, approval processes such as applications or third party verification, and possible participant funding for protocols and/of verification.

Related Policies/Programs in Place

Climate inventories and registries; county or municipal offset efforts.

Type(s) of GHG Reductions

Wide variety, including forestry and land use, process and end use efficiency, innovative technologies (hybrid vehicle conversions etc.).

Estimated GHG Savings and Costs per $MtCO_2e$

Basically unknown at this time. Note that offsets, if sold to out of state emission markets with binding regulatory regimes such as the EU, could be used by others and such offsets would not lead to overall emission reductions. Only emissions that are recorded and retired permanently in Minnesota or sold into voluntary emission markets such as the Chicago Climate Exchange are actually 'real and additional' GHG reductions. Concerns over the permanence of land use and other behaviors introduce further uncertainty, as does the permissibility of offsets for use in a potential mandatory GHG emission reduction program.

Key Uncertainties

Willingness of Minnesota actors to undertake offset investments.

Stringency of offset accounting and resulting quality of offsets.

Ties to external markets and pricing.

Public (agency) versus private (non profit or business) oversight and program administration.

Additional Benefits and Costs

Probably unquantifiable co-benefits from emission reduction actions.

Benefits for actors to develop GHG accounting, option evaluation, and institutional infrastructure to facilitate GHG emission reduction efforts.

Potential to pave the way for other policies.

Feasibility Issues

Time and resources to develop offset program and any required protocols, verification etc.

Status of Group Approval

Pending – [until MCCAG moves to final agreement at meeting #6 or #7]

Level of Group Support

TBD – [blank until MCCAG meeting #6 or #7]

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]

Multi State Cap and Trade

1. A full list of assumptions we adopted in our simulation model is summarized as follows:

Geographical Configurations:

- W1: WCI partners — Arizona, California, New Mexico, Oregon, Utah, Washington, British Columbia, and Manitoba
- W2: WCI partners and five observers — Arizona, California, New Mexico, Oregon, Utah, Washington, British Columbia, and Manitoba plus Colorado, Idaho, Montana, Nevada, and Wyoming
- M1: Midwestern C&T partners — Iowa, Illinois, Kansas, Michigan, Minnesota, Wisconsin, and Manitoba
- M2: Midwestern C&T partners and observers — Iowa, Illinois, Kansas, Michigan, Minnesota, Wisconsin, and Manitoba plus Indiana, Ohio, and South Dakota

Economy Wide Cap and Trade Cases:

Case I: High Cost Case:

- the simulation target year is 2025
- all sectors are included in the emission accounting and mitigation effort
- all GHG emissions are considered
- all gross emissions (excluding sinks) are considered
- all emissions are consumption-based
- emission data for WCI states (and provinces) come from CCS inventories and forecasts studies for respective states; emission projections in 2025 are estimated based on the assumption that the annual growth rate between 2020 and 2025 is the same as the annual growth rate between 2005 and 2020 projected by CCS
- emission projections in 2025 for Midwestern states are calculated based on EIA regional projected emission growth rates: Iowa, Kansas, Minnesota, and South Dakotas belong to West North Central Region; Indiana, Illinois, Ohio, Michigan, and Wisconsin belong to East North Central Region.
- emission projections in 2025 for the two Canadian provinces come from *Canada's Energy Outlook 2006* by Natural Resources Canada; again we assume a same annual growth rate of total emissions in 2020-2025 as in 2005-2020.
- offsets are not included
- no safety valve (permit price limit) is included
- marginal cost curves embody direct mitigation costs only
- marginal cost curves do not include various transactions costs
- marginal cost curves do not distinguish between producer vs. consumer allocation of permits
- marginal cost curves of Arizona, New Mexico, Colorado, Montana, Washington, and Minnesota are developed based on mitigation costs of individual policy options presented in CCS reports of the respective State Climate Change Action Plans

- marginal cost curves of other WCI states (province) are developed by a parametric shift method using New Mexico's marginal cost curve as a reference; marginal cost curves of other Midwestern states (province) are developed by a parametric shift method using Minnesota's marginal cost curve as a reference; the parametric shift rule assumes a direct relationship between the slope of the marginal cost and the carbon intensity of a state.
- in order to run simulations including both MGA and WCI states in year 2025, we used 2020 marginal cost curves for WCI states for the year 2025; we also assumed that the same emission cap in year 2025 (30% below the 2005 level) for MGA states applies to WCI states as well

Case II: Low Cost Case:

- same assumptions as for Case I, except:
- since three policy options in the Energy Supply sector of Minnesota have more than one sensitivity scenario, we developed marginal cost curves for both high and low cost cases. In the high cost case, we used the highest cost scenario for each of the three options. In the low cost case, we used the lowest cost scenario for each option.
- marginal cost curves for other Midwestern states are developed based on both Minnesota's high and low cost curves

Power sector only Cap and Trade Cases:

- same assumptions as for Economy Wide runs, except:
- emission caps are for power sector only, i.e., only power sector is committed to reduce 2025 baseline emission to 30% below the 2005 level.
- power sector marginal cost curves of Arizona, Colorado, Montana, New Mexico, Washington, and Minnesota are developed based on policy options directly designed for electricity sector; marginal cost curves for other WCI states are developed using New Mexico's curve as a reference, which other Midwestern states are based on Minnesota's curve. We used an average curve of WCI partners for British Columbia and an average curve of Midwestern partners for Manitoba.
- emission projections in 2025 for Midwestern states are calculated based on EIA regional projected emission growth rates. Iowa, Minnesota, South Dakotas belong to MAPP region (Mid Continent Area Power Pool). Illinois belongs to MAIN region (Mid-America Interconnected Network). Indiana and Ohio belong to ECAR region (East Central Area Reliability Coordination Agreement). Kansas belongs to Southwest Power Pool region (SPP). Part of Michigan belongs to ECAR region and part in MAIN. Part of Wisconsin is in MAIN and part in MAPP. Weighted average regional growth rates are applied for Michigan and Wisconsin.

2. The model yields the following general results:

- GHG emission reductions for each state before and after permit trading
- Cost of GHG emission reductions for each state before and after trading
- Auction value of permits (some cases)
- Number of permits traded (bought and sold) by each state
- Equilibrium permit price
- Cost savings for each state of joining the Cap and Trade mechanism

Multi State Cap and Trade Simulations

TABLE M1-2025 (High). ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading			Cost Saving	Permits Traded	Emission Reduction w/ Trading		Emission Reduction Goal
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2)	(million tCO_2)	(percent from BAU)	(percent from BAU)
IA	407	-33	363	330	77	7.95	46.43	37.27	43.65
IL	35	752	-830	-78	113	-18.17	140.24	43.86	38.18
KS	529	-312	577	265	263	12.63	39.57	33.09	43.65
MI	37	230	-203	28	9	-4.44	107.75	39.82	38.18
MN	433	261	164	425	9	3.59	77.24	41.19	43.10
WI	20	239	-240	0	21	-5.25	67.04	41.42	38.18
MB	214	-46	169	122	91	3.69	9.45	34.55	48.04
Total	1,675	1,091	0	1,091	584	27.86[b]	487.73	40.27	40.27

[a] Permit Price = \$45.68/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$3.37/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 41.19% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

TABLE M1-2025 (Low). ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading			Cost Saving	Permits Traded	Emission Reduction w/ Trading		Emission Reduction Goal
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2)	(million tCO_2)	(percent from BAU)	(percent from BAU)
IA	295	-92	318	226	69	7.84	46.54	37.36	43.65
IL	-87	537	-724	-187	100	-17.84	139.92	43.76	38.18
KS	383	-351	502	152	232	12.38	39.83	33.30	43.65
MI	-91	81	-181	-100	9	-4.47	107.78	39.83	38.18
MN	305	149	148	297	8	3.64	77.19	41.16	43.10
WI	-50	142	-211	-68	18	-5.19	66.99	41.39	38.18
MB	173	-57	148	91	82	3.65	9.50	34.71	48.04
Total	928	410	0	410	518	27.50[b]	487.73	40.27	40.27

[a] Permit Price = \$40.58/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$1.93/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 41.16% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

TABLE M2-2025 (High). ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG
NINE MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
IA	407	50	309	359	48	6.20	48.17	38.67	43.65
IL	35	1,027	-1,193	-166	201	-23.94	146.01	45.67	38.18
KS	529	-249	564	315	214	11.31	40.90	34.19	43.65
MI	37	433	-433	0	37	-8.68	111.98	41.39	38.18
MN	433	408	25	433	0	0.50	80.33	42.84	43.10
WI	20	368	-396	-28	48	-7.94	69.73	43.09	38.18
MB	214	-31	168	137	77	3.36	9.79	35.76	48.04
IN	65	-560	552	-8	74	11.07	108.35	34.64	38.18
OH	67	-88	151	63	4	3.02	144.05	37.40	38.18
SD	271	-95	254	159	112	5.10	15.95	34.26	45.20
Total	2,078	1,264	0	1,264	814	40.55[b]	775.27	39.64	39.64

[a] Permit Price = \$49.85/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$5.08/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 42.84% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

TABLE M2-2025 (Low). ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG NINE MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
IA	295	-21	273	252	43	6.17	48.20	38.70	43.65
IL	-87	772	-1,034	-262	175	-23.39	145.46	45.49	38.18
KS	383	-297	492	194	189	11.11	41.09	34.36	43.65
MI	-91	253	-377	-124	33	-8.53	111.84	41.33	38.18
MN	305	275	30	305	0	0.67	80.15	42.74	43.10
WI	-50	252	-344	-92	42	-7.77	69.57	42.98	38.18
MB	173	-43	147	104	69	3.33	9.82	35.87	48.04
IN	-162	-692	469	-223	62	10.60	108.82	34.79	38.18
OH	-165	-290	123	-168	3	2.78	144.30	37.46	38.18
SD	208	-114	222	108	99	5.02	16.03	34.42	45.20
Total	809	94	0	94	716	39.69[b]	775.27	39.64	39.64

[a] Permit Price = \$44.23/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$3.43/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 42.74% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

TABLE M1W1-2025 (High). ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES, SIX WESTERN STATES, AND TWO CANADIAN PROVINCES IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
AZ	133	-1,402	1,005	-398	531	25.37	94.07	49.69	63.09
CA	947	4,171	-4,338	-167	1,114	-109.54	411.46	63.66	46.71
NM	853	-292	642	350	503	16.20	31.84	32.01	48.30
OR	260	429	-187	242	18	-4.72	50.27	54.19	49.10
UT	903	174	538	712	191	13.57	45.65	42.50	55.14
WA	2,574	-864	1,143	279	2,294	28.87	30.51	24.41	47.51
BC	158	106	50	156	2	1.26	33.62	41.53	43.09
IA	407	-145	418	273	134	10.56	43.81	35.17	43.65
IL	35	378	-372	6	29	-9.40	131.47	41.12	38.18
KS	529	-396	578	182	346	14.60	37.60	31.44	43.65
MI	37	-42	77	35	2	1.94	101.37	37.46	38.18
MN	433	61	327	389	45	8.26	72.56	38.69	43.10
WI	20	66	-47	19	1	-1.18	62.97	38.91	38.18
MB	214	-68	166	98	115	4.19	8.96	32.74	48.04
Total	7,502	2,177	0	2,177	5,325	121.64[b]	1,156.16	45.30	45.30

[a] Permit Price = \$39.60/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$4.58/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 42.35% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

TABLE M1W1-2025 (Low). ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG
SIX MIDWESTERN STATES, SIX WESTERN STATES, AND TWO CANADIAN PROVINCES IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
AZ	133	-1,451	1,005	-447	580	26.64	92.80	49.02	63.09
CA	947	3,820	-3,788	32	915	-100.46	402.38	62.25	46.71
NM	853	-313	631	319	534	16.75	31.30	31.47	48.30
OR	260	384	-135	250	10	-3.57	49.11	52.95	49.10
UT	903	136	549	685	218	14.57	44.65	41.57	55.14
WA	2,574	-879	1,103	224	2,349	29.26	30.12	24.10	47.51
BC	158	78	75	153	5	1.98	32.90	40.64	43.09
IA	295	-144	346	202	93	9.18	45.20	36.28	43.65
IL	-87	361	-504	-142	55	-13.36	135.43	42.36	38.18
KS	383	-390	505	115	269	13.39	38.82	32.46	43.65
MI	-91	-47	-45	-92	1	-1.20	104.51	38.63	38.18
MN	305	56	227	283	22	6.03	74.79	39.88	43.10
WI	-50	61	-117	-57	7	-3.11	64.90	40.10	38.18
MB	173	-67	147	80	93	3.90	9.25	33.79	48.04
Total	6,755	1,605	0	1,605	5,150	121.70[b]	1,156.16	45.30	45.30

[a] Permit Price = \$37.71/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$0.75/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 39.88% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

TABLE IM2W2-2025 (High). ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG NINE MIDWESTERN STATES, ELEVEN WESTERN STATES, AND TWO CANADIAN PROVINCES IN YEAR 2020

(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
AZ	133	-1,145	950	-195	329	19.53	99.91	52.77	63.09
CA	947	5,877	-7,211	-1,334	2,281	-148.33	450.25	69.66	46.71
NM	853	-181	665	484	369	13.69	34.36	34.54	48.30
OR	260	653	-478	176	84	-9.82	55.37	59.69	49.10
UT	903	373	440	813	90	9.05	50.17	46.71	55.14
WA	2,574	-784	1,315	531	2,042	27.06	32.33	25.86	47.51
BC	158	252	-99	152	6	-2.04	36.92	45.61	43.09
CO	8,996	-1,613	2,930	1,317	7,679	60.27	51.19	28.07	61.12
ID	86	197	-127	71	15	-2.61	22.87	49.15	43.55
MT	-167	-16	-221	-237	71	-4.54	16.46	39.72	28.75
NV	948	520	364	883	65	7.49	47.69	55.71	64.45
WY	2,662	-620	1,066	446	2,217	21.92	21.82	27.99	56.12
IA	407	25	326	351	56	6.72	47.66	38.26	43.65
IL	35	944	-1,081	-137	173	-22.25	144.32	45.14	38.18
KS	529	-268	569	301	228	11.70	40.51	33.87	43.65
MI	37	371	-361	10	27	-7.43	110.74	40.93	38.18
MN	433	364	68	432	1	1.40	79.42	42.35	43.10
WI	20	329	-348	-19	39	-7.15	68.94	42.60	38.18
MB	214	-35	168	133	81	3.46	9.69	35.40	48.04
IN	65	-612	589	-23	88	12.11	107.30	34.31	38.18
OH	67	-162	220	58	8	4.52	142.56	37.01	38.18
SD	271	-102	255	153	118	5.25	15.80	33.93	45.20
Total	20,431	4,366	0	4,366	16,064	204.17[b]	1,686.27	45.20	45.20

[a] Permit Price = \$48.61/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$4.58/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 42.35% below the baseline level in 2020 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

TABLE IM2W2-2025 (Low). ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG NINE MIDWESTERN STATES, ELEVEN WESTERN STATES, AND TWO CANADIAN PROVINCES IN YEAR 2020

(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
AZ	133	-1,225	975	-250	383	21.23	98.22	51.88	63.09
CA	947	5,366	-6,318	-952	1,898	-137.53	439.45	67.99	46.71
NM	853	-216	663	447	406	14.42	33.62	33.80	48.30
OR	260	585	-385	200	60	-8.38	53.92	58.13	49.10
UT	903	311	476	787	116	10.36	48.86	45.50	55.14
WA	2,574	-809	1,268	458	2,115	27.59	31.79	25.43	47.51
BC	158	206	-50	157	2	-1.08	35.97	44.43	43.09
CO	8,996	-1,649	2,804	1,155	7,841	61.04	50.42	27.65	61.12
ID	86	169	-92	77	9	-2.00	22.27	47.85	43.55
MT	-167	-34	-192	-226	59	-4.17	16.09	38.82	28.75
NV	948	460	402	862	86	8.75	46.43	54.23	64.45
WY	2,662	-636	1,023	387	2,276	22.26	21.48	27.56	56.12
IA	295	13	248	262	33	5.40	48.97	39.31	43.65
IL	-87	886	-1,191	-304	217	-25.92	147.99	46.29	38.18
KS	383	-271	484	213	170	10.53	41.68	34.85	43.65
MI	-91	337	-477	-140	49	-10.39	113.70	42.02	38.18
MN	305	336	-32	305	0	-0.69	81.51	43.47	43.10
WI	-50	305	-411	-106	56	-8.96	70.75	43.71	38.18
MB	173	-37	146	110	63	3.18	9.96	36.41	48.04
IN	-162	-621	415	-207	45	9.03	110.39	35.29	38.18
OH	-165	-189	25	-165	0	0.54	146.54	38.04	38.18
SD	208	-104	220	117	91	4.79	16.26	34.91	45.20
Total	19,162	3,185	0	3,185	15,977	198.44[b]	1,686.27	45.20	45.20

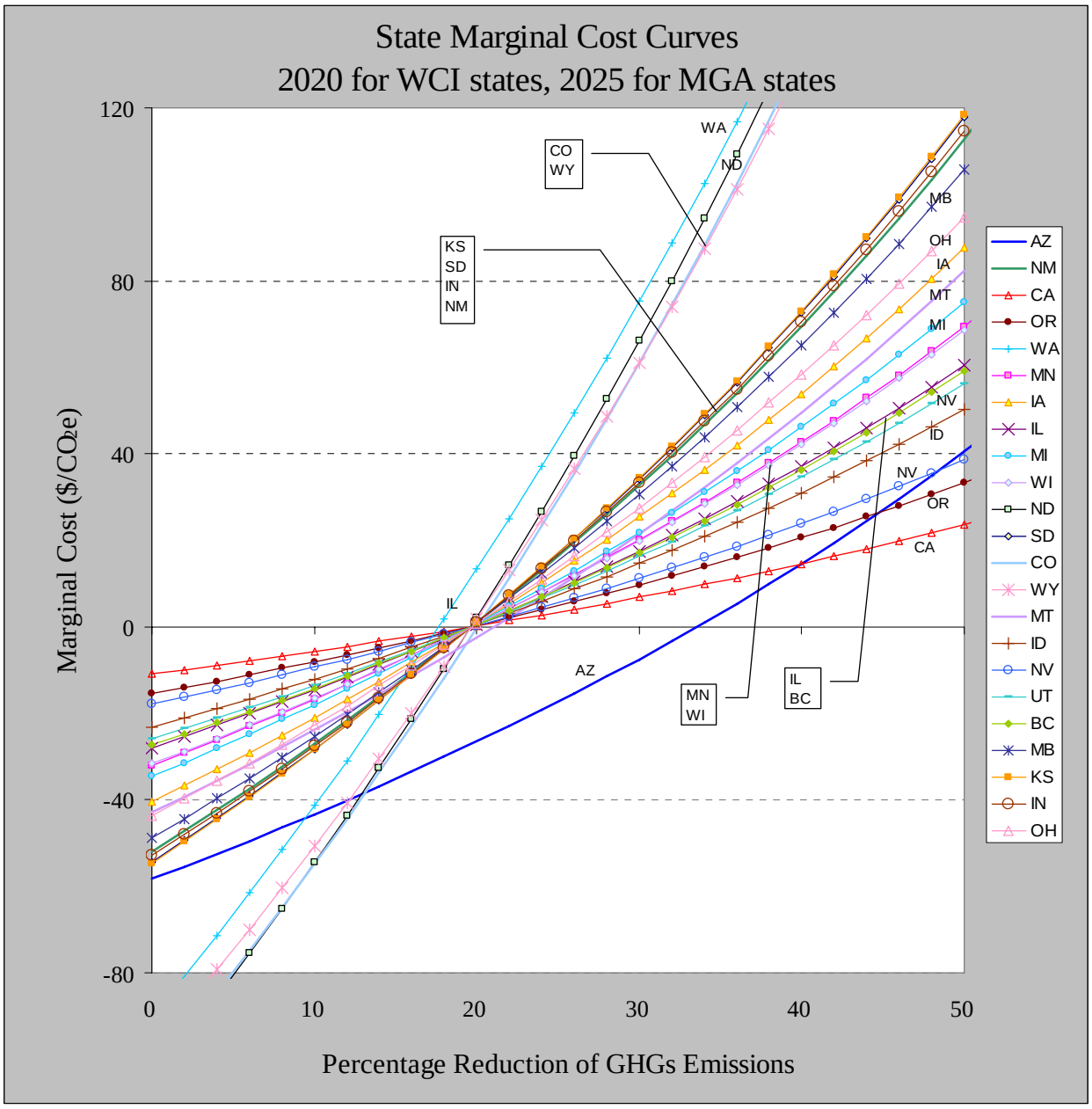
[a] Permit Price = \$45.94/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$4.13/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 43.47% below the baseline level in 2020 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

DATA TABLE

State	Cap: 30% Below 2005 Emissions in 2025 (million tCO_2e)	2025 BAU Gross Emissions (Consumption-based) (million tCO_2e)	GHG Mitigation Goal in 2025 (relative to BAU emissions)	Autarkic Marginal Mitigation Cost (dollars per tCO_2e)		Gross State Product in 2025 (million 2000 dollars)
				Low	High	
AZ	69.9	189.3	63.09%	83.7	83.7	481,628
CA	344.4	646.4	46.71%	20.5	20.5	2,923,222
NM	51.4	99.5	48.30%	104.7	104.7	94,564
OR	47.2	92.8	49.10%	32.2	32.2	297,081
UT	48.2	107.4	55.14%	69.0	69.0	204,725
WA	65.6	125.0	47.51%	208.8	208.8	471,781
BC	46.1	81.0	43.09%	43.0	43.0	146,610
CO	70.9	182.4	61.12%	332.3	332.3	563,455
ID	26.3	46.5	43.55%	37.5	37.5	98,835
MT	29.5	41.4	28.75%	18.4	18.4	41,520
NV	30.4	85.6	64.45%	66.6	66.6	236,707
WY	34.2	78.0	56.12%	268.9	268.9	39,577
IA	70.2	124.6	43.65%	65.5	58.5	206,621
IL	197.7	319.7	38.18%	33.4	29.6	768,315
KS	67.4	119.6	43.65%	88.6	79.1	146,593
MI	167.3	270.6	38.18%	41.4	36.7	524,088
MN	106.7	187.5	43.10%	50.5	45.1	392,084
WI	100.1	161.9	38.18%	37.9	33.5	342,743
MB	14.2	27.4	48.04%	97.2	87.1	37,581
IN	193.4	312.8	38.18%	63.3	56.0	396,501
OH	238.1	385.2	38.18%	52.4	46.4	590,200
SD	25.5	46.6	45.20%	95.1	85.1	57,361
Total	2,044.7	3,731.0	45.20%			9,061,793

Marginal Cost Curves for MGA and WCI states:



Note: Marginal cost curves of Midwestern states are developed based on MN 2025 curve. These curves are for the high cost scenario. The relative positions of state curves for the low cost scenario are the same, except all the curves shift downward slightly. Marginal cost curves of WCI states other than for AZ, CO, MT and WA are developed based on NM curve. These marginal cost curves are presented for a range of mitigation levels, including those higher than required to meet the cap in year 2025. We anticipate that there will be technology innovations in the future, i.e., the marginal cost curves will shift downward over time before higher levels of mitigation are necessary.

TABLE M1P-2025 (High). POWER SECTOR EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
IA	104	53	47	99	5	1.45	15.30	37.49	41.06
IL	160	370	-251	119	41	-7.82	44.60	54.12	44.63
KS	134	21	91	112	22	2.82	13.41	34.74	42.05
MI	88	254	-199	55	33	-6.19	34.98	48.12	39.60
MN	287	37	191	228	59	5.95	22.41	34.80	44.04
WI	205	67	117	184	21	3.63	22.07	36.84	42.90
MB	12	1	5	6	6	0.17	0.20	39.18	72.22
Total	990	803	0	803	187	14.02[b]	152.97	42.57	42.57

[a] Permit Price = \$32.14/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$1.64/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 34.80% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

TABLE M1P-2025 (Low). POWER SECTOR EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
IA	78	39	35	74	4	1.45	15.30	37.49	41.06
IL	119	276	-187	89	31	-7.82	44.60	54.12	44.63
KS	100	16	68	83	16	2.82	13.41	34.74	42.05
MI	66	189	-148	41	25	-6.19	34.98	48.12	39.60
MN	214	27	142	170	44	5.95	22.41	34.80	44.04
WI	153	50	87	137	16	3.63	22.07	36.84	42.90
MB	9	1	4	5	4	0.17	0.20	39.18	72.22
Total	737	598	0	598	139	14.02[b]	152.97	42.57	42.57

[a] Permit Price = \$23.93/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$1.22/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 34.80% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

TABLE M2P-2025 (High). POWER SECTOR EMISSION TRADING SIMULATION AMONG NINE MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
IA	104	66	35	102	2	1.04	15.71	38.50	41.06
IL	160	412	-309	103	57	-9.08	45.86	55.65	44.63
KS	134	33	84	117	17	2.48	13.76	35.64	42.05
MI	88	287	-244	43	45	-7.19	35.98	49.49	39.60
MN	287	56	183	238	49	5.37	22.99	35.70	44.04
WI	205	87	103	190	15	3.04	22.66	37.82	42.90
MB	12	1	5	6	6	0.16	0.20	40.25	72.22
IN	164	106	56	162	3	1.66	38.25	36.15	37.72
OH	229	137	87	224	5	2.57	52.24	35.95	37.72
SD	20	22	-1	20	0	-0.04	3.58	42.57	42.05
Total	1,403	1,205	0	1,205	198	16.32[b]	251.22	40.60	40.60

[a] Permit Price = \$33.98/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$2.43/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 35.70% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

TABLE M2P-2025 (Low). POWER SECTOR EMISSION TRADING SIMULATION AMONG NINE MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
IA	78	49	26	76	2	1.04	15.71	38.50	41.06
IL	119	307	-230	77	42	-9.08	45.86	55.65	44.63
KS	100	24	63	87	13	2.48	13.76	35.64	42.05
MI	66	214	-182	32	34	-7.19	35.98	49.49	39.60
MN	214	42	136	178	36	5.37	22.99	35.70	44.04
WI	153	65	77	141	11	3.04	22.66	37.82	42.90
MB	9	1	4	5	4	0.16	0.20	40.25	72.22
IN	122	79	42	120	2	1.66	38.25	36.15	37.72
OH	170	102	65	167	3	2.57	52.24	35.95	37.72
SD	15	16	-1	15	0	-0.04	3.58	42.57	42.05
Total	1,045	898	0	898	147	16.32[b]	251.22	40.60	40.60

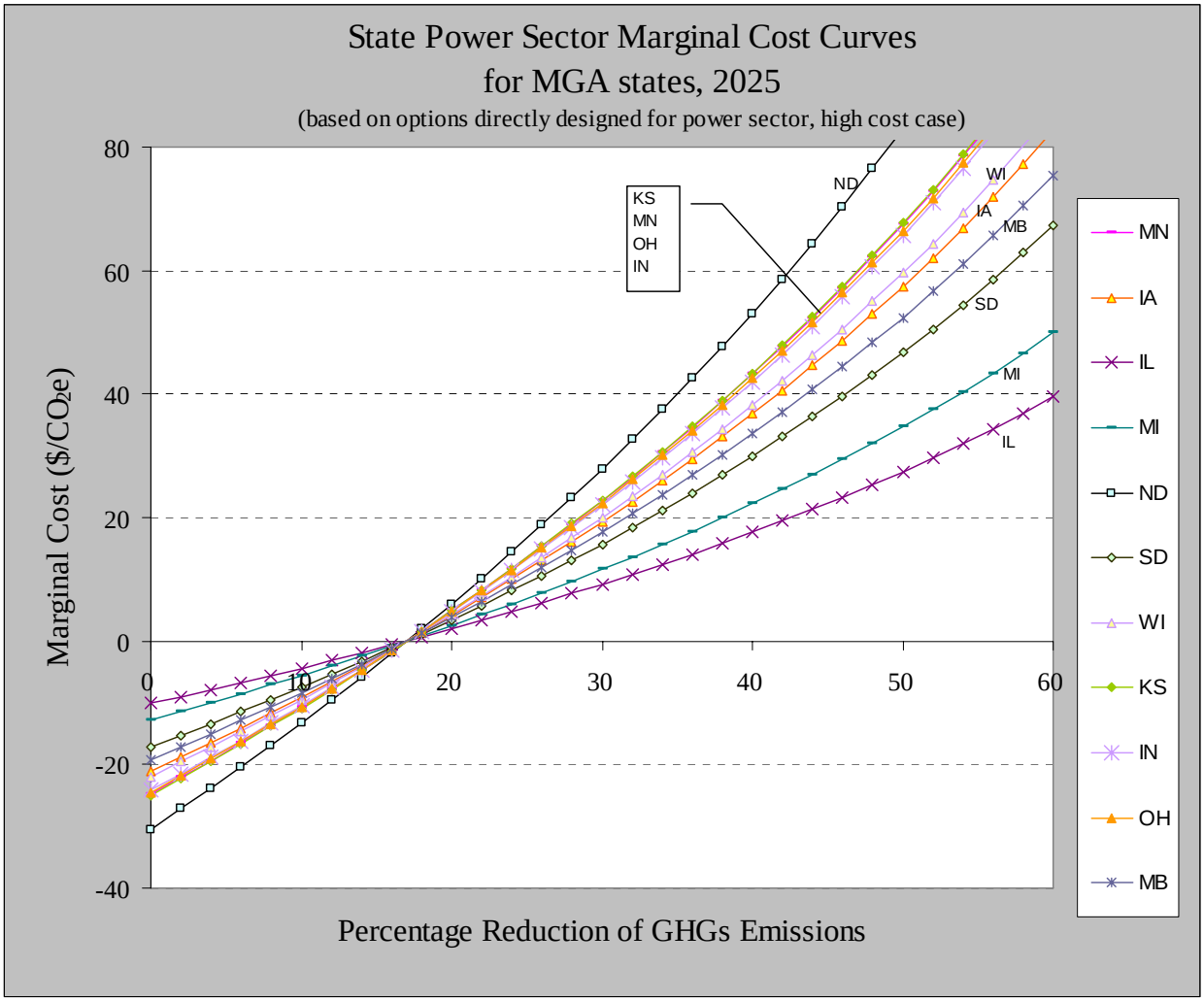
[a] Permit Price = \$25.30/tonCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO_2 equivalent in this simulation differs for each state. For MN, for example, it is \$1.81/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 35.70% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state.

[b] Represents number of permits bought or sold.

DATA TABLE
(for Power Sector)

State	Cap: 30% Below 2005 Emissions in 2025 (million tCO_2e)	2025 BAU Gross Emissions (Consumption-based) (million tCO_2e)	GHG Mitigation Goal in 2025 (relative to BAU emissions)	Autarkic Marginal Mitigation Cost (dollars per tCO_2e)		Gross State Product in 2025 (million 2000 dollars)
				Low	High	
IA	24.0	40.8	41.06%	28.9	38.8	4,085
IL	45.6	82.4	44.63%	16.3	21.9	17,231
KS	22.4	38.6	42.05%	35.8	48.0	3,273
MI	43.9	72.7	39.60%	16.2	21.7	12,042
MN	36.0	64.4	44.04%	39.1	52.5	5,482
WI	34.2	59.9	42.90%	32.8	44.0	5,775
MB	0.1	0.5	72.22%	84.3	113.2	583
IN	65.9	105.8	37.72%	27.7	37.2	9,264
OH	90.5	145.3	37.72%	28.0	37.7	12,566
SD	4.9	8.4	42.05%	24.7	33.1	1,033
Total	367.6	618.8	40.60%			71,334

Marginal Cost Curves for MGA states:



Note: Marginal cost curves of Midwestern states are developed based on MN 2025 curve. These curves are for the high cost scenario. The relative positions of state curves for the low cost scenario are the same, except all the curves shift downward slightly. These marginal cost curves are presented for a range of mitigation levels, including those higher than required to meet the cap in year 2025. We anticipate that there will be technology innovations in the future, i.e., the marginal cost curves will shift downward over time before higher levels of mitigation are necessary.

Auction Case

- In an auction case, we assume there would be no permit trading among regions.
- According to Coase Theorem, in equilibrium, each state will choose to mitigate the same level of emission as they would do in a permit trading market, and buy the allowance of remaining emission from the auctioneer.
- The auction price would bid up to the same level as the equilibrium price of permit in the permit trading market.
- The auction revenue can be used to fund those positive cost mitigation options. Here we would need further guidance from the TWG.

An Auction Case among MGA States

State	Total BAU Emissions in 2025 (million tCO2)	Emission Reduction Undertaken by the State[a]		Emission Allowances Bought from Auctioneer	Auction Cost (billion dollars)[b]
		(percent from BAU)	(million tCO_2)		
IA	124.57	37.27	46.43	78.14	3.57
IL	319.73	43.86	140.24	179.49	8.20
KS	119.60	33.09	39.57	80.03	3.66
MI	270.58	39.82	107.75	162.83	7.44
MN	187.53	41.19	77.24	110.29	5.04
WI	161.85	41.42	67.04	94.81	4.33
MB	27.37	34.55	9.45	17.92	0.82
Total	1,211.23	40.27	487.73	723.50	33.05

[a] In equilibrium, each state will choose to mitigate the same level of emissions as they would do in a permit trading market.

[b] The auction price would equal the equilibrium price of permit in the permit trading market.

MN-only Cap and Trade Scenario

GHG mitigation policy options are proposed and designed for Minnesota in the following four sectoral categories: 1) Energy Supply, 2) RCI (Residential, Commercial, Industrial), 3) Transportation and Land Use, and 4) Agriculture, Forestry, and Waste Management. Table 1 presents a list of options that currently have quantified mitigation potential and cost information. In this section, we study a cap and trade program between major sectors in Minnesota. In the last column of Table 1, we classify the options into four major sectors: 1) Power Sector; 2) Transportation Sector; 3) Sequestration; and 4) Other (including Industrial, Commercial, Ag, Forestry, Small Power Generation, etc.).

Table 1. Minnesota Mitigation Options List

	Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO2e)	Estimated Cost or Cost Savings per ton GHG Removed	Sector
Ag	Agricultural Crop Management_B. Nutrient Management	1.35	-$37.00	Sequestration
Ag	Agricultural Crop Management_A. No Till	1.3	-$0.25	Sequestration
Ag	In-state Liquid Biofuels Production _A. Ethanol carbon content	3	$1.00	Transportation sector
Ag	In-state Liquid Biofuels Production_C. Gasoline Displacement	13.6	$5.00	Transportation sector
Ag	Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production	3.8	$12.00	Other
Ag	Land Use Management Approaches for Protection and Enrichment of Soil Carbon_A. Preserve Land	0.45	$31.00	Sequestration
Ag	In-state Liquid Biofuels Production_B. Fossil diesel displacement	0.19	$62.00	Transportation sector
Ag	Land Use Management Approaches for Protection and Enrichment of Soil Carbon_B. Reinvest in Minnesota - Clean Energy (RIM-CE)	0.19	$110.00	Sequestration
F	Urban Forestry	2.7	-$12.00	Sequestration
F	Forest Protection - Reduced Clearing and Conversion to Non-Forest Cover	2.7	$3.00	Sequestration
F	Forestration	2.19	$13.00	Sequestration
F	Restocking	8.4	$33.00	Sequestration
W	End of Use Waste Management Practices - Landfilled Waste Methane	0.34	$1.00	Other
ES	Efficiency Improvements, Repowering and other Upgrades to Existing Plants (with RPS)_Reference Scenerio #2	1.87	$5.65	Power sector
ES	Generation Performance Standard_Reference Scenerio #3	0.62	$13.90	Power sector
ES	Renewable and/or Environmental Portfolio Standard_No coal additions	12.83	$20.10	Power sector
ES	Carbon Capture and Storage and/or Reuse Policies	3.8	$76.10	Power sector
ES	Advanced Fossil Fuel Technology Incentives, Support or Requirements (with RPS)	0.8	$106.20	Power sector
RCI	Improved Uniform Statewide Building Codes	0.0037	-$189.70	Other
RCI	Non-utility Strategies and Incentives to Encourage Energy Efficiency and Reduce GHG Emissions	0.13	-$37.10	Other
RCI	Maximize Savings from the Utility Conservation Improvement Program (CIP) (with RPS)	8.7	-$29.10	Power sector
RCI	Green Building Guidelines and Standards Based on Architecture 2030	0.421	-$0.26	Other
RCI	Incentives & Resources to Promote Combined Heat and Power (CHP) (with RPS)	4.9	$27.50	Other
TLU	Adopt California Clean Car Standards	7	-$18.00	Transportation sector
TLU	Expand Transit, Bicycle, and Pedestrian Infrastructure	0.2	$0.00	Transportation sector

Table 2 presents historical and projected GHG emissions from various sources in Minnesota. In Table 3, we aggregate the GHG emission sources into three major sectors corresponding to the sector classification we used for mitigation options in Table 1: 1) Power Sector; 2) Transportation Sector; and 3) Other. Emission from Sequestration is zero.

Table 2. Minnesota Gross GHG Emissions by Sector, 1990-2025: Historical and Projected

MMTCO2e

Source		1990	1995	2000	2005	2010	2015	2020	2025
1	Electricity (consumption-based)	35.03	40.88	43.40	51.46	53.23	60.93	62.61	64.37
2	Fossil Fuel Industry	1.37	1.95	2.12	2.25	2.60	3.02	3.50	4.07
3	RCI Fuel Use	25.61	31.08	31.32	32.00	34.99	37.17	38.64	40.48
4	Transport Onroad Gasoline	17.32	19.43	21.72	22.74	23.33	24.10	24.87	25.44
5	Transport Onroad Diesel	4.46	4.99	5.85	6.67	7.74	8.82	10.09	11.34
6	Jet Fuel/Other Transport	6.91	7.25	7.85	7.81	7.15	7.39	7.62	7.86
7	Agriculture	15.53	17.53	19.50	19.68	20.51	21.36	22.24	23.13
8	ODS Substitutes	0.00	0.08	0.41	0.65	0.93	1.23	1.60	2.06
9	Other Ind. Process	0.61	0.79	0.96	0.91	0.87	0.85	0.87	0.89
10	Waste Management	5.55	5.03	4.97	4.96	4.85	4.75	4.66	4.58
11	Forestry	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
	Total	**115.69**	**132.31**	**141.40**	**152.43**	**159.50**	**172.92**	**180.00**	**187.53**

Table 3. Minnesota Gross GHG Emissions from Three Major Sectors, 1990-2025: Historical and Projected

MMTCO2e

Source as in Table 2		1990	1995	2000	2005	2010	2015	2020	2025
1	Power sector	35.03	40.88	43.40	51.46	53.23	60.93	62.61	64.37
4-6	Transportation sector	28.70	31.68	35.42	37.22	38.21	40.30	42.59	44.64
2,3,7-11	Other (Industrial, Commercial, Ag, Forestry, Small Power Generation, etc.)	51.96	59.76	62.58	63.75	68.06	71.69	74.80	78.51
	Total	**115.69**	**132.31**	**141.40**	**152.43**	**159.50**	**172.92**	**180.00**	**187.53**

The 2025 emission cap in Minnesota is 30% below the 2005 level. We assume this emission cap applies to each of the three major sectors, i.e., each sector has an emission cap of 70% of its emission level in 2005. Sequestration does not have a cap.

Table 4. Cap in Year 2025: 30% below 2005 level

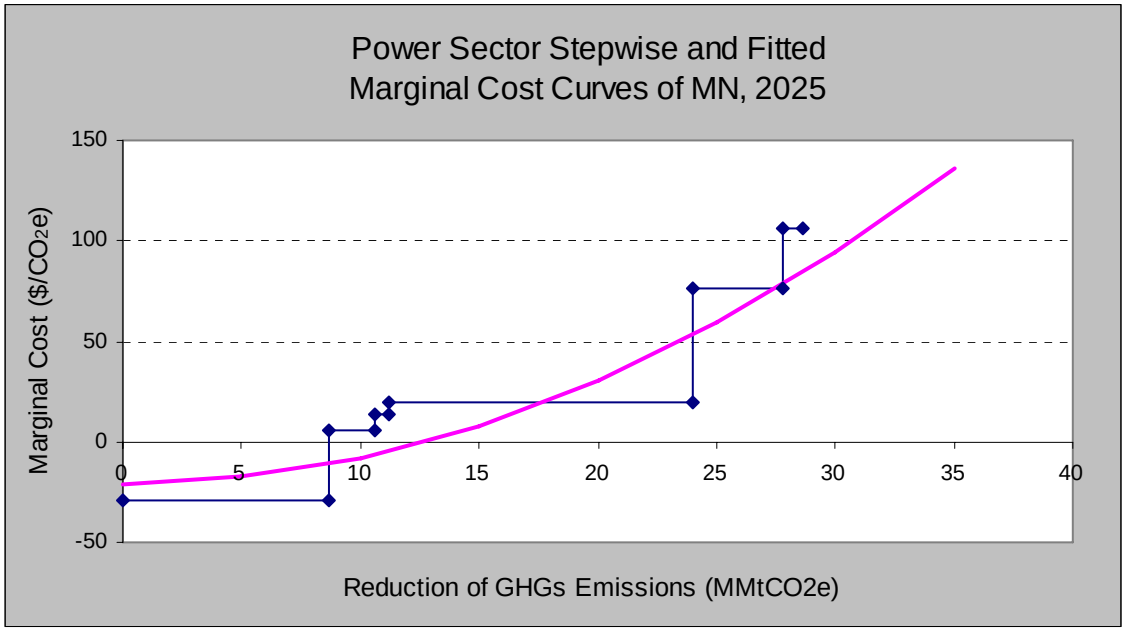
MMTCO2e

	2025 BAU Emission	Cap	Reduction Goal
Power sector	64.37	36.02	28.35
Transportation sector	44.64	26.06	18.59
Other	78.51	44.62	33.89

Next, we develop marginal cost curves for each of the four sectors. In the following figures of sector by sector cost curves, the horizontal axis represents the amount of GHG emission reduction. In previous inter-state simulations, we designated the horizontal axis to represent percentage reduction of emissions. We did not use percentage reduction here because Sequestration Sector has zero emission.

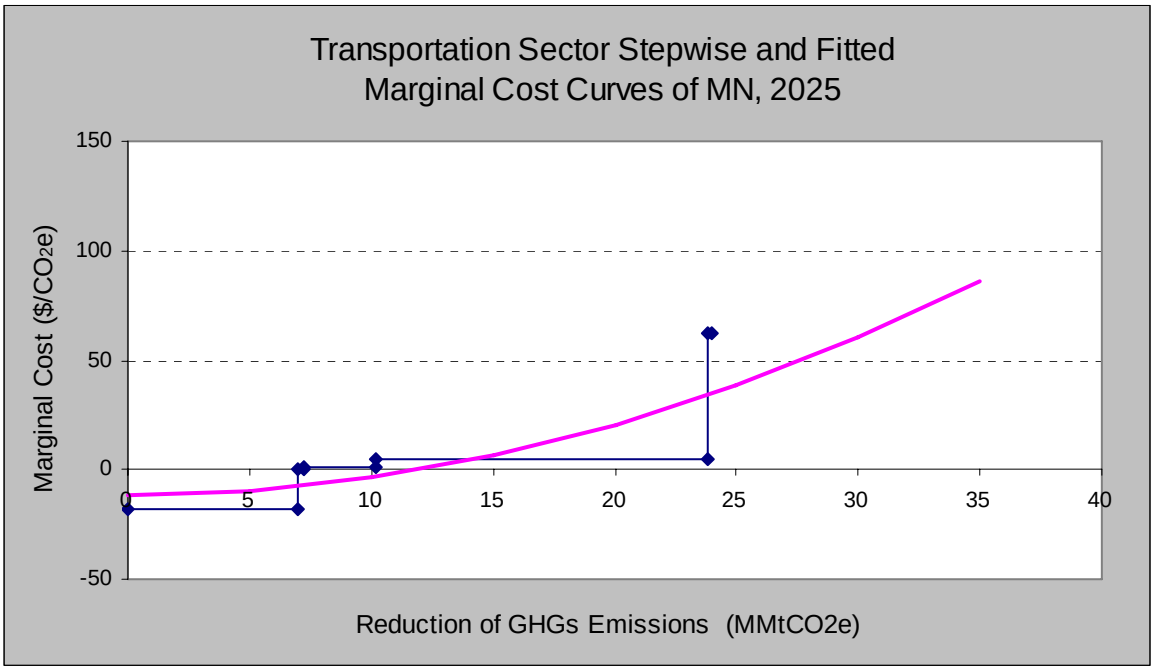
Power Sector

	Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO2e)	Estimated Cost or Cost Savings per ton GHG Removed	Cumulative GHG Reduction Potential (MMtCO2e)
RCI	Maximize Savings from the Utility Conservation Improvement Program (CIP) (with RPS)	8.7	-$29.10	8.7
ES	Efficiency Improvements, Repowering and other Upgrades to Existing Plants (with RPS)_Reference Scenerio #2	1.87	$5.65	10.57
ES	Generation Performance Standard_Reference Scenerio #3	0.62	$13.90	11.19
ES	Renewable and/or Environmental Portfolio Standard_No coal additions	12.83	$20.10	24.02
ES	Carbon Capture and Storage and/or Reuse Policies	3.8	$76.10	27.82
ES	Advanced Fossil Fuel Technology Incentives, Support or Requirements (with RPS)	0.8	$106.20	28.62



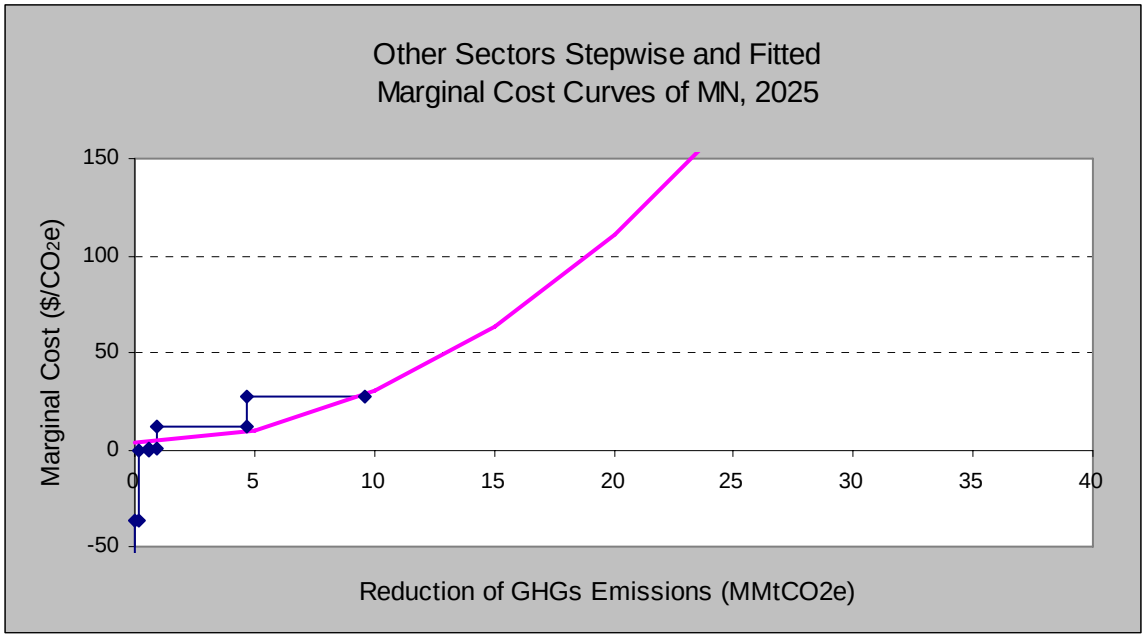
Transportation Sector

	Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO2e)	Estimated Cost or Cost Savings per ton GHG Removed	Cumulative GHG Reduction Potential (MMtCO2e)
TLU	Adopt California Clean Car Standards	7	-$18.00	7
TLU	Expand Transit, Bicycle, and Pedestrian Infrastructure	0.2	$0.00	7.2
Ag	In-state Liquid Biofuels Production _A. Ethanol carbon content	3	$1.00	10.2
Ag	In-state Liquid Biofuels Production_C. Gasoline Displacement	13.6	$5.00	23.8
Ag	In-state Liquid Biofuels Production_B. Fossil diesel displacement	0.19	$62.00	23.99



Other Sectors

	Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO2e)	Estimated Cost or Cost Savings per ton GHG Removed	Cumulative GHG Reduction Potential (MMtCO2e)
RCI	Improved Uniform Statewide Building Codes	0.0037	-$189.70	0.0037
RCI	Non-utility Strategies and Incentives to Encourage Energy Efficiency and Reduce GHG Emissions	0.13	-$37.10	0.1337
RCI	Green Building Guidelines and Standards Based on Architecture 2030	0.421	-$0.26	0.5547
Waste	End of Use Waste Management Practices - Landfilled Waste Methane	0.34	$1.00	0.8947
Ag	Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production	3.8	$12.00	4.6947
RCI	Incentives & Resources to Promote Combined Heat and Power (CHP) (with RPS)	4.9	$27.50	9.5947



Sequestration

	Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO2e)	Estimated Cost or Cost Savings per ton GHG Removed	Cumulative GHG Reduction Potential (MMtCO2e)
Ag	Agricultural Crop Management_B. Nutrient Management	1.35	-$37.00	1.35
F	Urban Forestry	2.7	-$12.00	4.05
Ag	Agricultural Crop Management_A. No Till	1.3	-$0.25	5.35
F	Forest Protection - Reduced Clearing and Conversion to Non-Forest Cover	2.7	$3.00	8.05
F	Forestration	2.19	$13.00	10.24
Ag	Land Use Management Approaches for Protection and Enrichment of Soil Carbon_A. Preserve Land	0.45	$31.00	10.69
F	Restocking	8.4	$33.00	19.09
Ag	Land Use Management Approaches for Protection and Enrichment of Soil Carbon_B. Reinvest in Minnesota - Clean Energy (RIM-CE)	0.19	$110.00	19.28

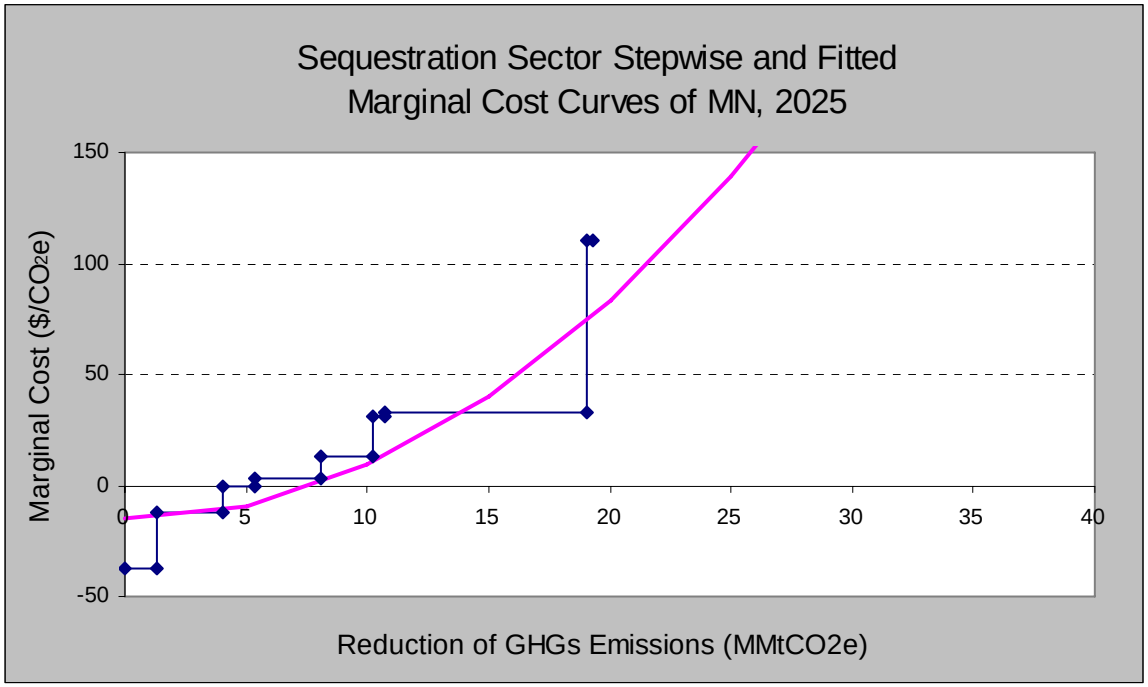


Table 5. Emission Trading Simulation Among Four Sectors in Minnesota
(million dollars or otherwise specified)

State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
Power Sector	383	68	241	309	74	4.81	23.54	36.58	44.04
Transportation Sector	-42	253	-462	-209	167	-9.22	27.81	62.30	41.64
Other	3,608	248	1,037	1,286	2,322	20.70	13.19	16.80	43.16
Sequestration	0	106	-816	-710	710	-16.28	16.28	n.a.	n.a.
Total	3,949	675	0	675	3,274	25.51[b]	80.83	43.10	43.10

[a] Permit Price = \$50.10/tonCO_2e.
[b] Represents number of permits bought or sold.

The emission reduction Minnesota as a whole needs to accomplish in 2025 is 43.10% of its BAU emission level. If we look at Minnesota economy-wide cost curve below, the marginal cost corresponding to 43.10% reduction of GHG emissions in 2025 is \$50.53/tonCO2e. This is consistent with our finding that an intra-state permit trading between sectors in Minnesota has an equilibrium permit price at \$50.10/tonCO2e.