Energy Supply
Technical Work Group

Summary List of Pending Priority Policy Options for Analysis

	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2025 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2015	2025	Total (2008–2025)			
ES-4	Transmission System Upgrading, Including Reducing Transmission Line and Distribution System Loss						
	Electric transmission and distribution upgrades	unquantified					Approved
	Natural gas transmission and distribution upgrades	**0.2**	**0.4**	**3.9**	**-$92.2**	**-$26.1**	**Approved**

Notes:

1. ES TWG recommendations in **bold** above

2. All option total are relative to the underlying assumption that electric expansion in MN proceeds with the recently legislated Conservation Improvement Program, Renewable Energy Standard and all planned additions including the Mesaba and Big Stone 2 stations.

ES-4. Transmission System Upgrading, Including Reducing Transmission Line and Distribution System Loss

Policy Description

Measures to improve transmission systems to reduce bottlenecks and enhance throughput may be required to meet long-term electricity demands and improve the efficiency of operations system wide. Opportunities may exist to substantially increase transmission line carrying capacity through the implementation of new construction and retrofit activities on the transmission grid, including incorporating advanced composite conductor technologies, capacitance technologies, and grid management software.

Siting new transmission lines can be a difficult process due to the regulatory time and cost of line construction including new Right-of-Way (R/W) acquisition. This increases environmental impacts through increased carbon emissions due to siting and clearing a R/W and the local impact on the environment, habitat, and on land use, enjoyment, and value of property.

Policy measures in support of this option could provide incentives to utilities to upgrade transmission systems and reduce barriers to Certificate of Need filings for new and existing transmission lines. Future development of renewable energy facilities may require the addition of new or improved transmission lines which must be seamlessly integrated into the transmission grid. Measures facilitating development of these projects can be a critical part of Minnesota's renewable energy future.

There are several energy efficiency measures that can be implemented to reduce the transmission and distribution line losses of electricity. Utilities use a variety of components throughout the transmission and distribution system to manage losses. Increasing the efficiency of these components can further reduce losses and associated GHG emissions. For example, the state of Vermont offers a rebate to encourage the installation of energy efficient transformers. Regulations, incentives, and/or support programs can be applied to achieve greater efficiency of transmission and distribution system components.

Any reduction of leaks during production, processing, and distribution on natural gas systems avoids methane emissions to the atmosphere and prevents the waste of valuable product.

Policy Design

Goals:

- Provide financial incentives for implementing smart energy (computer) technologies.
- Assess the effectiveness of the streamlining efforts enacted in 2005 to siting and routing of transmission lines to determine what additional streamlining activities should be enacted.
- Allow financial recovery credit for related efficiency savings resulting in GHG reductions even if it is not shown to be cost effective from a customer standpoint whether it results from upgrading transformers or reconductoring (replacing inefficient conductors).
- Improve individual line and grid efficiencies with incentives to reduce line losses.

- Provide financial R&D support to identify new technologies including improved leak surveying of natural gas systems and upgrading natural gas controllers that operate and vent natural gas.

Timing: The program should be launched in 2010. Reductions should be achieved over the 2010-2025 time period.

Parties Involved: Electric Utilities, Gas Utilities, Independent System Operator, Gas Pipeline Companies

Implementation Mechanisms

As noted above

Related Policies/Programs in Place

Renewable energy objective, 25 by 2025.

Type(s) of GHG Reductions

Reduced carbon dioxide from fossil-fuel electricity generation; Avoided emissions from increased siting of renewable energy facilities; avoided methane emissions from leaks in natural gas distribution.

Estimated GHG Reductions and Net Costs or Cost Savings

Data Sources:

- GHG Inventory and forecast for MN prepared by Randy Strait ("GHGemitsum07_Working.xls" spreadsheet in a worksheet called "Stationary nonCO2 emissions")
- US GHG Inventory (available at http://www.epa.gov/climatechange/emissions/downloads06/07CR.pdf)
- Annex 3 of 2007 US GHG Inventory (available at http://www.epa.gov/climatechange/emissions/downloads06/07Annex3.pdf)
- EPA, "Directed Inspection and Maintenance at Compressor Stations" (available at http://www.epa.gov/gasstar/pdf/lessons/ll_dimcompstat.pdf)
- EPA, "Reducing methane emissions from compressor rod packing systems" (available at http://epa.gov/gasstar/pdf/lessons/ll_rodpack.pdf)
- EPA, "Replacing wet seals with dry seals in centrifugal compressors" (available at http://www.epa.gov/gasstar/pdf/lessons/ll_wetseals.pdf)
- EPA, "Directed Inspection and maintenance at gate stations and surface facilities" (available at http://www.epa.gov/gasstar/pdf/lessons/ll_dimgatestat.pdf)
- EPA, "Convert engine starting to nitrogen" (available at http://www.epa.gov/gasstar/pdf/pro_pdfs_eng/convertenginestartingtonitrogen.pdf)
- EPA, "Retrofit pneumatic devices with low-bleed kits" (available at http://www.epa.gov/gasstar/workshops/midland-6806/gremillion2.pdf)

- EPA, "Using pipeline pump-down techniques to lower gas line pressure before maintenance" available at http://www.epa.gov/gasstar/pdf/lessons/ll_pipeline.pdf)

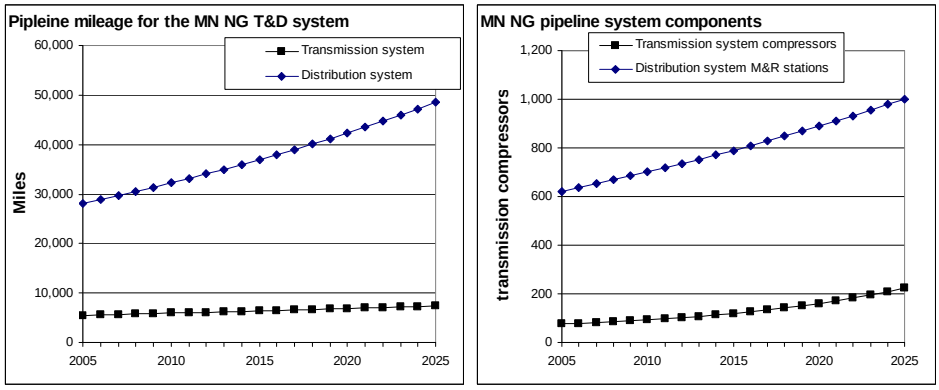
Quantification Methods:

This option would improve electricity transmission systems to reduce bottlenecks, enhance throughput, and improve the efficiency of operations system wide. The option also targets reduction of leaks in natural gas pipelines to avoid methane emissions to the atmosphere and prevent the waste of valuable product.

The option has been modeled thus far as an upgrade to the natural gas transmission and distribution pipeline system. This is due to the fact that the costs associated with upgrades to the electric transmission and distribution system remain speculative and are unquantified. The following assumptions were made regarding the analysis of upgrading the natural gas transmission and distribution system:

- The start year for the option is 2010.
- The methane reduction target for the MN natural gas transmission system is 25% of projected emissions in 2025 in the Reference Case.
- The methane reduction target for the MN natural gas distribution system is 15% of projected emissions in 2025 in the Reference Case.
- The ramp-up period for full implementation of methane leak mitigation for the MN natural gas transmission system is 10 years.
- The ramp-up period for full implementation of methane leak mitigation for the MN natural gas transmission system is 8 years.

Regarding the characteristics of the MN natural gas transmission system, the chart below summarizes the total projected mileage for both the transmission and distribution system (left), and the total projected number of compressors for the transmission system and the total number of metering and regulating (M&R) stations for the distribution system (right).



For the MN natural gas transmission system, there were several mitigation option analyzed for their collective impact on reducing methane leaks, as follows:

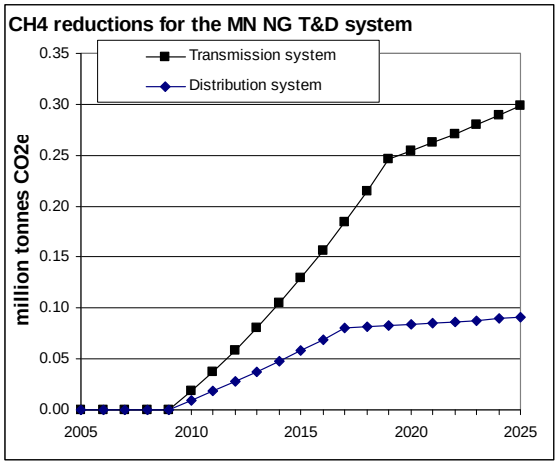
- Directed Inspection and Maintenance at Compressor Stations
- Reducing methane emissions from compressor rod packing systems
- Replacing wet seals with dry seals in centrifugal compressors

- Directed Inspection and maintenance at gate stations and surface facilities
- Convert engine starting to nitrogen
- Retrofit pneumatic devices with low-bleed kits
- Using pipeline pump-down techniques to lower gas line pressure before maintenance

For the MN natural gas distribution system, there were one mitigation option analyzed for its impact on reducing methane leaks, as follows:

- Directed Inspection and maintenance at gate stations and surface facilities

Regarding CO2-equivalent (CO2e) emissions reductions, the impact of the collective options is summarized in the chart below. The curves represents the annual CO2e reductions associated with avoiding methane leaks in the MN natural gas pipeline system. The annual emission reductions in 2015 and 2025 are 0.2 and 0.4 million tonnes CO2e, respectively. The cumulative emission reductions over the 2010-2025 forecast period are 3.9 million tonnes CO2e.



Regarding the annual costs of the option, there are incremental costs from biomass associated with capital improvements, O&M, and fuel for each of the options considered. There are incremental savings associated with the value of the natural gas emissions avoided. The net present value of these annual costs are -$0.093 billion over the 2010-2025 period (2005$).

Regarding the cost effectiveness of the option, it was calculated as the quotient of the NPV and cumulative GHG emission reductions, -$26/tCO2e (2005$) (i.e., -$0.093 billion divided by 3.9 million tonnes and multiplied by a conversion factor of 1,000).

Key Assumptions: See Annex 2

Key Uncertainties

The proposal would need to be integrated with the existing Cap-X 2020 program.

Additional Benefits and Costs

None

Feasibility Issues

The options represent practices that are well within technical capabilities of natural gas pipeline operation and maintenance activities

Status of Group Approval

Pending—[until MCCAG moves to final agreement at meeting #8]

Level of Group Support

TBD—[blank until MCCAG meeting #8]

Barriers to Consensus

TBD—[blank until final vote by the MCCAG]

ES-4: Natural gas transmission & distribution upgrades

Start year for transmission option 2010

Transmission system reduction in emissions (%)

1

1 Loss reduction is equivalent to 25% relative to the magnitude of emissions in the Reference Case (default)

2 User-defined (Loss reduction is equivalent to 25% relative to the magnitude of emissions in the Reference Case (default)

Ramp-up period for full upgrade of the transmission system (years)

1

1 Policy ramps up linearly over a 10 year period (default)

2 User-defined (Policy ramps up linearly over a 10 year period)

Phase-in for trasnmission system upgrading

Start year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
2008				0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2009					0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2010						2.5%	5.0%	7.5%	10.0%	12.5%	15.0%	17.5%	20.0%	22.5%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%
2011							0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2012								0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2013									0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2014										0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2015											0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2016												0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2017													0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2018														0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2019															0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2020																0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2021																	0.0%	0.0%	0.0%	0.0%	0.0%
2022																		0.0%	0.0%	0.0%	0.0%
2023																			0.0%	0.0%	0.0%
2024																				0.0%	0.0%
2025																					0.0%
	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	5.0%	7.5%	10.0%	12.5%	15.0%	17.5%	20.0%	22.5%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%

Start year for distribution system option 2010

Distribution system reduction in emissions (%)

1

1 Loss reduction is equivalent to 15% relative to the magnitude of emissions in the Reference Case (default)

2 User-defined (Loss reduction is equivalent to 15% relative to the magnitude of emissions in the Reference Case (default)

Ramp-up period for full upgrade of the distribution system (years)

1

1 Policy ramps up linearly over a 8 year period (default)

2 User-defined (Policy ramps up linearly over a 8 year period)

Phase-in for distribution system upgrading

Start year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
2008				0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2009					0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2010						1.9%	3.8%	5.6%	7.5%	9.4%	11.3%	13.1%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
2011							0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2012								0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2013									0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2014										0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2015											0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2016												0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2017													0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2018														0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2019															0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2020																0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2021																	0.0%	0.0%	0.0%	0.0%	0.0%
2022																		0.0%	0.0%	0.0%	0.0%
2023																			0.0%	0.0%	0.0%
2024																				0.0%	0.0%
2025																					0.0%
	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	3.8%	5.6%	7.5%	9.4%	11.3%	13.1%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%

ES-4. Natural gas transmission & distribution upgrades (continued)

Conversion factors

GWP	21	metric tons CO2e/metric ton CH4
1 Mcf	19.14	kg CH4
1 Mcf	1.03	mmbtu

Real discount rate 5%

Upper limit of emission reductions relative annual emissions

80% assumption

Natural gas savings by each mitigation option considered

Directed Inspection and Maintenance at Compressor Stations	29,413	Mcf of NG saved per year per station		
Reducing methane emissions from compressor rod packing systems	865	Mcf of NG saved per year per compressor		
Replacing wet seals with dry seals in centrifugal compressors	45,120	Mcf of NG saved per year per centrifugal compressor		
Directed Inspection and maintenance at gate stations and surface facilities	115	Mcf of NG saved per year per station		
Convert engine starting to nitrogen	1,350	Mcf of NG saved per year per engine		
Retrofit pneumatic devices with low bleed kits	219	Mcf of NG saved per year per device	10	devices per compressor station
Using pipeline pump-down techniques to lower gas line pressure before maintenance	26,548	Mcf of NG saved per year per pipeline length	20	miles between block valves

Real levelized costs to achieve NG reductions for each mitigation option considered for the transmission system (2005$/Mcf avoided)

Directed Inspection and Maintenance at Compressor Stations	1.529
Reducing methane emissions from compressor rod packing systems	0.151
Replacing wet seals with dry seals in centrifugal compressors	22.213
Directed Inspection and maintenance at gate stations and surface facilities	5.198
Convert engine starting to nitrogen	1.015
Retrofit pneumatic devices with low bleed kits	3.318
Using pipeline pump-down techniques to lower gas line pressure before maintenance	11.550

Weighted average city gate natural gas price (2005$/Mcf)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
2005$/mmbtu	8.3	8.5	7.9	7.9	7.5	7.3	7.0	6.8	6.6	6.7	6.6	6.7	6.9	6.8	6.7	6.8	6.8	6.9	7.0	7.1	7.1
2005$/Mcf	8.5	8.8	8.2	8.1	7.7	7.5	7.2	7.0	6.8	6.9	6.8	6.9	7.1	7.0	6.9	7.0	7.0	7.1	7.3	7.3	7.3