



Commission on Climate Change

Maryland Climate Change Commission Mitigation Working Group

Energy Supply Technical Work Group

Meeting #10

February 5, 2008

Maryland Department of the Environment
Maryland Energy Administration
Center for Climate Strategies

Call to Order and Roll Call

- Technical Work Group (TWG) Members
- Maryland Department of the Environment (MDE) and Maryland Energy Administration (MEA)
- Members of the Public
- Center for Climate Strategies

Agenda

- Call to order and roll call
- Review and approve call #9 summary
- Review and discuss quantification of priority policy options
 - ES-4 CCSR
 - ES-7 Renewable or Environmental Portfolio Standard
 - ES-8 Efficiency Improvements and Repowering Existing Plants
 - ES-10 Generation Performance Standards
 - ES-1 Promotion of Renewable Energy Resources (may be ready)
 - NOTE: ES-5 Clean Distributed Generation is being quantified by the RCI TWG
- Suggestions for analysis of revised policies
- Discussion of cap and trade modeling with Adam Rose and Dan Wei
- Public input and announcements
- Agenda, Time and Date for Next Meeting

Stepwise Planning Process

1. Develop inventory and forecast of emissions - Ongoing
2. Identify a full range of possible actions - **Sept. 7**
3. Identify initial priorities for analysis - **Sept. 28**
4. Develop straw proposals - **Oct. 26**
5. Quantify GHG reductions and costs/savings - Dec/Jan
6. Evaluate externalities, feasibility issues - Dec/Jan
7. Develop alternatives to address barriers - Jan/Feb
8. Aggregate results - Feb
9. Iterate to final agreements - Feb/Mar
10. Finalize and report recommendations - Mar

An Overview of the Cap and Trade Model

Rose-Zhang Permit Trading Model

- Purpose: Simulate basic features of cap & trade systems (and related policy refinements) to determine emission & cost implications
 - Extensive prior applications (Global, EU, US regions, RGGI)
 - Flexible & transparent framework
 - Readily accommodates data refinements & updates
 - Readily accommodates simple & complex designs

R-Z Model Features

- Based on sound economic principles
- Main inputs (for each entity)
 - emission levels
 - marginal mitigation costs
 - initial permit allocations
- Main outputs (for each entity)
 - pre-trading mitigation costs
 - post-trading mitigation costs
 - permit purchases/sales (volume & value)
 - permit price

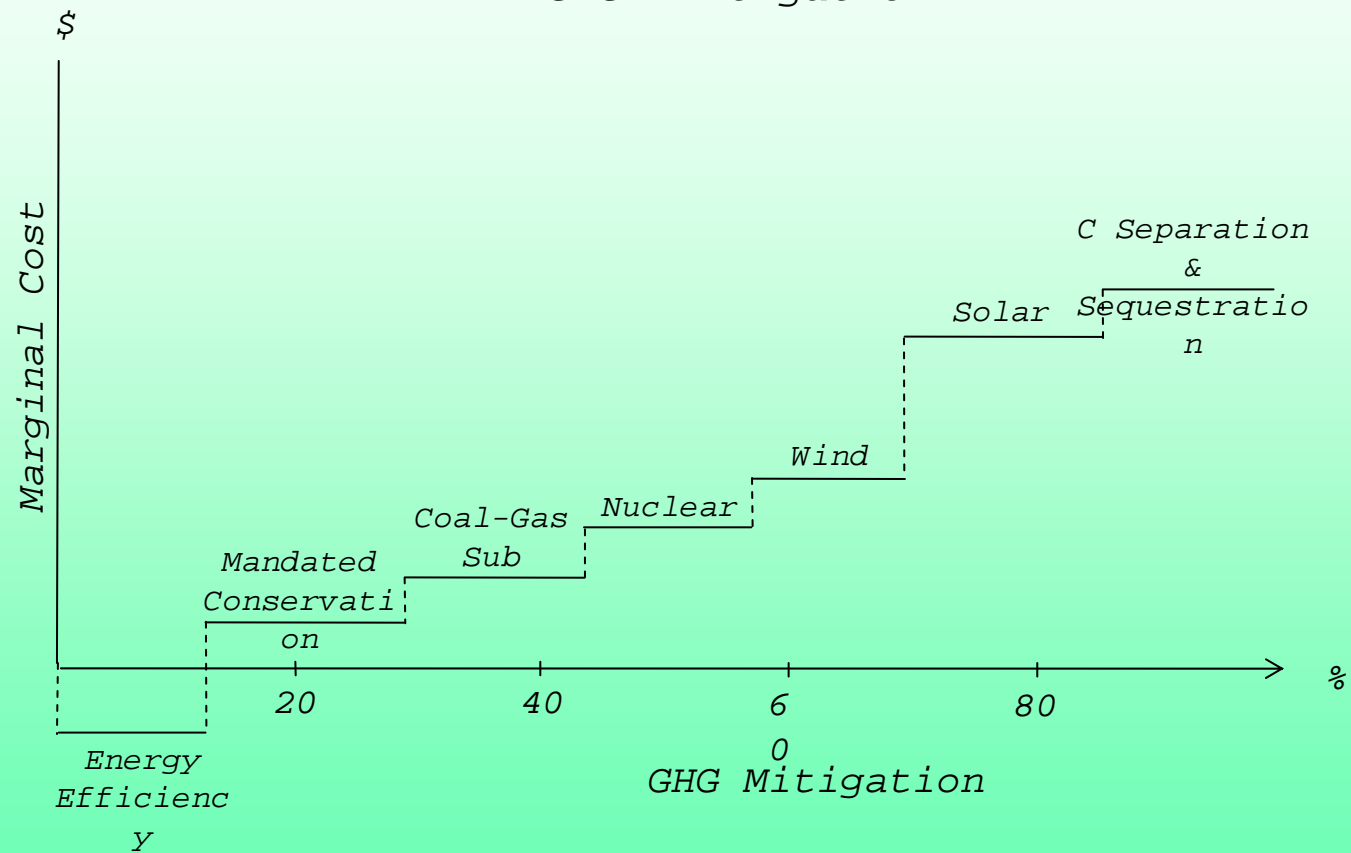
Evaluation Of Permit Trading Flexibility

(All entries represent departure from CO2 mitigation only unless otherwise indicated)

Study/Application	How	What	Where
Rose-Oladosu (2002) U.S.	Sequestration Permit price 64% lower	Methane Permit price 23% lower	
Stevens-Rose (2002) Global			Global trading Cost savings 85%
Springer (2003) Global		Methane and nitrous oxide Permit price 25-49% lower	From Annex I trading to global trading Average permit price 67% Lower
Zhang (2004) Global			From Annex I trading to global trading Permit price 76 - 79% lower
Akimoto et al. (2004) Global	Sequestration CO ₂ shadow price 32% lower		
IPCC (2001) Global			Global trading Marginal abatement costs 29 - 78% lower
Rose-Zhang (2004) U.S.			National trading Cost savings 41%

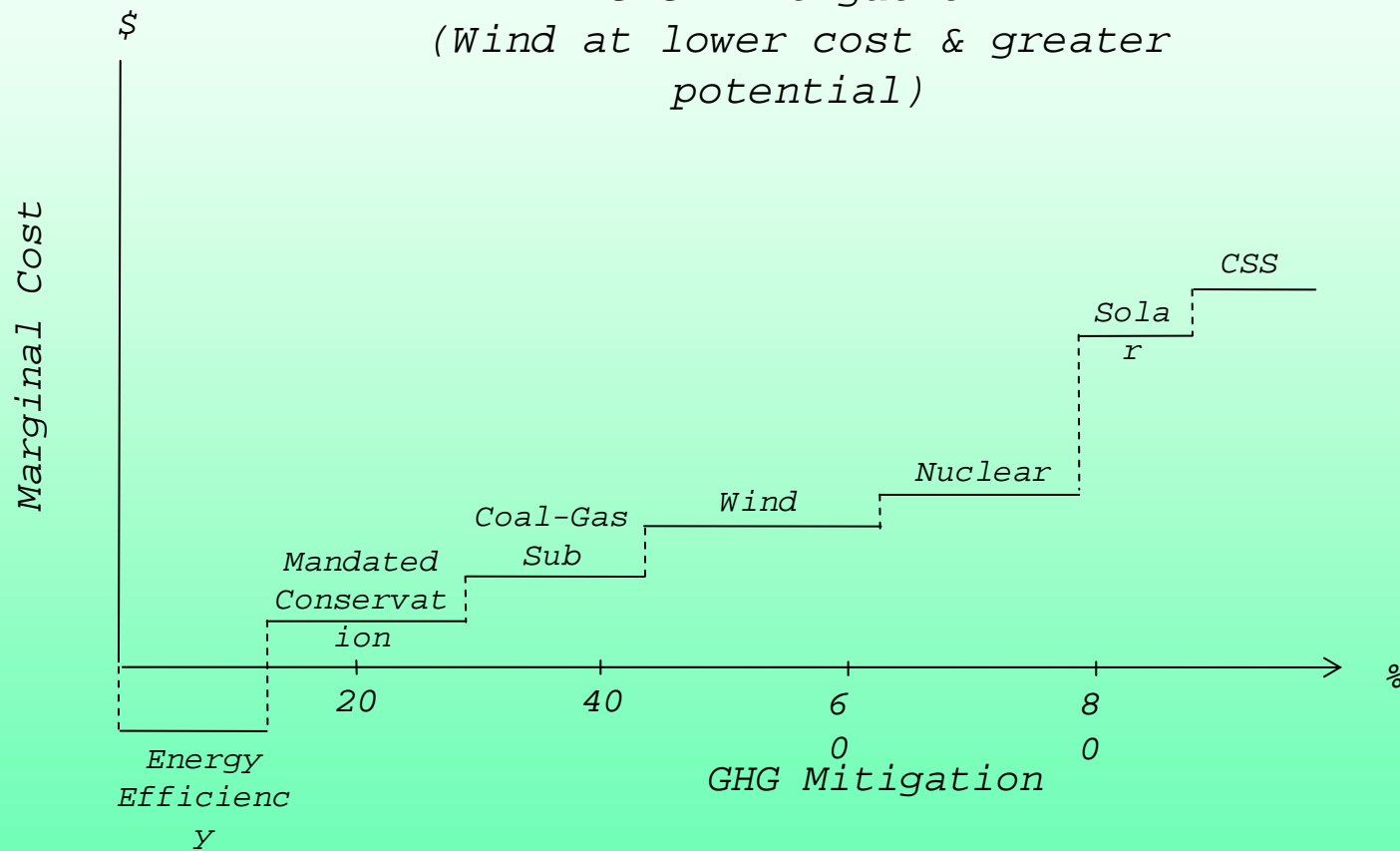
Sample Cost Curve

Figure 1. Marginal Costs of GHG Mitigation



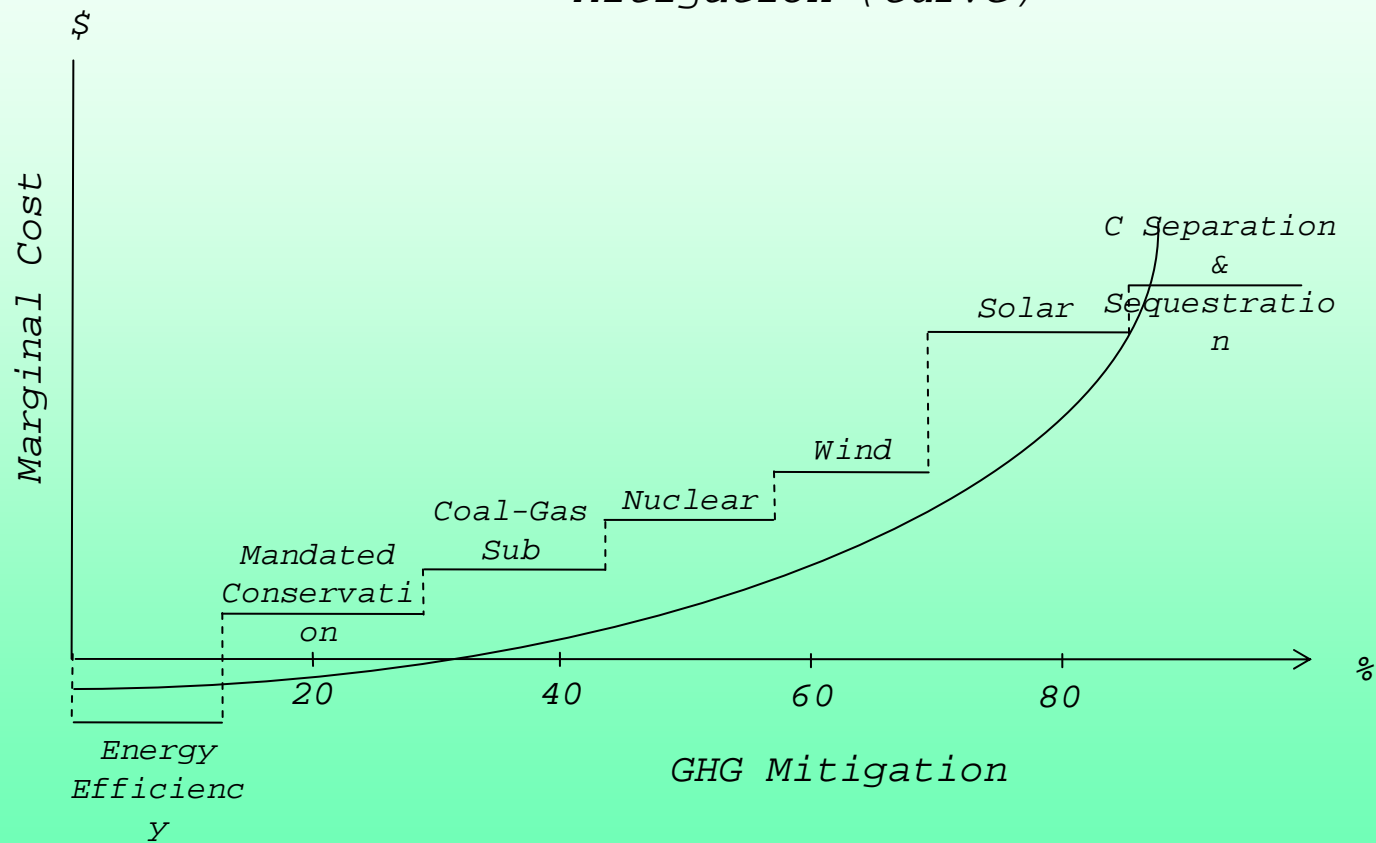
Sample Cost Curve

Figure 2. Marginal Costs of GHG Mitigation
(Wind at lower cost & greater potential)



Sample Cost Curve

Figure 3. Marginal Costs of GHG Mitigation (Curve)



Minnesota as an Example

GHG Mitigation Options List of Minnesota, 2025

Sector	Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential (MMtCO ₂ e)	Estimated Cost or Cost Savings per ton GHG Removed	GHG Reduction Potential as Percentage of 2025 Baseline Emissions	Cumulative GHG Reduction Potential	Weights (add-up to 100)
RCI	MN: Improved Uniform Statewide Building Codes	0.005	-\$576.00	0.00%	0.00%	0.01
RCI	MN: Support Strong Federal Appliance Standards and Require High State Standards in the Absence of Federal Standards	1.4	-\$124.00	0.71%	0.71%	1.59
RCI	MN: Maximize Savings From the Utility Conservation Improvement Program (CIP)	14.7	-\$63.20	7.44%	8.15%	16.72
TLU	MN: Adopt California Clean Car Standards	1.16	-\$39.00	0.59%	8.74%	1.32
AFW	MN: Agricultural Crop Management_B. Nutrient Management	1.3	-\$37.00	0.66%	9.39%	1.48
RCI	MN: Non-Utility Strategies and Incentives To Encourage Energy Efficiency and Reduce GHG Emissions	1.3	-\$37.00	0.66%	10.05%	1.48
RCI	MN: Conservation Improvement-Type Program for Propane and Fuel Oil Efficiency	0.05	-\$28.00	0.03%	10.08%	0.06
RCI	MN: Green Building Guidelines and Standards Based on Architecture 2030	0.94	-\$27.00	0.48%	10.55%	1.07
ES	MN: Transmission System Upgrading, Including Reducing Transmission Line and Distribution System Loss--Natural gas transmission and distribution upgrades	0.4	-\$26.10	0.20%	10.75%	4.32
AFW	MN: Forestry Management Programs to Enhance GHG Benefits_B. Urban forestry	2.7	-\$12.00	1.37%	12.12%	3.07
AFW	MN: Front-End Waste Management Techs._B. Recycling	3.4	-\$11.00	1.72%	13.84%	4.10
AFW	MN: In-State Liquid Biofuels Production_A. Ethanol carbon content	2.2	-\$9.00	1.11%	14.95%	0.47
RCI	MN: Program To Reduce Emissions of Non-Fuel, High-Global-Warming-Potential GHGs	0.05	-\$5.00	0.03%	14.98%	5.63
AFW	MN: Agricultural Crop Management_A. Soil Carbon Management	1.3	-\$2.00	0.66%	15.64%	10.24
TLU	MN: Climate-Friendly Transportation Pricing / Pay as You Drive	2.1	-\$1.00	1.06%	16.70%	0.46
ES	MN: Generation Performance Standard	0	\$0.00	0.00%	16.70%	2.50
ES	MN: Nuclear Power Support and Incentives--Installation of a nuclear power station in 2020	0	\$0.00	0.00%	16.70%	0.46
ES	MN: Advanced Fossil Fuel Technology Incentives, Support or Requirements	0	\$0.00	0.00%	16.70%	0.96
TLU	MN: Expand Transit, Bicycle, and Pedestrian Infrastructure	0.3	\$0.00	0.15%	16.85%	0.50
AFW	MN: End of Life Waste Management Practices_A. Landfilled Waste Methane	0.73	\$1.00	0.37%	17.22%	9.56
AFW	MN: Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production	3.8	\$3.00	1.92%	19.14%	0.22
AFW	MN: Forest Protection--Reduced Clearing and Conversion to Non-Forest Cover	2.7	\$3.00	1.37%	20.51%	0.22
AFW	MN: Front-End Waste Management Techs._A. Source Reduction	3.6	\$3.00	1.82%	22.33%	17.86
AFW	MN: Front-End Waste Management Techs._C. Composting	0.41	\$3.00	0.21%	22.54%	0.03
RCI	MN: Incentives & Resources To Promote Combined Heat and Power (CHP)	4.95	\$3.80	2.50%	25.04%	0.72
AFW	MN: In-State Liquid Biofuels Production_C. Gasoline Displacement	9	\$5.00	4.55%	29.60%	0.00
ES	MN: Efficiency Improvements, Repowering and other Upgrades to Existing Plants--Biomass co-	0.4	\$12.00	0.20%	29.80%	100.00
AFW	MN: Forestry Management Programs to Enhance GHG Benefits_A. Forestation	2.2	\$13.00	1.11%	30.91%	0.00
TLU	MN: Reduce Maximum Speed Limits	0.4	\$15.50	0.20%	31.11%	0.00
AFW	MN: End of Life Waste Management Practices_C. WTE Preprocessing	0.84	\$32.00	0.43%	31.54%	0.00
AFW	MN: Land Use Management Approaches for Protection and Enrichment of Soil Carbon_A. Preserve Land	0.44	\$33.00	0.22%	31.76%	0.00
AFW	MN: Forestry Management Programs to Enhance GHG Benefits_D. Restocking	8.4	\$33.00	4.25%	36.01%	0.00
AFW	MN: Land Use Management Approaches for Protection and Enrichment of Soil Carbon_B. Reinvest in Minnesota--Clean Energy (RIM-CE)	0.19	\$34.00	0.10%	36.11%	0.00
AFW	MN: In-State Liquid Biofuels Production_B. Fossil diesel displacement	0.19	\$55.00	0.10%	36.20%	0.00
ES	MN: Renewable and/or Environmental Portfolio Standard	15.7	\$56.40	7.94%	44.15%	0.00
ES	MN: Distributed renewable energy	0.023	\$78.10	0.01%	44.16%	0.00
AFW	MN: End of Life Waste Management Practices_B. Residuals Management	0.63	\$80.00	0.32%	44.48%	0.00

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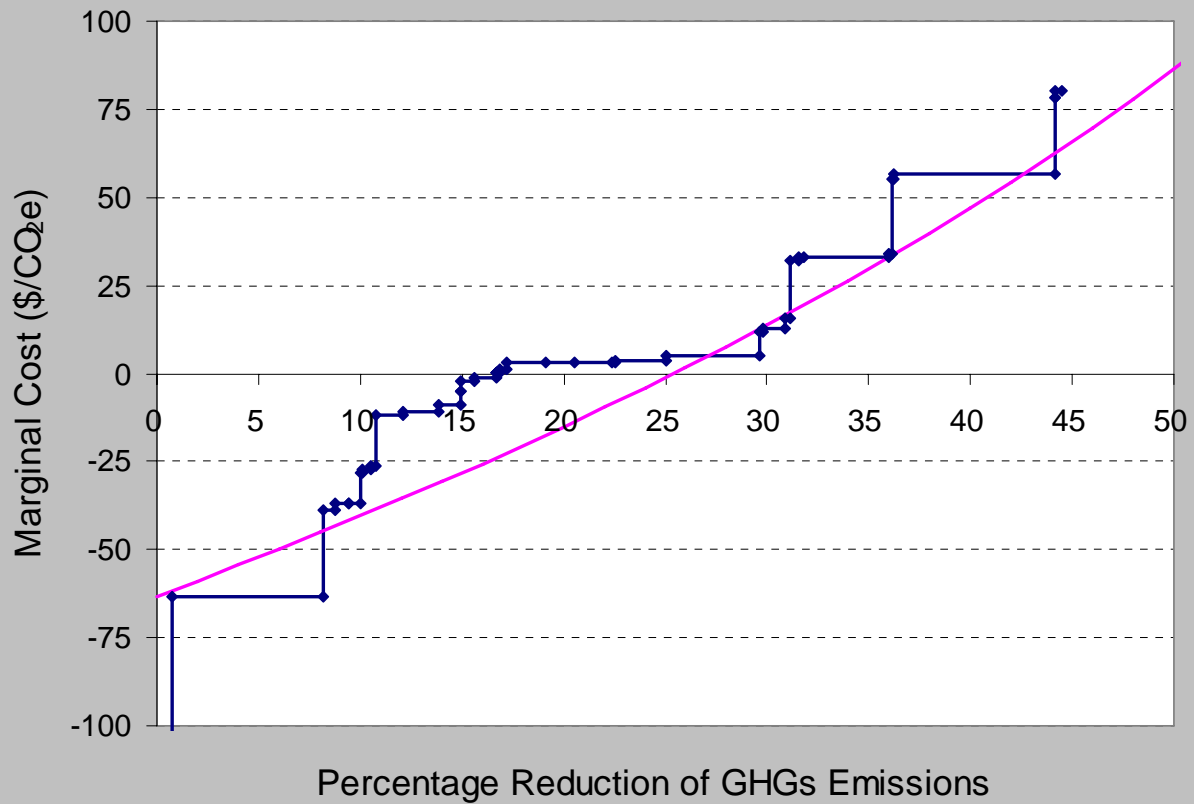
2025 projected consumption-based gross CO₂ emission level is 197.65 Million Metric Tons CO₂e.

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197.65

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Economy-wide Stepwise and Fitted
Marginal Cost Curves of MN, 2025



Sample Outputs

(multi-state cap and trade)

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			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	-478	-910	344	-565	87	7.10	47.91	38.01	43.65
IL	-1,581	-941	-756	-1,697	116	-15.61	138.64	43.02	38.18
KS	-621	-1,392	510	-882	261	10.53	42.27	34.94	43.65
MI	-1,663	-1,445	-234	-1,679	16	-4.83	109.06	39.95	38.18
MN	-439	-972	451	-521	81	9.31	79.82	40.38	45.09
WI	-915	-706	-233	-939	24	-4.81	67.32	41.11	38.18
MB	-178	-122	-83	-204	26	-1.70	8.10	39.29	31.02
Total	-5,876	-6,487	0	-6,487	611	26.94 ^b	493.11	40.28	40.28

^a Permit Price = \$48.45/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 -\$12.17/tonCO₂e. Please note that the average mitigation cost is related to mitigation level of a state, which for this case is 40.38% 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.

Sample Outputs

(Minnesota only cap and trade)

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	2,653	-692	1,141	449	2,203	17.42	24.14	30.38	52.31
Transportation Sector	-68	216	-457	-241	173	-6.98	20.71	52.06	34.51
Other	928	-9	584	575	352	8.92	24.97	31.80	43.16
Sequestration	0	272	-1,268	-996	996	-19.36	19.36	n.a.	n.a.
Total	3,512	-213	0	-213	3,725	26.35 ^b	89.18	45.10	45.10

^a Permit Price = \$65.48/tonCO₂e.

^b Represents number of permits bought or sold.

Policy Refinements

- Production-based vs. Consumption-based allocation
- Economic sector (emitter) disaggregation
- Offsets
- Flexibility
 - how (e.g., sequestration)
 - what (e.g., CO₂, methane, nitrous oxides, SFCs)
 - where (e.g., alternative configurations of states)
 - when (e.g., permit banking & borrowing)

Potential Permit Trading Anomalies

- Participants as a whole gain from flexibility
- However, individual states may not because new entrants:
 - may raise the permit price
 - may undercut existing states' permit sales
 - may be able to exercise monopoly power
 - may increase inequities

Next Steps

- Review/Refine Cap and Trade Proposal
- Receive C&T Modeling Analysis
- Receive and Review Remaining Quantification of Policies
- Revise/Refine Policy Option design and implementation

Public Input, Announcements

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Next ES TWG Meeting

- Date and Location:
 - February 12, 2008
- Agenda:
 - Review quantification of remaining options
 - Redraft PODs to reflect results of analysis and feasibility issues
 - Receive early C&T modeling runs (if possible)

