



**MINNESOTA**  
Climate Change  
Advisory Group



# Minnesota Climate Change Advisory Group

Cap and Trade Technical Work Group Meeting #7

December 07, 2007

Minnesota Department of Commerce  
Minnesota Pollution Control Agency  
The Center for Climate Strategies

# Agenda

- Call to order
- Roll Call of cap-and-trade TWG members and public
- Discussion of new analytical results from modeling
- Feedback on text of C&T-1 straw policy option
- Discussion of information needs for non-cap and trade policy options
- Discussion of arrangements and agenda for in-person meeting on December 14
- Public input and announcements

# Overview

- This week's updates include:
  - Develop marginal cost curve for Minnesota from the preliminary cost data of individual policy options of the state.
  - Re-develop marginal cost curves for other Midwestern states based on Minnesota's curve.
  - Run simulations for two geographical configurations for both economy-wide and power sector only cases with the new cost curves: 1) Midwestern regional C&T partner states (including Manitoba) and 2) All Midwestern regional C&T partners and observers.
  - Adjust the C&T base year to 2025 and apply the emission cap of 30% below 2005 level in 2025 to all Midwestern states and Manitoba.

# Interpretation of Results (1)

- For economy-wide C&T simulations, both the equilibrium permit price and the costs of compliance are significantly higher than before:
  - The permit price jumps from \$11.97/tCO<sub>2</sub>e to \$43.49 for the basic 7-state MW partners run.
  - The overall cost increases from a negative \$1.7 billion per year for the group of 7 states to a positive \$4.5 billion.
  - The average mitigation cost per unit of CO<sub>2</sub>e for Minnesota increases from -\$5.30/tonCO<sub>2</sub>e to \$8.53 in the 7-state MW partners run.
  - The relative position of the states has not changed much, and MN still buys the most permits.
  - Including the observer states will increase the permit price even more but will not change the relative positions of the core partners.

# Interpretation of Results (2)

- The explanation for the higher costs stems from 3 sources:
  - We are now simulating a cap of 30% below 2005 levels in the Year 2025 (an effective 45.9% reduction in the year 2025), rather than 22.5% below 2005 levels in 2020 (an effective 36.12% reduction in year 2020).
  - The shape of the marginal cost curves is exponential, so the 25% higher reduction level leads to a cost increases a few times that percentage in each state.
  - We replaced our old MN mitigation marginal cost curve with one that is based on a technical working group analysis, which should be more accurate. The group found that the cost savings range was only 10% rather than the 20% we estimated before. In fitting the curve through the step function, we struck a compromise on the x-axis intercept and used 15%, but this is still lower than before. Moreover, the new MN curve is steeper than before, i.e., marginal cost increases at an even greater increasing rate.
  - Decomposing these effects, the more stringent cap is responsible for about \$9 of the permit price increase, and the new curve for about \$22 of it.

# Interpretation of Results (3)

- The simulation results for power sector only case do not have significant changes, since the new power sector cost curve developed from Minnesota cost data does not differ much from the curve we used before. The major reason for the changes in simulation results is the more stringent cap.
  - The permit price increases from \$10.68/tCO<sub>2</sub>e to \$13.74 for the basic 7-state MW partners run.
  - The overall cost increases from \$373 million per year for the group of 7 states to \$604 million.
  - The average mitigation cost per unit of CO<sub>2</sub>e for Minnesota increases from \$1.82/tonCO<sub>2</sub>e to \$2.46 in the 7-state MW partners run.
  - The relative position of the states has not changed much, and MN still buys the most permits.
  - Including the observer states will increase the permit price but not affect the relative positions of the core partners.

# Midwestern Partners (All Sectors)

TABLE IM1-2025. ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading <sup>a</sup>			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO <sub>2</sub> e)	(million tCO <sub>2</sub> e)	(percent from BAU)	(percent from BAU)
IA	1,357	39	814	853	504	18.72	35.77	28.66	43.65
IL	550	2,280	-2,335	-55	605	-53.68	175.93	54.95	38.18
KS	1,450	-32	851	819	631	19.56	32.75	27.32	43.65
MI	797	1,124	-350	774	23	-8.05	111.51	41.15	38.18
MN	1,504	627	717	1,344	160	16.48	73.49	37.49	45.90
WI	579	503	74	577	2	1.69	60.23	37.14	38.18
MB	425	10	229	239	186	5.27	7.88	28.78	48.04
Total	6,662	4,551	0	4,551	2,111	61.73 <sup>b</sup>	497.56	40.74	40.74

<sup>a</sup> Permit Price = \$43.49/tonCO<sub>2</sub>e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO<sub>2</sub>e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO<sub>2</sub> equivalent in this simulation differs for each state. For MN, for example, it is \$8.53/tonCO<sub>2</sub>e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 37.49% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO<sub>2</sub> mitigated will equal the *total* mitigation cost for each state.

<sup>b</sup> Represents number of permits bought or sold.

# Midwestern Partners+Observers (All Sectors)

TABLE IM2-2025. ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG  
NINE MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading <sup>a</sup>			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO <sub>2</sub> e)	(million tCO <sub>2</sub> e)	(percent from BAU)	(percent from BAU)
IA	1,357	144	816	961	397	16.45	38.04	30.47	43.65
IL	550	2,861	-3,285	-423	973	-66.19	188.43	58.85	38.18
KS	1,450	61	872	933	517	17.57	34.74	28.99	43.65
MI	797	1,507	-808	699	98	-16.27	119.74	44.18	38.18
MN	1,504	875	554	1,429	76	11.16	78.82	40.21	45.90
WI	579	706	-132	574	5	-2.66	64.58	39.82	38.18
MB	425	33	237	270	155	4.77	8.38	30.61	48.04
IN	2,043	216	1,367	1,584	460	27.55	92.12	29.39	38.18
OH	1,514	1,455	59	1,514	0	1.18	146.23	37.87	38.18
SD	547	71	320	391	157	6.45	14.60	31.35	45.20
Total	10,767	7,929	0	7,929	2,837	85.12 <sup>b</sup>	785.68	39.93	39.93

<sup>a</sup> Permit Price = \$49.63/tonCO<sub>2</sub>e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO<sub>2</sub>e mitigated (*its marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO<sub>2</sub> equivalent in this simulation differs for each state. For MN, for example, it is \$11.10/tonCO<sub>2</sub>e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 40.21% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO<sub>2</sub> mitigated will equal the *total* mitigation cost for each state.

<sup>b</sup> Represents number of permits bought or sold.

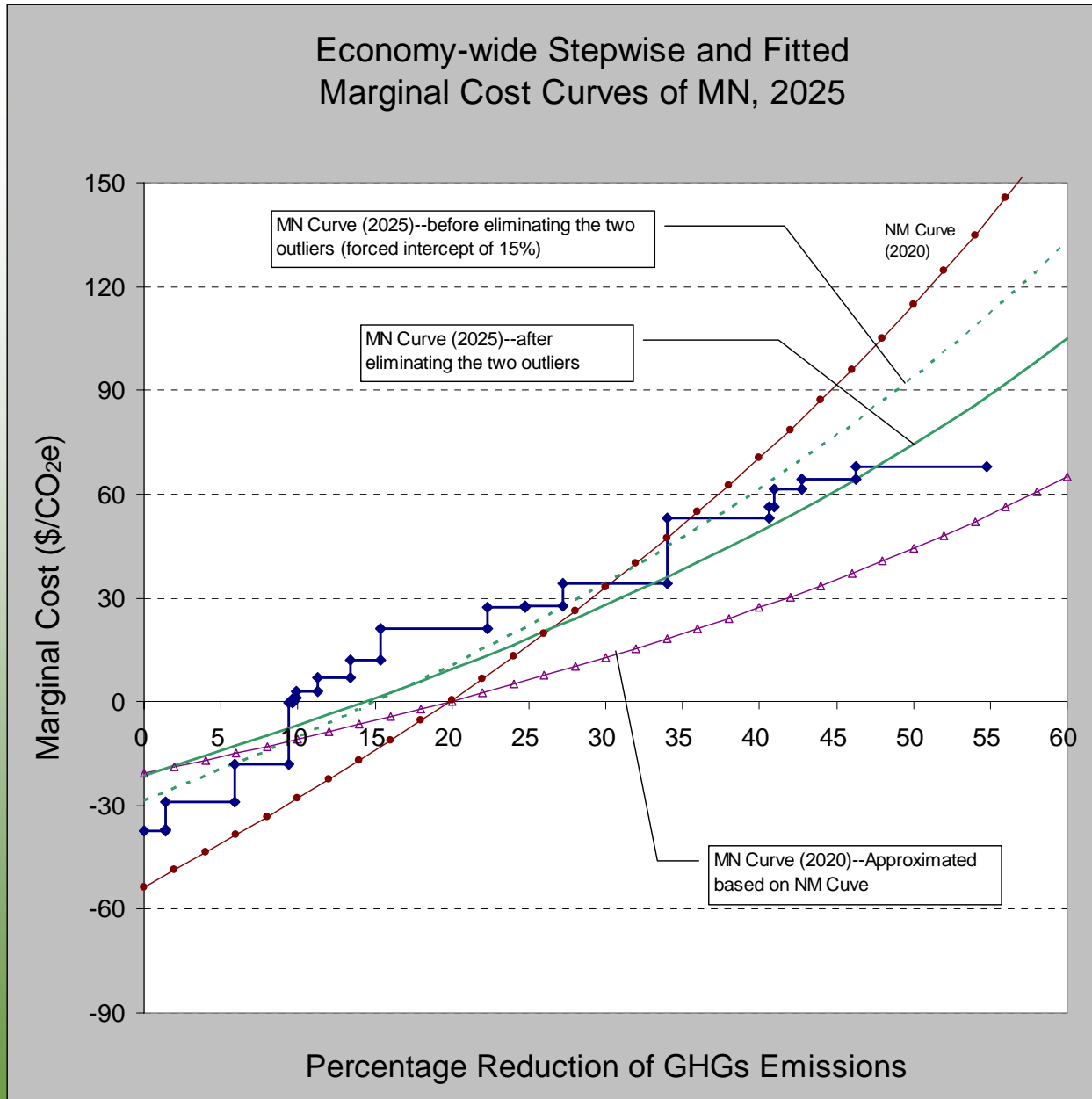
# Mitigation Cost Data for Minnesota

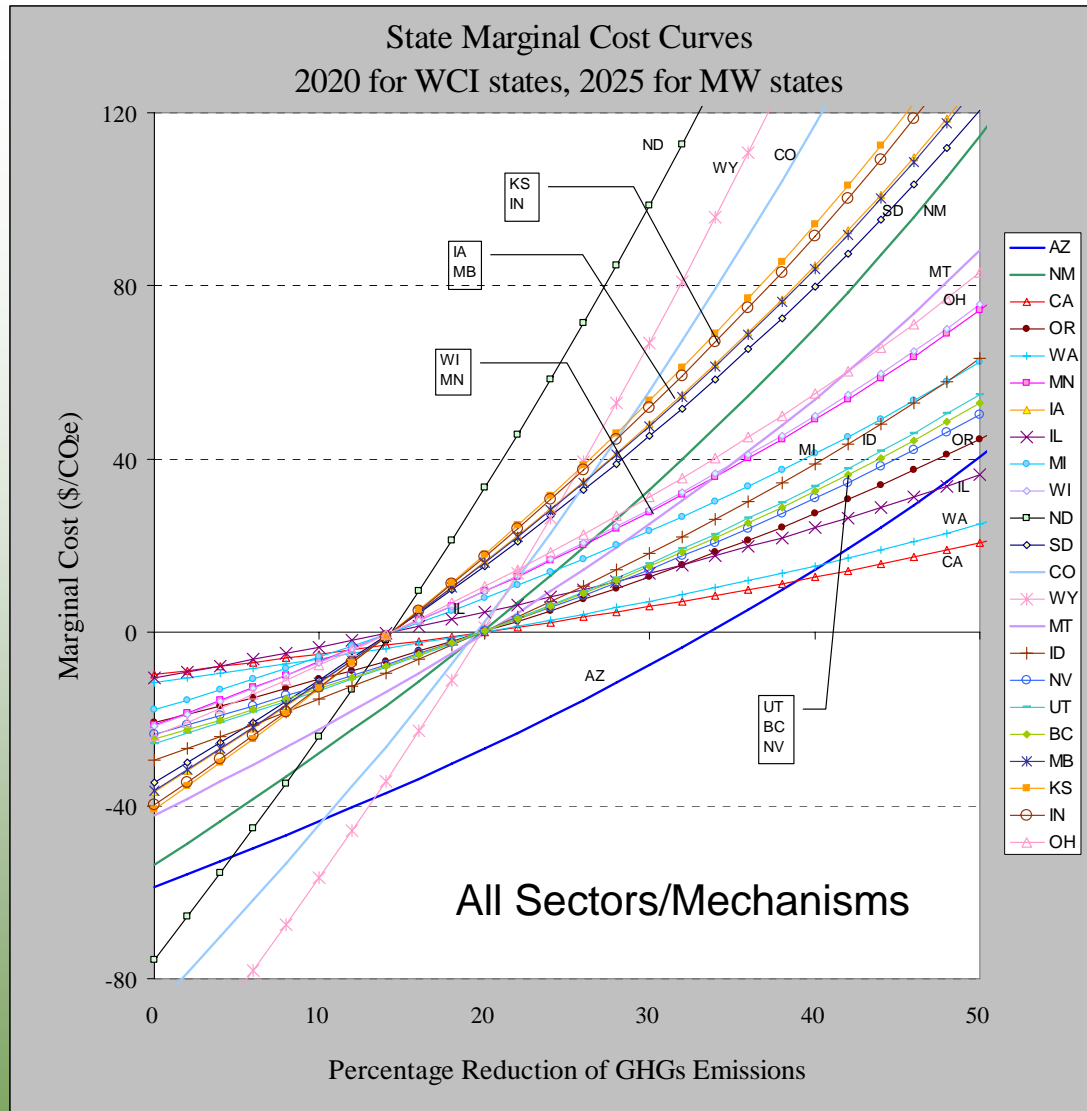
Draft

Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO <sub>2</sub> e)	Estimated Cost or Cost Savings per ton GHG Removed	GHG Reduction Potential as Percentage of 2025 Baseline Emissions	Cumulative GHG Reduction Potential
Improved Uniform Statewide Building Codes	0.0037	-\$189.70	0.00%	0.00%
Agricultural Crop Management	2.65	-\$37.25	1.35%	1.35%
Non-utility Strategies and Incentives to Encourage Energy Efficiency and Reduce GHG Emissions	0.13	-\$37.10	0.07%	1.42%
Maximize Savings from the Utility Conservation Improvement Program (CIP) (with RPS)	8.7	-\$29.10	4.44%	5.86%
Adopt California Clean Car Standards	7	-\$18.00	3.57%	9.43%
Green Building Guidelines and Standards Based on Architecture 2030	0.421	-\$0.26	0.21%	9.64%
Expand Transit, Bicycle, and Pedestrian Infrastructure	0.2	\$0.00	0.10%	9.75%
End of Use Waste Management Practices - Landfilled Waste Methane	0.34	\$1.00	0.17%	9.92%
Forest Protection - Reduced Clearing and Conversion to Non-Forest Cover	2.7	\$3.00	1.38%	11.30%
Efficiency Improvements, Repowering and other Upgrades to Existing Plants (with RPS)	4.11	\$7.04	2.10%	13.39%
Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production	3.8	\$12.00	1.94%	15.33%
Renewable and/or Environmental Portfolio Standard	13.67	\$21.17	6.97%	22.31%
Generation Performance Standard	4.8	\$27.20	2.45%	24.75%
Incentives & Resources to Promote Combined Heat and Power (CHP) (with RPS)	4.9	\$27.50	2.50%	27.25%
Forestry Management Programs to Enhance GHG Benefits	13.29	\$34.00	6.78%	34.03%
Advanced Fossil Fuel Technology Incentives, Support or Requirements (with RPS)	12.96	\$52.93	6.61%	40.64%
Transmission System Upgrading, including reducing transmission line and distribution system loss (with RPS)	0.57	\$56.50	0.29%	40.93%
Carbon Capture and Storage and/or Reuse Policies	3.62	\$61.41	1.85%	42.78%
Nuclear Power Support and Incentives (with RPS)	6.78	\$64.18	3.46%	46.24%
In-state Liquid Biofuels Production	16.79	\$68.00	8.57%	54.81%
Land Use Management Approaches for Protection and Enrichment of Soil Carbon	0.64	\$141.00	0.33%	55.13%

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Note: Marginal cost curves of WCI states other than for AZ, CO, and MT, are developed based on NM 2020 curve. Marginal cost curves of Midwestern states are developed based on MN 2025 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 (for WCI states) or 2025 (for Midwestern states). 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

# Summary Data Table -- All Sectors Draft

DATA TABLE

State	Cap: 30% Below 2005 Emissions in 2025 (million tCO <sub>2</sub> e)	2025 BAU Gross Emissions (Consumption- based) (million tCO <sub>2</sub> e)	GHG Mitigation Goal in 2025 (relative to BAU emissions)	Autarkic Marginal Mitigation Cost (dollars per tCO <sub>2</sub> e)	Gross State Product in 2025 (million 2000 dollars)
IA	70.3	124.8	43.65%	99.6	169,873
IL	197.9	320.2	38.18%	22.1	1,530,932
KS	67.5	119.8	43.65%	110.8	146,593
MI	167.5	271.0	38.18%	37.8	757,008
MN	106.1	196.0	45.90%	63.4	459,636
WI	100.3	162.2	38.18%	45.8	373,455
				0.0	
MB	14.2	27.4	48.04%	117.8	37,581
IN	193.8	313.4	38.18%	83.8	394,939
OH	238.7	386.1	38.18%	50.4	808,808
SD	25.5	46.6	45.20%	100.1	67,246
Total	1,181.8	1,967.5	39.93%		4,746,072

# Midwestern Partners (Power Sector) <sup>Draft</sup>

TABLE IM1P-2025. POWER SECTOR EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading <sup>a</sup>			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO <sub>2</sub> e)	(million tCO <sub>2</sub> e)	(percent from BAU)	(percent from BAU)
IA	122	26	68	94	28	4.93	11.94	29.05	41.06
IL	65	265	-294	-29	93	-21.41	58.41	70.46	44.63
KS	121	26	67	93	28	4.86	11.46	29.53	42.05
MI	65	172	-135	37	28	-9.79	38.74	53.00	39.60
MN	419	54	211	265	154	15.36	22.01	30.28	51.40
WI	163	60	81	141	22	5.87	20.00	33.16	42.90
MB	6	1	3	3	3	0.18	0.18	35.22	72.22
Total	962	604	0	604	357	31.20 <sup>b</sup>	162.73	44.05	44.05

<sup>a</sup> Permit Price = \$13.74/tonCO<sub>2</sub>e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO<sub>2</sub>e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO<sub>2</sub> equivalent in this simulation differs for each state. For MN, for example, it is \$2.46/tonCO<sub>2</sub>e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 30.28% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO<sub>2</sub> mitigated will equal the *total* mitigation cost for each state.

<sup>b</sup> Represents number of permits bought or sold.

# Midwestern Partners+Observers (Power Sector)

TABLE IM2P-2025. POWER SECTOR EMISSION TRADING SIMULATION AMONG  
NINE MIDWESTERN STATES PLUS MANITOBA IN YEAR 2025

(million dollars or otherwise specified)

State	Before Trading	After Trading <sup>a</sup>			Cost Saving	Permits Traded (million tCO <sub>2</sub> e)	Emission Reduction After Trading		Emission Reduction Cap (percent from BAU)
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost			(million tCO <sub>2</sub> e)	(percent from BAU)	
IA	122	34	65	100	22	4.37	12.51	30.43	41.06
IL	65	299	-356	-57	122	-23.72	60.72	73.25	44.63
KS	121	34	65	99	23	4.31	12.01	30.94	42.05
MI	65	199	-175	24	41	-11.69	40.64	55.60	39.60
MN	419	69	214	284	135	14.30	23.07	31.74	51.40
WI	163	74	73	147	16	4.88	20.99	34.81	42.90
MB	6	1	3	3	3	0.18	0.19	37.00	72.22
IN	218	98	101	199	19	6.72	33.45	31.41	37.72
OH	220	211	10	220	0	0.65	54.50	37.28	37.72
SD	15	15	0	15	0	0.02	3.51	41.84	42.05
Total	1,416	1,034	0	1,034	381	35.42 <sup>b</sup>	261.59	41.49	41.49

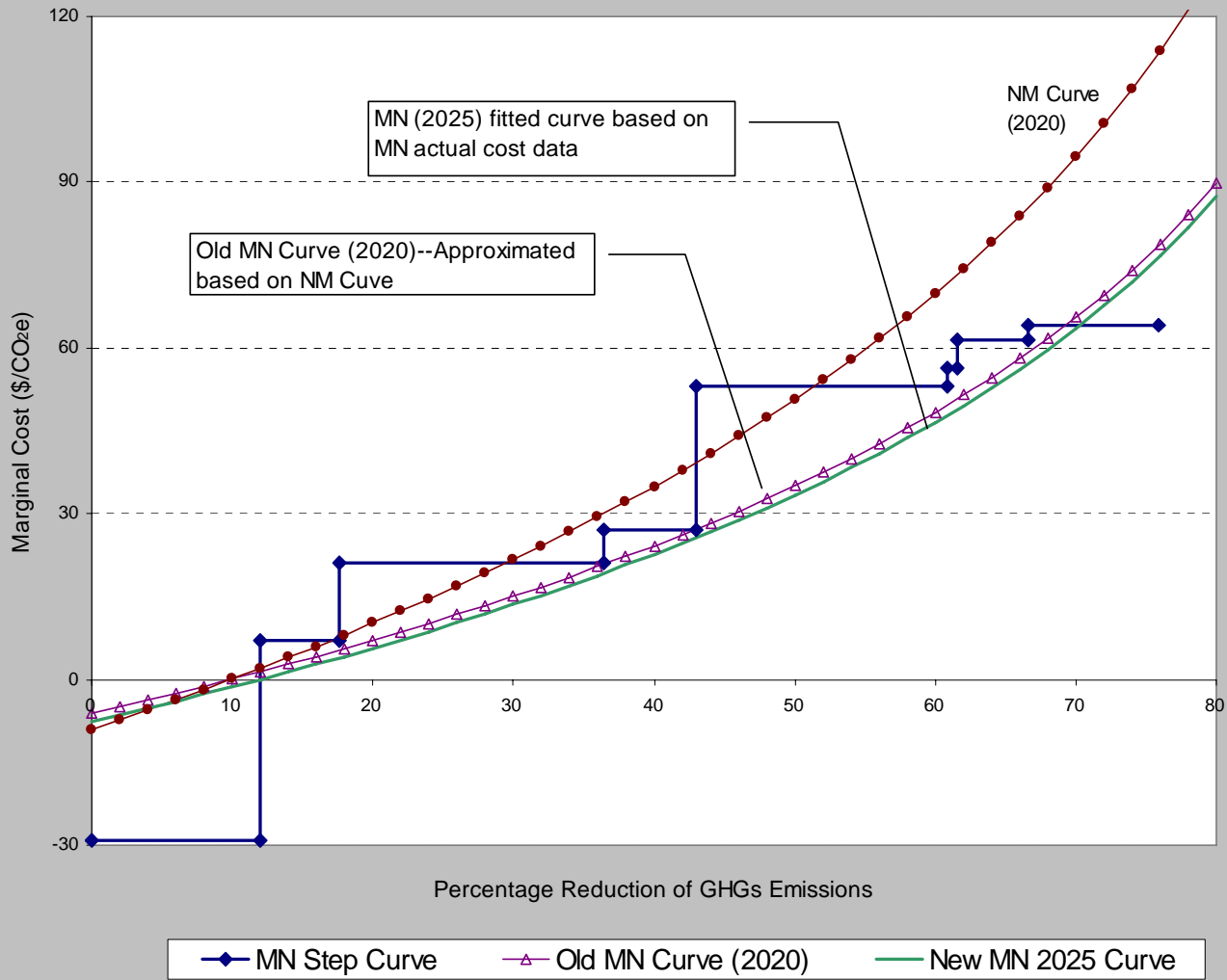
<sup>a</sup> Permit Price = \$14.99/tonCO<sub>2</sub>e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO<sub>2</sub>e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO<sub>2</sub> equivalent in this simulation differs for each state. For MN, for example, it is \$3.00/tonCO<sub>2</sub>e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 31.74% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO<sub>2</sub> mitigated will equal the *total* mitigation cost for each state.

<sup>b</sup> Represents number of permits bought or sold.

# Mitigation Cost Data for Minnesota (Options Designed for Power Sector)

Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO <sub>2</sub> e)	Estimated Cost or Cost Savings per ton GHG Removed	GHG Reduction Potential as Percentage of 2025 Baseline Emissions	Cumulative GHG Reduction Potential
Maximize Savings from the Utility Conservation Improvement Program (CIP) (with RPS)	8.7	-\$29.10	11.96%	11.96%
Efficiency Improvements, Repowering and other Upgrades to Existing Plants (with RPS)	4.11	\$7.04	5.65%	17.61%
Renewable and/or Environmental Portfolio Standard	13.67	\$21.17	18.79%	36.40%
Generation Performance Standard	4.8	\$27.20	6.60%	43.00%
Advanced Fossil Fuel Technology Incentives, Support or Requirements (with RPS)	12.96	\$52.93	17.82%	60.82%
Transmission System Upgrading, including reducing transmission line and distribution system loss (with RPS)	0.57	\$56.50	0.78%	61.60%
Carbon Capture and Storage and/or Reuse Policies	3.62	\$61.41	4.98%	66.58%
Nuclear Power Support and Incentives (with RPS)	6.78	\$64.18	9.32%	75.90%

### Power Sector Stepwise and Fitted Marginal Cost Curves of MN, 2025





# Summary Data Table – Power Sector Draft

DATA TABLE  
(for Power Sector)

State	Cap: 30% Below 2005 Emissions in 2025 (million tCO <sub>2</sub> e)	2025 BAU Gross Emissions (Consumption-based) (million tCO <sub>2</sub> e)	GHG Mitigation Goal in 2025 (relative to BAU emissions)	Autarkic Marginal Mitigation Cost (dollars per tCO <sub>2</sub> e)	Gross State Product in 2025 (million 2000 dollars)
IA	24.2	41.1	41.06%	25.6	3,359
IL	45.9	82.9	44.63%	5.8	34,334
KS	22.5	38.8	42.05%	25.8	3,273
MI	44.2	73.1	39.60%	8.2	17,393
MN	35.3	72.7	51.40%	35.0	6,426
WI	34.4	60.3	42.90%	21.6	6,293
MB	0.1	0.5	72.22%	51.7	583
IN	66.3	106.5	37.72%	20.8	9,228
OH	91.1	146.2	37.72%	15.3	17,221
SD	4.9	8.4	42.05%	15.1	1,211
Total	368.9	630.5	41.49%		99,321

# Public Input & Announcements

# Next Meeting