

A Report to the  
Minnesota Legislature  
on the Emissions and  
Control Costs of  
High Global Warming  
Potential Gases.



**Minnesota  
Pollution  
Control  
Agency**

Prepared by: Minnesota Pollution Control Agency  
Environmental Analysis and Outcomes Division  
Air Policy and Mobile Sources Unit  
Climate Change Program  
Saint Paul, Minnesota, 55155

MPCA Staff  
Contacts: Jim Sullivan  
(651) 757-2769  
Barbara Conti  
(651) 757-2288

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## Summary

The Minnesota Pollution Control Agency has prepared a report for the Minnesota Legislature that identifies the various sources, uses and control technologies for gases with high global warming potentials released in the state of Minnesota. The report was specifically developed to comply with Minn. Stat. §216H, and provides information that can be used to further implement the greenhouse gas targets and deadlines identified in the Next Generation Energy Act. Information used to develop the evaluation included similar evaluations published by other public-sector entities, specialty literature, discussions with industry representatives and data submitted on the purchase of high global warming potential gases under Minn. Stat. §216H. The information included emissions and cost effectiveness data. This report recommends a rule scoping process on high-global warming potential gases that will be used to better identify the manner in which to collect emission data, the role of voluntary programs in reducing emissions of high global warming potential gases and the role of greenhouse gas emission reporting in a broader greenhouse gas reporting strategy.

## Introduction

The Minnesota Pollution Control Agency (MPCA) was directed to generate a report on the use, emission sources, alternatives and cost effectiveness of control options for high global warming potential (GWP) gases in Minnesota that is consistent with the following requirements (Minn. Stat. §216H):

By February 1, 2009, the commissioner of the Pollution Control Agency shall submit a report to the chairs and ranking minority members of the senate and house of representatives committees with primary jurisdiction over environmental policy that identifies the uses and emissions sources of hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride in this state and suggests options for reducing or eliminating those uses and emissions and the costs of implementing those options. The options for reducing emissions must include phasing out specific consumer products containing high global warming potential gases where that is cost-effective.

This report is an important step in developing and implementing a statewide greenhouse gas reduction strategy, consistent with the targets identified in the 2007 Next Generation Energy Act (Act). The Act included requirements for Minnesotans to increase energy efficiency, expand community-based energy development, and establish a statewide goal to reduce greenhouse gas (GHG) emissions. The act established aggressive goals for Minnesotans to reduce statewide GHG emissions across all sectors:

- 15% below 2005 levels by 2015
- 30% below 2005 levels by 2025
- 80% below 2005 levels by 2050

Gases with high global warming potentials (high-GWPs) comprise approximately two percent of the annual statewide emissions budget (See Figure #1), consistent with a national emission inventory. The Minnesota Climate Change Advisory Group (MCCAG) climate change action plan noted that “Industrial process emissions accounted for about 1% of the state’s greenhouse gas emissions in 2005, and these emissions are rising due to the increasing use of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) as substitutes for ozone-depleting

chlorofluorocarbons (CFCs).”<sup>1</sup> The contributions of greenhouse gases by economic sector in Minnesota are presented in Figure #1 and were adapted from the MCCAG Climate Change Action Plan. The emissions from industrial processes comprise the emissions of high-GWP gases. Emissions of HFCs from automobile air conditioning units and sulfur hexafluoride (SF<sub>6</sub>) emissions from the utility sector increase the percentage of high-GWP emissions in Minnesota to approximately two percent of the statewide annual emissions of greenhouse gases.

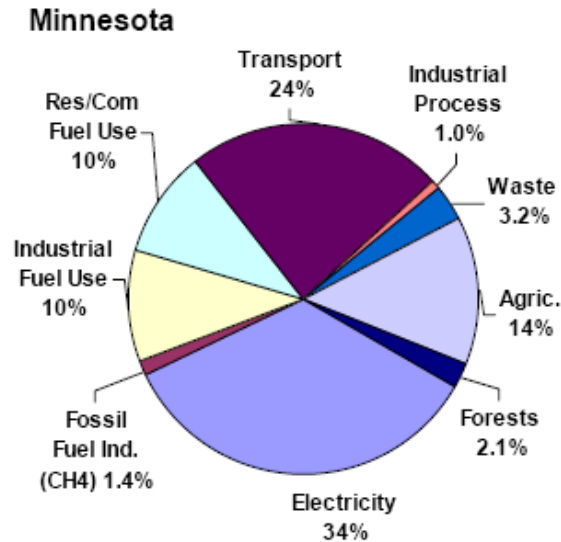
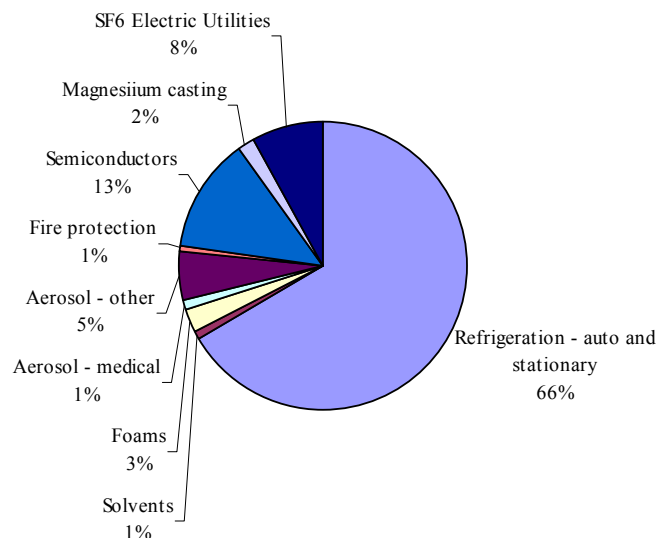


Figure #1 – Annual Contributions (percentage) of Greenhouse Gases by Economic Sector in Minnesota.

Figure #2 - HGWP Gases National Distribution (by CO<sub>2</sub>eq) 2010



<sup>1</sup> Minnesota Climate Change Advisory Group, 2008. Final Report. A Report to the Minnesota Legislature. Saint Paul, MN. EX-2.

This percentage equates to approximately 3 million tons of carbon dioxide equivalent emitted annually. The distribution of contributions of high-GWP gases in Minnesota is likely to be similar to the national emission profile (See Figure #2). While high-GWP gas emissions may be small, they are typically emissions where control technologies or substitute gases exist. Reducing high-GWP gas emissions from the annual statewide emissions budget is a step in attaining the statewide emission reduction goals under the Next Generation Energy Act.

The MCCAG offered a three-pronged policy design to address the development of a long-term emission control strategy for high-GWP gases:

- Elimination of emissions of high-GWP greenhouse gases (GHGs) at reasonable cost;
- Promotion and funding for process optimization; and,
- Use of lower-impact alternatives for coolants, refrigerants, aerosols, solvents, and insulation.

To implement the policy directions identified above, the MCCAG identified the following mechanisms:

- MPCA rulemaking process for a comprehensive GHG reporting strategy that includes high-GWP gases;
- Legislative action to provide tax incentives and funding for technical support and assistance; and,
- Technical support through the Minnesota Technical Assistance Program (MnTAP) or similar entities.

Based on the MCCAG evaluation, many of the sectors appear to be able to reduce emissions within a \$15 per ton carbon dioxide equivalent control cost. The MCCAG considered this value to be a reasonable cost. After reviewing the technical and administrative data on the high-GWPP reporting, the MPCA developed two specific recommendations based on the sector review and the MCCAG Climate Change Action Plan. The MPCA's specific recommendations for future high-GWP gas activities are provided at the end of this Report.

### Scope of the Report

This report is a summary of the MPCA technical evaluation on control effectiveness and cost conducted for each economic sector where high-GWP gases are used. The sectors include refrigeration and cooling, foam blowing industries, fire suppression, semiconductor manufacturing, magnesium casting electrical generation and transmission, and specific consumer products. The results of this analysis are found in the MPCA *Technical Evaluation on the Emissions and Control Costs of High Global Warming Potential Gases* (Technical Report), developed in conjunction with this report.<sup>2</sup> A copy of the Technical Report is available for review and can be found on the MPCA website.<sup>3</sup>

### Sources of Information

The information used in this Report was obtained from the following sources:

- Review of existing high-GWP reports compiled by various public sector entities;

<sup>2</sup> Minnesota Pollution Control Agency, 2009. Technical Evaluation on the Emissions and Control Costs of High Global Warming Potential Gases. Saint Paul, Minnesota.

<sup>3</sup> <http://www.pca.state.mn.us/hot/legislature/reports/>.

- Review of available specialty literature;
- Case study data; and,
- 2007 MPCA high-GWP chemical purchase and manufacturer reporting data.

The information developed from existing high-GWP reports was reviewed for analytical methodology, and relevance to industry in Minnesota. Many of the reports used in this analysis were developed to assess national and international emissions. While the specific emission inventories may not directly reflect the Minnesota situation, control technologies and costs are considered to be relevant and applicable to industry in Minnesota. Specialty literature was used where information was lacking or found to be out of date.

The MPCA attempted to use the high-GWP reporting data collected for the 2007 reporting season, pursuant to Minn. Stat. §216H.11. The modest response rate limited the MPCA's use of this data in the Report. For further discussion on reporting response rate, see the discussion in the *Program Administration Evaluation* in this report.

The foundation for the MPCA Report is the 2001 Environmental Protection Agency (EPA) *U.S. High GWP Gas Emissions 1990-2010: Inventories, Projections, and Opportunities for Reductions* and the EPA 2006 *Global Mitigation of Non-CO<sub>2</sub> Greenhouse Gas* report. The EPA reports presented the following data for each high-GWP emission sector:

- Baseline emissions of high-GWP gases. The source of the emissions in the United States was summarized, followed by a baseline forecast of U.S. emissions from that source through 2020.
- This baseline was estimated under a “no-action” case scenario and, for some sectors, a “voluntary technology adoption” scenario where active industry efforts existed.
- High-GWP gas emission reduction options and associated costs.

The MPCA used this presentation format throughout the various sectors analyzed. Since few voluntary efforts appear to exist in Minnesota, the MPCA used the “no action” baseline to predict future emissions. Other bodies of information, including peer-reviewed and professional specialty literature, were employed to augment and update various features of the EPA analysis. The data and information used in this report was evaluated to determine that it accurately and credibly reflected the uses of high-GWP gases in the various sectors in Minnesota.

The Technical Report is composed of 10 chapters. Chapter 1 is an introduction to the issues presented through the legislation and an overview of climate change and engineered gases. The work presented in Chapter 2 is a review of previous and existing policy and regulatory approaches from Minnesota, other states, federal activities and international efforts. The analytical approach to the project is described in Chapter 3. Chapters 4 through 9 are a review of each sector that may potentially be affected by a high-GWP program. This analysis includes the costs associated with emission control or elimination.

### **Discussion of Findings**

The MPCA reviewed the various high-GWP gas emission control strategies and cost estimates for selected economic sectors where these gases are used. In addition, the MPCA reviewed the implementation of the statutory reporting requirements for the purchase and manufacture of high-GWP gases.

### Technical Evaluation

The MPCA recommendations are guided in part by recommendations from the MCCAG. The MCCAG policy direction for this report was the elimination of high-GWP emissions at a reasonable cost. The MCCAG stated that “For purposes solely of calculation of the costs and effects of this recommendation, a reasonable cost is determined to be \$15 per ton CO<sub>2</sub> equivalent.” The MPCA notes that many of the sectors reviewed may be able to reduce emissions within the \$15 per ton cost criteria. The information provided below is a review of the predicted national baseline data by sector, the potential reductions that are achievable using the \$15 control price, and the percent reduction if control technology is adopted. This information is presented for the years 2010 and 2020.

Table #1 - National Emission Reduction and Cost Analysis using a \$15/tCO<sub>2</sub>e Control cost (EPA, 2006).

Sector	2010 Baseline (MtCO <sub>2</sub> eq) <sup>d</sup>	2010 a Reduction (\$15/tCO <sub>2</sub> e) <sup>d</sup>	2010 b Reduction (%)	2020 Baseline (MtCO <sub>2</sub> eq)	2020 a Reduction (\$15/tCO <sub>2</sub> e)	2020 b Reduction (%)	Options/Comments
Refrigeration (auto and stationary)	148	11.5	7.8	264	78	29.5	Least cost are leak repair for large system, recovery for small system and enhanced HFC-134a system for mobile air conditioning.
Solvent	1.7	0.43	25.3	2	1.05	52.5	Substitution and improved system design
Foams	5.7	0.2	3.5	11.3	1.17	10.4	Substitution
Aerosol - medical	2.7	0	0	5.5	0	0	No effective substitutes
Aerosol - other	12.1	4.67	38.6	14.8	8.43	57.0	Assumes no effective voluntary program – “no action” baseline
Fire protection	1.6	0	0.0	1.9	0	0.0	Long life of installed system - replacements being developed
Semiconduct ors	28.2	20.0	70.9	46.1	32.7	70.9	Assumes “no action” baseline
Magnesium Casting	4.6	4.5	97.8	6.4	6.26	97.8	There is an IMA goal to phase out by 2011 but participation in MN is not known - assumed “no action” baseline
Electrical Utilities SF <sub>6</sub>	17.6	10.05	57.1	18.9	10.78	57.0	Assumes “no action” baseline
Total	222.2	51.35	23.1 c	370.9	138.39	37.3 c	

- a This column represents the amount removed by sector at a cost of \$15 per ton of carbon dioxide equivalent.
- b This column represents the percentage of pollutants removed, by sector, from the overall baseline for 2010 and 2020.
- c The value in the shaded area represents the overall percentage of pollutants removed from all sectors in comparison to the baseline for 2010 and 2020.
- d Million ton of carbon dioxide equivalent (MtCO<sub>2</sub>eq) – Dollars per ton of carbon dioxide equivalent (\$/tCO<sub>2</sub>e).

### Program Administration Evaluation

The MPCA implemented the manufacturer and purchaser reporting requirements through a combination of a mass mailing and email effort. On September 8, 2008, the MPCA sent a total of 3,260 letters informing permittees and other likely businesses of the new reporting requirement. In addition, notice was provided in the State Register on September 15, 2008, along with an email to members of the MPCA Listserve, comprised of members of the public interested in the topic of air quality and climate change. The letter provided information on the nature of the reporting requirements, thresholds for reporting and a link to the MPCA website for additional information. The MPCA high-GWP website provides information on the requirements of the statute, reporting forms and supporting data.

The MPCA high-GWP reporting data for 2007, required by Minn. Stat. §216H.11, is presented in Table #1. Of the 3,260 letters sent by MPCA, a total of 279 letters were returned as undeliverable. Our overall response rate for this effort was less than 2%, restricting the inferential value of the data for this report. The following table is a breakdown of the reporting results:

Table #2 – High-GWP Reporting Response by Sector

Sector	Number of Reports Submitted	Approximate size of the sector
HVAC/Refrigeration	32	>5,000
Utilities	5	<200
Semiconductor	5	6
Fire Suppression	1	20,000
Consumer product	2	Not known at this time.
Foam Blowing Agent	1	52
Magnesium casting	1	20
Other	1	*
Manufacturers of high-GWP gases	5	30
Total Reports	53	

\* This category represents to use of a high-GWP gas that does not fit into a specific sector category.

The low response rate is likely a function of three factors: the data collection method, including the content of the MPCA letter; the limited time available to build industry cooperation; and the 500 metric ton carbon dioxide equivalent reporting threshold.

The language of the statute required purchasers of high-GWP gases that exceeded 500 metric tons carbon dioxide equivalent to report the purchase and to describe the use. The statute did not describe or define the scope of a purchaser for purposes of reporting under the statute. The MPCA designed the reporting program to address end-users of high-GWP gases. In an effort to minimize or eliminate double-counting, the MPCA requested that if a contractor or service provider managed high-GWP gases for a company, then the vendor or service provider should submit the report on behalf of their client. This approach was primarily designed to facilitate reporting in the refrigeration and heating/cooling sector, with recognition that other sectors may operate in a similar fashion. This practice was unsuccessful. Very few contractors provided a report. Those that submitted a report did so only for their own purchases and did not provide end use destination information. Several contractors contacted the MPCA and indicated that they were not willing to report as doing so would make their client list public, thereby revealing their



client base to competitors. The Minnesota Data Practices Act does not provide protection to client lists.

Several chain restaurants indicated that while they owned many of their facilities, gas purchases varied from a central operations center to individual contracts with a local service provider. As a result, they felt that each of their individual operations would not result in a 500 metric ton carbon dioxide equivalent purchase and would not submit a company-wide report. Enforcing the statute under this situation presented a difficult challenge in part due to the imprecise nature of the definition of a purchaser under the statute.

There are two elements of the statute that if met, require a regulated party to submit a report. The first is the purchase of a high-GWP gas that exceeds 500 metric tons of carbon dioxide equivalent. The challenges of applying this threshold to purchasers in Minnesota were presented above. The second element is the “point of sale” aspect of a purchase under the statute. In order to be subject to reporting under the statute, a purchase of a high-GWP gas must be made in Minnesota. A number of companies contacted the MPCA and noted that while they had purchased gas quantities that exceeded 500 metric tons of carbon dioxide equivalent, their service provider, contractor or corporate operations center purchased the gas outside of Minnesota. As many of the service providers, contractors, or corporations did not make any purchase of high-GWP gases within the state of Minnesota, there was no legal obligation for them to make a report for themselves or their Minnesota clients. Enforcement under these circumstances would have been difficult and resource intensive.

Conducting a rule scoping process would greatly facilitate this effort to clarify the universe of entities required to report and information required to build a credible dataset. The recommended rule scoping process would allow the MPCA to better understand the purchaser/end user relationship and develop a more precise definition of purchaser consistent with the statute and industry practice, thereby enhancing reporting efficiency and enforceability.

Finally, there was insufficient time between the effective date of the statute and the reporting deadline to develop the sector-specific parameters that make for a successful emission reporting program. The initial short reporting window affected our ability to create effective links with the association and trade organizations within this diverse collection of sectors. The ability to meet with trade associations was considered paramount in light of the low reporting threshold (500 metric tons – carbon dioxide equivalent) and the relationship between purchases of high-GWP gases and emissions and the diversity of operating scenarios.

The data reviewed in the development of the Technical Report indicates that the use of high-GWP gases in Minnesota presents challenges for control and substitution along with some opportunities for innovation. For some sectors, a substitute gas is not available. For other sectors, high-GWP gases are integral to the manufacturing process. Consumer products that contain potential emissions of high-GWP gases (e.g., aerosols) are not a substantial component of the state’s GHG emission inventory. California has initiated a review of aerosol “dusters” (e.g., cans of “air” used to clean computers) which may lead to a ban in that state. The MPCA does not yet have sufficient knowledge of the issues involved with “dusters” and their use in Minnesota. Based on MPCA’s review of high-GWP gas bans by other states, the MPCA does not see opportunities for significant reductions in high-GWP gas emissions in Minnesota resulting from a specific ban at this time.

The MPCA also implemented the mobile air conditioner (MAC) leak rate statute (Minn. Stat. §216H.12). The language of the mobile air conditioner leakage report is presented as follows:

**Minn. Stat. §216H.12 - Mobile Air Conditioner Leakage Rates**

Subdivision 1. Leakage disclosure. Beginning January 1, 2009, a manufacturer selling or offering for sale a new motor vehicle in this state containing a mobile air conditioner that uses the high-GWP greenhouse gas HFC-134a (1,1,1,2-tetrafluoroethane) as a refrigerant must, 90 days prior to the initial sale or offer for sale, report to the commissioner the leakage rate, in grams of refrigerant per year, for the type of mobile air conditioner contained in that make, model, and model year. The leakage rate must be calculated using the information provided in the most recently published version of the SAE International document J2727, "HFC-134a Mobile Air Conditioning System Emission Chart." The method by which the leakage rate is calculated, accounting for each component of the air conditioning unit, must also be reported to the commissioner.

Subd. 2. Posting. Beginning January 1, 2009, the agency and the Office of the Attorney General must post on their Web sites:

- (1) the leakage rate disclosed by a manufacturer under subdivision 1 for each model and make of new motor vehicle sold or offered for sale in this state; and,
- (2) the following statement: "Vehicle air conditioning systems may leak refrigerants. Information provided in the chart compares the potential global warming effects of refrigerant leakage from different makes and models of vehicles."

To notify automobile manufacturers of Minnesota's new reporting requirement, two outreach efforts were made. One letter was a traditional mailing that was sent to manufacturer's environmental staff, as identified through the Interstate Mercury Education and Reduction Clearinghouse. The second notification was sent by electronic mail (email) to interested parties who are members of the Association of International Automobile Manufacturers and/or the Auto Alliance.

The report form was included in the email and was also available on the MPCA's web site. A new web page was posted specifically for the MAC program. Reports for over 360 makes and models from 17 manufacturers were submitted. A small number of manufacturers have no direct sales in Minnesota and do not report. MPCA staff compiled the reported data in a spreadsheet which was posted on the MPCA's MAC program web site and the Minnesota Attorney General's web site in December, 2008. Updates for newly-released vehicle models or changes to existing vehicle data will be made periodically, most likely on a quarterly basis. Information from this data collection effort was used in the Technical Report.

**Recommendations**

The MPCA offers the following two specific recommendations based on the sector review and the MCCAG Climate Change Action Plan:

**Recommendation #1**

The MPCA recommends that a rule scoping process be conducted to develop a rule to reduce high-GWP emissions through reasonable cost efforts. As noted in the sector evaluations, many of the sectors appear to be able to reduce emissions within a \$15 a ton carbon dioxide equivalent control cost. A rule scoping process would provide for greater resolution of the sector-specific operations that could lead to more cost-effective regulation and could commence in 2009 with completion in 2011. This process would include consideration of appropriate product bans.

Within the rule-scoping process, the MPCA would also be able to determine the role of a voluntary emissions reduction program in an overall statewide strategy of high-GWP emission reduction. Several voluntary industry and EPA-sponsored programs exist; however, most Minnesota companies are not currently participating. The rule scoping process would be useful in determining the opportunities for volunteer emission reduction program membership based on potential emission control technology and substitutes.

#### Recommendation #2

The MPCA recommends that the current high-GWP reporting scheme be converted to an emission-based program, along with an increase in the mandatory reporting threshold. The rationale for this approach is based on the nature of high-GWP gas usage and purchase behavior. The purchase of high-GWP gases is not a robust surrogate for determination of annual emissions for comparison to the targets in the Next Generation Energy Act. The use of high-GWP gas purchases as a means to evaluate emissions is imprecise, in part because of the lack of alignment between purchase and gas usage within the state. As noted above, the purchase of high-GWP gases must be made within the state and above the specific reporting threshold in order to be subject to reporting. Many large high-GWP gas consumers purchase their high-GWP commodities outside the state, thereby eliminating the need to report.

The emission reporting threshold should be increased to a value consistent with programs in other states and countries. Thresholds in other states range between 2,500 and 100,000 tons of carbon dioxide equivalent, with most states pursuing thresholds in the range of 10,000 tons. The rationale for this value is based on the administrative burden placed on smaller generators of high-GWP emissions with respect to cost and the need to focus regulatory resources on facilities that are high-volume emitters of high-GWP gases. Minnesota is one of the few states that specifies a high-GWP reporting threshold rather than an aggregate of all climate change gases (i.e., combination of CO<sub>2</sub> and non-CO<sub>2</sub> gases). A long-term goal of the Next Generation Energy Act is to reduce GHG emissions consistent with specific statutory targets and deadlines. Emission reporting is the manner in which statewide performance is evaluated with these expectations. Shifting the focus from high-GWP purchases to a facility-specific emission reporting requirement would further the implementation of the Next generation Energy Act.

The development of an emission reporting scheme would be best served through the rule scoping process. A rule scoping process would allow the MPCA to better identify participants, basic data elements (including reporting thresholds), reporting frequency, *di minimis* values and the scope of reporting (e.g., sectors, direct and indirect emissions). The reporting process should also harmonize the high-GWP activities with other climate change activities proposed by MCCAG including greenhouse gas reporting.