



MINNESOTA
Climate Change
Advisory Group



Minnesota Climate Change Advisory Group

Cap and Trade Technical Work Group Meeting #9

December 21, 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
- Review/approve notes from Meeting #8, held December 14
- Review revised text of C&T-1, Cap and Trade policy option
- Review results of MN-only modeling and sector-specific marginal cost curves
- Review PCA information regarding regulated industrial sources (if available)
- Discuss/decide policy recommendation regarding
 - Distribution of allowances
 - Early action incentives
- Discuss remaining PODs (time permitting)
 - C&T-4 Carbon Tax
 - C&T-5 Market Advisory Group
 - C&T-6 Participate in Regional Efforts
 - C&T-7 Carbon Credit System
- Public input and announcements
- Adjourn

Overview

This week's updates include:

- Updated Gross State Product forecasts in year 2025 based on newly released 10-year state employment projections by Bureau of Labor Statistics. Re-estimated marginal cost curves of states that lack direct cost data based on the updated calculation of carbon intensity (ratio of CO₂ emission and Gross State Product) in 2025.
- Re-ran MGA states simulations for two geographical configurations for both economy-wide and power sector only cases, and for both high and low cost cases: 1) MGA partner states (including Manitoba) and 2) MGA partner states and observer states. In addition, simulations were run for MGA states plus links to WCI states for the economy-wide case, and for both high and low cost cases.
- In order to run simulations including both MGA and WCI states in year 2025, we used 2020 marginal cost curves for WCI states for the year 2025. We also assumed that the same emission cap in year 2025 (30% below the 2005 level) for MGA states applies to WCI states as well.
- Developed marginal cost curves for four major sectors of MN: 1) Power Sector; 2) Transportation Sector; 3) Sequestration Sector; and 4) Other Sector.
- Ran MN-only simulation of a cap and trade program among four major sectors of MN.

Interpretation of Results (1)

- For simulations of cap and trade among MGA states, both the equilibrium permit price and the costs of compliance are higher than the results from last week. For the economy-wide case, the permit price ranges between \$40.58/tCO₂e (low-cost case) and \$45.68/tCO₂e (high-cost case) for the basic 7-state MGA partners run. For the power sector only case, the permit price ranges between \$23.93/tCO₂e (low-cost case) and \$32.14/tCO₂e (high-cost case) for the basic 7-state MGA partners run. The higher permit prices and compliance costs stem from the adjustment of the marginal cost curve of some MGA states, such as Illinois and Michigan. The marginal cost curves of MGA states (besides Minnesota) are approximated based on the Minnesota's curve and the state's carbon intensity. The updated GSP forecasts of IL and MI we obtained this week are lower than the ones we used before, which translates into a higher carbon intensity for these two states. Based on our cost curve approximation assumption, higher carbon intensity is associated with steeper or higher marginal cost curves. As a result of the increased cost curves of IL and MI, the equilibrium permit price among MGA states goes up.

Interpretation of Results (2)

- The power sector scenario indicates a lower per unit cost of compliance compared with the economy-wide scenario for MGA states simulations. This is reflected in relatively lower permit prices of trading in the power sector only simulations. One possible explanation is that economies of scale in mitigation of carbon in the electric power are greater than found in other sectors for these states.
- For both the economy-wide and power sector only scenarios, the permit price goes up if the three observer states join the MGA cap and trade program, since on average the observers have higher mitigation costs compared with the MGA partner states.

Interpretation of Results (3)

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

Interpretation of Results (4)

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

Inter-state Cap and Trade Simulations

Midwestern Partners -- High Cost Case Draft (All Sectors)

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

(million dollars or otherwise specified)

State	Before Trading	After Trading			Cost Saving	Permits Traded	Emission Reduction w/ Trading		Emission Reduction Goal
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO ₂)	(million tCO ₂)	(percent from BAU)	(percent from BAU)
IA	407	-33	363	330	77	7.95	46.43	37.27	43.65
IL	35	752	-830	-78	113	-18.17	140.24	43.86	38.18
KS	529	-312	577	265	263	12.63	39.57	33.09	43.65
MI	37	230	-203	28	9	-4.44	107.75	39.82	38.18
MN	433	261	164	425	9	3.59	77.24	41.19	43.10
WI	20	239	-240	0	21	-5.25	67.04	41.42	38.18
MB	214	-46	169	122	91	3.69	9.45	34.55	48.04
Total	1,675	1,091	0	1,091	584	27.86 ^b	487.73	40.27	40.27

^a Permit Price = \$45.68/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$3.37/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 41.19% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Midwestern Partners -- Low Cost Case Draft (All Sectors)

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

(million dollars or otherwise specified)

State	Before Trading	After Trading			Cost Saving	Permits Traded	Emission Reduction w/ Trading		Emission Reduction Goal
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO ₂)	(million tCO ₂)	(percent from BAU)	(percent from BAU)
IA	295	-92	318	226	69	7.84	46.54	37.36	43.65
IL	-87	537	-724	-187	100	-17.84	139.92	43.76	38.18
KS	383	-351	502	152	232	12.38	39.83	33.30	43.65
MI	-91	81	-181	-100	9	-4.47	107.78	39.83	38.18
MN	305	149	148	297	8	3.64	77.19	41.16	43.10
WI	-50	142	-211	-68	18	-5.19	66.99	41.39	38.18
MB	173	-57	148	91	82	3.65	9.50	34.71	48.04
Total	928	410	0	410	518	27.50 ^b	487.73	40.27	40.27

^a Permit Price = \$40.58/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$1.93/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 41.16% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Midwestern Partners+Observers – High Cost Case (All Sectors)

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

(million dollars or otherwise specified)

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

^a Permit Price = \$49.85/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$5.08/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 42.84% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Midwestern Partners+Observers – Low Cost Case (All Sectors)

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

(million dollars or otherwise specified)

State	Before Trading	After Trading ^a			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO ₂ e)	(million tCO ₂ e)	(percent from BAU)	(percent from BAU)
IA	295	-21	273	252	43	6.17	48.20	38.70	43.65
IL	-87	772	-1,034	-262	175	-23.39	145.46	45.49	38.18
KS	383	-297	492	194	189	11.11	41.09	34.36	43.65
MI	-91	253	-377	-124	33	-8.53	111.84	41.33	38.18
MN	305	275	30	305	0	0.67	80.15	42.74	43.10
WI	-50	252	-344	-92	42	-7.77	69.57	42.98	38.18
MB	173	-43	147	104	69	3.33	9.82	35.87	48.04
IN	-162	-692	469	-223	62	10.60	108.82	34.79	38.18
OH	-165	-290	123	-168	3	2.78	144.30	37.46	38.18
SD	208	-114	222	108	99	5.02	16.03	34.42	45.20
Total	809	94	0	94	716	39.69 ^b	775.27	39.64	39.64

^a Permit Price = \$44.23/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$3.43/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 42.74% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Midwestern and WCI Partners – High Cost Case (All Sectors)

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

(million dollars or otherwise specified)

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

^a Permit Price = \$39.60/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$4.58/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 42.35% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Midwestern and WCI Partners – Low Cost Case (All Sectors)

TABLE MIW1-2025 (Low). ECONOMY-WIDE EMISSION TRADING SIMULATION AMONG SIX MIDWESTERN STATES, SIX WESTERN STATES, AND TWO CANADIAN PROVINCES IN YEAR 2025

(million dollars or otherwise specified)

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

^a Permit Price = \$37.71/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$0.75/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 39.88% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Midwestern and WCI Partners+Observers – High Cost Case (All Sectors)

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

(million dollars or otherwise specified)

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

^a Permit Price = \$48.61/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$4.58/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 42.35% below the baseline level in 2020 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Midwestern and WCI Partners+Observers

– Low Cost Case (All Sectors)

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

(million dollars or otherwise specified)

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

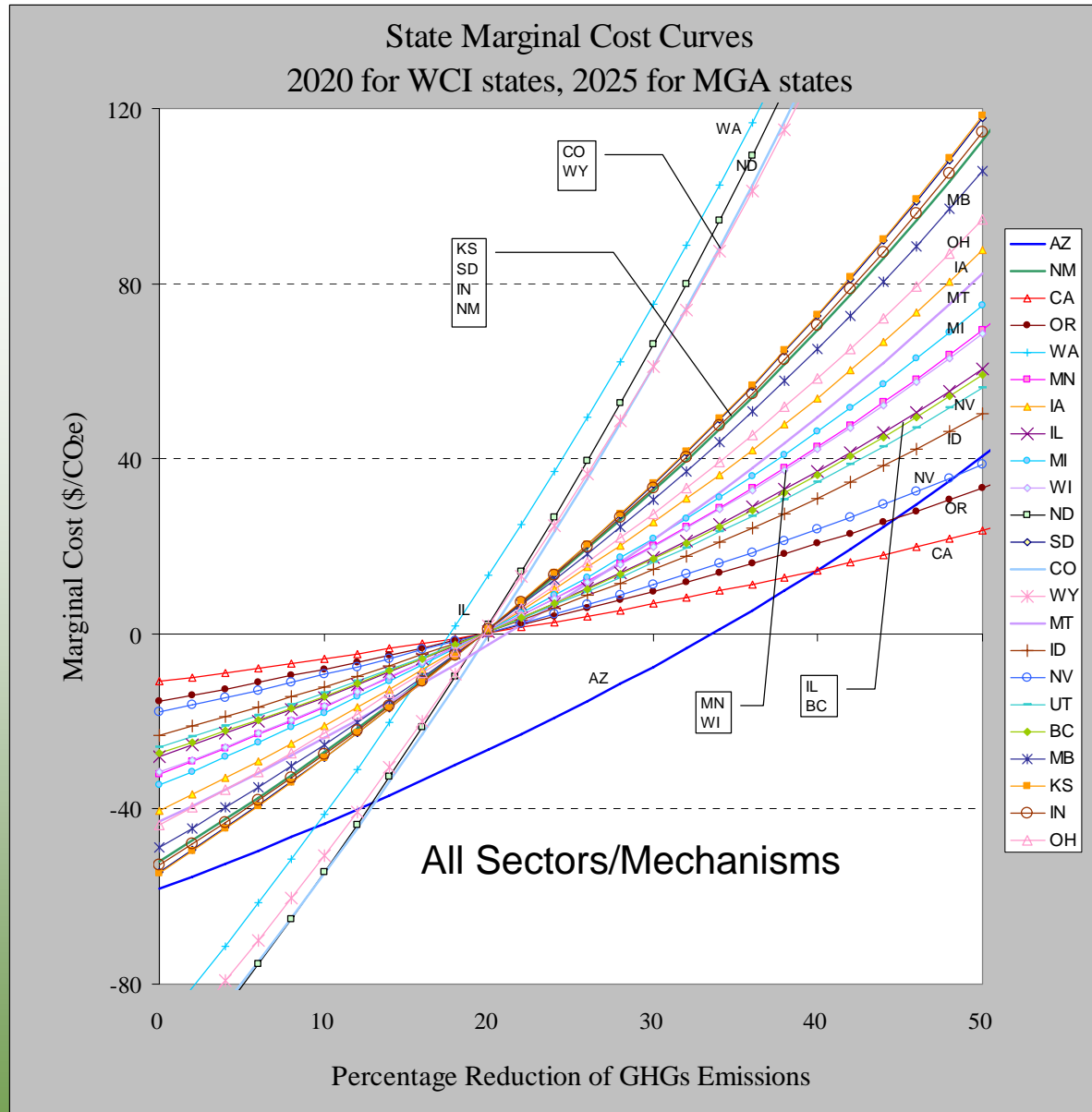
^a Permit Price = \$45.94/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$4.13/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 43.47% below the baseline level in 2020 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Summary Data Table -- All Sectors Draft

DATA TABLE

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



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

Midwestern Partners -- High Cost Case Draft (Power Sector)

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

(million dollars or otherwise specified)

State	Before Trading	After Trading ^a			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO ₂ e)	(million tCO ₂ e)	(percent from BAU)	(percent from BAU)
IA	104	53	47	99	5	1.45	15.30	37.49	41.06
IL	160	370	-251	119	41	-7.82	44.60	54.12	44.63
KS	134	21	91	112	22	2.82	13.41	34.74	42.05
MI	88	254	-199	55	33	-6.19	34.98	48.12	39.60
MN	287	37	191	228	59	5.95	22.41	34.80	44.04
WI	205	67	117	184	21	3.63	22.07	36.84	42.90
MB	12	1	5	6	6	0.17	0.20	39.18	72.22
Total	990	803	0	803	187	14.02 ^b	152.97	42.57	42.57

^a Permit Price = \$32.14/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$1.64/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 34.80% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Midwestern Partners -- Low Cost Case Draft (Power Sector)

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

(million dollars or otherwise specified)

State	Before Trading	After Trading ^a			Cost Saving	Permits Traded	Emission Reduction After Trading		Emission Reduction Cap
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO ₂ e)	(million tCO ₂ e)	(percent from BAU)	(percent from BAU)
IA	78	39	35	74	4	1.45	15.30	37.49	41.06
IL	119	276	-187	89	31	-7.82	44.60	54.12	44.63
KS	100	16	68	83	16	2.82	13.41	34.74	42.05
MI	66	189	-148	41	25	-6.19	34.98	48.12	39.60
MN	214	27	142	170	44	5.95	22.41	34.80	44.04
WI	153	50	87	137	16	3.63	22.07	36.84	42.90
MB	9	1	4	5	4	0.17	0.20	39.18	72.22
Total	737	598	0	598	139	14.02 ^b	152.97	42.57	42.57

^a Permit Price = \$23.93/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$1.22/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 34.80% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Midwestern Partners+Observers – High Cost Case (Power Sector)

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

(million dollars or otherwise specified)

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

^a Permit Price = \$33.98/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$2.43/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 35.70% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Midwestern Partners+Observers – Low Cost Case (Power Sector)

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

(million dollars or otherwise specified)

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

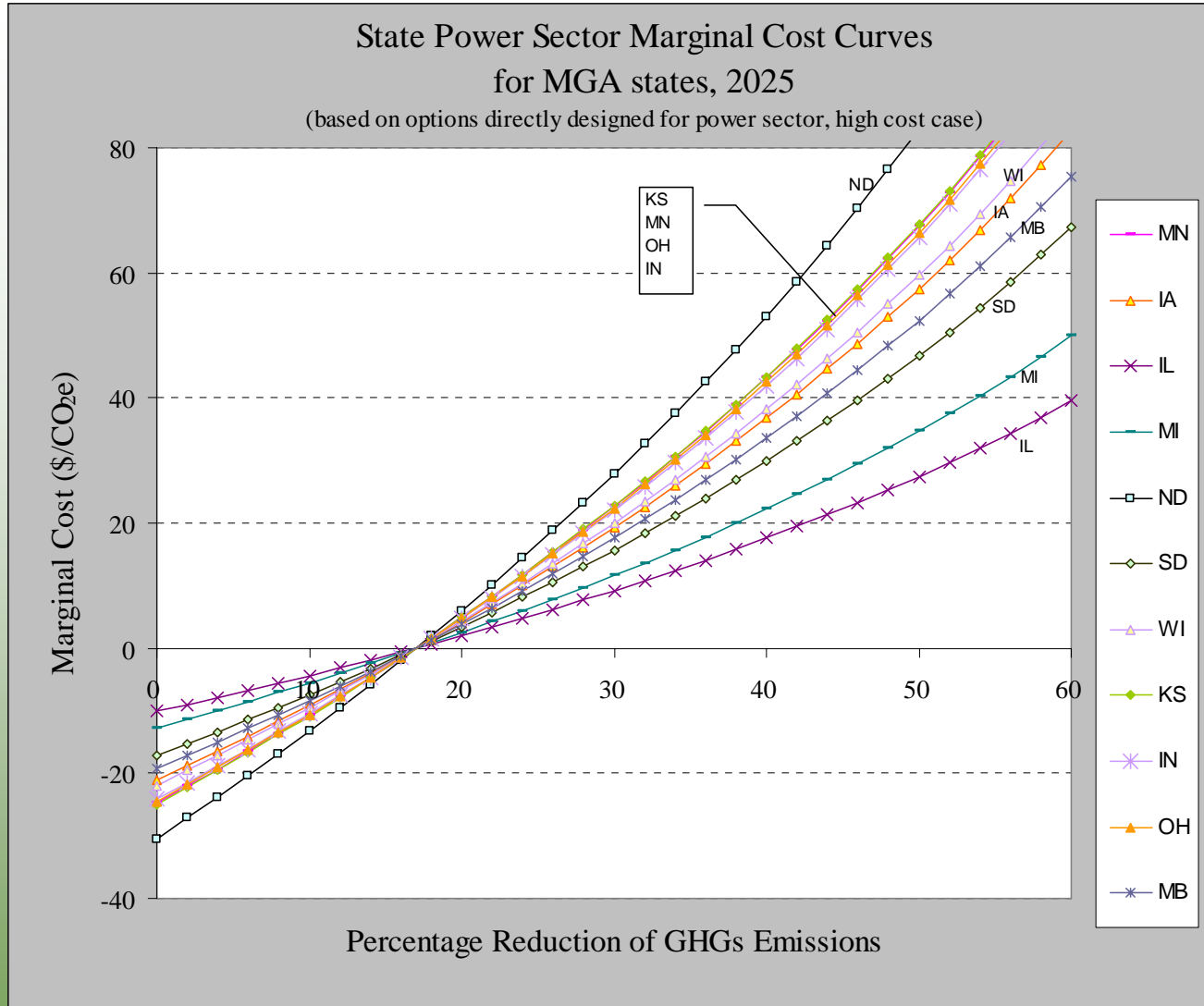
^a Permit Price = \$25.30/tonCO₂e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO₂e mitigated (its *marginal* mitigation cost). It is the same for each state for a given case. The *average* mitigation cost per unit of CO₂ equivalent in this simulation differs for each state. For MN, for example, it is \$1.81/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 35.70% below the baseline level in 2025 for MN. Multiplying the average mitigation cost by the number of tons of CO₂ mitigated will equal the *total* mitigation cost for each state.

^b Represents number of permits bought or sold.

Summary Data Table – Power Sector^{Draft}

DATA TABLE
(for Power Sector)

State	Cap: 30% Below 2005 Emissions in 2025 (million tCO ₂ e)	2025 BAU Gross Emissions (Consumption- based) (million tCO ₂ e)	GHG Mitigation Goal in 2025 (relative to BAU emissions)	Autarkic Marginal Mitigation Cost (dollars per tCO ₂ e)		Gross State Product in 2025 (million 2000 dollars)
				Low	High	
IA	24.0	40.8	41.06%	28.9	38.8	4,085
IL	45.6	82.4	44.63%	16.3	21.9	17,231
KS	22.4	38.6	42.05%	35.8	48.0	3,273
MI	43.9	72.7	39.60%	16.2	21.7	12,042
MN	36.0	64.4	44.04%	39.1	52.5	5,482
WI	34.2	59.9	42.90%	32.8	44.0	5,775
MB	0.1	0.5	72.22%	84.3	113.2	583
IN	65.9	105.8	37.72%	27.7	37.2	9,264
OH	90.5	145.3	37.72%	28.0	37.7	12,566
SD	4.9	8.4	42.05%	24.7	33.1	1,033
Total	367.6	618.8	40.60%			71,334



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

Auction Case

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

An Auction Case among MGA States

An Auction Case among MGA States

State	Total BAU Emissions in 2025 (million tCO ₂)	Emission Reduction Undertaken by the State ^a		Emission Allowances Bought from Auctioneer	Auction Cost (billion dollars) ^b
		(percent from BAU)	(million tCO ₂)		
IA	124.57	37.27	46.43	78.14	3.57
IL	319.73	43.86	140.24	179.49	8.20
KS	119.60	33.09	39.57	80.03	3.66
MI	270.58	39.82	107.75	162.83	7.44
MN	187.53	41.19	77.24	110.29	5.04
WI	161.85	41.42	67.04	94.81	4.33
MB	27.37	34.55	9.45	17.92	0.82
Total	1,211.23	40.27	487.73	723.50	33.05

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

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

MN-only Cap and Trade Simulation

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

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

Minnesota Gross GHG Emissions from Three Major Sectors, 1990-2025: Historical and Projected
MMTCO_{2e}

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

Cap in Year 2025: 30% below 2005 level

MMTCO_{2e}

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

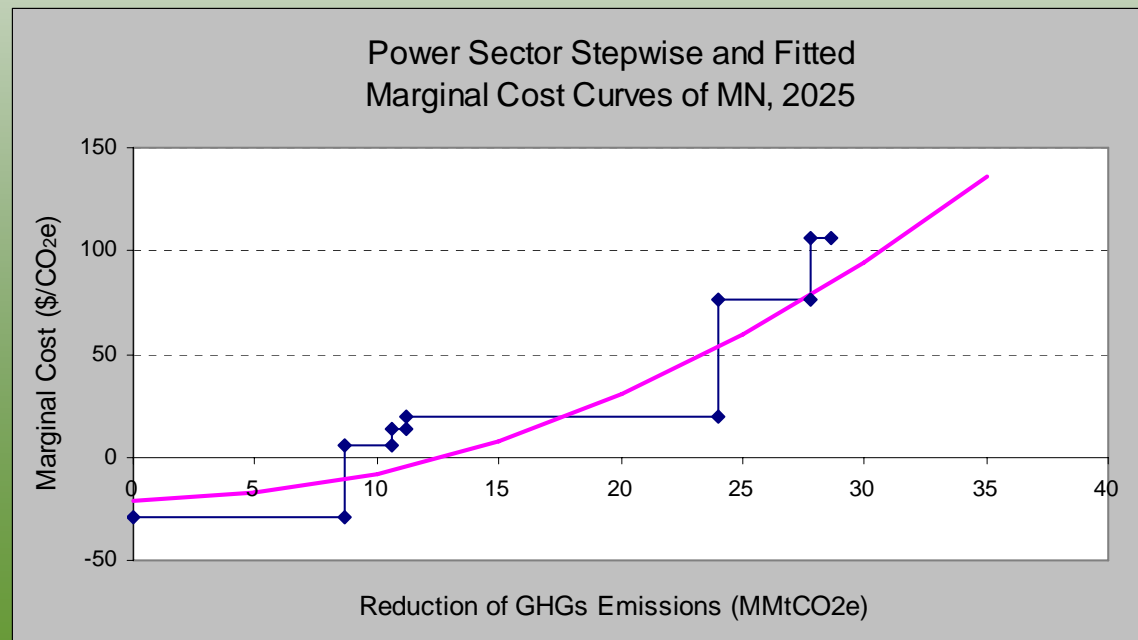
The 2025 emission cap in Minnesota is 30% below the 2005 level. We assume this emission cap applies to each of the three major sectors other than sequestration, i.e., each sector has an emission cap of 70% of its emission level in 2005. Sequestration Sector does not have a cap and we assume its BAU emission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

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

Power Sector

Draft

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



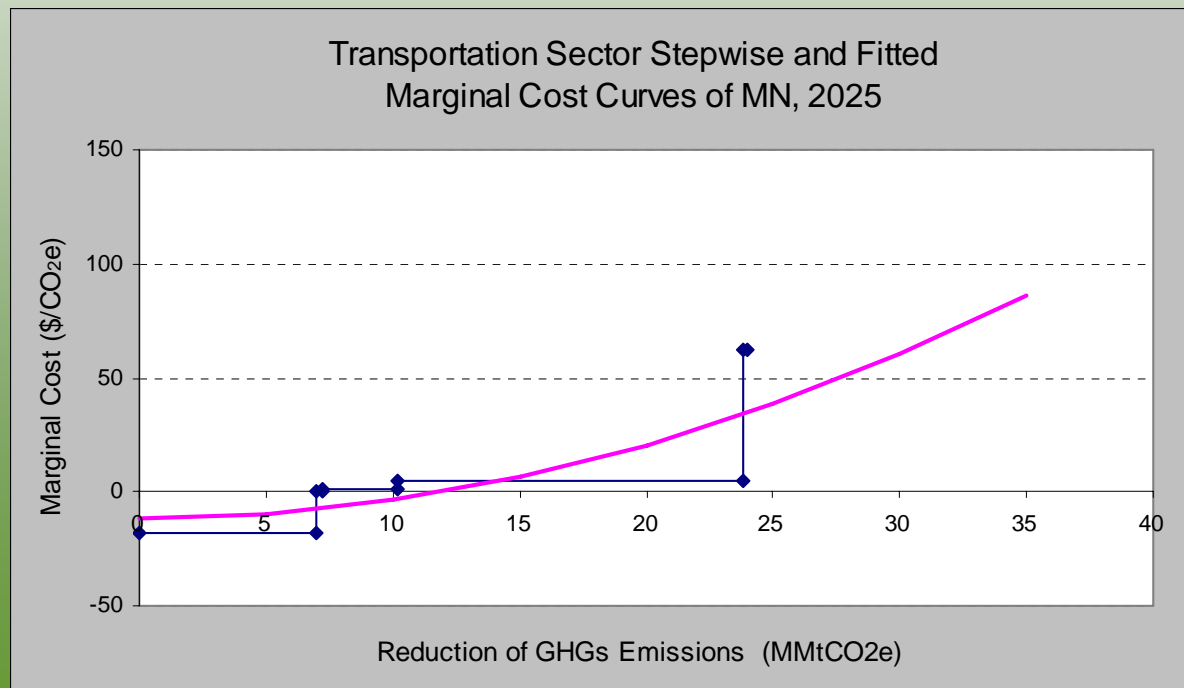
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Transportation Sector

Draft

	Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO ₂ e)	Estimated Cost or Cost Savings per ton GHG Removed	Cumulative GHG Reduction Potential (MMtCO ₂ e)
TLU	Adopt California Clean Car Standards	7	-\$18.00	7
TLU	Expand Transit, Bicycle, and Pedestrian Infrastructure	0.2	\$0.00	7.2
Ag	In-state Liquid Biofuels Production _A. Ethanol carbon content	3	\$1.00	10.2
Ag	In-state Liquid Biofuels Production _C. Gasoline Displacement	13.6	\$5.00	23.8
Ag	In-state Liquid Biofuels Production _B. Fossil diesel displacement	0.19	\$62.00	23.99



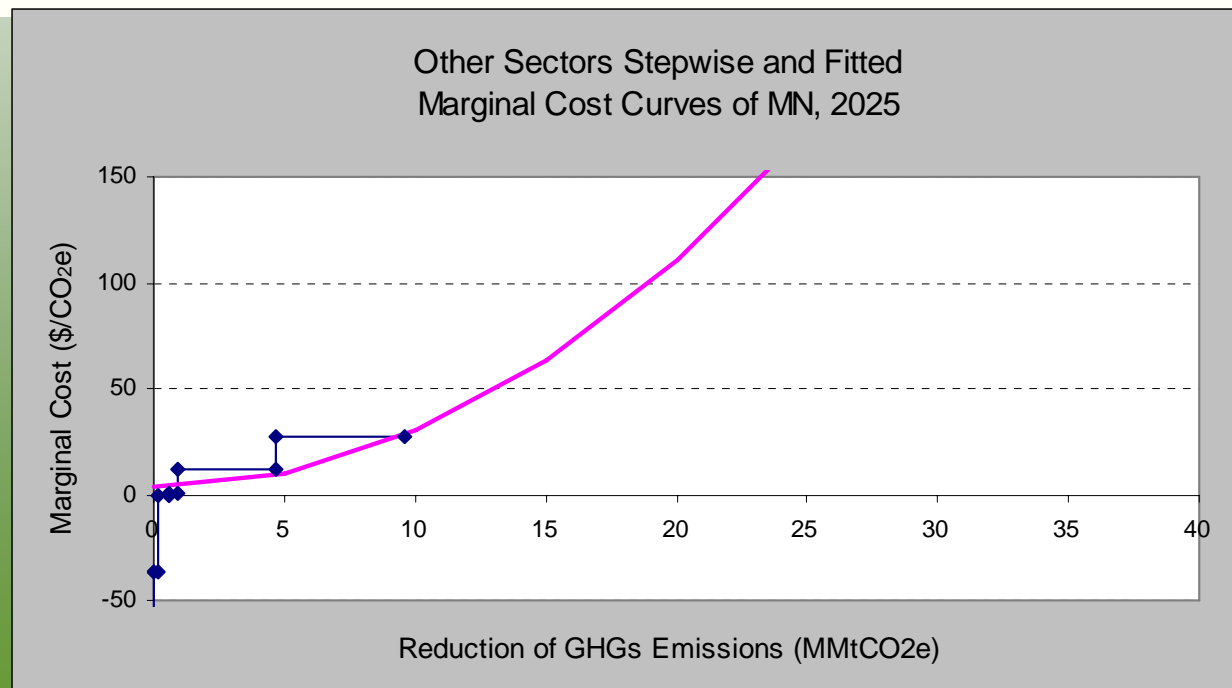
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Other Sectors

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	Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO ₂ e)	Estimated Cost or Cost Savings per ton GHG Removed	Cumulative GHG Reduction Potential (MMtCO ₂ e)
RCI	Improved Uniform Statewide Building Codes	0.0037	-\$189.70	0.0037
RCI	Non-utility Strategies and Incentives to Encourage Energy Efficiency and Reduce GHG Emissions	0.13	-\$37.10	0.1337
RCI	Green Building Guidelines and Standards Based on Architecture 2030	0.421	-\$0.26	0.5547
Waste	End of Use Waste Management Practices - Landfilled Waste Methane	0.34	\$1.00	0.8947
Ag	Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production	3.8	\$12.00	4.6947
RCI	Incentives & Resources to Promote Combined Heat and Power (CHP) (with RPS)	4.9	\$27.50	9.5947

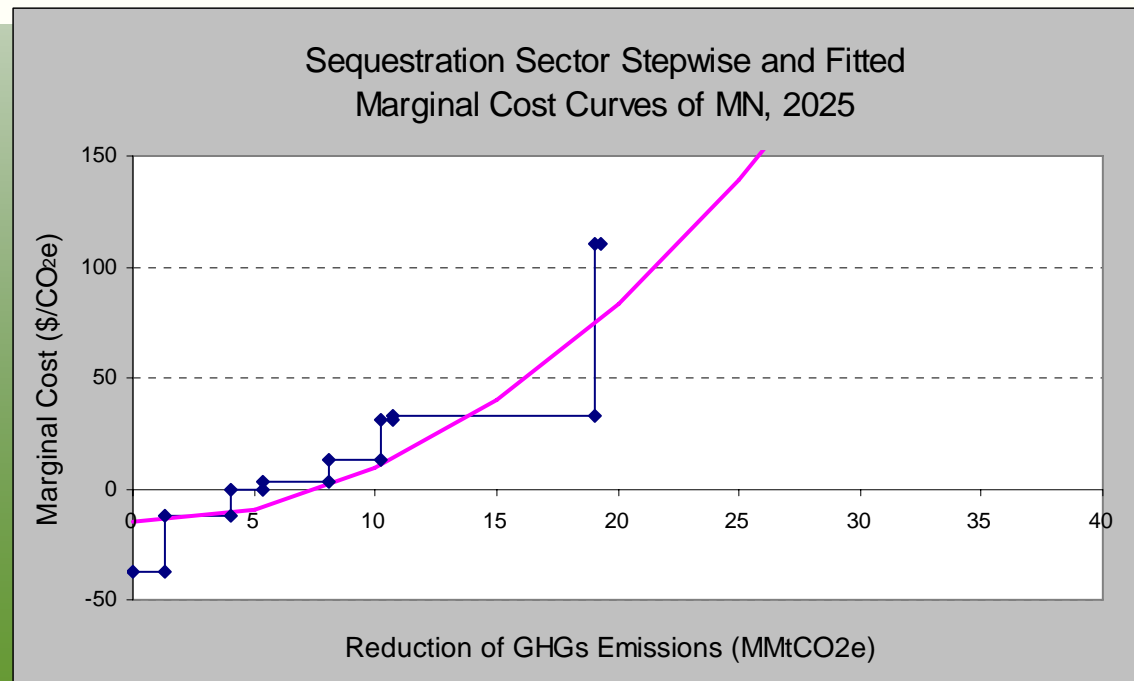


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Sequestration

	Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO ₂ e)	Estimated Cost or Cost Savings per ton GHG Removed	Cumulative GHG Reduction Potential (MMtCO ₂ e)
Ag	Agricultural Crop Management_B. Nutrient Management	1.35	-\$37.00	1.35
F	Urban Forestry	2.7	-\$12.00	4.05
Ag	Agricultural Crop Management_A. No Till	1.3	-\$0.25	5.35
F	Forest Protection - Reduced Clearing and Conversion to Non-Forest Cover	2.7	\$3.00	8.05
F	Forestration	2.19	\$13.00	10.24
Ag	Land Use Management Approaches for Protection and Enrichment of Soil Carbon_A. Preserve Land	0.45	\$31.00	10.69
F	Restocking	8.4	\$33.00	19.09
Ag	Land Use Management Approaches for Protection and Enrichment of Soil Carbon_B. Reinvest in Minnesota - Clean Energy (RIM-CE)	0.19	\$110.00	19.28



Emission Trading Simulation Among Four Sectors in Minnesota

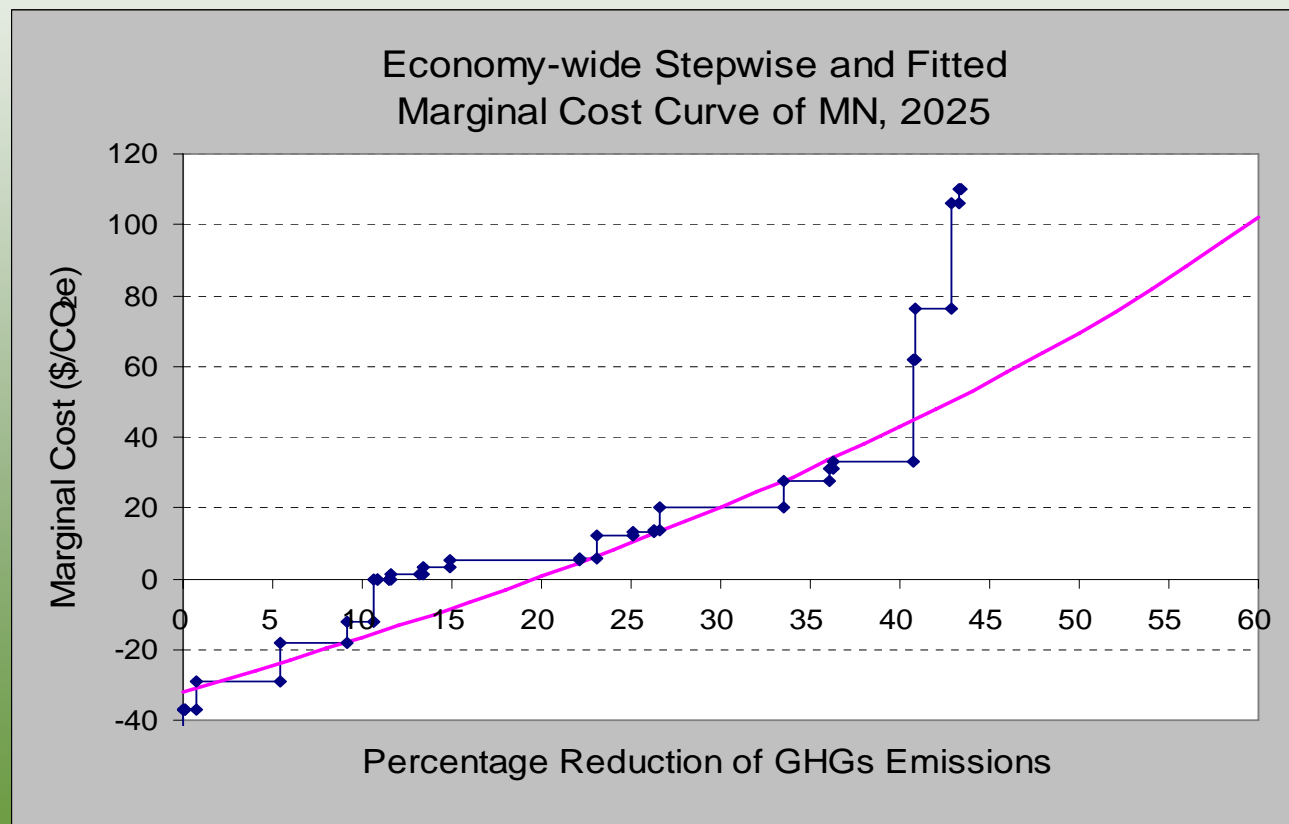
(million dollars or otherwise specified)

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

^a Permit Price = \$50.10/tonCO₂e.

^b Represents number of permits bought or sold.

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



Public Input & Announcements

Next Meeting