MINNESOTA ENVIRONMENTAL QUALITY BOARD

Wednesday, December 17, 2014

Meeting Location: MPCA Board Room
520 Lafayette Road North
St. Paul, Minnesota 55155
1:00 p.m. – 4:00 p.m.

Please see attached for a map of visitor parking
The Jupiter Parking Lot is for all day visitors and is located across from the Law Enforcement Center on Grove Street.
The Blue Parking Lot is also available for all day visitors and is located off of University and Olive Streets.

AGENDA

I. *Adoption of Consent Agenda
Proposed Agenda for December 17, 2014 Board Meeting
November Meeting Minutes

II. Introductions

III. Chair's Report

IV. Executive Director's Report

V. Minnesota Environment and Energy Report Card Update

VI. CSEO Update

VII. Adjourn

Note: Items on the agenda are preliminary until the agenda is approved by the board.

This agenda and schedule may be made available in other formats, such as Braille, large type or audiotape, upon request. People with disabilities should contact Elizabeth Tegdesch, Board Administrator, as soon as possible to request an accommodation (e.g., sign language interpreter) to participate in these meetings.

MINNESOTA ENVIRONMENTAL QUALITY BOARD

Wednesday, December 17, 2014

Meeting Location: MPCA Board Room
St. Paul, Minnesota
1:00 p.m. – 4:00 p.m.

ANNOTATED AGENDA

General
This month's meeting will take place in the MPCA Board Room at 520 Lafayette Road in St. Paul. The meeting will begin at 1:00 p.m. Staff will be available for briefing and questions at 12:30 p.m. *Please see attached for a map of visitor parking. The Jupiter Parking Lot is for all day visitors and is located across from the Law Enforcement Center on Grove Street. The Blue Parking Lot is also available for all day visitors and is located off of University and Olive Streets.*

I. *__Adoption of Consent Agenda__
Proposed Agenda for December 17, 2014 Board Meeting
November Meeting Minutes

II. **Introductions**

III. **Chair's Report**

IV. **Executive Director's Report**

V. **Minnesota Environment and Energy Report Card Update**

Presenter: Megan Eischen, Communications, EQB Staff
Todd Biewen, Assistant Division Director, Minnesota Pollution Control Agency
Steve Loomis, Planner Principal State, Minnesota Department of Commerce
Andy Holdsworth, Data and Performance Management Supervisor, Minnesota Department of Natural Resources

Materials enclosed: Executive Order 11-32, Minnesota Environment and Energy Report Card available at the following link:
https://www.eqb.state.mn.us/sites/default/files/documents/EQB%20Report%20Card%20Final.pdf

Issue before the Board: Pursuant to Executive Order 11-32, interagency staff will provide updates to the 2012 Minnesota Environment and Energy Report Card.

Background: Executive Order 11-32 (attached) called for the annual preparation of an Environment and Energy Report Card. In 2012-2013, the EQB held listening sessions around the state culminating in the Environmental Congress. The Minnesota Environment and Energy Report Card was distributed at these events to measure and communicate progress on the topics of water, land, air, energy, and climate.

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* *Items requiring discussion may be removed from the Consent Agenda*
***Denotes a Decision Item*

Discussion: EQB and interagency staff will lead a discussion with the Board on the updated metrics and discuss opportunities for communicating annual updates going forward.

VI. CSEO Update

Presenter: Anna Henderson, Planner, EQB Staff

Materials enclosed: An example policy option description for an increased renewable energy standard, a table of preliminary results for all policies, and a CSEO overview.

Issue before the Board: Staff will provide a concise overview of the project and an update on results.

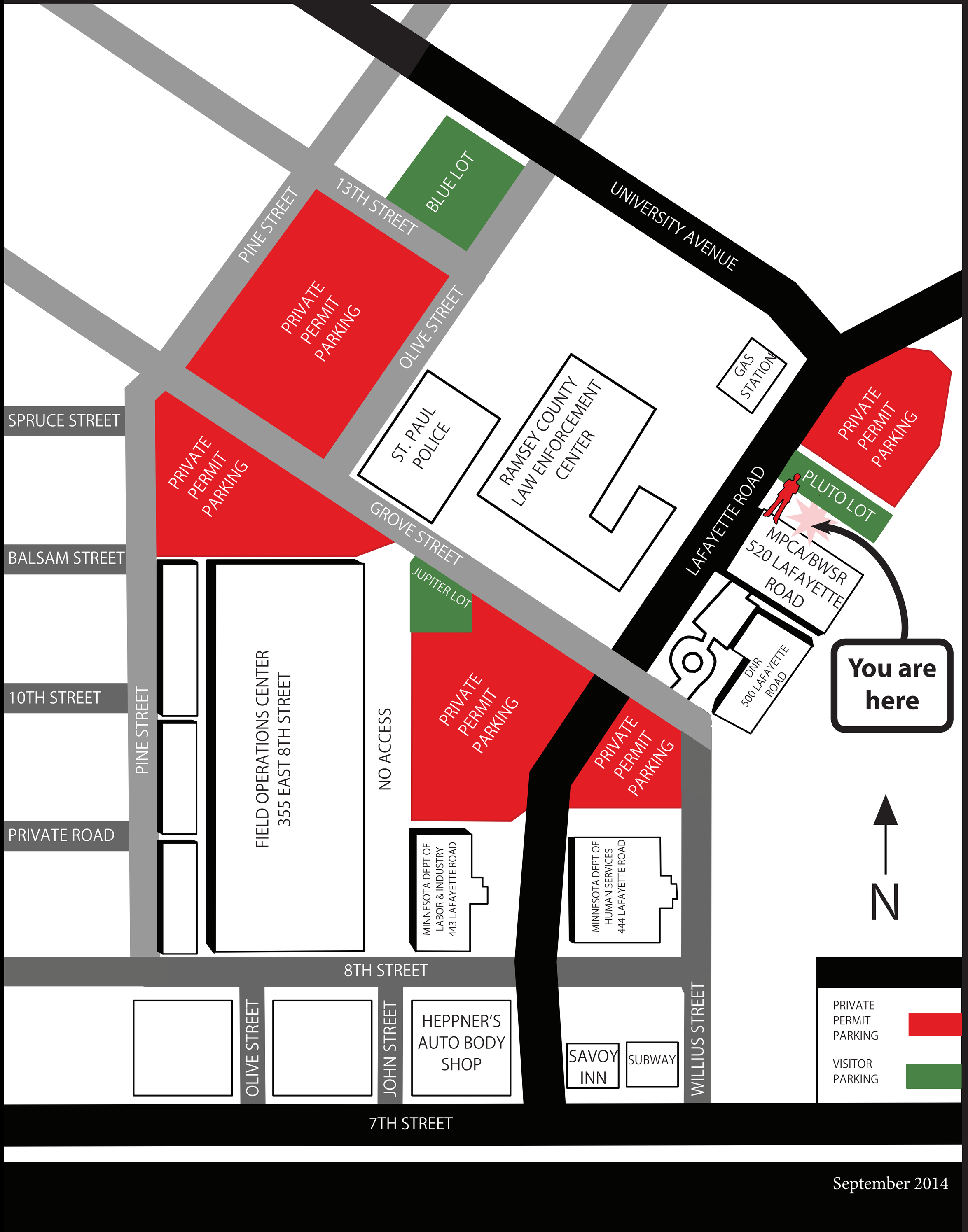
Background: The Climate Solutions and Economic Opportunities (CSEO) analysis is part of an evaluation of policy options from across Minnesota's economic sectors for their potential to grow our economy and to reduce greenhouse gases that contribute to climate change. Some of the strategies being analyzed are in statute or are taken from publicly vetted state agency plans. However, some of the options have not had previous examination and the analysis aims to provide information to inform ongoing discussions. Our goal is to provide timely and relevant information to allow for discussion on Minnesota's roadmap for developing a low carbon economy.

Discussion: EQB staff will lead a discussion with the Board on the project and be available to answer questions.

VII. Adjourn

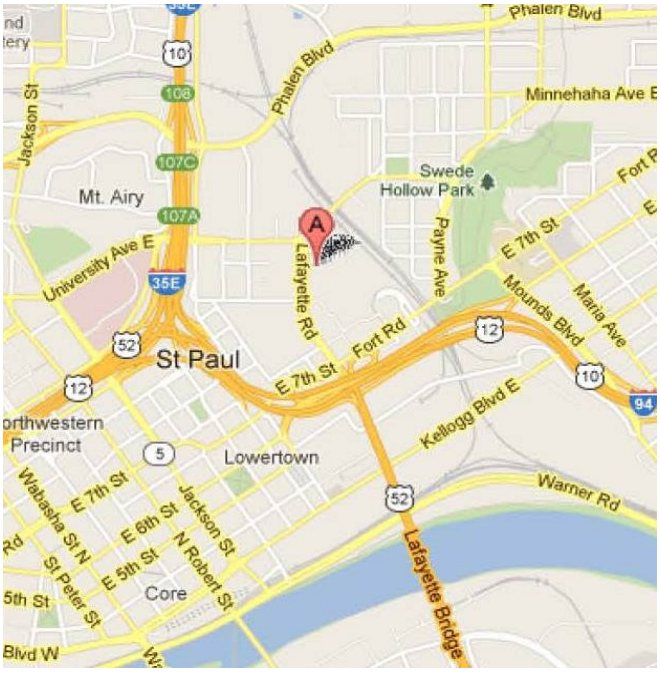
VISITOR PARKING MAP

Minnesota Pollution Control Agency
Board of Water and Soil Resources



September 2014

Driving Directions and Bus Routes to 520 Lafayette Road, St. Paul, Minnesota



Driving Directions:

Northbound on 35E: Exit on Pennsylvania Avenue. Turn right on Pennsylvania, then another immediate right onto Mississippi (almost like doing a u-turn). Follow to University Avenue, turn left. Follow to Lafayette Road, turn right and take the first immediate turn to the left, which is our four-hour visitor parking in front of the MPCA/BWSR building. If visitor parking in front of the building is full, additional visitor parking locations are noted in green on the map below. Visitor parking is free. You will need to register your vehicle and show a photo ID to the security guard at the front entrance to the building.

Southbound on 35E: Exit on University Avenue, turn left. Follow to Lafayette Road, turn right and take the first immediate turn to the left which is our four-hour visitor parking in front of the MPCA/BWSR building. If visitor parking in front of the building is full, additional visitor parking locations are noted in green on the map below. Visitor parking is free. You will need to register your vehicle and show a photo ID to the security guard at the front entrance to the building.

Eastbound on I-94 (from Minneapolis): Exit on 7th Street, turn left. Follow to Lafayette Road, turn left onto Lafayette. The MPCA/BWSR building is about 3 blocks from 7th Street on Lafayette, on the right hand side of the street. Turn right into the front parking lot, which is our four-hour visitor parking. If visitor parking in front of the building is full, additional visitor parking locations are noted in green on the map below. Visitor parking is free. You will need to register your vehicle and show a photo ID to the security guard at the front entrance to the building.

Westbound on I-94: Exit on Mounds Boulevard, follow to 7th Street. Turn left onto 7th Street. Follow 7th to Lafayette Road. Turn right on Lafayette. The MPCA/BWSR building is on the right hand side of the street, about 3 blocks from 7th. Turn right into the front parking lot, which is our four-hour visitor parking. If visitor parking in front of the building is full, additional visitor parking locations are noted in green on the map below. Visitor parking is free. You will need to register your vehicle and show a photo ID to the security guard at the front entrance to the building.

Bus Routes Serving Lafayette Road:

- Direct to 520 Lafayette: routes 64, 53, and 860L.
- To 3 blocks south at 7th and Lafayette: routes 61 and 74.

Park-and-ride facilities are available with all day buses at: I-394/I-494 Plymouth Transit Center, Maplewood Mall, and Mall of America. For more information contact Metro Transit (bus agency) at 612-373-3333.

MINNESOTA ENVIRONMENTAL QUALITY BOARD
MEETING MINUTES

Wednesday, November 19, 2014
MPCA Room Board Room, 520 Lafayette Road N, St. Paul

EQB Members Present: Dave Frederickson, Kate Knuth, Mike Rothman, John Saxhaug, Erik Tomlinson, Charlie Zelle, Matt Massman, Kristen Eide-Tollefson, Tom Landwehr, Katie Clark-Sieben, Julie Goehring, Brian Napstad, Michelle Beeman, Sandy Rummel (Met Council)

EQB Members Absent: Dr. Ed Ehlinger, John Stine

Staff Present: Will Seuffert (EQB), Megan Eischen (EQB), Caroline Magnuson (EQB), Heather Arends (EQB), Anna Henderson (EQB), Beth Tegdesch (MPCA for EQB)

Chair Dave Frederickson called the meeting to order at 1:11 p.m.

I. Adoption of Consent Agenda and Minutes

A motion to adopt the Consent Agenda and approve the August and September meeting minutes was made and seconded.

II. Introductions

III. Chair's Report

IV. Executive Director's Report

We are excited to share EQB's two signature inter-agency initiatives. Today you will hear a preliminary report on the Minnesota Clean Energy Economy Profile and Climate Solutions and Economic Opportunities. Both of these projects have involved a high level of inter-agency coordination over the past year helping us better understand the broad economic benefits incurred by our Clean Energy Policies and help us better understand options for mitigating climate change and the potential for future growth in our economy. Thanked the staff for the heavy lifting and the commissioners for their leadership on these projects. We are very excited that we had the opportunity to work with outside consultants who bring a level of expertise on analyzing these policies and accessing their impacts and just as excited to the participating agencies that have made the investment to staff resources to participate in this effort, building the data inventory and institutional capacity to carry much of this work forward. We hope we can build off of this to sustain this going forward. Thanks to Bill Grant and David Thornton for their hard work in helping steer this project and Anna Henderson for managing the project. Reminder that we initiate the stakeholder process for CSEO will be held tomorrow morning at the Science Museum. The next meeting presenting inter-agency updates to the EQB Energy and Environment Report Card that was published in 2012.

V. Minnesota Clean Energy Economy Profile

Presenters: Bill Grant, Deputy Commissioner, Department of Commerce
Weston Merrick, Economic Analyst, DEED

The presenters shared an overview of *Minnesota Clean Energy Profile: How Industry Sectors are Advancing Economic Growth,* which is a recently completed report that analyzes Minnesota's policies, employment, wages and innovation in five clean energy sectors. The objectives were to create a clean energy strategy for MN that can do a number of things; to allow us to compete in the global market for clean energy which has been growing tremendously over the last few years

now estimated at over a trillion dollars worldwide; grow small businesses in Minnesota and create high paying jobs; reduce dependence on imported energy; mitigate price volatility; achieve environmental emissions goals.

Discussion followed.

VI. Climate Solutions and Economic Opportunities

Presenters: Thomas Peterson, President and CEO, Center for Climate Strategies
David Thornton, Assistant Commissioner, Pollution Control Agency

Presentation shared on the progress and next steps on the Climate Solutions and Economic Opportunities (CSEO).

Discussion followed.

The following people gave testimony:

- Muna Khalif, Sierra Club/American Relief Agency for the Horn of Africa (ARAHA)
- Tess Ergen, Sierra Club/ARAHA
- Tim Rudnicki, Minnesota Bio-Fuels Association

VII. Silica Sand Technical Advisory Team (SSTAT) and Ordinance Library Update

Presenter: Heather Arends, State Program Administrator Director, EQB and DNR

1. 11 questions related to the City of Wabasha's draft mining and extraction ordinances were shared and responses overviewed.
2. A draft mock-up of the Silica Sand Ordinance Library was presented. The library will be implemented as soon as a web designer is available.

Discussion and comments followed.

VIII. Adjourn

If you would like to hear the audio recording of this meeting, go to the following link:
ftp://files.pca.state.mn.us/pub/EQB_Board/

STATE OF MINNESOTA

EXECUTIVE DEPARTMENT

MARK DAYTON
GOVERNOR

Executive Order 11-32

Directing the Work of the Environmental Quality Board

I, Mark Dayton, Governor of the State of Minnesota, by virtue of the authority vested in me by the Constitution and applicable statutes, do hereby issue this Executive Order:

Whereas, the Minnesota Environmental Quality Board (EQB) is composed of nine state agency heads, five citizen members, and a governor's representative, who serves as chair;

Whereas, the EQB is directed by law to:

1. Determine which environmental problems of interdepartmental concern to state government it shall consider and initiate interdepartmental investigations into those matters that it determines are in need of study, including but not limited to topics of future population and settlement patterns, air and water resources and quality, solid waste management, transportation and utility corridors, economically productive open space, energy policy and need, growth and development, and land use planning;

2. Review programs of state agencies that significantly affect the environment and coordinate those it determines are interdepartmental in nature, and ensure agency compliance with state environmental policy; and

Whereas, Minnesota's environmental review processes are complex, with multiple policy-setting and governing bodies, and are in need of review and revision to ensure that they respond to the public value of promoting economic growth, while also protecting Minnesota's precious natural resources; and

Whereas, the EQB by virtue of its composition is uniquely able to align state economic, energy and environmental policies to create a sustainable future for the our state, our economy, and our environment; and

Whereas, a well-functioning EQB can advance this Administration's goal to deliver the best services to the public at the best price; and

Whereas, the EQB does not have sufficient dedicated staff resources to undertake these vital planning and policy coordination functions.

Now, Therefore, in order to ensure that the EQB fulfills its policy-making and coordination roles I hereby order that:

1. By November 15, 2012, the EQB shall evaluate and make recommendations on how to improve environmental review, given the changes made in Chapter 4, House File 1, and the recommendations contained in the Office of the Legislative Auditor Environmental Review and Permitting Report.

2. By November 15, 2012, the EQB will evaluate and make recommendations for improved environmental governance and coordination.

3. By November 15, 2012, the EQB shall prepare an environmental and energy report card that identifies metrics which the State of Minnesota can use to measure its performance and progress protecting Minnesota's valuable air, water and land resources. Once initially established, the environment and energy report card shall be an annual report with renewed priorities, initiatives, and goals and an updated report card.

4. By January 15, 2013, the EQB shall organize and host an environmental congress focused on the current state of Minnesota's environment, utilizing the elements in the report card.

5. Each member agency of the EQB shall dedicate to the EQB the staff resources requested by the EQB Chair, for purposes of carrying out the work directed by this Executive Order.

Under Minnesota Statutes 2011, Section 4.035, subdivision 2, this Executive Order is effective 15 days after publication in the State Register and filing with the Secretary of State and shall remain in effect until rescinded by proper authority or it expires in accordance with Minnesota Statutes 2011, Section 4.035, subdivision 3.

In Testimony Whereof, I have set my hand on November 16, 2011.

Mark Dayton
Governor

Filed According to Law:

Mark Ritchie
Secretary of State

THE CENTER FOR
CLIMATE STRATEGIES

ES-1. Increase Renewable Energy Standards

Policy Description

This policy option would expand the Renewable Electricity Standard (RES) to:

- 40% by 2030 (modeling assumptions: 31% wind + 3% hydro + 3% biomass CHP + 3% solar)
- 50% by 2030 (modeling assumptions: 34% wind + 3% hydro + 3% biomass CHP + 10% solar)

Purpose and Rationale:

Legislation passed in 2013 supports the investigation of higher levels of renewable energy use in Minnesota, starting with increasing the Renewable Electricity Standard to 40% by 2030, and to higher proportions thereafter (MN Laws 2013, Chapter 85 HF 729, Article 12, Sections 1, 4, and 7). State legislation also sets the goal that by 2030, ten percent (10%) of the retail electric sales in Minnesota be generated by solar energy (MN Stat. §216B.1691).

Causal Chain for GHG Reductions

The diagram below illustrates how the policy leads to GHG reductions.

- "First Stage" refers to the direct physical impacts of the policy, namely a lower CO2e intensity of the electric system, increased manufacture of renewable systems, and lower fossil fuel use for every MWh of electricity produced;
- "Second Stage" refers to indirect physical impacts of the policy, namely GHG reductions allocated to consumers, GHG increases associated with increased renewable manufacturer activity, and lower absolute levels of GHGs and primary energy;
- "Third Stage" refers to reductions in direct upstream GHGs and fossil fuel use; and
- "Fourth Stage" refers to indirect upstream GHGs and fossil fuel use.

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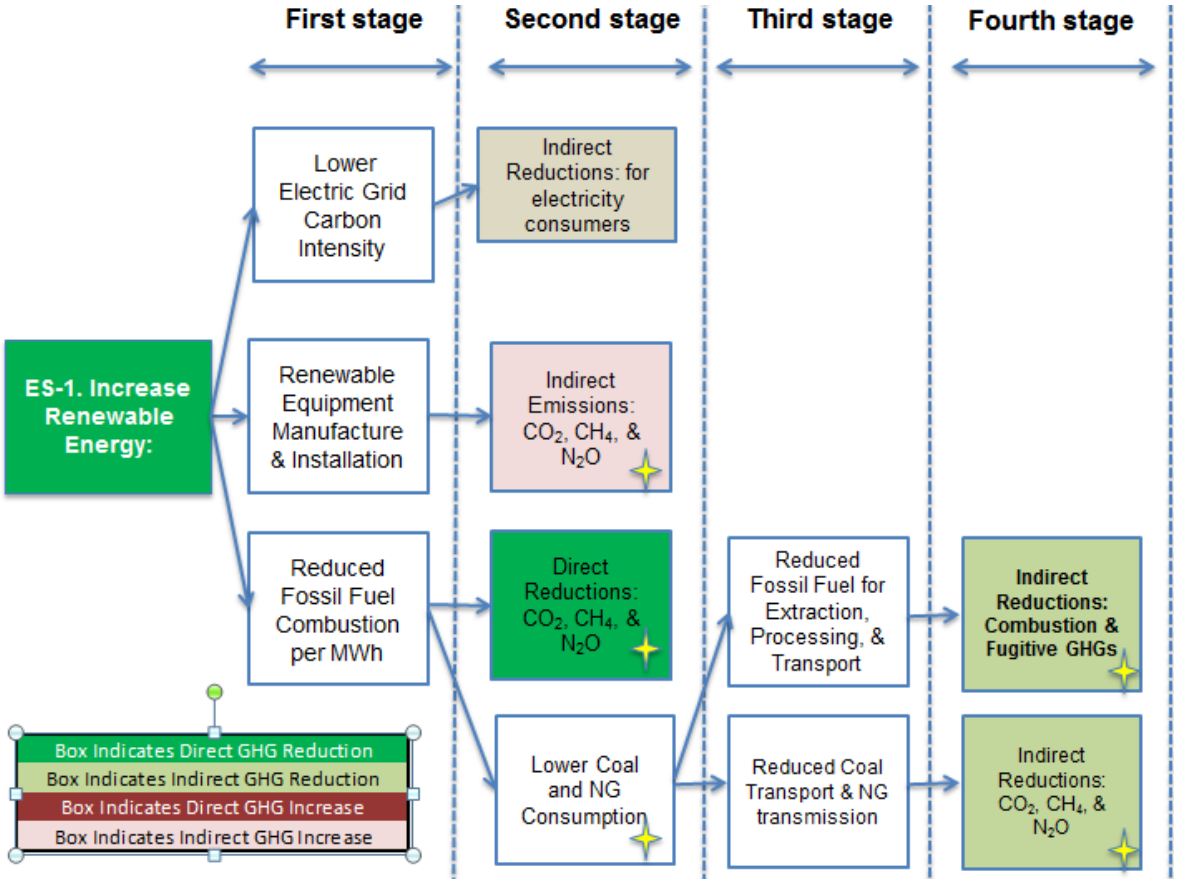


Policy Design

Goals: Model the GHG impacts of increasing the Renewable electricity standard to:

- 40% by 2030 – (modeling assumptions: 31% wind + 3% hydro + 3% biomass CHP + 3% solar)
- 50% by 2030 – (modeling assumptions: 34% wind + 3% hydro + 3% biomass CHP + 10% solar)
- Goals are stated as a percent of annual MN retail electricity sales (representing total contribution and not 'new' or 'incremental').

Note: Large industrial ratepayers are exempted from the current Solar Electricity Standard (216B.1691, Subd 2f. (d)) but as the specifics of the exemption are still in progress, for the purpose of modeling the proposed goals these ratepayers will be included in calculations of retail sales.

Timing: Current standards are ~28.5% by 2025:

- 30% by 2020 for Xcel,
- 25% x 2025 for all other utilities, and

- 1.5% additional Solar Electricity standard for Investor Owned Utilities (this works out to ~1% of MN total retail sales)

Parties Involved: This requirement would apply to all retail electricity sales in Minnesota. Implementation of this policy would require the enactment of enabling legislation and subsequent regulation by the PUC. Affected parties include ratepayers, utilities, transmission owners, power producers, renewable energy providers (in MN and neighboring states), and MISO.

Entities subject to RES Statute[1]:

- Basin Electric Power Cooperative
- Central Minnesota Municipal Power Agency (CMMPA)
- Dairyland Power Cooperative
- East River Electric Cooperative
- Great River Energy (GRE)
- Heartland Consumer Power District
- Interstate Power and Light
- L&O Power Cooperative
- Minnkota Power Cooperative
- Minnesota Municipal Power Agency (MMPA)
- Minnesota Power
- Missouri River Energy Services
- Northwestern Wisconsin Electric Company
- Ottertail Power Company
- Southern Minnesota Municipal Power Agency (SMMPA)
- Xcel Energy

Note: Large industrial ratepayers are exempted from the current solar electricity standard (216B.1691, Subd 2f. (d)) but as the specifics of the exemption are still in progress, for the purpose of modeling the proposed goals these ratepayers will be included in calculations of retail sales.

Other: Renewable Energy Credits used for compliance have a four year shelf life.

[1] In the Matter of Detailing Criteria and Standards for Measuring an Electric Utility's Good Faith Efforts in Meeting the Renewable Energy Objectives Under Minn. Stat. §216B.1691, Docket No. E999/CI-03-869, Order Setting Filing Requirements and Clarifying Procedures, (November 12, 2008).

Implementation Mechanisms

Regulatory Framework

Regulatory framework for wind, solar and hydro based on existing statute (Minnesota Statute 216B.1691) and PUC orders

Relevant PUC dockets/orders:

- Docket No. E-999/M-08-1163, In the Matter of Commission Consideration and Determination on Compliance with Renewable Energy Obligations and Renewable Energy Standards,
- E-999/CI-04-1616, In the Matter of a Commission Investigation into a Multi-State Tracking and Trading Systems for Renewable Energy Credits
- Docket No. 14-12 / E999/PR-14-237, In the Matter of Commission Consideration and Determination on Compliance with Renewable Energy Standards
- Docket No. 13-542 – In the Matter of the Implementation of Solar Energy Standards Pursuit to 2013 Amendments to Minnesota Statutes, Section. 216B.2691
- Docket No. 11-852 - In the Matter of Utility Renewable Energy Cost Impact Reports Required by Minnesota Statutes Section 216B.1691, Subd. 2e

RES Milestones

	MN Utilities Milestone	Xcel Milestone
2010	7.0%	15.0%
2012	12.0%	18.0%
2016	17.0%	25.0%
2020	20.5%	31.5%
2025	25.5%	31.5%

Note: The 1.5% Solar Electricity Standard applies to Investor Owned Utilities and takes effect in 2020. Accounting for the relative load of OTP and MN Power to the other non-Xcel MN utilities, the SES effectively comes out to about 0.5% of the retail sales for non-Xcel MN utilities.

Related Policies/Programs in Place and Recent Actions

MN Renewable Energy Integration and Transmission Study (MRITS) - Legislation passed in 2013 required a an engineering study of increasing the state's Renewable Energy Standards (RES) to 40% by 2030, and to higher proportions thereafter, while maintaining system reliability; The study must incorporate and build upon prior study work.

The study was conducted by Minnesota utilities and transmission companies in coordination with MISO and directed by the Minnesota Department of Commerce. Review and input was provided by a Technical Review Committee (TRC) comprised of individuals with experience and expertise in electric transmission system engineering, electric power system operations, and renewable energy generation technology.

The study was Minnesota centric with a study area focused on Minnesota within the MISO footprint and adjoining neighboring regions of the IS (Integrated System – Basin & WAPA) and MH (Manitoba Hydro).

The engineers conducted three analyses:

- The development of a conceptual transmission plan.
- The evaluation of the power system over one year, hour-by-hour to understand operational impacts.
- The overall system strength and stability of the region power system.

Study scenarios for MRITS:

- **Baseline: 28.5% of MN Retail sales** in 2028 from wind/solar (current MN RES & SES) with **13% MISO** in 2028 from wind/solar (current MISO state RESs)
- **S1: 40% of MN retail sales** in 2028 from wind/solar; with **15% MISO** in 2028 from wind/solar (current non-MN RESs + MN @40%)
- **S2: 50% of MN retail sales** in 2028 from wind/solar; with **25% MISO** in 2028 from wind/solar

The final study completed November 1, 2014 included: 1) A conceptual plan for transmission for generation interconnection and delivery and for access to regional geographic diversity and regional supply and demand side flexibility, and 2) Identification and development of potential solutions to any critical issues encountered.

The results from the study show that the addition of wind and solar generation to supply 40% of Minnesota's annual electric retail sales can be reliably accommodated by the electric power system.

Additional analysis would need to be done for adding renewables at levels significantly higher than 40%.

Note: Modeling assumptions for the Minnesota Renewable Energy Integration and Transmission Study differ from those assumptions used in the CSEO modeling (e.g. total load, energy consumption, siting, and % wind and PV)

Estimated Net GHG Reductions and Net Costs or Savings

Scenario	2030 GHG reductions (Tg CO_2e)	2015 – 2030 cumulative reductions (Tg CO_2e)	Net present value of societal costs, 2015 – 2030 (MM $2014)	Cost effectiveness ($2014/ ton CO_2e)	Net Incremental cost $2014/kWh
40% Scenario	10.7	90.0	$1,018	$11.31	$0.00085
50% Scenario	16.4	115.1	$1,340	$11.64	$0.00112

Data Sources:

- Common Forecast assumptions spreadsheet developed for the MNCSEO project by Steve Roe ("MN Common Forecast Data 20140829.xlsx")
- Electric system assumptions: final version of the power sector forecast prepared by Peter Ciborowski
- Utility RES compliance reporting data in docket 14-12
- Generator data from the Midwest Renewable Energy Tracking System.
- Siler-Evans et al "Marginal Emissions Factors for the U.S. Electricity System," 2012
- *Final Report - 2006 Minnesota Wind Integration Study Volume I* http://www.uwig.org/windrpt_vol%201.pdf
- *Wind, solar PV and NGCC* cost and performance assumptions from *Lazard's Levelized Cost of Energy Analysis – Version 8.0* http://www.lazard.com/PDF/Levelized%20Cost%20of%20Energy%20-%20Version%208.0.pdf
- For Biomass CHP, cost and performance assumptions are for industrial facilities as per the RCII-1 analysis, i.e., RCII-1_for_review_10-14-2014.xlsx. Note that heat rate for biomass CHP plants are in reference to electric generation efficiency only

Quantification Methods:

Using the assumptions below regarding resources on the electric margin, a spreadsheet analysis was undertaken using the methods summarized in the bullets below:

- Incremental renewable energy generation over and above the levels in the BAU were developed over the period 2015-2030 and costed using real levelized assumptions,
- Annual decremental marginal generation levels due to the penetration of renewable generation was calculated on the basis of the margin assumptions below.

margin based on hourly gross power output data over the 2006-2011 time period from the Continuous Emissions Monitoring System (CEMS).

- For the first model year of 2014 we use the average over the 2006 – 2011 period of the marginal emissions fractions for the MRO region provided by Siler-Evans et al. This seems to be a fairly conservative approach that should allow us to capture the fluctuation in marginal resource observed in the MRO region from 2006-2011 that occurred in response to natural gas pricing fluctuations over the same time period. The result from these assumptions is a margin for biomass CHP that is 79%coal, 20% NG and the balance oil-fired.

- Looking forward we expect some coal retirements and more natural gas plants to be installed, so we assume that the coal fraction will decrease as the marginal resource over the CSEO modeling period from 2014 – 2030. We use the starting point in 2014 and then extrapolate out to 2030 using the rate of change in marginal resource fractions from AEO2014. Using this slope we calculate a marginal resource fraction trending to ~70%coal/30%NG on the margin in 2030 as the generation fleet shifts to natural gas.

- *Avoided cost of energy:* The avoided cost of energy from coal, NGCT, NGCC, and oil-fired units accounted for real escalation in fuel prices as well as fixed and variable O&M costs.

- *Avoided cost of capacity:* The low end range of LCOE numbers published in Lazard's September update were used: http://www.lazard.com/PDF/Levelized%20Cost%20of%20Energy%20-%20Version%208.0.pdf Lazard's analysis breaks down the LCOE numbers by region for resource dependent variable generation like wind and solar instead of just giving a wide national range and the numbers are closer to what we are seeing. In calculating the avoided cost, efficiency measures, new wind and solar will displace/delay the need for new natural gas CC & CT units. We use an Effective Load Carrying Capacity of 14% for wind and 45% for solar.

- *Generation siting in-state vs out-of-state:* Under the statute governing Minnesota's RES, renewable generation at eligible renewable capacity located in any of the MRETs states may be used to generate RECs for compliance purposes. For the modeling here to simulate the RES, for both the business as usual case and the increased RES scenarios, we are including generation that counts toward the MN RES even if it is sited out-of-state. [Note: Under the MPCA's reporting framework for Next Generation Energy Act goals, renewable energy generation that occurs outside of Minnesota, whether earning MN RECs or not, does not figure in emissions (or emissions-avoided) calculations.]

- *Policy model interactions:* Increased efficiency on the demand- side will amplify the effect of existing renewable generation resources but it will also reduce the

- The avoided CO2e emissions associated with process heat from biomass CHP facilities was calculated.
- The annual net amounts of CO2e emissions and costs for each of the above categories was calculated and discounted using a 5% real discount rate
- Avoided emissions costs were not calculated due to uncertainty in the valuation method for proposed regulation.
- Cost of new transmission to deliver increased levels of renewable energy were not calculated in the CSEO model due to uncertainty in assigning such costs to renewables, which vary considerably from project to project.[2]
- Indirect costs and emissions of ancillary services were not calculated due to uncertainty in assessing the portion on ancillary services attributable to renewable energy compared to the ancillary services needed to support conventional generation that that would be offset by additional renewable generation.[3]

Key Assumptions:

- A key assumption concerned the resources on the electric margin that would be displaced by incremental renewable generation.
- As wind turbines primarily generate electricity during off-peak hours, the marginal resource being displaced by wind was assumed to be 100% coal.
- As solar PV installations generate electricity during daytime hours, about half of which is over peak load hours, the assumed marginal resource displaced by solar PV was assumed to be a mix of 50% NGCC and 50% NGCT.
- As biomass CHP generates kWh across all hours of the year, the system margin as estimated by Siler-Evans et al "Marginal Emissions Factors for the U.S. Electricity System" was used as a reasonable estimate of Marginal Resources on a Megawatt-hour basis based on historic energy generation data. The Siler-Evens et al analysis provides regional estimates of the share of generation resource on the

[2] While renewable energy can be a driver for new transmission investment, transmission improvements are long-term investments that are made for a variety of reasons with multiple benefits from reduced congestion, improved reliability, and economics. Allocation of a specific percentage of the cost of transmission investments to a general increment of renewable generation can be contentious without adequate documentation. Note: in the recent MRITS study, costs of a conceptual transmission plan for similar levels of renewables were identified (the modeling assumptions used in MRITS differ from those assumptions used in the CSEO modeling (e.g. total load, energy consumption, siting, and % wind and PV). MRITS modeled higher levels of variable renewables with 40 and 50% from wind and solar only. CSEO includes biomass and hydro in the 40 and 50% modeling.

[3] If ancillary service cost is calculated for renewables, then it will also need to be calculated for other technologies displaced by renewable energy. Furthermore, large coal plants are a driver of contingency reserves on the bulk electric grid, but MISO has confirmed that dispersed generation such as wind does not require contingency reserves.

need for new capacity from renewable or fossil resources. Additional CHP capacity may have the effect of reducing electric demand if it is in must-run mode. So even though it is a supply side resource, its effect on the operation and dispatch of other resources in the region may be similar to demand side efficiency.

Key Uncertainties

PTC/ITC extension: Uncertainty in Federal renewable policy, such as extension of the Production Tax Credit for wind energy and Investment Tax Credit for solar electricity may impact the cost to implement a higher RES. The fact that many utilities have reached RES compliance early may have been influenced by the expected expiration of the PTC & ITC, but if the PTC or ITC is not extended, it's not certain whether this trend will continue.

Increased energy efficiency will amplify the effect of existing renewable energy resources on percent goals.

Additional Benefits and Costs

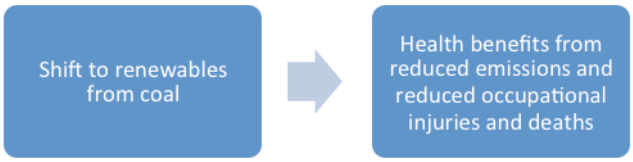
- Job creation (construction, maintenance, project design, manufacturing, forest product harvesting, etc.)
- Reduced GHG emissions from fossil fuels
- Increased county property tax income from wind and solar energy production taxes

Potential Health Impacts

Decreasing reliance on fossil fuels and increasing the use of renewable energy sources is likely to reduce health risks for the public and energy workers. Shifting to renewable energy sources from coal will decrease emissions of a variety of pollutants, including $PM_{2.5}$, carbon dioxide, sulfur dioxide, nitrogen oxides, and mercury compounds. (EPA; Kappos) These pollutants have been shown to have a variety of negative cardiac and pulmonary health effects. $PM_{2.5}$ can have especially serious effects, including significant increases in cardiovascular and cardiopulmonary disease and cancer mortality, exacerbation of respiratory illness, and long-term effects on respiratory function, particularly in children and older adults. (Pope 2002, Pope 2000, Bernard) Reducing these emissions may have a notable impact on morbidity and mortality associated with electricity generation, as health and environmental damages from electricity generation in Minnesota total an estimated $2.1 billion, with coal combustion-related emissions accounting for 94% of these damages. (Goodkind and Polasky)

This shift is also likely to decrease occupational injuries and deaths associated with energy extraction, generation and distribution. Mining is the second most dangerous industry in the United States, with 15.6 fatal occupational injuries per 100,000 workers having occurred in 2012, and conventional energy generation and distribution also

present significant occupational risks. (Bureau of Labor Statistics, Sumner) By contrast, occupational risks appear lower in both the wind and solar industries. (Fthenakis, Sumner)



*Reducing energy-related emissions is likely to reduce the risk for respiratory and cardiovascular illness, and cancer in exposed populations.

Feasibility Issues

Reliability study - The results from the study show that the addition of wind and solar generation to supply 40% of Minnesota's annual electric retails sales can be reliably accommodated by the electric power system. The analyses show that with upgrades to existing transmission, the power system can be successfully operated for all hours of the year with wind and solar to achieve 40% renewable energy. Additional analysis would need to be done for adding renewables at levels significantly higher than 40%. (more details above in the section on Related Policies and Recent Actions)

EPA 111(d) – an increased RES could be an effective component in Minnesota's plan to meet EPA targets for reducing carbon pollution from existing power plants.

Large Hydro - Certain interests (e.g. Utilities, MH) will push to allow large hydro in an increased RES.

Cost - Large Industrial/commercial & low income customers may resist higher RES based on the assumption of higher cost. A Lawrence Berkeley National Lab Report Lawrence Berkeley National Lab Report suggests that the RES in MN is saving ratepayers money in some cases or that there is a modest cost increase associated with it in other cases:

> ***Minnesota***
>
> *Minnesota's RPS requires Xcel Energy (Northern States Power) to obtain 31.5% by 2020, including 1.5% solar. Other utilities have separate requirements. Public utilities are required to obtain 26.5% renewable energy by 2025, including 1.5% solar. Non-public utilities are required to obtain 25% renewable energy by 2025 but do not have a solar requirement (DSIRE 2013). In 2012, Northern States Power met the RPS requirement of 13% with 5,637,456 MWh of RECs. Northern States Power has generated surplus RECs each year since 2008. The REC bank provides them the flexibility to defer the installation of new renewables and use banked RECs to comply with RPS obligations (Xcel Energy 2011).*
>
> *Of the fourteen utilities that submitted compliance reports, eight stated that complying with the RPS has resulted in little or no additional costs, if not slight*

savings for customers. Northern States Power reported that its renewable investments have been cost-effective and actually kept prices in 2008-2009 about 0.7% lower than they would have been without renewables. Northern States Power calculated the rate impact by determining the difference between the costs of implementing and not implementing the RPS, and then by determining the cost difference on a ¢/kWh basis by dividing the costs by total retail sales (Xcel Energy 2011).

Six utilities, including Great River Energy (GRE), reported that their efforts to comply with the policy are leading to increased costs for customers. GRE found that its wind energy purchases increased retail customer bills by about 1.6%, or about $1.50/month for an average residential customer (Haugen 2011).

http://emp.lbl.gov/sites/all/files/lbnl-6589e.pdf

		GHG Reductions (TgCO2e)				$ Costs/Savings	
Policy No.	**Policy Recommendation**	**2020 (one year) In-State**	**2030 (one year) In-State**	**2015-2030 In-State Cumulative Reductions**	**2015-2030 (In-State + Out-of-State)**	**Net Present Value 2015-2030 (MM$)**	**Cost Effectiveness ($/tCO2e)**
Energy Supply							
ES-1 (40%)	Renewable Energy Standard	-2	-11	-84	-84	1204	14
ES-1 (50%)	Renewable Energy Standard	-2	-16	-110	-110	1632	15
ES-2 (S1)	Repower Sherco 1&2 to natural gas	-6	-6	-74	-74	2	0.03
ES-2 (S2)	Repower Sherco 1&2 to natural gas	-6	-6	-68	-68	2	0.03
ES-2 (S3)	Repower Sherco 1&2 to natural gas	-6	-6	-72	-72	2	0.03
ES-4	CAA Section 111(d) Scenario	In Progress					
	Sector Total After Adjusting for Overlaps	-8	-22	-184	-184	1634	
Demand-Side							
RCII-1	Combined Heat and Power	-2	-6	-52	-53	-455	-9
RCII-2	SB 2030 Building Guidelines	-1	-10	-58	-64	-1030	-18
RCII-3	Reduction of High GWP GHGs	Not Quantified					
RCII-4	2.5%/yr Energy Efficiency	-1	-5	-34	-44	-1205	-31
RCII-5	Thermal Renewable Energy	-1	-3	-21	-29	804	37
	Sector Total After Adjusting for Overlaps	-5	-24	-165	-191	-1751	
Transportation							
TLU-1	Transportation Pricing	-2	-2	-23	-30	2807	92
TLU 1A	PAYD Insurance	0	-1	-9	-9	-1816	-159
TLU 1B	Carbon Tax	-1	-1	-8	-8	1898	173
TLU 1C	Fuel Tax	0	0	-6	-6	2726	342
TLU-2	Compact Metro Development	0	-1	-8	-9	-833	-94
TLU 2A	Reduced Home Energy Needs	0	-1	-8	-9	-759	-87
TLU 2B	Reduced VMT	0	0	0	0	-74	-1155
TLU 2& 3	Combined SmartGAP Run	0	0	-2	-2	-404	-195
TLU-3	Metro Mass Transit	0	0	-2	-2	-330	-165
TLU-4	Electric Vehicles	In Progress					
	Sector Total After Adjusting for Overlaps	-2	-3	-33	-43	1644	
Agriculture							
A-1	Fertilizer Reduction	In Progress					
A-2	Cover Crops	0	-1	-7	-7	-1240	-171
A-3	Increase Perennials	-1	-2	-21	-21	-2112	-99
A-4	Advanced Biofuels is nested into A-5						
A-5	State Biofuel Goal	0	0	-2	-4	296	69
	Sector Total After Adjusting for Overlaps	-2	-3	-31	-33	-2430	
Forestry							
FOLU-1	Protect Peatlands	Not Quantified					
FOLU-2	Best Management Practices	Nested into RCII					
FOLU-3	Community Forests*	0	-1	-7	-7	2004	273
FOLU-4	Disturbance Response	-1	-1	-15	-6	74	3
FOLU-5	Conservation of natural land*	0	0	-3	-3	2923	975
	Sector Total After Adjusting for Overlaps	-1	-3	-18	-16	5001	
Waste							
WM-1	Waste Water Treatment Efficiency	In Progress					
WM-2	Waste Reduction	In Progress					
WM-3	Increased Recycling and Composting	In Progress					
	Sector Total After Adjusting for Overlaps						
	Total	**-19**	**-56**	**-431**	**-468**	**4098**	**10**

**Total cost benefits and full GHG reduction potential not seen until future years*

The Climate Solutions and Economic Opportunities (CSEO) analysis is part of an evaluation of policy options from across Minnesota's economic sectors for their potential to grow our economy and to reduce greenhouse gases that contribute to climate change. Some of the strategies being analyzed are in statute or are taken from publicly vetted state agency plans. However, some of the options have not had previous examination and the analysis aims to provide information to inform ongoing discussions. Our goal is to provide timely and relevant information to allow for discussion on Minnesota's roadmap for developing a low carbon economy.

More information about these policies can be found at http://www.environmental-initiative.org/projects/policy-options-cseo-stakeholder-engagement

Agriculture

- Nitrogen management in agriculture
- Support healthy soils with increased use of cover crops
- Support healthy soils with increased use of perennials
- Conventional and advanced biofuel liquid petroleum replacement state goals

Forestry Management

- Protect the carbon sequestered in Minnesota's peatlands
- Manage for healthy forests with thinning applications
- Increase and maintain community tree canopies
- Tree planting in response to landscape-level forest disturbances
- Conservation on private lands to maintain and improve vegetative cover

Waste and Water

- Water use/management and energy efficiency integration
- Establishing an energy conservation goal for Publicly Owned Treatment Works
- Front-end waste management

Land Use and Transportation

- Transportation pricing mechanisms
- Improve land development and urban form through densification in the Metro
- Draft 2040 transportation policy plan by the Metropolitan Council
- Electric vehicles/Zero Emission Vehicle standard

Energy Supply

- Increase the Renewable Energy Standard
- Repowering and retirement for existing coal-fired power plants

Demand Side Energy Efficiency

- Incentives and resources to promote combined heat and power
- SB 2030 "Zero Energy Ready" building guidlines
- Increase the energy efficiency requirement
- Incentives and resources to promote thermal renewables