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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$_2$e) 2020	Permit Price† ($/tCO$_2$e) 2020	Level of Support
		2015	2020	2025	Total (2008–2025)				
C&T-1 Cap and Trade Program	Midwestern Partners C&T (All Sectors)		54.11				–$5.30	$11.97	
	Midwestern Partners+Observers C&T (All Sectors)		55.93				–$4.72	$13.29	
	Midwestern Partners plus WCI Partners C&T (All Sectors)		52.87				–$5.70	$11.08	
	Midwestern Partners plus WCI Partners+Observers C&T (All Sectors)		56.47				–$4.54	$13.70	
	Midwestern Partners+Observers plus WCI Partners+Observers C&T (All Sectors)		57.04				–$4.36	$14.11	
	Midwestern Partners C&T (Power Sector)		16.40				$1.82	$10.68	
	Midwestern Partners+Observers C&T (Power Sector)		17.02				$2.16	$11.42	
	Midwestern Partners plus WCI Partners C&T (Power Sector)		15.25				$1.20	$9.32	
	Midwestern Partners plus WCI Partners+Observers C&T (Power Sector)		16.59				$1.92	$10.90	

Option No.	Policy Option	GHG Reductions ($MMtCO_2e$)				Net Present Value (Million $)	Cost-Effective-ness* ($/tCO2e) 2020	Permit Price† ($/tCO2e) 2020	Level of Support
		2015	2020	2025	Total (2008–2025)				
	Midwestern Partners+Observers plus WCI Partners+Observers C&T (Power Sector)		16.92				$2.10	$11.30	
C&T-2	MN-Only C&T (merged into C&T-1)								
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: Midwestern C&T partners include Iowa, Illinois, Kansas, Michigan, Minnesota, Wisconsin, and Manitoba; Midwestern 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. The emission cap for WCI is 15% below the 2005 level in Year 2020. The emission cap for Midwestern states is 22.5% below the 2005 level in Year 2020 (as an average of Minnesota's 2015 and 2025 emission caps).

* 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 thus far are only preliminary. All simulations undertaken so far are preliminary and are intended to illustrate the workings of the model. Currently, we have very limited data on mitigation/sequestration options for Midwestern States. Preliminary results given here may change significantly when better data is available.

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

- All western states
- All RGGI states of the Northeast
- 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 barrier. 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

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 as means of ensuring full attainment of sector-based or economy wide caps on emissions, or as enhanced methods of providing flexibility to compliance.

The Cap-and-Trade TWG will examine the feasibility of requiring initial covered sectors and entities to meet 2007 emission levels beginning in 2010. This would allow two years 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 Cap-and-Trade TWG recommends the analysis of three potential cap-and-trade programs. This Policy Option Description considers a regional, or multi-state program, a Minnesota-only program and a national program, consistent with the requirements of Subd. 5(b) of Minnesota Statute 216H.02.

The Cap-and-Trade TWG is also examining the advisability of Minnesota joining either the Western Climate Initiative (WCI) or the Regional Greenhouse Gas Initiative (RGGI). Whether one-state or Midwest regional, the program should be designed to maximize market trading with the RGGI and the Western Climate Initiative (WCI). Modeling runs will examine the following: Minnesota-only; a new Midwest regional program including Minnesota, Iowa, Wisconsin, Michigan, Illinois, and possibly others; Minnesota as a Partner in the WCI, and Minnesota as a Member in RGGI. The effect on Minnesota of a likely U.S. national program will also be examined.

Sectors and Sources Covered: According to the *Draft Minnesota GHG Inventory and Reference Case Projection* (CCS, July 2007), electricity consumption accounted for 31% of Minnesota's total GHG emissions in 2000. But transportation (25%) and residential and commercial fuel use and industrial fuel use and processes (24.5%) account for nearly half of the total. A cap-and-trade program that limited and reduced emissions from all of these sectors could, potentially, achieve substantial reductions – provide it is feasible. To do so the cap-and-trade would need to cover all economic sectors, although it should be noted that the

proportionality of reductions from each of these sectors is not necessarily the same as emissions from them. Further, administrative or political/economic constraints may argue for a configuration that does not include all sectors, or may argue for differential treatment of each sector. 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.

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.

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.

Related Policies/Programs in Place

A wide array of existing policies and measures are in place in Minnesota and likely to be expanded in the future. These will have a substantial interactive effect on a cap and trade program and vice versa. For instance the role of a cap and trade program could be to guarantee the implementation of policies needed to reach a target, or to expand the level of effort needed to reach a target. These policy areas include efficiency and conservation, renewable energy, transportation efficiency, waste management, agriculture and forest conservation, 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:

- Midwestern Partners C&T
  (All Sectors)
- Midwestern Partners+Observers C&T
  (All Sectors)
- Midwestern Partners plus WCI Partners C&T
  (All Sectors)
- Midwestern Partners plus WCI Partners+Observers C&T
  (All Sectors)
- Midwestern Partners+Observers plus WCI Partners+Observers C&T
  (All Sectors)
- Midwestern Partners C&T
  (Power Sector)

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

Results thus far are only preliminary. All simulations undertaken so far are preliminary and are intended to illustrate the workings of the model. Currently, we have very limited data on mitigation/sequestration options for 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
- 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. For all the economy-wide simulations, the total cost of achieving the carbon emission caps is negative for almost all the states. This means that compliance with the caps will result in an overall cost saving to these states. This result is due to the existence of an extensive range of cost-saving options such as improvements in energy efficiency. Though not included in the summary table, simulations that use a set of "upper-bound" cost estimates, which include only half as many cost-saving options as the base case, indicate positive costs of compliance. Note that 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. For both the economy-wide and power sector only scenarios, the permit price is lowest for the case of trading among WCI partners. The equilibrium permit price increases in the

following order: trading among Midwestern partners, trading among Midwestern partners plus observers, trading among WCI partners plus observers.

3. The power sector scenario indicates a lower per unit cost of compliance compared with the economy-wide scenario for both Midwestern and WCI trading configurations. This is reflected in relatively lower permit prices of trading in 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.

4. Minnesota is a permit buyer in the simulations of all the geographic configurations. The biggest seller in the WCI simulations is California. The biggest seller in the Midwestern States simulations is Illinois. California is also the biggest seller in the simulations that include both WCI and Midwestern states. Minnesota is the biggest buyer among Midwestern states. Without WCI observers, the biggest buyer in the Western states simulations is Arizona. Colorado is the biggest buyer if the simulation includes the five WCI observers. It is also the biggest buyer in a comprehensive simulation that covers all WCI states and Midwestern states (including observers).

The simulation results indicate that the Midwestern states 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. Note that including the three observers — IN, OH, and SD in the Midwestern trading will increase the compliance costs of Minnesota, since on average the observers have higher mitigation costs compared with the Midwestern partner states.

Table of Model Results for Multi State Cap and Trade Scenarios

Option No.	Policy Option	GHG Reductions ($MMtCO_2e$)				Net Present Value (Million $)	Cost-Effectiveness* ($/tCO$_2$e) 2020	Permit Price† ($/tCO$_2$e) 2020	Level of Support
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	Midwestern Partners plus WCI Partners+Observers C&T (Power Sector)		16.59				1.92	10.90	
	Midwestern Partners+Observers plus WCI Partners+Observers C&T (Power Sector)		16.92				2.10	11.30	
C&T-2	MN-Only C&T (merged into C&T-1)								
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, and New Mexico, Washington, Oregon, California and Canadian Provinces (developed based on mitigation costs of individual policy options presented in CCS reports or other assessments of the respective State/Provincial 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 will develop the marginal cost curve of Midwestern states based on Minnesota actual cost data as a next step. 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 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.

[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.

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]

ATTACHMENT

CAP AND TRADE MODELING RESULTS

The presentation this week includes several simulations on expanded geographical configurations of Midwestern and Western states, plus an adjustment of the target for the Midwestern states to a cap of 22.5% below Year 2005 levels:

1. For the Midwestern states, we ran simulations for two geographical configurations: 1) Midwestern regional C&T partner states (including Manitoba) and 2) All Midwestern regional C&T partners and observers. Please note that we did not include North Dakota in any of the simulations this week, since it is not an observer of the Midwestern regional C&T alignment. However, we include the marginal cost curve of North Dakota in the attached figures. From the figures we see that North Dakota has a higher marginal cost curve than the average level of the Midwestern states. Thus, including North Dakota would increase the permit price of Midwestern states trading.

2. For the Western Climate Initiative, we also ran simulations for two geographical configurations: 1) WCI partners (including the two Canadian Provinces — British Columbia and Manitoba) and 2) All WCI partners and observers.

3. We ran simulations that join the expanded Midwestern and Western states together for both economy-wide and power sector only scenarios.

4. Please note that a new column is added to the end of the results tables. The last column now presents the emission reduction goals (caps before trading) expressed as percentages of the 2020 business-as-usual (BAU) emission levels.

5. For power sector only scenarios, we developed the marginal cost curves following the most conservative strategy — including only the options that are directly designed for power sector emission reduction. Therefore, our simulation results for power sector only cases yield upper-bound estimations of mitigation compliance costs.

6. Again, we have very limited data on mitigation/sequestration options for most states at this time. Currently, we only have primary cost data for Arizona, New Mexico, Colorado, and Montana. Better data will yield more accurate results.

Economy-wide Cap and Trade Simulations

Option No.	Policy Option[1]	Permit Price[2] ($/tCO2e)	Largest Seller (million tCO2)	Largest Buyer (million tCO2)	MN Gain (%)	MN GHG Reductions (MMtCO2e)	MN Cost-Effectiveness[3] ($/tCO2e)
		2020	2020	2020	2020	2020	2020
C&T-1 Cap & Trade	WCI Partners C&T (All Sectors)	10.52	CA 37.57	AZ 14.61	-	-	-
	WCI Partners+Observers C&T (All Sectors)	15.04	CA 74.86	CO 35.94	-	-	-
	Midwestern Partners C&T (All Sectors)	11.97	IL 24.01	MN 12.28	67.36	54.11	-5.30
	Midwestern Partners+Observers C&T (All Sectors)	13.29	IL 28.98	MN 10.46	49.37	55.93	-4.72
	Midwestern Partners plus WCI Partners C&T (All Sectors)	11.08	CA 42.39	AZ 14.22	81.16	52.87	-5.70
	Midwestern Partners plus WCI Partners+Observers C&T (All Sectors)	13.70	CA 64.18	CO 36.35	44.48	56.47	-4.54
	Midwestern Partners+Observers plus WCI Partners+Observers C&T (All Sectors)	14.11	CA 67.55	CO 36.22	39.65	57.04	-4.36

[1] WCI partners include Arizona, California, New Mexico, Oregon, Utah, Washington, British Columbia, and Manitoba; WCI observers include Colorado, Idaho, Montana, Nevada, and Wyoming; Midwestern C&T partners include Iowa, Illinois, Kansas, Michigan, Minnesota, Wisconsin, and Manitoba; Midwestern C&T observers include Indiana, Ohio, and South Dakota. The emission cap for WCI is 15% below the 2005 level in Year 2020. The emission cap for Midwestern states is 22.5% below the 2005 level in Year 2020 (as an average of Minnesota's 2015 and 2025 emission caps).

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

[3] This represents the average cost per tCO_2e mitigated/sequestered for Minnesota.

Power Sector Cap and Trade Simulations

Option No.	Policy Option[1]	Permit Price[2] ($/tCO2e)	Largest Seller (million tCO2)	Largest Buyer (million tCO2)	MN Gain (%)	MN GHG Reductions (MMtCO2e)	MN Cost-Effectiveness[3] ($/tCO2e)
		2020	2020	2020	2020	2020	2020
C&T-1 Cap & Trade	WCI Partners C&T (Power Sector)	7.91	CA 31.04	AZ 14.60	-	-	-
	WCI Partners+Observers C&T (Power Sector)	11.14	CA 44.74	AZ 13.15	-	-	-
	Midwestern Partners C&T (Power Sector)	10.68	IL 14.57	MN 10.86	34.28	16.40	1.82
	Midwestern Partners+Observers C&T (Power Sector)	11.42	IL 16.32	MN 10.25	30.75	17.02	2.16
	Midwestern Partners plus WCI Partners C&T (Power Sector)	9.32	CA 37.41	AZ 13.96	41.28	15.25	1.20
	Midwestern Partners plus WCI Partners+Observers C&T (Power Sector)	10.90	CA 43.84	AZ 13.26	33.20	16.59	1.92
	Midwestern Partners+Observers plus WCI Partners+Observers C&T (Power Sector)	11.30	CA 45.36	AZ 13.08	31.31	16.92	2.10

[1] WCI partners include Arizona, California, New Mexico, Oregon, Utah, Washington, British Columbia, and Manitoba; WCI observers include Colorado, Idaho, Montana, Nevada, and Wyoming; Midwestern C&T partners include Iowa, Illinois, Kansas, Michigan, Minnesota, Wisconsin, and Manitoba; Midwestern C&T observers include Indiana, Ohio, and South Dakota. The emission cap for WCI is 15% below the 2005 level in Year 2020. The emission cap for Midwestern states is 22.5% below the 2005 level in Year 2020 (as an average of Minnesota's 2015 and 2025 emission caps).

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

[3] This represents the average cost per tCO_2e mitigated/sequestered for Minnesota.

Summary of simulation findings of November 28, 2007:

5. In this week's simulations, we applied a new emission mitigation cap for Midwestern states in 2020. Since Minnesota has state GHG mitigation goal (cap) of 15% below its 2005 emission level by 2015, and 30% by 2025, we assume an emission cap of 22.5% below the 2005 level in year 2020 for Minnesota to replace the cap of 15% below the 2005 level in 2020 that we used previously. This cap is also applied to the other Midwestern states in the simulations. Because of the increase in the emission cap, permit prices for Midwestern states under a trading arrangement increased. With the higher emission cap, the permit price in the Midwestern states trading market is now higher than the permit price of the trading among WCI partners.

6. Even with the change in emission cap, permit purchasing and selling states in Midwest remain the same as before. Minnesota is a permit buyer in both simulations with or without the observer states. Kansas, a new state included in the Midwestern trading, is also a permit buyer.

7. For all the economy-wide simulations, the total cost of achieving the carbon emission caps is negative for almost all the states. This means that compliance with the caps will result in an overall cost saving to these states. This result is due to the existence of an extensive range of cost-saving options such as improvements in energy efficiency. Though not included in this weeks' presentation, simulations that use a set of "upper-bound" cost estimates, which include only half as many cost-saving options as the base case, indicate positive costs of compliance. Note that 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.

8. For both the economy-wide and power sector only scenarios, the permit price is lowest for the case of trading among WCI partners. The equilibrium permit price increases in the following order: trading among Midwestern partners, trading among Midwestern partners plus observers, trading among WCI partners plus observers.

9. The power sector scenario indicates a lower per unit cost of compliance compared with the economy-wide scenario for both Midwestern and WCI trading configurations. This is reflected in relatively lower permit prices of trading in 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.

10. Minnesota is a permit buyer in the simulations of all the geographic configurations. The biggest seller in the WCI simulations is California. The biggest seller in the Midwestern States simulations is Illinois. California is also the biggest seller in the simulations that include both WCI and Midwestern States. Minnesota is the biggest buyer among Midwestern states. Without WCI observers, the biggest buyer in the Western States simulations is Arizona. Colorado is the biggest buyer if the simulation includes the five

WCI observers. It is also the biggest buyer in a comprehensive simulation that covers all WCI states and Midwestern states (including observers).

11. The simulation results indicate that the Midwestern states 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. Note that including the three observers — IN, OH, and SD in the Midwestern trading will increase the compliance costs of Minnesota, since on average the observers have higher mitigation costs compared with the Midwestern partner states.

12. Since Manitoba is a partner in both WCI and Midwestern trading coalitions, it is interesting to compare the simulation results and evaluate which group is the best for this province to join. The results show that Manitoba is slightly better off joining the WCI than joining the Midwestern states in trading. However, the gains are only minimal.

TABLE IM1. ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES PLUS MANITOBA 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)
IA	-191	-351	99	-252	61	8.27	30.29	26.01	33.11
IL	-276	-61	-287	-349	73	-24.01	112.34	36.54	28.73
KS	-202	-380	103	-278	75	8.58	28.44	25.44	33.11
MI	-368	-308	-67	-375	7	-5.60	80.36	30.88	28.73
MN	-83	-287	147	-140	56	12.28	54.11	29.44	36.12
WI	-258	-246	-12	-258	0	-0.99	45.74	29.37	28.73
MB	-47	-73	18	-56	9	1.48	6.66	26.22	32.03
Total	-1,425	-1,706	0	-1,706	281	30.60[b]	358	30.83	30.83

[a] Permit Price = \$11.97/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 -\$5.30/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 29.44% 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 IM2. ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG NINE MIDWESTERN STATES PLUS MANITOBA 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)
IA	-191	-341	100	-241	51	7.50	31.05	26.67	33.11
IL	-276	2	-385	-384	108	-28.98	117.31	38.16	28.73
KS	-202	-372	105	-267	64	7.91	29.10	26.03	33.11
MI	-368	-271	-113	-384	16	-8.52	83.28	32.00	28.73
MN	-83	-264	139	-125	41	10.46	55.93	30.43	36.12
WI	-258	-227	-34	-260	3	-2.52	47.27	30.35	28.73
MB	-47	-71	17	-54	7	1.31	6.83	26.89	32.03
IN	-903	-1,050	117	-933	30	8.79	77.68	25.81	28.73
OH	-685	-657	-29	-686	1	-2.18	108.70	29.32	28.73
SD	25	-158	83	-75	100	6.23	12.09	25.95	39.33
Total	-2,988	-3,408	0	-3,408	421	42.20[b]	569.23	30.29	30.29

[a] Permit Price = \$13.29/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 -\$4.72/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 30.43% 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 IW1. ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG SIX 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	-1,348	-1,663	154	-1,510	162	14.61	61.88	38.35	47.41
CA	-394	-77	-395	-473	79	-37.57	223.05	36.94	30.72
NM	-279	-491	88	-403	125	8.36	21.41	23.22	32.28
OR	-90	-146	43	-103	13	4.12	24.20	28.26	33.06
UT	30	-219	125	-94	124	11.89	25.70	26.74	39.12
WA	-84	-54	-34	-88	4	-3.25	39.90	34.30	31.51
BC	-165	-167	2	-165	0	0.18	20.75	26.99	27.23
MB	-47	-75	18	-58	11	1.67	6.47	25.47	32.03
Total	-2,377	-2,894	0	-2,894	517	40.82[b]	423.36	33.66	33.66

[a] Permit Price = \$10.52/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 CA, for example, it is -\$0.35/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 36.94% below the baseline level in 2020 for CA. 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 IW2. ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG 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	-1,348	-1,624	173	-1,451	103	11.52	64.96	40.27	47.41
CA	-394	398	-1,126	-728	334	-74.86	260.34	43.12	30.72
NM	-279	-475	106	-369	90	7.05	22.72	24.63	32.28
OR	-90	-110	19	-91	1	1.25	27.07	31.60	33.06
UT	30	-185	139	-47	77	9.22	28.38	29.53	39.12
WA	-84	26	-143	-117	33	-9.51	46.16	39.68	31.51
BC	-165	-139	-31	-169	4	-2.03	22.96	29.87	27.23
MB	-47	-68	16	-52	5	1.08	7.05	27.77	32.03
CO	1,555	-1,344	540	-803	2,358	35.94	35.39	22.48	45.31
ID	-110	-106	-4	-111	0	-0.29	12.49	28.33	27.67
MT	-165	-164	-77	-242	77	-5.15	10.92	26.24	13.86
NV	291	-119	201	82	209	13.37	21.95	30.37	48.87
WY	188	-761	187	-574	763	12.41	15.42	22.23	40.12
Total	-618	-4,670	0	-4,670	4,052	91.84[b]	575.81	35.06	35.06

[a] Permit Price = \$15.04/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 CA, for example, it is \$1.53/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 43.12% below the baseline level in 2020 for CA. 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 IM1W1. ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES, SIX 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	-1,348	-1,659	158	-1,501	154	14.22	62.26	38.59	47.41
CA	-394	-25	-470	-495	101	-42.39	227.87	37.74	30.72
NM	-279	-489	91	-399	120	8.19	21.57	23.39	32.28
OR	-90	-143	42	-101	11	3.75	24.56	28.68	33.06
UT	30	-216	128	-88	118	11.56	26.03	27.09	39.12
WA	-84	-45	-45	-90	6	-4.05	40.70	34.99	31.51
BC	-165	-164	-1	-165	0	-0.10	21.03	27.36	27.23
IA	-191	-357	97	-259	69	8.78	29.77	25.57	33.11
IL	-276	-101	-228	-329	53	-20.58	108.91	35.42	28.73
KS	-202	-386	100	-286	83	9.03	27.98	25.03	33.11
MI	-368	-331	-40	-371	3	-3.59	78.36	30.11	28.73
MN	-83	-301	150	-151	68	13.52	52.87	28.76	36.12
WI	-258	-258	1	-258	0	0.05	44.69	28.70	28.73
MB	-47	-75	18	-57	10	1.59	6.54	25.76	32.03
Total	-3,755	-4,549	0	-4,549	794	70.71[b]	773.15	32.31	32.31

[a] Permit Price = \$11.08/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 -\$5.70/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 28.76% 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 IM1W2. ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG SIX 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	-1,348	-1,637	170	-1,467	119	12.43	64.06	39.71	47.41
CA	-394	244	-879	-635	241	-64.18	249.66	41.35	30.72
NM	-279	-480	102	-378	100	7.44	22.33	24.22	32.28
OR	-90	-122	29	-93	4	2.09	26.23	30.62	33.06
UT	30	-196	137	-59	89	10.00	27.59	28.71	39.12
WA	-84	0	-106	-105	21	-7.70	44.35	38.13	31.51
BC	-165	-148	-19	-167	2	-1.38	22.32	29.03	27.23
CO	1,555	-1,350	498	-852	2,406	36.35	34.98	22.22	45.31
ID	-110	-111	0	-110	0	0.03	12.18	27.61	27.67
MT	-165	-167	-68	-235	70	-4.93	10.70	25.71	13.86
NV	291	-128	192	64	227	14.01	21.31	29.49	48.87
WY	188	-763	172	-591	780	12.56	15.27	22.02	40.12
IA	-191	-338	100	-238	48	7.27	31.28	26.86	33.11
IL	-276	22	-417	-396	120	-30.46	118.79	38.64	28.73
KS	-202	-369	106	-264	61	7.71	29.30	26.21	33.11
MI	-368	-259	-129	-388	20	-9.40	84.16	32.34	28.73
MN	-83	-256	136	-121	37	9.92	56.47	30.72	36.12
WI	-258	-221	-41	-262	4	-2.98	47.73	30.65	28.73
MB	-47	-70	17	-53	6	1.25	6.88	27.09	32.03
Total	-1,995	-6,349	0	-6,349	4,354	121.05[b]	926.60	33.32	33.32

[a] Permit Price = \$13.70/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 -\$4.54/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 30.72% 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. ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG NINE MIDWESTERN STATES, ELEVEN WESTERN STATES, AND TWO CANADIAN PROVINCES IN YEAR 2020

(million dollars or otherwise specified)

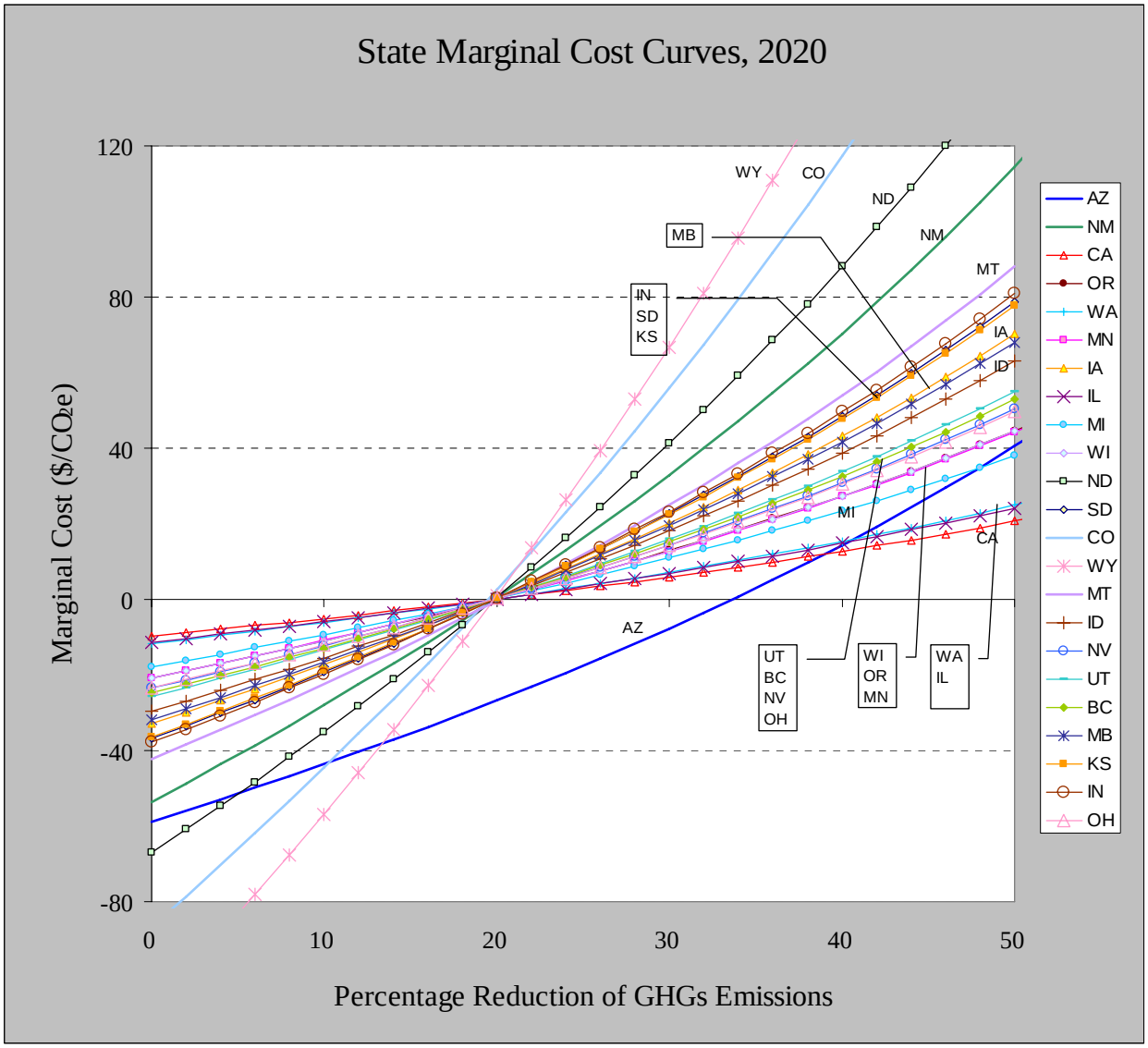
State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
AZ	-1,348	-1,633	171	-1,461	114	12.15	64.34	39.88	47.41
CA	-394	291	-953	-662	268	-67.55	253.02	41.91	30.72
NM	-279	-478	103	-375	97	7.32	22.45	24.35	32.28
OR	-90	-118	26	-93	3	1.83	26.49	30.93	33.06
UT	30	-193	138	-55	85	9.75	27.84	28.97	39.12
WA	-84	8	-117	-109	24	-8.27	44.92	38.62	31.51
BC	-165	-145	-22	-168	3	-1.59	22.52	29.29	27.23
CO	1,555	-1,348	511	-837	2,391	36.22	35.11	22.30	45.31
ID	-110	-109	-1	-110	0	-0.07	12.28	27.84	27.67
MT	-165	-166	-71	-237	72	-5.00	10.77	25.87	13.86
NV	291	-125	195	70	221	13.81	21.51	29.76	48.87
WY	188	-763	177	-586	774	12.51	15.32	22.08	40.12
IA	-191	-334	99	-235	45	7.04	31.52	27.07	33.11
IL	-276	43	-452	-409	133	-32.00	120.33	39.14	28.73
KS	-202	-366	106	-260	58	7.50	29.51	26.40	33.11
MI	-368	-246	-145	-392	24	-10.31	85.07	32.69	28.73
MN	-83	-249	132	-117	33	9.35	57.04	31.03	36.12
WI	-258	-214	-49	-263	5	-3.46	48.20	30.95	28.73
MB	-47	-70	17	-53	6	1.20	6.94	27.30	32.03
IN	-903	-1,035	109	-926	23	7.73	78.74	26.16	28.73
OH	-685	-629	-59	-689	4	-4.21	110.72	29.86	28.73
SD	25	-155	86	-70	95	6.06	12.25	26.31	39.33
Total	-3,558	-8,036	0	-8,036	4,478	132.45[b]	1,136.90	32.52	32.52

[a] Permit Price = \$14.11/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 -\$4.36/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 31.03% 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: 15% (for WCI) and 22.5% (for Midwestern) Below 2005 Emissions in 2020 (million tCO_2e)	2020 BAU Gross Emissions (Consumption-based) (million tCO_2e)	GHG Mitigation Goal in 2020 (relative to BAU emissions)	Autarkic Marginal Mitigation Cost (dollars per tCO_2e)	Gross State Product in 2020 (million 2000 dollars)
AZ	84.8	161.3	47.41%	33.3	343,077
CA	418.3	603.8	30.72%	6.4	2,646,412
NM	62.5	92.2	32.28%	41.0	72,944
OR	57.3	85.7	33.06%	17.1	173,774
UT	58.5	96.1	39.12%	32.1	158,412
WA	79.7	116.3	31.51%	8.3	422,766
BC	55.9	76.9	27.23%	10.9	131,513
CO	86.1	157.4	45.31%	154.3	376,326
ID	31.9	44.1	27.67%	13.8	63,226
MT	35.9	41.6	13.86%	-14.1	30,675
NV	37.0	72.3	48.87%	47.9	130,218
WY	41.5	69.4	40.12%	143.6	27,075
IA	77.9	116.4	33.11%	27.0	150,136
IL	219.1	307.5	28.73%	6.0	1,152,878
KS	74.8	111.8	33.11%	29.9	130,301
MI	185.5	260.2	28.73%	9.5	619,495
MN	117.4	183.8	36.12%	21.3	376,731
WI	111.0	155.7	28.73%	11.1	316,708
MB	17.3	25.4	32.03%	0.0 23.8	33,872
IN	214.5	301.0	28.73%	20.2	337,599
OH	264.2	370.8	28.73%	12.4	675,223
SD	28.3	46.6	39.33%	46.6	53,541
Total	2,359.3	3,496.2	32.52%		8,422,903



Note: Marginal cost curves other than for AZ, CO, and MT are developed based on NM curve. These marginal cost curves are presented for a range of mitigation levels, including those much higher than required to meet the cap in year 2020. 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 IM1P. POWER SECTOR EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES PLUS MANITOBA 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)
IA	82	15	47	61	21	4.36	9.62	23.58	34.27
IL	54	171	-156	15	39	-14.57	45.76	55.80	38.03
KS	30	17	11	29	1	1.04	8.85	25.43	28.42
MI	40	106	-82	24	16	-7.68	30.42	42.49	31.77
MN	222	30	116	146	76	10.86	16.40	24.70	41.06
WI	118	34	63	97	22	5.87	15.75	26.38	36.21
MB	3	0	1	2	1	0.11	0.12	28.78	57.50
Total	550	373	0	373	176	22.25[b]	126.92	35.68	35.68

[a] Permit Price = \$10.68/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 \$1.82/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 24.70% 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 IM2P. POWER SECTOR EMISSION TRADING SIMULATION AMONG NINE MIDWESTERN STATES PLUS MANITOBA 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)
IA	82	19	46	65	18	4.01	9.97	24.44	34.27
IL	54	190	-186	4	50	-16.32	47.50	57.93	38.03
KS	30	21	8	29	1	0.70	9.19	26.40	28.42
MI	40	120	-102	18	22	-8.94	31.69	44.25	31.77
MN	222	37	117	154	68	10.25	17.02	25.63	41.06
WI	118	41	60	101	18	5.26	16.36	27.40	36.21
MB	3	0	1	2	1	0.11	0.12	29.93	57.50
IN	113	53	52	105	8	4.56	26.01	25.01	29.39
OH	117	117	0	117	0	0.03	41.94	29.37	29.39
SD	13	8	4	12	0	0.35	2.66	31.72	35.84
Total	792	605	0	605	187	25.26[b]	202.46	33.14	33.14

[a] Permit Price = \$11.42/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 \$2.16/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 25.63% 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 IW1P. POWER SECTOR EMISSION TRADING SIMULATION AMONG SIX 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	-35	-413	115	-297	262	14.60	25.57	34.93	54.88
CA	13	169	-245	-76	89	-31.04	62.94	48.01	24.33
NM	90	-4	41	37	53	5.16	5.08	17.84	35.94
OR	56	4	32	36	20	4.00	6.76	21.34	33.97
UT	159	-4	64	60	99	8.12	6.68	18.26	40.44
WA	11	17	-6	11	0	-0.73	7.54	32.91	29.70
BC	0	0	-2	-2	2	-0.25	0.25	22.32	0.00
MB	3	0	1	1	2	0.13	0.10	24.30	57.50
Total	297	-230	0	-230	527	32.02[b]	114.91	35.30	35.30

[a] Permit Price = \$7.91/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 CA, for example, it is \$2.69/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 48.01% below the baseline level in 2020 for CA. 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 IW2P. POWER SECTOR EMISSION TRADING SIMULATION AMONG 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	-35	-399	146	-252	217	13.15	27.02	36.91	54.88
CA	13	299	-498	-199	212	-44.74	76.64	58.46	24.33
NM	90	4	48	52	38	4.30	5.95	20.86	35.94
OR	56	17	30	47	9	2.66	8.11	25.57	33.97
UT	159	7	77	85	75	6.96	7.84	21.43	40.44
WA	11	33	-28	5	6	-2.48	9.28	40.51	29.70
BC	0	1	-3	-3	3	-0.30	0.30	26.87	0.00
MB	3	0	1	2	1	0.11	0.12	29.49	57.50
CO	571	-94	140	46	525	12.56	7.97	13.98	36.02
ID	3	9	-8	1	2	-0.73	2.61	40.76	29.40
MT	19	6	10	15	4	0.88	1.65	15.01	22.99
NV	57	14	31	45	12	2.78	6.91	25.24	35.37
WY	120	3	54	56	64	4.84	4.65	20.58	42.01
Total	1,067	-100	0	-100	1,167	48.24	159.04	35.35	35.35

[a] Permit Price = \$11.14/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 CA, for example, it is \$3.90/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 58.46% below the baseline level in 2020 for CA. 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 IM1W1P. POWER SECTOR EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES, SIX 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	-35	-407	130	-277	242	13.96	26.21	35.80	54.88
CA	13	224	-349	-124	137	-37.41	69.31	52.87	24.33
NM	90	-1	45	44	46	4.78	5.46	19.17	35.94
OR	56	9	32	41	15	3.41	7.36	23.22	33.97
UT	159	1	71	71	88	7.60	7.20	19.66	40.44
WA	11	23	-14	9	2	-1.52	8.32	36.35	29.70
BC	0	0	-2	-2	2	-0.27	0.27	24.34	0.00
IA	82	8	47	55	27	5.02	8.96	21.96	34.27
IL	54	136	-104	33	22	-11.14	42.32	51.61	38.03
KS	30	11	16	27	3	1.67	8.22	23.61	28.42
MI	40	82	-49	33	7	-5.26	28.01	39.11	31.77
MN	222	18	112	130	92	12.02	15.25	22.96	41.06
WI	118	23	65	88	30	7.01	14.61	24.47	36.21
MB	3	0	1	1	1	0.12	0.11	26.62	57.50
Total	844	129	0	129	715	55.60[b]	241.60	35.49	35.49

[a] Permit Price = \$9.32/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 \$1.20/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 22.96% 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 IM1W2P. POWER SECTOR EMISSION TRADING SIMULATION AMONG SIX 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	-35	-400	144	-256	221	13.26	26.91	36.77	54.88
CA	13	289	-478	-189	202	-43.84	75.73	57.77	24.33
NM	90	3	48	51	39	4.36	5.88	20.64	35.94
OR	56	16	30	46	10	2.76	8.01	25.27	33.97
UT	159	6	77	83	77	7.04	7.76	21.21	40.44
WA	11	32	-26	6	5	-2.36	9.16	39.99	29.70
BC	0	1	-3	-3	3	-0.29	0.29	26.55	0.00
CO	571	-94	137	43	528	12.60	7.93	13.91	36.02
ID	3	9	-8	1	2	-0.69	2.57	40.23	29.40
MT	19	5	10	15	4	0.90	1.63	14.79	22.99
NV	57	13	31	44	12	2.86	6.83	24.94	35.37
WY	120	2	53	55	65	4.89	4.60	20.37	42.01
IA	82	16	46	62	20	4.26	9.73	23.84	34.27
IL	54	176	-165	12	42	-15.10	46.29	56.45	38.03
KS	30	19	10	29	1	0.94	8.95	25.72	28.42
MI	40	110	-88	22	18	-8.06	30.81	43.02	31.77
MN	222	32	116	148	74	10.68	16.59	24.98	41.06
WI	118	36	62	98	20	5.68	15.93	26.69	36.21
MB	3	0	1	2	1	0.11	0.12	29.12	57.50
Total	1,614	271	0	271	1,342	70.34[b]	285.73	35.49	35.49

[a] Permit Price = \$10.90/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 \$1.92/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 24.98% 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 IM2W2P. POWER SECTOR EMISSION TRADING SIMULATION AMONG NINE MIDWESTERN STATES, ELEVEN WESTERN STATES, AND TWO CANADIAN PROVINCES IN YEAR 2020

(million dollars or otherwise specified)

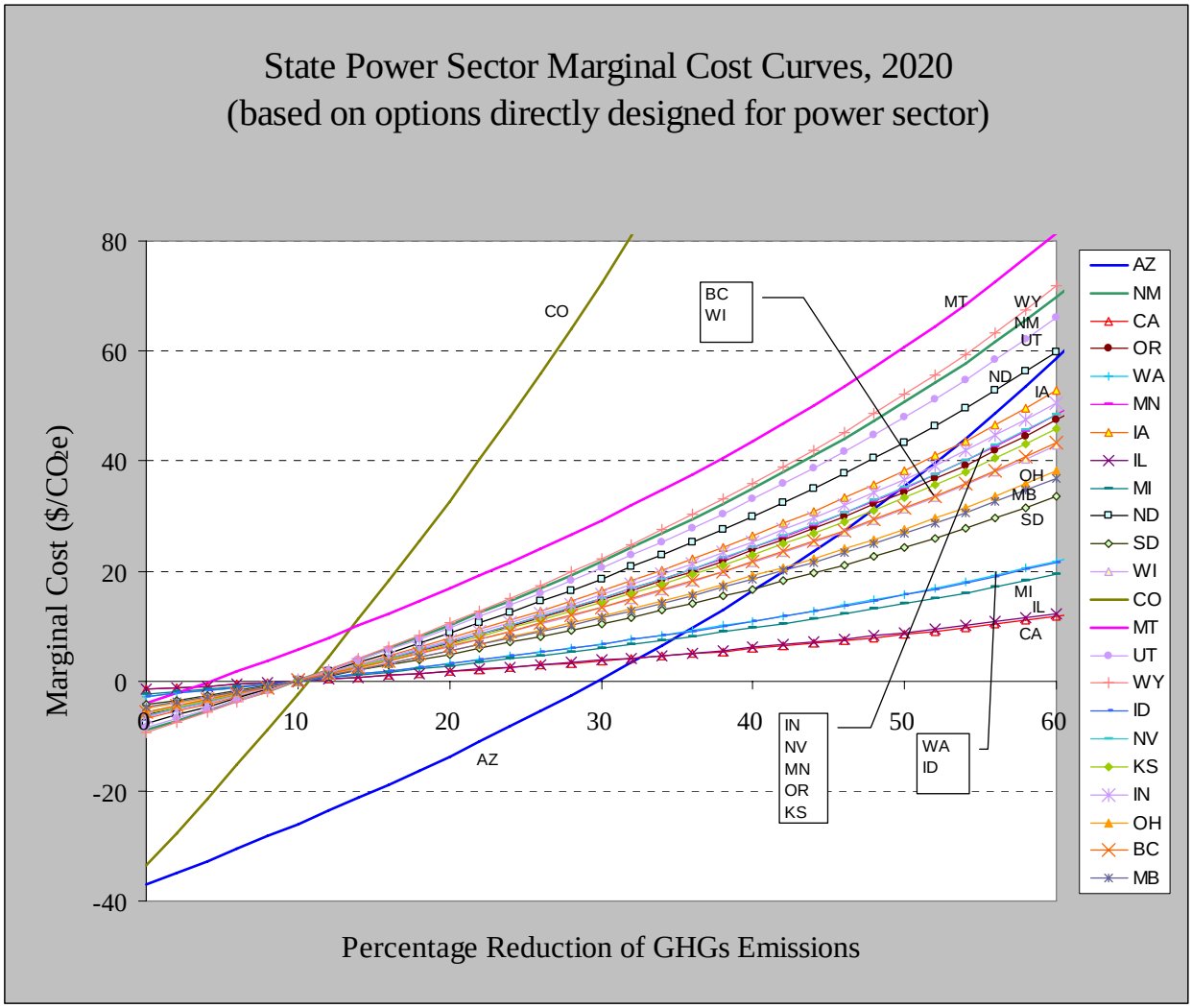
State	Before Trading	After Trading[a]			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
AZ	-35	-398	148	-250	215	13.08	27.09	37.01	54.88
CA	13	306	-512	-207	220	-45.36	77.25	58.93	24.33
NM	90	4	48	53	37	4.25	5.99	21.01	35.94
OR	56	18	29	47	9	2.60	8.17	25.78	33.97
UT	159	8	78	86	74	6.90	7.90	21.59	40.44
WA	11	34	-29	5	6	-2.56	9.36	40.87	29.70
BC	0	1	-3	-3	3	-0.30	0.30	27.10	0.00
CO	571	-94	142	48	523	12.54	8.00	14.03	36.02
ID	3	10	-8	1	2	-0.75	2.63	41.12	29.40
MT	19	6	10	15	4	0.86	1.67	15.15	22.99
NV	57	15	31	45	11	2.72	6.97	25.44	35.37
WY	120	3	54	57	63	4.81	4.69	20.73	42.01
IA	82	18	46	64	18	4.07	9.92	24.31	34.27
IL	54	187	-181	6	49	-16.04	47.23	57.60	38.03
KS	30	21	9	29	1	0.76	9.13	26.24	28.42
MI	40	118	-99	19	21	-8.74	31.49	43.98	31.77
MN	222	36	117	152	69	10.34	16.92	25.48	41.06
WI	118	40	60	100	18	5.35	16.26	27.24	36.21
MB	3	0	1	2	1	0.11	0.12	29.74	57.50
IN	113	51	53	104	9	4.71	25.86	24.86	29.39
OH	117	114	3	117	0	0.28	41.69	29.19	29.39
SD	13	8	4	12	0	0.36	2.65	31.52	35.84
Total	1,856	503	0	503	1,353	73.75[b]	361.27	34.07	34.07

[a] Permit Price = \$11.30/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 \$2.10/tonCO_2e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 25.48% 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
(for Power Sector)

State	Cap: 15% (for WCI) and 22.5% (for Midwestern) Below 2005 Emissions in 2020 (million tCO_2e)	2020 BAU Gross Emissions (Consumption-based) (million tCO_2e)	GHG Mitigation Goal in 2020 (relative to BAU emissions)	Autarkic Marginal Mitigation Cost (dollars per tCO_2e)	Gross State Product in 2020 (million 2000 dollars)
AZ	33.0	73.2	54.88%	46.2	6,219
CA	99.2	131.1	24.33%	2.5	43,086
NM	18.3	28.5	35.94%	29.3	1,568
OR	20.9	31.7	33.97%	18.1	2,564
UT	21.8	36.6	40.44%	33.7	2,123
WA	16.1	22.9	29.70%	6.7	4,030
BC	1.1	1.1	0.00%	-5.6	2,040
CO	36.5	57.0	36.02%	99.0	5,935
ID	4.5	6.4	29.40%	6.5	1,144
MT	8.5	11.0	22.99%	20.3	1,121
NV	17.7	27.4	35.37%	19.8	2,166
WY	13.1	22.6	42.01%	38.9	1,210
IA	26.8	40.8	34.27%	20.5	2,968
IL	50.8	82.0	38.03%	5.6	25,856
KS	24.9	34.8	28.42%	13.0	2,909
MI	48.9	71.6	31.77%	6.6	14,234
MN	39.1	66.4	41.06%	25.3	5,267
WI	38.1	59.7	36.21%	18.3	5,337
MB	0.2	0.4	57.50%	0.0 34.2	948
IN	73.4	104.0	29.39%	15.2	7,888
OH	100.8	142.8	29.39%	11.4	14,377
SD	5.4	8.4	35.84%	14.0	964
Total	699.1	1,060.4	34.07%		153,953



Note: Marginal cost curves other than for AZ, CO, and MT are developed based on NM curve. These marginal cost curves are presented for a range of mitigation levels, including those much higher than required to meet the cap in year 2020. 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.

Cap and Trade among WCI and Midwestern States

1. The assumptions we adopted in our simulation model are 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: Base Case Mitigation Cost:

- the simulation target year is 2020
- 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 2020 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 2020 for the two Canadian provinces come from *Canada's Energy Outlook 2006* by Natural Resources Canada
- offsets are not included
- no safety valve (permit price limit) is included
- we did not include auction costs/revenues in this week's simulations; if we need to include auction payments, the maximum payment for each state would be associated with a case where the amount of permits auctioned would be equal to each state's cap. Also, the price per permit would be set at the equilibrium permit price.
- 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, and Montana 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 (provinces) and all the Midwestern states are developed by a parametric shift method using New Mexico'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.
- emission caps for WCI states (provinces) are 15% below 2005 levels by year 2020
- Minnesota has state GHG mitigation goal (cap) of 15% below its 2005 emission level by 2015, 30% by 2025, and 80% by 2050, we assume an emission cap of 22.5% below the 2005 level for Minnesota in 2020 (an average of its 2015 and 2025 emission caps). This emission cap is also applied to other Midwestern states.

Case II: Upper-bound Mitigation Cost (did not include in this week's runs):

- same assumptions as for Case I, except:
- assumes half the cost-saving mitigation level for each state, i.e., the marginal cost curves are shifted upward so that the zero marginal cost level occurs at half the emission reduction level of Case I; this represents the worst-case condition, or upper-bound cost estimate, for each state to join the cap and trade mechanism

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 2020 baseline emission to 15% (WCI) or 22.5% (Midwestern) below the 2005 level.
- power sector marginal cost curves of Arizona, Colorado, Montana, and New Mexico are developed based on policy options directly designed for electricity sector; marginal cost curves for other states are developed using New Mexico's curve as a reference. We used an average curve of WCI partners for British Columbia and an average curve of Midwestern partners for Manitoba.
- emission projections in 2020 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