

Sulfur Hexafluoride (SF₆) Emission Reductions from the Electric Power Industry

Summary:

This initiative uses a pollution prevention approach, including a best management practice (BMP) manual and recordkeeping and reporting requirements, to ensure that all SF₆ emission reductions are quantified and permanent.

Possible New Measure(s) Background:

SF₆ is identified as the most potent non-CO₂ GHG, with the ability to trap heat in the atmosphere 23,900 times more effectively than CO₂. Approximately 80 percent of SF₆ gas produced is used by the electric power industry in high-voltage electrical equipment as an insulator or arc-quenching medium. SF₆ is emitted to the atmosphere during various stages of the equipment's life cycle. Leaks increase as equipment ages. The gas can also be accidentally released at the time of equipment installation and during servicing. Table 1 presents annual SF₆ emission from the Pennsylvania electricity sector. The trend illustrates an approximate annual rate of decline of 2.8%

Table 1. Annual SF₆ Emissions from Pennsylvania's Electric Power Sector (MMtCO₂e)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
MMtCO ₂ e	0.628	0.650	0.629	0.608	0.609	0.613	0.561	0.533	0.538	0.513

~~A regulatory program could be developed in Pennsylvania that uses a pollution prevention approach, including a BMP manual and recordkeeping and reporting requirements to ensure that all SF₆ emission reductions are quantified and permanent. The reduction of SF₆ emissions from the electric power industry is available as one of the offset opportunities for any cap and trade program established for large emitters under the Northeast Regional Greenhouse Gas Initiative (RGGI).~~

~~As part of this regulatory program, a manual could be developed that would identify BMPs that would be required of all owners and operators of electric power systems. BMP practices could include proper handling techniques, identification and elimination of leaks, and the replacement of equipment that does not meet specific leak rate thresholds. An example of BMPs would be the recent Duquesne Light Company decommissioning of an old substation to recover the SF₆ gas and reclaim it to American Society for Testing and Materials (ASTM) standards. The project resulted in the removal of approximately 7,300 lbs of SF₆ that otherwise would have been emitted to the atmosphere. As a part of SF₆ Emission Reduction Partnership for Electric Power Systems, Exelon's PECO subsidiaries set a SF₆ goal in March 2006, to commit to an SF₆ leak rate of no more than 10 percent for 2006. To help achieve this goal, the companies provided additional training to substation personnel to minimize SF₆ gas leaks and revised the gas handling procedures. Annual recordkeeping and reporting requirements would be required to ensure the quantification and reduction of SF₆ emissions.~~

Work Plan Costs and GHG Reductions:

EPA identifies several categories of reduction measures. The following text is from the EPA Web site:¹

- **Recycling Equipment**

¹ US EPA. Final Report on U.S. High Global Warming Potential (High GWP) Emissions 1990-2010: Inventories, Projections, and Opportunities for Reductions. Chapter 3: Cost And Emission Reduction Analysis Of Sf6 Emissions From Electric Power Transmission And Distribution Systems In The United States.

http://www.epa.gov/highgwp/pdfs/chap3_elec.pdf

- The capital costs of recycling equipment range from around \$5,000 to over \$100,000 per utility. For this analysis, typical recycling expenditures have been set at \$25,500 per utility. However, this capital investment produces O&M savings of nearly \$1,600 per year per utility due to reduced purchases of SF6.
- **Leak Detection and Repair**
 - There are no capital costs associated with leak detection and repair and O&M costs are estimated to be \$2,190 per utility due to the increased labor costs associated with this option.
- **Equipment Replacement/Accelerated Capital Turnover**
 - The capital costs of this option vary by equipment type. Circuit breakers (below 34.5 kV) may be replaced with vacuum breakers. The replacement cost varies from \$25,000 to \$75,000 per unit. Medium and high voltage breakers are expected to continue to use SF6 because no other option is currently available. Older breakers are assumed to leak more and are being replaced by new equipment (as part of routine turnover) at a cost of approximately \$200,000 to \$750,000 per unit. Additional research into the existing equipment stock and potential for replacement will be necessary to develop cost estimates for emission reductions.
- **Advanced Leak Detection Technologies**
 - The capital cost per GasVue leak detection camera is approximately \$100,000. Additional research into the potential emission reductions from this option will be necessary to develop estimates for O&M costs and the total cost of emission reductions.

Summary of Measures and Costs

The most promising options to reduce SF6 emissions from electric power systems are SF6 recycling and SF6 leak detection and repair. SF6 recycling could reduce emissions by about 10 percent, and is currently cost-effective. Leak detection and repair could reduce emissions cost-effectively by 20 percent.²

Actual EPA partnership experience shows that even greater reductions have been experienced. The 2010 annual report shows that partner emission rates have declined by 62 percent, from more than 14 percent of consumption to 3.8 percent.³

Table 2. Work Plan Cost and GHG Results

Annual Results (2020)			Cumulative Results (2013-2020)		
GHG Reductions (MMtCO ₂ e)	Costs (Million \$)	Cost-Effectiveness (\$/tCO ₂ e)	GHG Reductions (MMtCO ₂ e)	Costs (NPV, Million \$)	Cost-Effectiveness (\$/tCO ₂ e)
0.11	0.07	0.59	0.86	0.34	0.39

Quantification Approach and Assumptions:

- The SF₆ program is assumed to be implemented linearly over a 5-year period beginning in 2013. By the end of 2017, SF₆ reductions are assumed to be 30 percent of forecasted emissions from the electricity sector. The reductions are split into 20 percent leak detection and 10 percent recycling.
 - Note that future reductions could be much larger than this, based on actual experiences by SF₆ partner utilities.
- The cost estimates employ an 8 percent discount rate, a 10-year project lifetime, and an SF6 price of \$8/lb. Mitigation costs for leak detection are estimated at \$0.44/tCO₂e, and recycling equipment at \$0.90/tCO₂e.⁴

² http://www.epa.gov/highgwp/pdfs/chap3_elec.pdf p. 3-3.

³ http://www.epa.gov/electricpower-sf6/documents/sf6_2010_ann_report.pdf page 3.

- SF₆ emissions from the electric power sector are estimated at 0.63 MMtCO₂e in 2000 and at 0.38 MMtCO₂e in 2020. Emissions in the interim period are linearly interpolated.

Other Costs and Benefits

- ~~Industry—Mitigating emissions is cheaper than purchasing new SF₆ supplies. These benefits are not quantified here for lack of specific cost data.~~
- ~~DEP—No costs authorized or anticipated. Therefore, development of any regulatory program would be required to be accomplished through existing resources and budget.~~
- ~~Funding sources—EPA's voluntary cooperative program is implemented under federal funding independent of Pennsylvania's budget process.~~

Implementation Steps:

~~DEP and the Public Utility Commission should work with PA's Electric Power Generators Association to encourage greater participation in EPA's voluntary SF₆ emission reduction partnership. The partnership is a voluntary cooperative program is implemented and summarized at <http://www.epa.gov/electricpower-sf6/>. Participation in this program entails taking the following actions: Pennsylvania's major power producers are participants.~~

- ~~Estimate current annual SF₆ emissions;~~
- ~~Annually inventory emissions of SF₆ using an emissions inventory protocol;~~
- ~~Establish a strategy for replacing older, leakier pieces of equipment;~~
- ~~Implement SF₆ recycling;~~
- ~~Ensure that only knowledgeable personnel handle SF₆; and~~
- ~~Submit annual progress reports.~~

~~Pennsylvania electric distribution companies participating in the partnership include:~~

- ~~Allegheny Power~~
- ~~Duquesne Light Company~~
- ~~PECO Energy~~

Potential Overlap:

Not applicable.

Subcommittee Recommendations:

While the EGTD was supportive of SF₆ reductions, because of a) the small amount of CO₂ equivalents that could be reduced, b) the long term trend downwards of SF₆ releases and c) ongoing industry and USEPA efforts to further reduce losses, we view this as a work plan of limited value or potential. However it is forwarded to warrant future review and updating.

⁴ http://www.epa.gov/highwp/pdfs/chap3_elec.pdf Exhibit 3.4.