Sulfur Hexafluoride (SF_6) 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 SF_6 emission reductions are quantified and permanent.

Background:
SF_6 is identified as the most potent non-CO_2 GHG, with the ability to trap heat in the atmosphere 23,900 times more effectively than CO_2. Approximately 80 percent of SF_6 gas produced is used by the electric power industry in high-voltage electrical equipment as an insulator or arc-quenching medium. SF_6 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 SF_6 emission from the Pennsylvania electricity sector. The trend illustrates an approximate annual rate of decline of 2.8%

Table 1. Annual SF_6 Emissions from Pennsylvania's Electric Power Sector (MMtCO2e)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
MMtCO2e	0.628	0.650	0.629	0.608	0.609	0.613	0.561	0.533	0.538	0.513

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**
  - 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**

[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 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 ($MMtCO_2e$)	**Costs (Million $)**	**Cost-Effectiveness ($/tCO_2e$)**	**GHG Reductions ($MMtCO_2e$)**	**Costs (NPV, Million $)**	**Cost-Effectiveness ($/tCO_2e$)**
0.11	0.07	0.59	0.86	0.34	0.39

Quantification Approach and Assumptions:

- The SF_6 program is assumed to be implemented linearly over a 5-year period beginning in 2013. By the end of 2017, SF_6 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 SF_6 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 $0.44/$tCO_2e$, and recycling equipment at $0.90/$tCO_2e$.[4]
- SF_6 emissions from the electric power sector are estimated at 0.63 $MMtCO_2e$ in 2000 and at 0.38 $MMtCO_2e$ in 2020. Emissions in the interim period are linearly interpolated.

Implementation Steps:

DEP and the Public Utility Commission should work with the Energy Association of PA (EAP) to encourage greater participation in EPA's SF6 emission reduction partnership. The partnership is a voluntary program summarized at http://www.epa.gov/electricpower-sf6/. Participation in this program entails taking the following actions:

- 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.

[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.
[4] http://www.epa.gov/highgwp/pdfs/chap3_elec.pdf Exhibit 3.4.

The Pennsylvania electric distribution companies participating in the partnership include:

- Allegheny Power
- Duquesne Light Company
- PECO Energy

The EAP should work with and encourage all of Pennsylvania's distribution companies to participate in this volunteer program.

Potential Overlap:

Not applicable.

Subcommittee Recommendations: