SF_6 Emissions Reduction Partnership for Electric Power Systems

Annual Report — 2000

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INTRODUCTION

To combat global climate change, the United States Environmental Protection Agency (EPA) implements a variety of voluntary programs aimed at reducing emissions of greenhouse gases. One of the newest programs is the SF_6 Emissions Reduction Partnership for Electric Power Systems, which was launched in April, 1999. The partnership's primary goal is to achieve environmental and economic benefits by reducing emissions of sulfur hexafluroide (SF_6), an extremely potent and persistent greenhouse gas. These emissions can occur during the operation and maintenance of circuit breakers and other high voltage equipment used in the transmission and distribution of electricity. This annual report documents the partnership's history, its success in 2000, and future goals.

WHAT IS SF_6?

SF_6 is a synthetic gas used as an insulating medium in the electric power industry. Worldwide SF_6 sales in 1999 were just more than 5,000 metric tons, excluding SF_6 produced in China and Russia. Electric power systems account for approximately 80 percent of sales, either through direct purchases of the gas for servicing equipment or the purchases of new SF_6-containing equipment.

SF_6's unique chemical properties make it an excellent electrical insulator. Its high dielectric strength, high vapor pressure, arc-quenching abilities, and lack of toxic or corrosive effects make it an efficient and easy to handle insulator. SF_6 is used widely in gas-insulated substations, circuit breakers, and other electrical switchgear that allow for the safe transmission and distribution of electricity. SF_6's unique chemical properties also make it suitable for many non-utility applications. It is used as a cover gas in the magnesium industry; for plasma etching in semiconductor manufacturing; as a reactive gas in aluminum recycling to reduce porosity; as thermal and sound insulation; and in atmospheric tracer studies and medical applications.

CLIMATE IMPACT OF SF_6

Under ideal operating conditions, SF_6 would remain entirely contained within the transmission and distribution equipment. However, during real-world equipment operation, maintenance, and SF_6 recycling activities, gas is emitted into the atmosphere. Fugitive emissions of SF_6 can escape from gas-insulated substations and switchgear through seals, especially from older equipment. It can also be released during equipment installation and when equipment is opened for servicing. In 1999, the SF_6 emissions from the electric power systems in the United States were estimated at 4.7 million metric tons of carbon equivalent (MMTCE). SF_6 has an extremely high global warming potential: 23,900 times higher than an equivalent amount of carbon dioxide over a 100-year time horizon. This potential, combined with an atmospheric lifetime of 3,200 years, makes SF_6 a powerful greenhouse gas. Thus, a relatively small amount of SF_6 in the atmosphere is important to global climate change.

WHAT IS THE PARTNERSHIP?

The SF_6 Emissions Reduction Partnership for Electric Power Systems is a voluntary, non-regulatory partnership between EPA and the electric power industry aimed at reducing SF_6 emissions. The partnership provides a forum for EPA and the industry to work together to reduce SF_6 emissions in technically and economically feasible ways—thereby helping to ameliorate the problem of global climate

change. The electric power industry has a real opportunity to help reduce the nation's SF_6 emissions through cost-effective operational improvements and equipment upgrades.

Partnership Benefits

- Financial savings
- Help protect the global climate through emissions reductions
- Share information
- Receive positive company recognition
- Provide strategic direction in the partnership's growth

To become a partner, an interested party signs a Memorandum of Understanding (MOU), thereby committing to its terms. The MOU is a voluntary agreement between EPA and industry partners that outlines the roles and responsibilities of each party. EPA developed the MOU with substantial industry input to make it flexible and user-friendly, and the industry's input continues as the partnership expands. As a result, the roles and responsibilities of the EPA and the partners outlined in the MOU reflect each party's expertise and abilities to reduce emissions. The key feature of the MOU is its flexibility. The MOU commits partners to explore only the emissions abatement strategies that are both technically and economically feasible, permitting individual partners to determine the best strategy for their particular situation.

Partner's responsibilities outlined in the MOU include:

- Submitting an annual inventory of SF_6 emissions using the standardized inventory protocol that includes performing an inventory at the start and end of a predetermined reporting year;
- Developing a replacement strategy for older, leakier pieces of equipment;
- Establishing SF_6 management procedures and ensuring that only trained personnel handle SF_6;
- Developing a company-wide policy for the proper handling of SF_6, including a commitment to recycling; and
- Establishing an emissions reduction goal within 18 months of signing the MOU.

EPA's responsibilities in the MOU include:

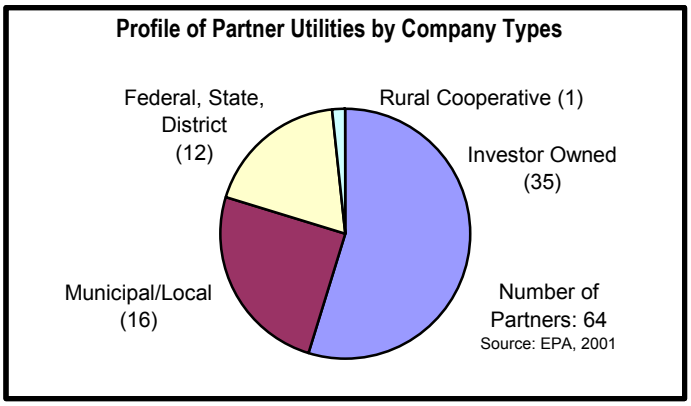
- Recognizing partners for their achievements in SF_6 emissions reduction and protecting the environment;
- Identifying protocols to inventory and report SF_6 emissions;
- Tracking emissions reductions;
- Serving as a clearinghouse for technical information on successful emission reduction strategies; and
- Encouraging all utilities with SF_6-filled equipment to join the partnership.

A copy of the MOU can be obtained at:

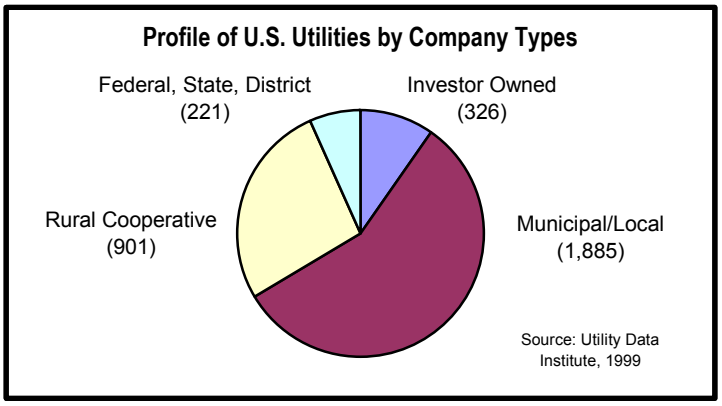
http://www.epa.gov/highgwp1/sf6/memorandum_of-understanding.html.

THE HISTORY OF THE PARTNERSHIP

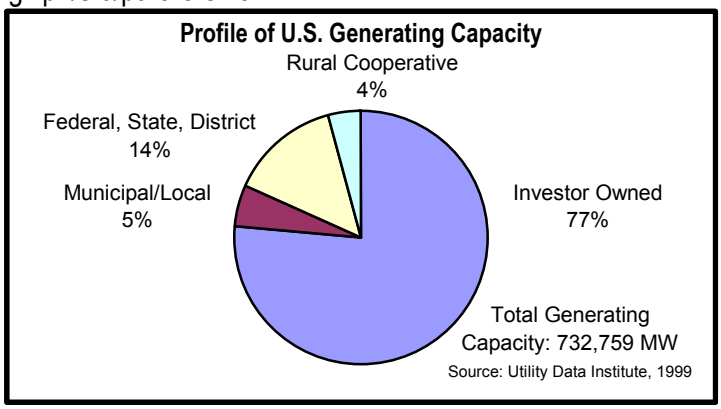
During EPA's first conference on SF_6, which took place on August 9-10, 1995, in Washington, D.C., EPA first proposed the idea of forming an SF_6 emissions reduction partnership for electric power systems. For the next three years, EPA and the electric utility industry continued an informal dialogue, and in early 1998, the agency drafted the first version of the MOU. In the interest of creating a comprehensive, workable and fair partnership, EPA asked for input from the electric utility industry throughout the MOU development process.



On April 8, 1998, after sending out an initial draft of the MOU, EPA convened an informal group of 26 utility representatives in Washington, D.C. to discuss the document. Participants represented investor-owned, municipal, federal, and rural utilities as well as the Edison Electric Institute, the American Public Power Association, the National Rural Electric Cooperative Association, and EPRI. Comments received during this daylong meeting led to numerous improvements in the draft MOU. From April through October of that year, the MOU was revised and distributed for comment a number of times, not only to those who had attended the meeting, but also to a much wider industry audience.



During that time, the partnership's program manager also solicited feedback on the MOU at various utility conferences where he gave presentations on the evolution of the partnership. The MOU was finalized in November, 1998, whereupon recruitment efforts commenced. At the partnership's official launch on April 25, 1999, 50 partners, of various net generation capacities, were present. As of July 2001, there are 64 partners, cumulatively representing nearly 28 percent of the electric generating capacity and 40 percent of the net electric generation in the United States. A complete list of partners is located at http://www.epa.gov/highgwp1/sf6/partners.html



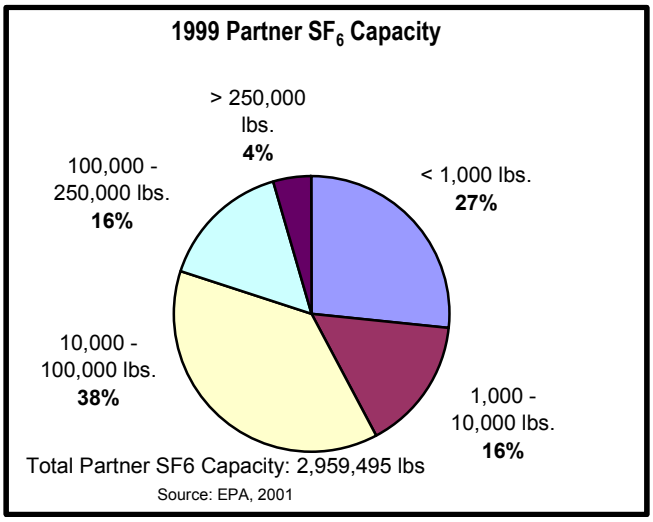
The partners represent a wide cross section of the industry:

- ❑ Investor-owned utilities operated as private tax-paying businesses, controlled by either citizens or investment groups representing them;

- ❑ Municipal utilities owned and operated by the municipalities they serve;
- ❑ Rural cooperatives, utilities owned cooperatively by their customers where return on investment takes the form of products or services, rather than dividends; and
- ❑ Government-owned utilities owned and operated by federal, state, regional, or county governments.

Although the majority of utilities are classified as municipal, investor-owned systems account for more than 75 percent of total electricity generating capacity nationwide (UDI, 1999).

The individual partners exhibit disparate SF_6 usage patterns. Their SF_6 name-plate capacities, the amount of SF_6 in operating equipment, range from 25 pounds to more than 600,000 pounds. Some partners have only a few SF_6-filled pieces of equipment, while others have thousands.



PARTNERSHIP STATUS AND ACCOMPLISHMENTS

The partner's annual reports are the key mechanism for tracking emissions reductions. It documents reductions, outlines abatement strategies implemented and planned by the partners, and provides other background information useful in understanding the obstacles and opportunities the partners face in pursuing their goals. To evaluate the overall progress of the partnership and retain partner anonymity, EPA aggregates the results regarding emissions and emissions rates. Table 1 shows some results regarding SF_6 capacity, emissions, and emissions rates from the 1999 partner annual reports—the first set of reports submitted under the partnership.

Table 1: Aggregated Statistics from 1999 Partner Report

Value	Average	Median
Emissions Rate	10%	9%
Capacity (lbs.)	72,929	23,305
SF_6 Emissions (lbs.)	13,275	2,593

Emissions Rate is measured as a percentage of SF_6 capacity.

Some partners have achieved significant reductions through measures such as purchasing recycling carts, offering SF_6 management training, replacing older, leakier circuit beakers with new tight-fighting ones, and using leak detection technologies (for example, laser systems and halogen detectors) to identify and respond to problem leaks.

On November 2-3, 2000, EPA and the Australian Greenhouse Office sponsored an international conference in San Diego, California, titled, *SF_6 and the Environment: Emission Reduction Strategies.* This conference brought together 185 attendees from 11 countries, representing the electric utility and

magnesium industries and other interested parties, to discuss and learn about a wide array of issues relating to the use, handling, and management of SF_6. The plenary sessions covered issues of interest to both industries, including updates on domestic and international initiatives relating to SF_6 and the general policy and science of global climate change. For most of the two-day conference, representatives from the two industries pursued separate tracks with sessions designed specifically for their industry.

Consolidated Edison — ConEd's leak prevention strategy utilizes laser-imaging technology and computerized SF_6 inventory tracking to identify equipment that is currently leaking and equipment technology types or equipment locations that may be prone to leaks. To date, leaks have been successfully detected and 54 dual pressure circuit breakers have been replaced.

ConEd has also rigorously pursued reuse and recycling of SF_6. They have trained workers in handling procedures, established three SF_6 reclaiming centers, and purchased gas carts, ending their previous practice of simply returning cylinders to the manufacturer.

Lastly, ConEd has been working with the Electric Power Research Institute (EPRI) to develop a solid-state breaker, which would not require any SF_6.

The conference provided an excellent forum for industry leaders to share their expertise on the latest policy, technological, and scientific advances regarding SF_6 emissions. Plenary presentations at the conference highlighted trends in global SF_6 sales, the role of SF_6 in climate change, and international SF_6 emissions reduction efforts. The utility break-out sessions focused on leak detection technologies, SF_6 recycling, alternatives to using pure SF_6, and successful reduction measures undertaken by partners. With participants from so many countries, the conference also demonstrated the international differences in SF_6 markets, emission patterns, and emission reduction programs.

Under the partnership, EPA has also been instrumental in generating better data on worldwide production and sales of SF_6. This type of information is important to scientists and policymakers alike, who want to better understand the flow of SF_6 through the economy and the environment. The first major survey of SF_6 production and sales was funded through a voluntary effort by SF_6 producers and completed in 1996. To build on the success of that first survey, the EPA and the National Electrical Manufacturers Association (NEMA) teamed to fund a second production and sales survey, completed by RAND in October, 2000. As a result of both of these efforts, sales and distribution data for SF_6 have now been compiled from the major manufacturers around the world for the period 1961-1999 (manufacturers in China and Russia, and possibly additional ones in other countries, did not participate in the survey). Cumulative data for this period show the following overall distribution of sales by market sector:

American Electric Power — AEP operates a large electricity generation, transmission, and distribution network with over 24,000 MW of generating capacity, 17,000 transmission miles, and 118,000 distribution miles. It serves approximately 2.9 million customers in the United States. AEP's SF_6-containing equipment spans a broad range of specifications: its system has 1,270 SF_6 gas circuit breakers, ranging from 46kV to 765kV, and three gas-insulated substations.

AEP's commitment to reduce its emissions of SF_6 by identifying and repairing or replacing leaky equipment is a simple matter of dollars and cents. Despite the low cost of SF_6 itself, the total annual cost of servicing leaky equipment is greater than the up-front cost of carrying out a laser-imaging leak-detection campaign. Assuming that 10 to 15 percent of its circuit breaker population is leaking at the rate of 2lbs. of SF_6 per month, the costs of leaky equipment can surpass $300,000 per year.

In addition to its efforts to remove leaky equipment from its network, AEP is also engaged in R&D to find a high voltage, high capacity SF_6 breaker that will out- perform older breakers.

50%	Original (Electrical) Equipment Manufacturers
31%	Electric Utilities
6%	Magnesium Industry
3%	Usage for Adiabatic/ Shock Absorbing Properties (e.g., tires)
3%	Electronics Industry
7%	All Other Uses (accelerators, optical fiber production, glazing, biotechnology, lighting, medical, refining, pharmaceutical, laboratory/university research, sound proof windows)

Overall sales have gone from 7,571 metric tons in 1996, when the last survey ended, to 5,067 in 1999, the last year of the second survey. This reduction is roughly 2,500 metric tons. The survey did not attempt to determine the causes for the decline, but it is likely due to a combination of factors, including increased prices for SF_6, the creation of country-level programs aimed at reducing greenhouse gas emissions, such as this partnership, and independent efforts on the part of utilities and other SF_6 users to reduce emissions. In the electricity sector, specifically, recent years have seen improvements in and the increased use of leak detection and recycling equipment, trends that clearly could have contributed to a decrease in demand. The data are important for analyzing trends, sources and applications of SF_6 as well as calculating emissions. A continued effort is underway to involve all SF_6 producers in the survey, including those in China and Russia and any other countries not currently part of the data report.

Florida Power and Light — After carefully mapping the multi-level management and operational decisions necessary, FP&L undertook a thorough leak inspection of its nearly 100,000 lbs. of SF_6 system. In four months, all 460 breakers on the FP&L system were checked for leaks using laser-imaging technology, and 40 breakers were either repaired or returned to the manufacturer.

Overall, FP&L discovered that their worst leaks occurred on older, dual pressure breakers. A large number of the leaks were found around fittings and connections. Surprisingly, 5 percent of the leaky equipment was relatively new and still under warranty.

FP&L experienced good results with the laser-imaging technology. Detection could be made from a distance of 20 to 30 meters and all the equipment could be left offline. Leaks as small as 50g SF_6/year were detected.

Other notable accomplishments of the partnership include the unveiling of the partnership web site in the summer of 1999 and the publication of a brochure in November, 2000. Potential and existing partners can now obtain a wide array of useful information by visiting the SF_6 Emissions Reduction Partnership for Electric Power Systems web site at http://www.epa.gov/highgwp1/sf6/. The site content includes the SF_6 brochure, the MOU, a current listing of partners, a catalog of SF_6-related materials, SF_6 management and handling guidelines submitted by partners, the proceedings from the San Diego conference, including the RAND survey report, useful internet links, and other relevant sources of information.

FUTURE GOALS

The partnership has made remarkable progress thus far; however, there is more work to be done. Recruitment remains a high priority, since partnership expansion will promote emissions reductions. And with more partners, there will be greater opportunities for sharing information on innovative, successful measures for emission reductions.

EPA will continue to create and distribute materials that are of use to its partners, and it is eager to hear from its partners and other interested parties about ways in which the goals of the partnership can be furthered. Over the next few years, EPA is confident that the partnership will grow and contribute significantly to the reduction of SF_6 emissions.

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EXISTING PARTNERS AS OF JULY 1, 2001

Allegheny Power (Greensburg, PA)
American Electric Power (Columbus, OH)
Athens Electric Department (Athens, AL)
Austin Energy (Austin, TX)
Bangor Hydro-Electric Company (Bangor, ME)
Big Rivers Electric Corporation (Henderson, KY)
Bonneville Power Administration (Portland, OR)
Central Maine Power Company (Augusta, ME)
Central Vermont Public Service Corporation (Rutland, VT)
Cinergy Services, Inc., on behalf of The Cincinnati Gas & Electric Company and PSI Energy, Inc. (Cincinnati, OH)
City Light, Water & Cable (Paragould, AR)
City of Monroe (Monroe, NC)
Columbia River PUD (St. Helens, OR)
Commonwealth Edison (Chicago, IL)
Commonwealth Electric (Wareham, MA)
Connecticut Light and Power Company (Berlin, CT)
Consolidated Edison Company of New York, Inc. (New York, NY)
Crisp County Power Commission (Cordele, GA)
Duquesne Light Company (Pittsburgh, PA)
Edison International (Irvine, CA)
El Paso Electric Company (El Paso, TX)
Eugene Water & Electric Board (Eugene, OR)
FirstEnergy Corporation (Akron, OH)
Florida Power and Light Company (Juno Beach, FL)
Fort Pierce Utilities Authority (Fort Pierce, FL)
GPU Energy (Reading, PA)
Grand Island Utilities Department (Grand Island, NE)
Hastings Utilities (Hastings, NE)
Kings River Conservation District (Fresno, CA)
Maine Public Service Company (Presque Isle, ME)
Manitowoc Public Utilities (Manitowoc, WI)
Menasha Electric and Water Utilities (Menasha, WI)
Muscatine Power and Water (Muscatine, IA)
Nashville Electric Service (Nashville, TN)
Nebraska Public Power District (Doniphan, NE)
New York Power Authority (New York, NY)
Niagara Mohawk Power Corp (Syracuse, NY)
North Atlantic Energy Service Corporation (Seabrook, NH)
Northeast Utilities Services Company (Hartford, CT)
Northern Indiana Public Service Company (Merriville, IN)
OG&E Electric Services (Oklahoma City, OK)
PG & E Corporation (San Francisco, CA)
Public Service Company of New Hampshire (Manchester, NH)

PUD No. 1 of Douglas County (East Wenatchee, WA)
PUD No. 1 of Pend Oreille County (Newport, WA)
Reliant Energy HL & P (Houston, TX)
Rochester Gas & Electric (Rochester, NY)
Salt River Project (Phoenix, AZ)
San Antonio City Public Service Board (San Antonio, TX)
Silicon Valley Power (Santa Clara, CA)
South Carolina Electric & Gas Company (Columbia, SC)
Southern Company (Atlanta, GA)
Southwestern Electric Power Company (Shreveport, LA)
Tennessee Valley Authority (Knoxville, TN)
Texas Municipal Power Agency (Bryan, TX)
The Memphis Light, Gas & Water Division (Memphis, TN)
The Montana Power Company (Butte, MT)
Town of Wallingford (Wallingford, CT)
TXU (Dallas, TX)
Village of Prairie du Sac (Prairie du Sac, WI)
Wellton-Mohawk Irrigation and Drainage District (Wellton, AZ)
West Texas Utilities (Abilene, TX)
Western Massachusetts Electric Company (West Springfield, MA)
Wisconsin Electric Power Company (Milwaukee, WI)