

SF₆

Emission Reduction Partnership for Electric Power Systems

2007 Annual Report

December 2008



**SF₆ Emission Reduction
Partnership for Electric Power Systems**



1999

Inception of the “Partnership” with 49 Charter Partners.

2000

1st International Conference on SF₆ and the Environment held in San Diego, CA.

2001–2003

Technical literature developed and made available on program Web site including, “Byproducts of SF₆ Use in the Electric Power Industry” and “Catalog of Guidelines and Standards for the Handling and Management of SF₆.”

2nd International Conference on SF₆ and the Environment held in San Diego, CA in 2002.

2004

3rd International Conference on SF₆ 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 SF₆ emissions offered. Field study on leak rates from circuit breakers manufactured between January 1998 and December 2002 is completed.

2006

4th International Conference on SF₆ and the Environment held in San Antonio, TX (substation tour). Partnership participation increases to 77 companies representing 42% of U.S. grid.

2007

The SF₆ emission rate dropped to 5.5 percent; Partners have reduced SF₆ emissions by more than half of baseline emissions.

The SF₆ Emission Reduction Partnership for Electric Power Systems

The United States Environmental Protection Agency (EPA) manages numerous voluntary public-private partnerships that are designed to address climate change through slowing the growth of greenhouse gas emissions. One such partnership, which is one of a suite of programs that addresses high global warming potential (GWP) emissions, is the SF₆ Emission Reduction Partnership for Electric Power Systems. Sulfur hexafluoride (SF₆) is a man made gaseous fluorinated compound that has a long atmospheric lifetime of 3,200 years. As compared to carbon dioxide, SF₆ traps 23,900 times more heat in Earth's atmosphere. For electric utilities in the United States, participation in this program signifies recognition of the opportunity they have to reduce their carbon footprint through

cost-effective reductions in SF₆ gas emissions. The electric utility industry uses SF₆ gas for high voltage electrical insulation, current interruption, and arc quenching in the transmission and distribution of electricity. No clear alternative exists for this gas that is used extensively in circuit breakers, gas-insulated substations, and switch gear, due to its inertness and dielectric properties. In order to reduce emissions of this potent greenhouse gas, Partners are identifying sources of fugitive emissions from equipment using different leak detection methods and fixing these problems by repairing or replacing the problem equipment. Additionally, Partners are educating gas handlers and implementing techniques to reduce emissions that occur during installation, servicing, and disposal.

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Partner Accomplishments

Since 1999, EPA's SF₆ Partners have made significant reductions in emissions of SF₆, and in 2007, that trend continued. In this section, the results of the 2007 reporting year, as well as cumulative emission reductions for the program in comparison to the 1999 baseline year, are presented.

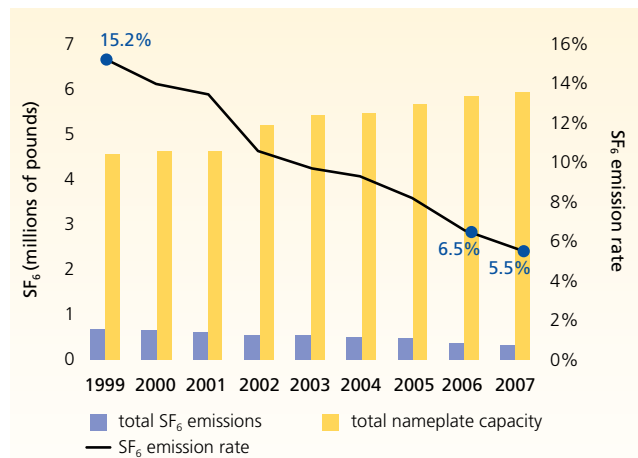
Partner-Reported Emissions

The Partnership's annual average SF₆ emission rate, the ratio of SF₆ emissions relative to total nameplate capacity (i.e., the total quantity of SF₆ contained in electrical equipment) has declined significantly since 1999. As shown by the line in Figure 1, the average 2007 SF₆ emission rate is 5.5 percent, down from 6.5 percent in 2006. Since the beginning of the Partnership in 1999 the Partnership's SF₆ emission rate has decreased

by 64 percent from the 1999 baseline emission rate of 15.2 percent.

The aggregated program statistics for each year since the 1999 Partnership launch are summarized in Table 1.¹ The results presented in this report are based on a methodology to

Figure 1: SF₆ Emission Rate Trends



Estimation Methods

- ▶ Results in Table 1 are based on Partners in the program in 2007 as the representative population size for estimates for the entire time-series (1999-2007). To estimate emissions and nameplate capacity not reported by Partners, a set of assumptions was developed. For example, if a Partner provided a report for 2005 and 2007 but not for 2006, a 2006 estimate was determined through linear interpolation.²

¹ Trends across years should be evaluated using the SF₆ emission rate, rather than SF₆ emissions.

² Reports published prior to 2007 did not follow the stated new methodology.

address instances when reporting Partners have not provided a complete data set, and to account for the evolving size of the program.

Results for the 2007 reporting year include total reported SF₆ emissions of 326,878 pounds, the lowest estimated emissions for the program overall to date, and a nameplate capacity of 5,899,489 pounds, the largest overall to date.

A summary of the total estimated SF₆ emission reductions achieved by Partners through 2007 is presented in Table 2, which are derived by evaluating emissions estimates (as shown in Table 1). Emissions reductions are also presented in terms of pounds and million metric tons of carbon dioxide equivalent (MMTCO₂E) with the Partnership's inception year (1999) as the baseline.

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total SF ₆ Emissions (lbs)	693,416	638,106	617,704	546,528	527,090	498,543	460,828	377,374	326,878
Total SF ₆ Nameplate Capacity (lbs)	4,563,183	4,614,480	4,610,478	5,180,931	5,395,612	5,432,255	5,670,725	5,827,600	5,899,489
SF ₆ Emission Rate ^a	15.2%	13.8%	13.4%	10.5%	9.8%	9.2%	8.1%	6.5%	5.5%

a – Emission rate is defined as total emissions divided by total nameplate capacity (i.e., the total quantity of SF₆ contained in electrical equipment).

	1999 ^a	2000	2001	2002	2003	2004	2005	2006	2007
Total Partner-Reported SF ₆ Emissions (lbs)	693,416	638,106	617,704	546,528	527,090	498,543	460,828	377,374	326,878
Total Partner-Reported SF ₆ Emissions (MMTCO ₂ e)	7.52	6.92	6.70	5.92	5.71	5.40	4.99	4.09	3.54
Reduction from Baseline (lbs)	–	55,310	75,712	146,889	166,326	194,873	232,589	316,042	366,538
Reduction from Baseline (MMTCO ₂ e)	–	0.60	0.82	1.59	1.80	2.11	2.52	3.43	3.97
Percent Reduction from Baseline	–	8.0%	10.9%	21.2%	24.0%	28.1%	33.5%	45.6%	53.0%

NOTE: Historical totals have been updated based on most recent data made available by Partners.
a – Baseline year.

To date, SF₆ Partners have achieved a 53 percent decrease in absolute emissions from the 1999 baseline year. From 2006 to 2007, Partners were able to reduce emissions of SF₆ gas by 50,496 pounds, or the equivalent of 0.55 MMTCO₂. Cumulatively, from 1999 through 2007, the emissions reductions total 1,554,278 pounds or 16.85 MMTCO₂E (i.e., the sum of “Reduction from Baseline” as provided in row 3, Table 2).

Methods Partners Use to Reduce Emissions of SF₆ Gas:

- ▶ Equipment leak detection and repair
- ▶ Equipment upgrades and the replacement of old with new equipment
- ▶ Training employees in best management practices to handle, manage, and monitor SF₆
- ▶ Systematic operations tracking including cylinder management and SF₆ gas recycling cart use

Cumulative SF₆ emissions reductions of 1,554,278 pounds relative to the 1999 baseline are equivalent to CO₂ emissions reductions from:

- ▶ **3.1 million** cars not driven for one year
- ▶ **39.1 million** barrels of oil not used
- ▶ **4.4 million** households reducing electricity use by 50 percent for one year

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

Partnership Update

In 2007 and 2008, the Partnership has continued to grow and support companies in their efforts to reduce SF₆ emissions. Within the past year, two new companies have joined the program's efforts to help reduce SF₆ emissions from electric power systems. These new Partners, in addition to all other companies, are encouraged to set reduction goals through 2012, which will help the Partnership as a whole achieve its aggregate reduction goal. A fundamental component to emission reduction efforts is properly reporting emissions, which gives a more accurate estimate of achievements to date. To that end, a summary of the common mistakes seen on reporting forms and corrections to those mistakes is provided.

2009 Workshop on SF₆ Emission Reduction Strategies

EPA will be hosting the Partnership's 2009 Workshop on SF₆ Emission Reduction Strategies in Phoenix, Arizona on February 4–5, 2009 at the Hyatt Regency Phoenix. EPA will celebrate the program's 10 year anniversary at the workshop with special recognition to Partners that have contributed to the success of the program throughout the decade. The workshop, which will be held immediately following the 12th Annual EUEC 2009 Conference and Expo will feature technical presentations on best management practices, exhibitors that provide a variety of services to electric utilities on SF₆ management, training, and a site tour of SF₆ Partner, Arizona Public Service. This

Workshop Topics and Events

- ▶ SF₆ Emission Reduction Partnership 10 Year Anniversary – Program Update and Partner Recognition Ceremony
- ▶ Managing an SF₆ Gas Inventory: Best Management Practices
- ▶ Personnel Training: SF₆ Gas Handling
- ▶ SF₆ Leaks from Equipment: Leak Detection, Repair, and Replacement
- ▶ Training Course on SF₆ Emissions Reductions through Recovery, Recycling, and Reuse
- ▶ SF₆ Partner, Arizona Public Service, Site Tour

event will serve as an excellent opportunity for field personnel and environmental staff from electric companies, including both Partners and potential new Partners, to receive important technical training and information that can improve SF₆ gas handling and subsequent

emission reductions. For more information on registration and the current agenda, please visit the SF₆ Emission Reduction Partnership for Electric Power System Web site at www.epa.gov/electricpower-sf6.

New Partners and Upcoming 10 Year Anniversary

Since 2007, EPA has welcomed two new Partners into the SF₆ Emission Reduction Partnership for Electric Power Systems, New York State Electric and Gas, a sister company to Partner, Rochester Gas & Electric Corporation, and VT Transco LLC. The Partnership began with 49 participants in 1999 and has grown to a total of 78 Partners. 2009 will mark the Partnership's 10 year anniversary. Our charter members are specially recognized in the complete Partner list, which can be referenced at the end of this report.

Program Goals

Newest Partners of the SF₆ Emission Reduction Partnership for Electric Power Systems:

- New York State Electric and Gas – Ithaca, NY
- VT Transco LLC – Rutland, VT

Over the past two years, EPA has organized an effort to establish a collective Partnership goal by asking Partners to choose 2012 as a target year for the goal they wish to establish. In undertaking this effort, the intent is to encourage companies to evaluate how their company can meet the challenge to further reduce SF₆ emissions by a target year common

Setting an SF₆ Emission Reduction Goal

Within 18 months of signing the MOU, Partners agree to establish an emission reduction goal. EPA encourages Partners to evaluate their goals annually and update them to reflect ongoing performance. EPA accepts any goals set by Partners.

Goals may include:

- ▶ A long-term target to reduce absolute emissions or emission rate by a certain year –
 - *Example: Reduce emissions (or emission rate) by 50 percent by 2012.*
- ▶ Annual or short-term rolling targets –
 - *Example: Lowering the emission rate from 6 to 5 percent by the next reporting year.*
- ▶ A stewardship goal –
 - *Example: Maintain low or zero emissions.*

to all Partners in the program. As illustrated in Figure 2, more than 60 percent of companies report emissions rates of 3.5 percent or less. Figure 3 depicts a projected trajectory that SF₆ emissions will take through 2012 to achieve a Partnership established goal of a 3.5 percent emission rate for the target year.

EPA encourages those that have not re-assessed their goals to do so in light of their current progress. Partners should also develop a long term strategy for their use of SF₆ and consider the procedures that can be put in place to bolster mitigation efforts.

Revisiting the SF₆ Emission Inventory Reporting Form

The Partnership’s recommended method for estimating SF₆ emissions is with the SF₆ Emission Inventory Reporting Protocol and Form. This form is based on the mass-balance method, which works by tracking and systematically accounting for all company uses of SF₆ during the reporting year. The quantity of SF₆ that cannot be accounted for is then assumed to have been emitted to the atmosphere. This method ensures that potential emissions from both equipment losses and handling losses are captured in the overall emission estimate. Other methods, such as simply recording amounts of SF₆ gas used to top off equipment with low levels of the gas will not capture any potential losses from SF₆ gas handling.

Figure 2: 2007 Emission Rates of Partners

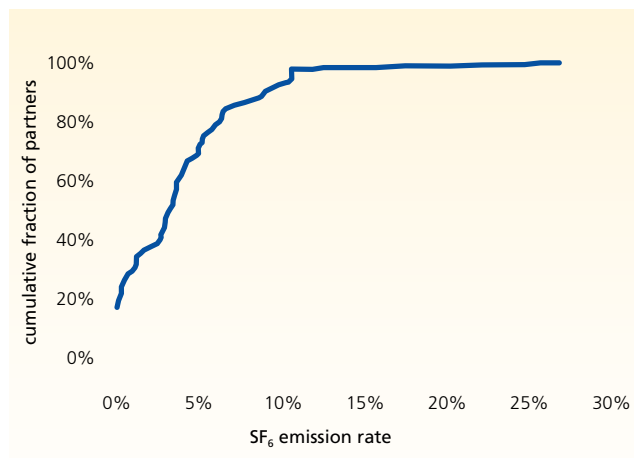
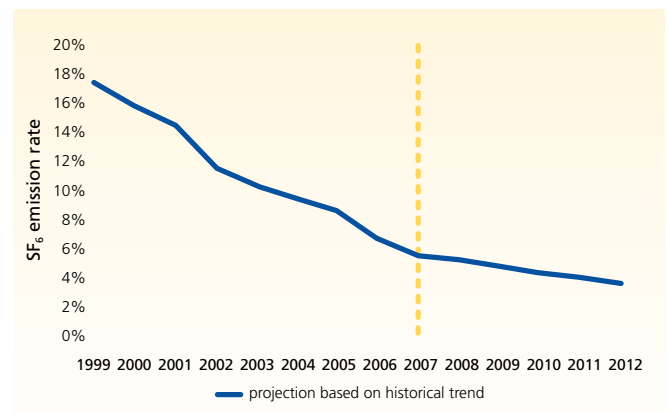


Figure 2 benchmarks the rates and range of emissions amongst Partner companies. The purpose of the Partnership is to enable all participating companies to improve management of their use of SF₆ and reduce emissions to cost-effective, technically feasible levels. Emission rates may differ due to a number of variables including the total SF₆ nameplate capacity of the system, net transmission miles, age and geographic location of equipment, and number of years participating in the Partnership, amongst other factors.

Figure 3: Partnership SF₆ Emission Rates, Actual and Projected



When EPA reviews Partner submittals, potential mistakes are noted and EPA attempts to contact Partners to better understand their inputs and provide guidance on improving data collecting and reporting. This year, EPA identified some common confusion regarding two inputs in the form: “SF₆ provided by equipment

manufacturers with or inside equipment” and “total nameplate capacity of new equipment,” as highlighted below. Partners are encouraged to contact EPA’s Program Manager with any questions or concerns on the guidance provided in the textbox below.

Common Mistakes on Reporting of SF₆ Purchases/Acquisitions

Mistake: Reporting that no SF₆ is provided by manufacturers with or inside equipment (Section B, number 4, “B4”), while simultaneously reporting a non-zero nameplate capacity for new equipment (Section D, number 10, “D10”).

Clarification: High voltage equipment typically comes with as much as a 20% nominal charge of the total nameplate capacity. When new nameplate capacity is reported (D10), but SF₆ provided by manufacturers is not reported (or reported as zero) (B4), emissions are incorrectly estimated.

Correction: Calculate B4 by assessing exactly how much SF₆ gas arrives with or alongside new equipment. At a very minimum, EPA recommends developing a basic estimate of the typical nominal charge that is associated with a new piece of equipment.

Purchase/ Acquisitions of SF ₆	3. SF ₆ purchased from producers or distributors in cylinders	
	4. SF ₆ provided by equipment manufacturers with/inside equipment	
	5. SF ₆ returned to the site after off-site recycling	
	B. Total Purchase/Acquisitions (3+4+5)	
Sales/ Disbursements of SF ₆	6. Sales of SF ₆ to other entities, including gas left in equipment that is sold	
	7. Returns of SF ₆ to supplier	
	8. SF ₆ sent to destruction facilities	
	9. SF ₆ sent off site for recycling	
	C. Total Sales/Disbursements (6-7-8-9)	
Change in Nameplate Capacity	10. Total nameplate capacity (proper full charge) of <u>new</u> equipment	
	11. Total nameplate capacity (proper full charge) of <u>retired</u> or <u>sold</u> equipment	
	D. Change in Capacity (10-11)	

Mistake: Reporting equivalent pounds for SF₆ provided by manufacturers with or inside equipment (B4), and nameplate capacity for new equipment (D10).

Clarification: High voltage equipment typically comes with as much as 20% nominal charge of the total nameplate capacity, in addition to the bulk gas that comes with the new equipment from manufacturers. The bulk gas is usually provided in quantities which are larger than the quantity required to fill the nameplate capacity.

Correction: Calculate B4 by assessing exactly how much gas arrives with or alongside the equipment. At a very minimum, EPA recommends developing a basic estimate of B4 that accounts for the quantity of SF₆ that accompanies new equipment.

Climate Change — Information and Resources

Over the course of the past century, humans have added substantial amounts of greenhouse gases into the atmosphere, increasing atmospheric concentrations. This increase alters the balance of incoming and outgoing energy into the Earth's atmosphere. The consequence of this change in balance is climate change. Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). The effects of these changes are subject to on-going studies.

As with any field of scientific study, there are uncertainties associated with the science of climate change. However, much of what scientists know is based on well-known physical laws and documented historical trends that substantiate many aspects of climate science. Many communication channels exist for scientists to share information and their knowledge about the causes and possible effects of climate change so people can fully understand the phenomenon. Provided below are suggestions sources to access information on climate change.

Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP). The goal of the IPCC is to make objective information about climate change

available to the policy and decision makers, and the public. Available on the IPCC Web site (<http://www.ipcc.ch/index.htm>) for public viewing are Assessment Reports that provide the most up-to-date information about the current state of knowledge on climate change. A new Assessment Report is published every four years. In addition, the IPCC provides Special Reports and Technical Reports addressing specialized topics on climate change.

U.S. Environmental Protection Agency

Through the United States Environmental Protection Agency (EPA) Web site (<http://www.epa.gov/climatechange/>) current information about climate change is available. Some of the topics covered include:

- Background
- Health effects
- U.S. regulatory initiatives
- The U.S. Greenhouse Gas Annual Inventory
- Emission reduction guidelines for homes, schools, and businesses
- Voluntary emissions reduction programs
- Science
- Policy
- Environmental effects

EPA continually updates their Web site in an effort to make the most recent information readily available. Additionally, EPA offers a feature that provides access to a database of frequently asked questions pertaining to climate change (http://climatechange.custhelp.com/cgi-bin/climatechange.cfg/php/enduser/std_alp.php). If a question does not appear in the database,

site users can send questions through the Web to EPA that will be directly answered and added to the database.

United Nations Framework Convention on Climate Change

In 1994, the United Nations Framework Convention on Climate Change (UNFCCC) was formed with the goal of sharing technology, adaptation and policy information to support the intergovernmental efforts to tackle the challenge posed by climate change. The UNFCCC is an international treaty, signed and ratified by 192 country members world wide, including the United States. While the Kyoto Protocol is an addition to the UNFCCC treaty, the

United States did not sign the Kyoto Protocol. Nonetheless, as a party to the UNFCCC, the United States complies with the commitment to develop an annual inventory on greenhouse gas emission and sinks.³

Available on the UNFCCC Web site (<http://unfccc.int/2860.php>) is information on international emissions data, science and policy, the Kyoto Protocol, and adaptation to effects of climate change, amongst other related topics. In addition, this information source provides links to National Reports on greenhouse gas emissions and details of national activity for all 192 member countries.

³ The most recent U.S. inventory is available at: <http://www.epa.gov/climatechange/emissions/index.html>

Continued Growth And Success

In 2007, SF₆ Partners collectively reduced the average SF₆ emission rate to 5.5 percent compared to 6.5 percent in 2006 and 15.2 percent in 1999. SF₆ emissions in 2007 are 53 percent lower than in the 1999 baseline year. Cumulatively, SF₆ Partners have prevented the escape of approximately 1.6 million pounds of SF₆ or 16.85 MMTCO₂e. Preventing the loss of this much gas into the atmosphere translates into an equivalent of \$9.3 million to \$14 million of avoided SF₆ purchases to replace such losses.⁴

⁴ Based on an SF₆ gas cost range of \$6 to \$9 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 SF₆ cylinder rental fees.

The demonstrated leadership of SF₆ Partners is critical to the future success of the program. EPA looks forward to celebrating the success of the program with its Partners in 2009 and exploring ways to further improve on current the strategies to reduce emissions of this greenhouse gas from electric power systems.

For additional information, please contact:

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List of Partners (as of December 2008)

* Charter Partner

Subsidiaries are indented under parent companies

Allegheny Power
Greensburg, PA

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

Columbia River People's Utility District*
St. Helens, OR

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*
Pittsburg, PA

E.ON U.S. LCC
Louisville, KY

Edison International
Rosemead, CA

El Paso Electric Company*
El Paso, TX

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

Florida Power and Light Company (FPL)*
Juno Beach, FL

FPL Energy New England Division
Seabrook, NH

Fort Pierce Utilities Authority*
Fort Pierce, FL

Grand Island Utilities Department*
Grand Island, NE

Great River Energy
Elk River, MN

Hastings Utilities*
Hastings, NE

ITC Transmission
Novi, MI

Kings River Conservation District*
Fresno, CA

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

NSTAR Electric and Gas
Westwood, MA

Boston Edison Company
Boston, MA

Cambridge Electric Light Company
Boston, MA

Commonwealth Electric Company
Boston, MA

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 Power Company
Westborough, MA

New England Electric Transmission Corporation
Westborough, MA

New England Hydro-Transmissions Company Inc.
Westborough, MA

Niagara Mohawk Power Corporation
Syracuse, NY

Nebraska Public Power District
Doniphan, NE

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)
Merrville, IN

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

PNM Resources
Alburquerque, NM

Pacificorp
Portland, OR

Pacific Power
Portland, OR

Rocky Mountain Power
Salt Lake City, UT

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

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

Seattle City Light
Seattle, WA

Silicon Valley Power*
Santa Clara, CA

South Carolina Electric & Gas Company
Columbia, SC

Southern Company*
Atlanta, GA

Tennessee Valley Authority (TVA)
Knoxville, TN

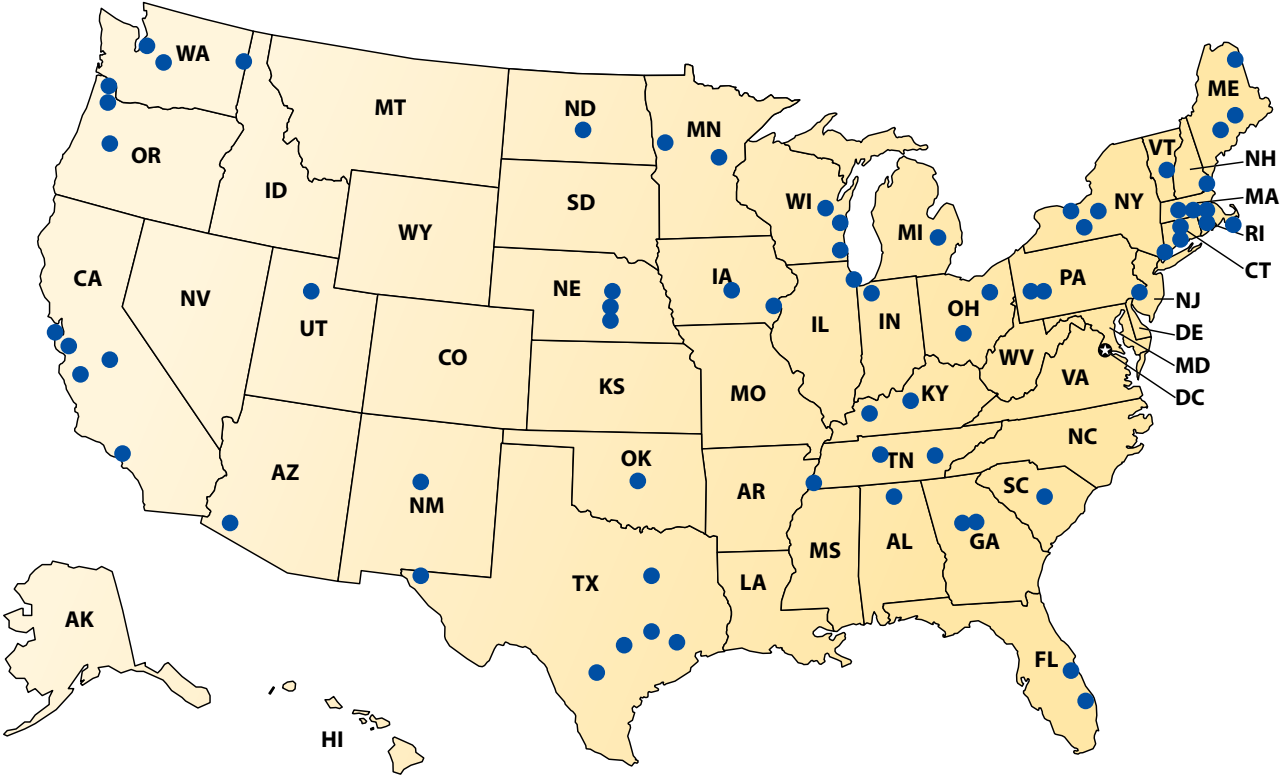
Texas Municipal Power Agency*
Bryan, TX

VT Transco LLC
Rutland, VT

Wallingford Electric Division*
Wallingford, CT

We Energies*
Milwaukee, WI

Distribution of Partners





United States
Environmental Protection
Agency

Climate Change Division (6207J)

www.epa.gov

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