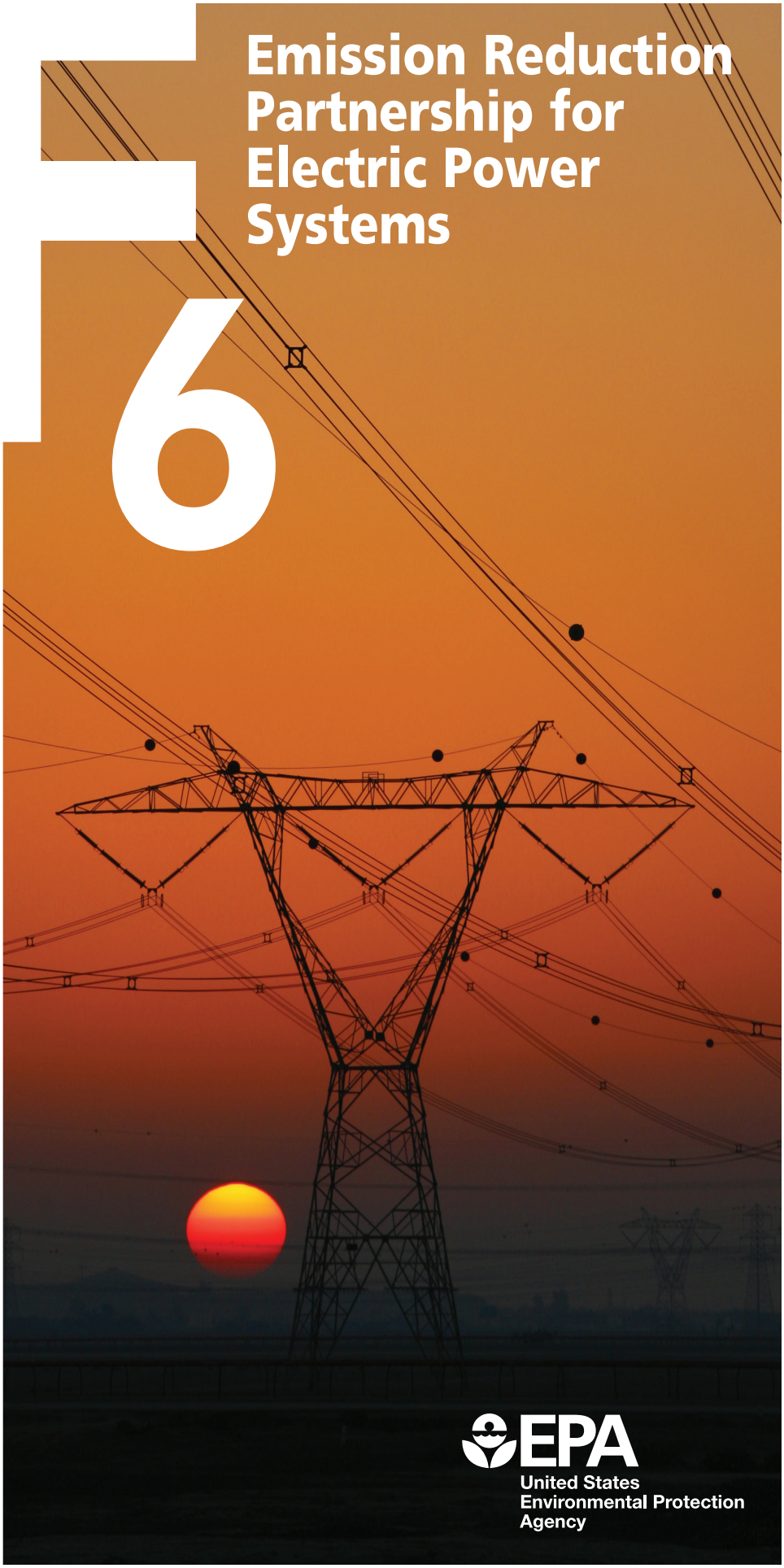
SF_6 Emission Reduction Partnership for Electric Power Systems

2013 Annual Report

April 2014



EPA
United States
Environmental Protection
Agency

SF_6 Emission Reduction
Partnership for Electric Power Systems

1999

Inception of the "Partnership" with 49 Charter Partners.

2000

1st International Conference on SF_6 and the Environment held in San Diego, CA.

2001–2003

Technical literature developed and made available on program web site including, "Byproducts of SF_6 Use in the Electric Power Industry" and "Catalog of Guidelines and Standards for the Handling and Management of SF_6."

2nd International Conference on SF_6 and the Environment held in San Diego, CA in 2002.

2004

3rd International Conference on SF_6 and the Environment held in Scottsdale, AZ (substation tour).

Partners start receiving customized benchmark reports on their progress in the program. Service Provider directory made available.

2005

Webcast tutorials on estimating and reporting SF_6 emissions offered. Field study on leak rates from circuit breakers manufactured between January 1998 and December 2002 is completed.

2006

4th International Conference on SF_6 and the Environment held in San Antonio, TX (substation tour). Partnership participation increases to 77 companies representing 42% of U.S. grid.

2007–2009

The SF_6 emission rate continues to drop; by 2007, Partners have reduced SF_6 emissions by more than half of baseline emissions. In 2009, the Partnership celebrates it 10 year anniversary at the 5th Workshop in Phoenix, AZ. Partners convene at a Partner Meeting in Chicago in June 2009, hosted by Partner utility ComEd.

2010

Partner utility Oncor hosts Partner Meeting in May in Dallas, Texas.

2012

The lowest SF_6 emission rate of the program to-date, 2.2% is achieved. Partner utility Southern Company hosts Partner meeting in April in Atlanta, GA

The SF_6 Emission Reduction Partnership for Electric Power Systems

Since 1999, members of the U.S. electric power industry and the U.S. Environmental Protection Agency (EPA) have been working together to identify and implement opportunities to reduce SF_6 emissions. The SF_6 Emission Reduction Partnership for the Electric Power Systems (the Partnership) is one of the many voluntary public-private partnerships managed by EPA that aim to reduce or slow the growth of greenhouse gas emissions. As part of the Partnership, Partner utilities voluntarily commit to reduce emissions of sulfur hexafluoride, or SF_6, a potent and long-lived greenhouse gas with a global warming potential (GWP) 22,800 times[1] that of carbon dioxide (CO_2). This means that SF_6 is 22,800[1] times more effective at trapping infrared radiation than an equivalent amount of CO_2 over a 100-year period. Greenhouse gases range in their potency, and SF_6 is classified as the highest GWP gas. Although SF_6 is emitted in smaller quantities than many other greenhouse gases, its extremely long atmospheric lifetime of 3,200 years causes it to accumulate in the earth's atmosphere for centuries.

Because of its unique dielectric properties, electric utilities rely heavily on SF_6 in electric power systems for voltage electrical insulation, current interruption, and arc quenching in the transmission and distribution of electricity. While SF_6 should theoretically remain contained within equipment, in reality, the gas is inadvertently emitted into the atmosphere as leaks develop during various stages of the equipment's lifecycle. SF_6 can also be released at the time of equipment manufacture, installation, servicing, or de-commissioning. Because there is no clear alternative to SF_6, Partners reduce their greenhouse gas emissions through implementing emission reduction strategies such as detecting, repairing, and/or replacing problem equipment, as well as educating gas handlers on proper handling techniques of SF_6 gas during equipment installation, servicing, and disposal. The Partnership fosters information sharing of these better management practices. This report presents the SF_6 emission reduction achievements of the Partnership through 2012.

[1] IPCC Fourth Assessment Report.

Inside the 2013 SF_6 Emission Reduction Partnership Annual Report

Partner Accomplishments

As part of their commitment to the Partnership, each year Partners report their SF_6 emissions and nameplate capacity estimates to EPA. (Note: Under EPA's Greenhouse Gas Reporting Program, Partners with a total nameplate capacity exceeding 17,820 pounds must report emissions and nameplate capacity under subpart DD - Use of Electric Transmission and Distribution Equipment). EPA collects and aggregates Partner information to determine the overall accomplishments of the Partnership. The results of the 2012 reporting year for the Partnership, including the cumulative emissions reduction for the program in comparison to the 1999 baseline year, are presented in the following section.

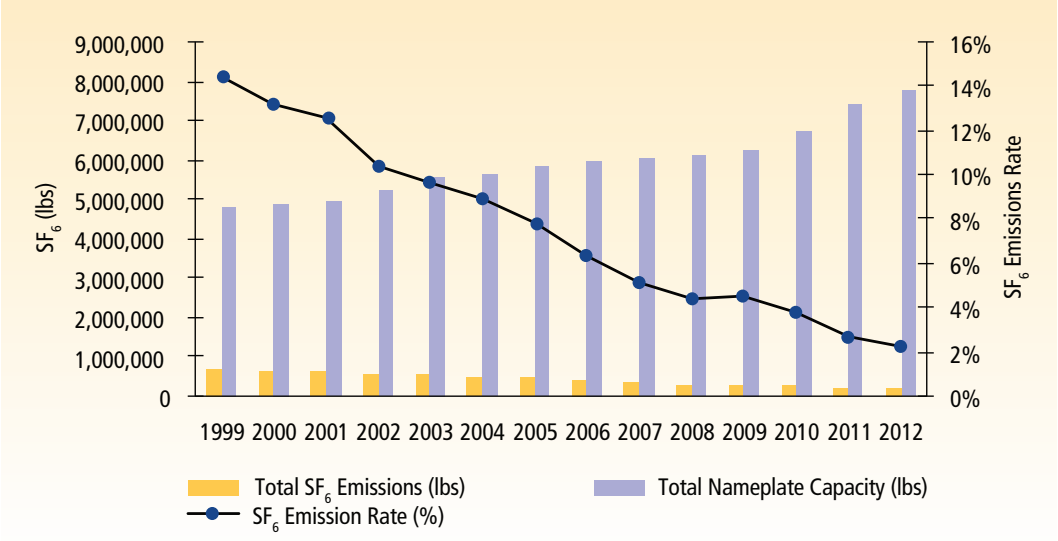
Partner-Reported Emissions Summary

The Partnership's annual average SF_6 emission rate, the ratio of SF_6 emissions relative to total SF_6 nameplate capacity (i.e., the total quantity of SF_6 contained in electrical equipment), is a benchmark metric by which achievements of the Partnership are tracked. As illustrated in Figure 1, the annual average SF_6 emission rate of Partners has decreased drastically since 1999. In the past five years, the emission rate has halved, from over 4 percent to just over 2 percent. Overall, the annual average SF_6 emission rate for the Partnership is down approximately 85 percent from the 1999 baseline emission rate of 14.4 percent to 2.2 percent in 2012.

Table 1 summarizes the Partnership's aggregate SF_6 emissions, nameplate capacity, and emission rate for the 1999 to 2012 reporting years.[2] From 2011 to 2012, total SF_6 emissions have decreased to 175,020 pounds, while the Partnership nameplate capacity increased to

[2] Trends across years should be evaluated using the SF_6 emission rate, rather than SF_6 emissions. The SF_6 emission rate is a valuable assessment of Partnership trends because it allows for a normalized comparison. While Partners vary in total SF_6 nameplate capacity, a larger utility, although using more SF_6, will not necessarily have a higher emission rate than a smaller utility.

*Figure 1: **SF_6 Emission Rate Trends***



7,790,070 pounds. Both of these changes led to an overall decrease in the annual average Partnership SF_6 emission rate. A summary of the Partnership's SF_6 emissions and reductions are presented in Table 2. The SF_6 emission reductions, presented in terms of pounds of SF_6 and million metric tons of carbon dioxide equivalent ($MMTCO_2e$), were calculated using a baseline year of 1999.

To date, Partners have decreased absolute emissions of SF_6 by 75 percent. Annual SF_6 reductions collectively made by Partners from 2011 to 2012 were 28,235 pounds, or the CO_2 equivalent of 0.31 million metric tons ($MMTCO_2e$). From 1999 through 2012, Partnership emissions reductions totaled close

Estimation Methods

Results in Table 1 are based on Partners in the program in 2012 as the representative population size for estimates for the entire time-series (1999-2012). To estimate emissions and nameplate capacity not reported by Partners; a set of assumptions was developed. For example, if a Partner reported for 2010 and 2012 but not for 2011, 2011 estimates were determined through linear interpolation.

TABLE 1: **Summary of Partnership SF_6 Emissions, Nameplate Capacity, and Emission Rate**

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total Partner-Reported SF_6 Emissions (lbs)	689,829	642,993	622,735	544,587	536,565	497,314	460,664	378,845	311,157	270,734	283,005	257,611	203,345	175,020
Total Nameplate Capacity (lbs)	4,803,982	4,870,199	4,932,295	5,246,167	5,537,370	5,597,696	5,859,631	5,991,759	6,046,284	6,091,273	6,277,773	6,715,608	7,415,256	7,790,070
SF_6 Emission Rate (%)[a]	14.4%	13.2%	12.6%	10.4%	9.7%	8.9%	7.9%	6.3%	5.1%	4.4%	4.5%	3.8%	2.7%	2.2%

Note: Historical estimates have been updated based on the estimation methodology used by EPA and data made available by Partners.
[a] Emission rate is defined as total emissions divided by total nameplate capacity (i.e., the total quantity of SF_6 contained in electrical equipment).

TABLE 2: **Summary of Absolute Partnership SF_6 Emission Reductions**

	1999[a]	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total Partner-Reported SF_6 Emissions (lbs)	689,829	642,993	622,735	544,587	536,565	497,314	460,664	378,845	311,157	270,734	283,005	257,611	203,345	175,020
Total Partner-Reported SF_6 Emissions ($MMTCO_2e$)	7.48	6.97	6.75	5.90	5.82	5.39	4.99	4.11	3.37	2.93	3.07	2.79	2.20	1.90
Reduction from Baseline (lbs)		46,835	67,094	145,242	153,264	192,515	229,165	310,984	378,672	419,095	406,824	432,218	486,484	514,809
Reduction from Baseline ($MMTCO_2e$)		0.51	0.73	1.58	1.66	2.09	2.48	3.37	4.10	4.54	4.41	4.68	5.27	5.58
Percent Reduction from Baseline		**6.8%**	**9.7%**	**21.1%**	**22.2%**	**27.9%**	**33.2%**	**45.1%**	**54.9%**	**60.8%**	**59.0%**	**62.7%**	**70.5%**	**74.6%**

Note: Historical estimates have been updated based on the estimation methodology used by EPA and data made available by Partners.
[a] Baseline year.

Cumulative SF_6 emissions reductions of 3,783,201 pounds relative to the 1999 baseline are equivalent to CO_2 emissions reductions from:

- **8.5 million** passenger cars not driven for one year
- **95.4 million** barrels of oil not used
- **11.6** coal-fired power plants for a year

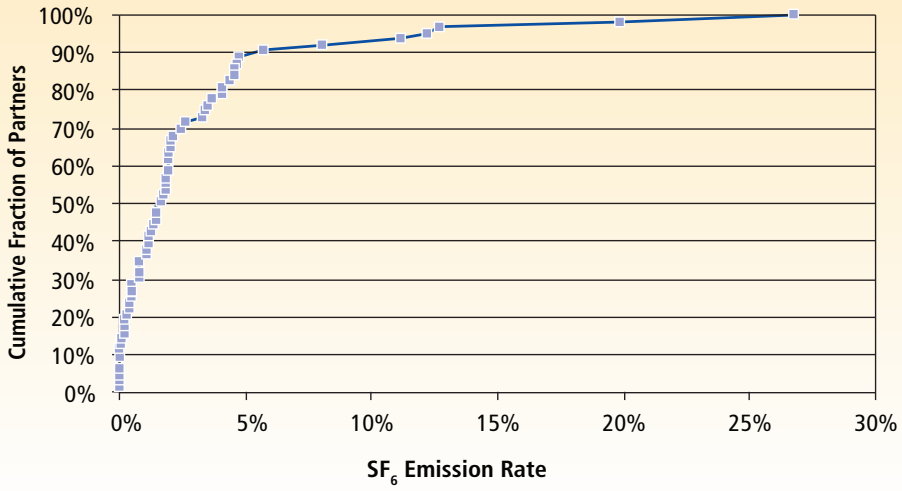
Because SF_6 has an atmospheric lifetime of 3,200 years (100-yr lifetime, reported in the IPCC Fourth Assessment Report), the benefits of reducing emissions accrue for many generations.

Source: **http://www.epa.gov/cleanenergy/energy-resources/calculator.html**

to a cumulative of 3.8 million pounds of SF_6 or 41 $MMTCO_2e$ (i.e., based on the sum of "Reduction from Baseline" as provided in Row 3, Table 2). If the Partnership's SF_6 emission rate of 14 percent remained unchanged since 1999, then the total amount of emissions emitted to the atmosphere since 1999 would be 6.1 million pounds greater than has actually occurred.

Figure 2 displays the distribution of Partners according to their emission rate. As illustrated, around 90 percent of Partners are below an emission rate of 5 percent, and around 70 percent of all Partners have achieved an emission rate of 2.5 percent or less. Emission rates of Partners vary due to a number of factors such as total nameplate capacity within their system, transmission miles, age and geographic location of equipment, and the number of years of participation in the Partnership.

*Figure 2: **SF_6 Emission Rate Trends***



Partner Spotlights

Partners that are involved in the EPA SF_6 Partnership are leaders in their industry in efforts to reduce SF_6 emissions.
Partners are actively seeking opportunities to improve the management and tracking of their cylinder inventories, maximizing recycling, and continually training personnel on responsible handling of SF_6 in the field. Another key action is prioritizing equipment repair and replacing equipment with major leaks as they see the financial benefit in such an investment (i.e., improved system reliability and avoided cost to replace gas lost to the atmosphere), in addition to environmental benefits. Biennial workshops also support technology transfer and information sharing.

Southern California Edison

Southern California Edison (SCE), one of the country's largest utilities, with nameplate capacity over 875,000 pounds, delivers power to more than 14 million people in 50,000 square miles of central, coastal, and southern California.

Since joining the Partnership in 1999 as a charter partner, SCE has reduced its emission rate from 9.7 percent to 1.2 percent in 2012, and has had an emission rate below the partnership average emission rate for the last six years. Since joining the Partnership, SCE's cumulative emission reductions have been equivalent to removing over 780,000 passenger cars from the road for one year.

SCE continues to be an active member of the Partnership. During the 2012 Workshop for SF_6 Emission Reduction Strategies, an SCE representative presented on "An Asset Management Approach for EPA/CARB SF_6 Regulations." In 2014, SCE will be hosting a site visit for the 2014 SF_6 Partnership conference to showcase its facilities and discuss the measures it has taken to reduce emissions.

Douglas County Public Utility District

Douglas County Public Utility District (PUD) is a non-profit power provider located in north-central Washington with total nameplate capacity under 4,000 pounds. Although one of the Partnership's smaller entities, Douglas County PUD has adopted an aggressive SF_6 management program and is consistently a high performing participant. Since joining the Partnership as a charter partner in 1999, they have lowered their emission rate from 22.1 percent to 0.2 percent in 2012. Douglas County PUD's emission rate has remained below one percent for the last nine years, which is one of the lowest Partner emission rates achieved over the last decade. Since joining the Partnership, its cumulative emission reductions have been equivalent to the emissions produced from over 200,000 barrels of oil. Douglas County PUD attributes their emission reduction success to setting annual goals and the adoption of a comprehensive program of improved gas handling techniques, greater emphasis on maintenance, a commitment to recycling, and replacement of equipment with persistent leaks.

Partnership Announcements and Updates

This section covers updates on outreach events, the latest developments in the Greenhouse Gas Reporting Program, and new Partners to the program.

Workshop on SF_6 Emission Reduction Strategies, Spring 2014

The SF_6 Emission Reduction Partnership for Electric Power Systems will be hosting another two-day Workshop May 6-7 in Long Beach, CA. Although the details on location and an exact date are not confirmed as of the time of this publication, EPA is pleased to announce that Partner utility Southern California Edison has offered to host a site visit in conjunction with the workshop.

The two-day workshop will bring together participants from Partner utilities, service providers, gas producers and distributors, and equipment manufacturers. Sessions will cover a range of issues such as climate change policy update, SF_6 emission reduction strategies, and managing and tracking SF_6 inventories. EPA is welcoming sponsors and will offer room for exhibitors.

Workshop details, including registration and hotel block, can be found at: **http://www.epa.gov/electricpower-sf6/workshops/index.html**

2012 Workshop: Atlanta, GA

On April 17-19, 2012, the Partnership held a workshop on SF_6 emission reduction strategies at Georgia Power Company Headquarters in Atlanta, GA.

This workshop brought together 100 participants from Partner utilities, service providers, gas producers and distributors, and equipment manufacturers. Sessions were held on various topics, including handling and tracking of SF_6 gas, climate change policy, a program introduction to the EPA Greenhouse Gas Reporting Program. Workshop participants were also offered a site tour of Southern Company's General Service Headquarters in Forest Park, GA and received a demonstration of various pieces of equipment, including recovery equipment, scales and bottles and weighing and calibration procedures, and a demonstration of camera leak detection.

Awards were given to four Partners for their success in achieving effective strategies for reductions of SF_6 and for sharing information on the environmental and economic benefits. Awards went to Commonwealth Edison Company, Consolidated Edison of New York, ITC Holdings Corp, and MidAmerican Company.

A roundtable discussion was held, allowing an open forum for Partners in attendance to discuss improving SF_6 emission and nameplate capacity estimates, best management practices, and mitigation strategies for SF_6 emission reductions and the future of the SF_6 Partnership.

EPA would like to specially recognize and thank Partner utility, Southern Company. This successful meeting would not have been possible without the hard work and hospitality of the staff.

Mandatory Reporting of Greenhouse Gases Rule

In response to the FY2008 Consolidated Appropriations Act (H.R. 2764; Public Law 110–161), in 2009, EPA issued the Final Mandatory Reporting of Greenhouse Gases Rule. The rule requires reporting of greenhouse gas (GHG) emissions from large sources and suppliers in the United States, and is intended to collect accurate and timely emissions data to inform future policy decisions.

Reporting requirements for Partners as well as other electric power systems, as set forth under Subpart DD of the regulation rule can be found on the EPA Greenhouse Gas Reporting Program website at: **http://www.epa.gov/ghgreporting**. Emissions from electric power systems are covered by the rule if the total nameplate capacity of SF_6-containing equipment exceeds 17,820 pounds of SF_6, which is estimated to be the equivalent to an emissions threshold of 25,000 metric tons of CO_2eq per year.

Electric Power Systems subject to this rule must submit mandatory reports covering calendar year 2013 by March 31, 2014. EPA will continue to communicate important announcements to Partners on the Partnership's email distribution list regarding the mandatory reporting of greenhouse gases.

New Partner

In 2013, the Partnership welcomed Entergy Corporation as a new Partner. Entergy delivers electricity to 2.8 million utility customers in Arkansas, Louisiana, Mississippi and Texas. The Partnership has continued to grow in size, nearly doubling from 49 members to 84 members as of April 2014. Charter members are specially recognized in the complete Partner list, which can be referenced at the end of this report.

Continued Growth and Success

When EPA and the electric power industry launched the Partnership in 1999, the challenge to reduce SF_6 emissions in technically and economically feasible ways was at hand. EPA and Partners met this challenge making significant reductions primarily by identifying and replacing or repairing old, leaking breakers. Over the years, Partners advanced their strategies to reduce SF_6 emissions, examining their system for all possible sources of potential emissions; purchasing new laser leak detection cameras; working with their vendors to receive SF_6 inventory related reports; tightening their gas cylinder inventories; purchasing more recycling carts; introducing software systems to better monitor and manage inventory; and improving on their overall management and training procedures. Voluntary action under the Partnership has yielded impressive results. In this reporting year, SF_6 partners collectively reduced the average SF_6 emission rate to 2.2 percent compared to 2.7 percent in 2011 and 14.4 percent in 1999. SF_6 emissions in the 2012 reporting year are 84 percent lower than in the 1999 baseline year. Cumulatively, over the course of the Partnership, SF_6 Partners have prevented the escape of approximately 3.8 million pounds of SF_6 or 41 $MMTCO_2e$. Preventing the loss of this much gas into the atmosphere translates into an equivalent of $30.4 million to $45.6 million of avoided SF_6 purchases to replace such losses.[3]

[3] Based on an SF_6 gas cost range of $8 to $12 per pound. Estimated cost savings does not consider other potential cost savings that might be realized indirectly, such as savings from reduced labor and maintenance expenditure or potential annual SF_6 cylinder rental fees.

EPA applauds all Partners for the program's success and encourages Partners to continue setting and working towards ambitious reduction goals with the program.

For additional information please contact:

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Partnership webpage:
http://www.epa.gov/electricpower-sf6/index.html

List of Partners (as of April 2014)

*Charter Partner

Subsidiaries are bulleted under parent companies

American Electric Power (AEP)*
Columbus, OH

Arizona Public Service Company (APS)
Phoenix, AZ

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

CenterPoint Energy*
Houston, TX

Central Maine Power Company*
Augusta, ME

Central Vermont Public Service Corporation*
Rutland, VT

City of Palo Alto
Palo Alto, CA

Consolidated Edison Company of New York, Inc.*
New York, NY

CPS Energy (formerly San Antonio City) Public Service Board)*
San Antonio, TX

Duquesne Light Company*
Pittsburgh, PA

Edison International
Rosemead, CA

El Paso Electric Company*
El Paso, TX

Entergy Corporation
New Orleans, LA

Eugene Water and Electric Board*
Eugene, OR

Exelon Energy Delivery (EED)

- **ComEd Energy Delivery***
  Chicago, IL
- **PECO Energy Delivery**
  Philadelphia, PA

FirstEnergy Corporation*
Akron, OH

- **Allegheny Power**
  Greensburg, PA

Fort Pierce Utilities Authority*
Fort Pierce, FL

Grand Island Utilities Department*
Grand Island, NE

Hastings Utilities*
Hastings, NE

ITC Transmission
Novi, MI

Kings River Conservation District*
Fresno, CA

Louisville Gas and Electric Company (LG&E) and Kentucky Utilities Company (KU)
Louisville, KY

Lower Colorado River Authority (LCRA)
Austin, TX

Maine Public Service Company*
Presque Isle, ME

Manitowoc Public Utilities*
Manitowoc, WI

Memphis Light, Gas & Water Division
Memphis, TN

Menasha Utilities*
Menasha, WI

MidAmerican Energy
Des Moines, IA

Montana-Dakota Utilities
Bismarck, ND

Muscatine Power & Water*
Muscatine, IA

Nashville Electric Service (NES)
Nashville, TN

National Grid

- **Granite State Electric**
  Northborough, MA
- **Massachusetts Electric**
  Northborough, MA

- **Nantucket Electric**
  Nantucket, MA
- **Narragansett Electric**
  Providence, RI
- **New England Electric Transmission Corporation**
  Westborough, MA
- **New England Hydro-Transmissions Company Inc.**
  Westborough, MA
- **New England Power Company**
  Westborough, MA
- **Niagara Mohawk Power Corporation**
  Syracuse, NY

Nebraska Public Power District
Doniphan, NE

New Hampshire Transmission-Seabrook Station
Seabrook, NH

New York Power Authority
New York, NY

New York State Electric and Gas
Ithaca, NY

Northeast Utilities Services Company*

- **Connecticut Light and Power Company**
  Berlin, CT
- **Public Service Company of New Hampshire**
  Manchester, CT
- **Western Massachusetts Electric Company**
  West Springfield, MA

Northern Indiana Public Service Company (NIPSCO)
Merriville, IN

NSTAR Electric and Gas
Westwood, MA

- **Boston Edison Company**
  Boston, MA
- **Cambridge Electric Light Company**
  Boston, MA
- **Commonwealth Electric Company**
  Boston, MA

Oglethorpe Power
Tucker, GA

Oklahoma Gas and Electric Corporation* (OG&E)
Oklahoma City, OK

Oncor (formerly TXU)*
Dallas, TX

Otter Tail Power Company
Fergus Falls, MN

Pacificorp
Portland, OR

- **Pacific Power**
  Portland, OR
- **Rocky Mountain Power**
  Salt Lake City, UT

Pacific Gas and Electric Corporation (PG&E)*
San Francisco, CA

PNM Resources
Albuquerque, NM

Public Utility District No. 1 of Douglas County
East Wenatchee, WA

Public Utility District No. 1 of Pend Oreille County*
Newport, WA

Rochester Gas and Electric Corporation
Rochester, NY

Salt River Project**
Phoenix, AZ

San Diego Gas & Electric
San Diego, CA

Seattle City Light
Seattle, WA

Silicon Valley Power*
Santa Clara, CA

South Carolina Electric & Gas Company
Columbia, SC

Southern Company*
Atlanta, GA

State of California – Department of Water Resources
Sacramento, CA

Tennessee Valley Authority (TVA)
Knoxville, TN

Texas Municipal Power Agency*
Bryan, TX

VT Transco LLC
Rutland, VT

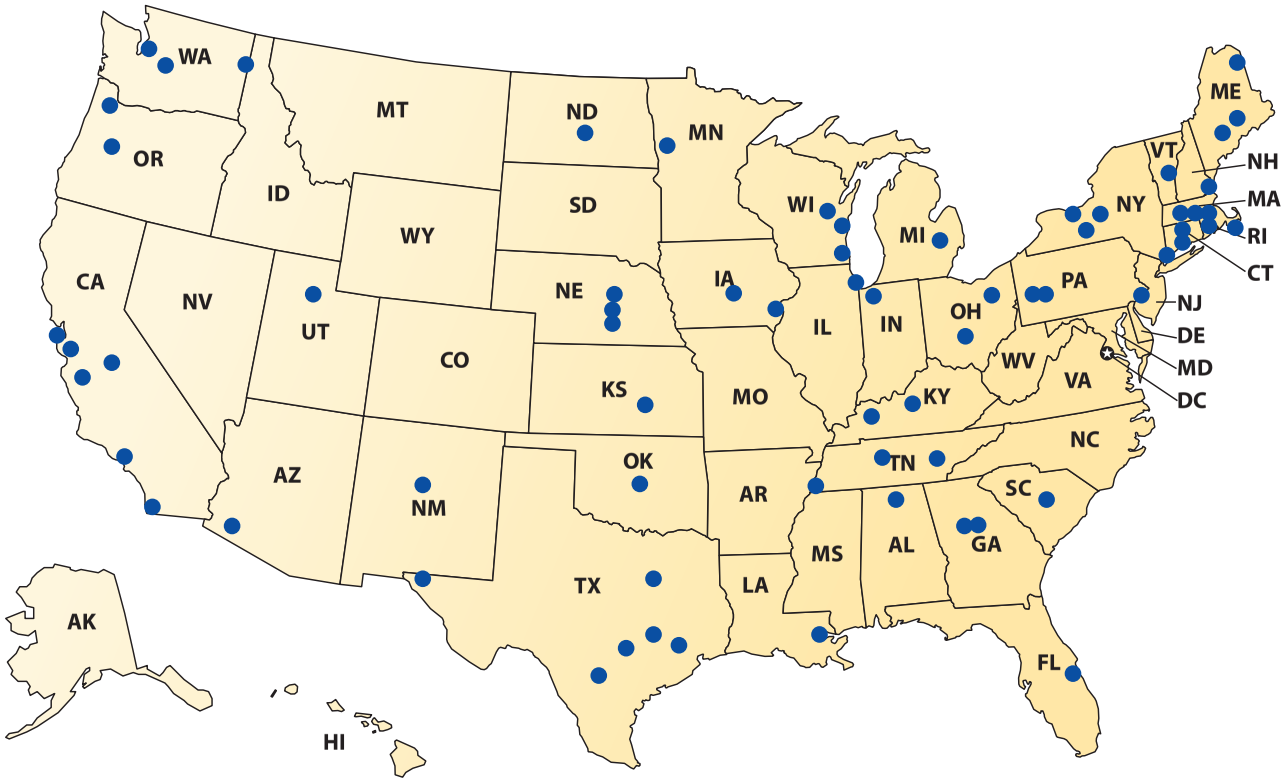
Wallingford Electric Division*
Wallingford, CT

We Energies*
Milwaukee, WI

Westar Energy
Wichita, KS

** Salt River Project is a Charter Partner that left the Partnership, but recently rejoined in 2009.

Distribution of Partners



United States
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Climate Change Division (6207J)
www.epa.gov
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