2. Reducing Emissions from Electric Power

Electric Power Industry

The electric power industry emitted approximately 2,352 million metric tons of carbon dioxide in 2000, 41 percent of total U.S. carbon dioxide emissions.[23] Carbon dioxide emissions result from the combustion of fossil fuels—coal, oil, and natural gas—during electricity generation. For example, coal, which accounts for 81 percent of electric power industry carbon dioxide emissions in 2000, is the primary energy source for U.S. electricity generation and has the highest rate of carbon dioxide emissions per unit of energy used among fossil fuels. When it is burned, coal emits about 70 percent more carbon dioxide per unit of energy consumed than does natural gas.

Since 1990, carbon dioxide emissions from the electric power industry have increased by 494 million metric tons or 26.5 percent, a trend that reflects U.S. economic growth and corresponding increases in energy consumption. In 2000, carbon dioxide emissions from the electric power industry increased by 4.7 percent, nearly double the decade's average annual increase of 2.4 percent. Contributing to the relatively large increase in emissions in 2000 was a 4.2-percent increase in fossil fuel use for electricity generation, including a 4.3-percent increase in coal-fired generation, a 7.1-percent increase in natural-gas-fired generation, and an 11.0-percent drop in generation from renewable fuels.

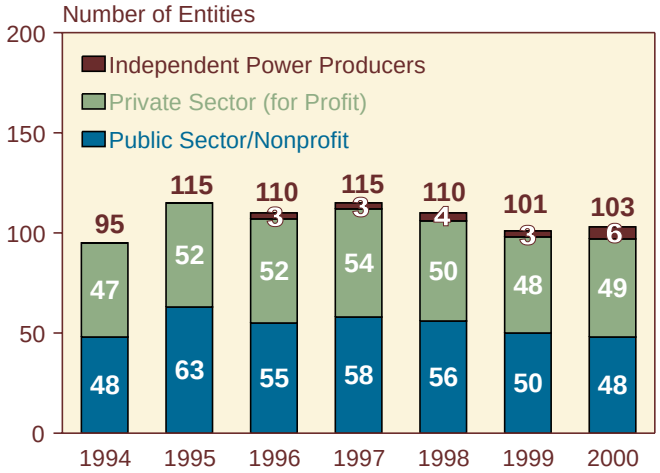
Projects Reported

For the 2000 reporting year, a total of 103 electric power providers reported to the Voluntary Reporting Program (Figure 4). This is a decrease from the peak of 115 electric power providers reporting in 1995 and 1997 but an 8-percent increase from the 95 reporters for the first reporting year, 1994. Since 1997, merger activity in the electric power industry as a result of deregulation has reduced the pool of electric utilities reporting to the Voluntary Reporting Program.

Electric power providers make up 54 percent of the total 183 project-level reporters for data year 2000. Forty-eight of the electric power industry reporters were public sector or nonprofit organizations, including electric cooperatives, municipal utilities, and other public-sector entities such as the Tennessee Valley Authority (TVA). Forty-nine entities were private-sector organizations, mostly investor-owned utilities (IOUs). The number of reporting independent power producers (IPPs) doubled from three for 1999 to six for 2000.

The 480 electric power projects reported for 2000 (Figure 5), represent a 6-percent increase from the 1999 reporting year total of 452 and a 113-percent increase from the 225 projects reported for 1994. Electric power projects were second to carbon sequestration (494 projects) as the most numerous in the Voluntary Reporting Program, accounting for 26 percent of all projects reported for 2000. Electric power projects are reported in two categories: (1) carbon content reduction; and (2) increasing energy efficiency in generation, transmission, and distribution. Carbon content reduction projects include availability improvements, fuel switching, and increases in lower emitting capacity. Increased efficiency through generation, transmission, and distribution projects include such activities as heat rate improvements, cogeneration and waste heat recovery, high-efficiency transformers, and reductions in line losses associated with electricity transmission and distribution. A total of 259 projects for increased energy efficiency in generation, transmission, and distribution were reported for

Figure 4. Number of Electric Power Reporters by Entity Type, Data Years 1994-2000

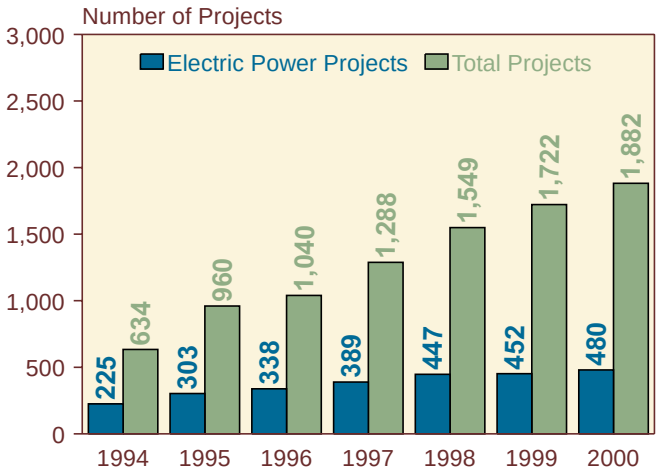


Source: Energy Information Administration, Forms EIA-1605 EIA-1605EZ.

[23]Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001), web site http://www.eia.doe.gov/oiaf/1605/1605a.html.

2000, and 249 carbon content reduction projects were reported.[24]

Figure 5. Electric Power Projects and Total Projects Reported, Data Years 1994-2000



Source: Energy Information Administration, Forms EIA-1605 EIA-1605EZ.

Reductions Reported

In 2000, total reported emission reductions from electric power projects (Table 9) included 132.7 million metric tons carbon dioxide equivalent from direct sources, 8.6 million metric tons from indirect sources, and 7.8 million metric tons from unspecified sources.[25] The 249 projects in the category "reducing carbon content" reported emission reductions of 120.4 million metric tons carbon dioxide equivalent from direct sources, 6.9 million metric tons from indirect sources, and 6.8 million metric tons from unspecified sources. The 259 projects included in the category "increasing energy efficiency in generation, transmission, and distribution" reported emission reductions of 15.6 million metric tons carbon dioxide equivalent from direct sources, 1.8 million metric tons from indirect sources, and 1.1 million metric tons from unspecified sources.

Many of the largest projects reported to the Voluntary Reporting Program are electric power projects. In 2000, 27 electric power projects reported direct reductions of 1 million metric tons carbon dioxide equivalent or more, representing 73 percent of all the projects that reported

Table 9. Number of Electric Power Projects and Emission Reductions Reported by Project and Reduction Type, Data Year 2000

Project Type	Number of Projects Reported	Emission Reductions Reported (Metric Tons Carbon Dioxide Equivalent)		
		Direct	Indirect	Unspecified[a]
Reducing Carbon Content	**249**	**120,406,794**	**6,936,723**	**6,785,090**
Availability Improvements	38	73,670,494	2,675,038	2,042,860
Fuel Switching	58	1,769,923	4,111,541	1,288,228
Increases in Lower Emitting Capacity	111	49,299,472	3,911,766	3,174,348
Other Carbon Reduction	54	24,118,541	-13,806	279,654
Increasing Energy Efficiency	**259**	**15,554,320**	**1,781,941**	**1,051,658**
Generation	***178***	***12,377,559***	***1,535,889***	***961,281***
Efficiency Improvements	160	10,261,214	324,581	961,281
Cogeneration and Waste Heat Recovery	18	2,116,344	1,211,308	--
Transmission and Distribution	***82***	***3,187,107***	***246,052***	***90,378***
High-Efficiency Transformers	39	1,587,511	197,049	16,998
Reconductoring	30	1,656,613	193,171	4,099
Distribution Voltage Upgrades	28	2,157,326	131,858	549
Other Transmission and Distribution	19	1,031,678	64,996	68,731
Total Electric Power Projects	**480**	**132,664,059**	**8,604,390**	**7,836,749**

[a]Unspecified reductions represent quantities reported on Form EIA-1605EZ, which does not distinguish between direct and indirect emission reductions.

Note: More than one project type may be assigned to a single project; therefore, the sums of the projects and reductions in each project type category may exceed the total numbers of projects and reductions in the totals and subtotals.

Source: Energy Information Administration, Forms EIA-1605 and EIA-1605EZ.

[24]More than one project type may be assigned to a single project; therefore, the sums of the projects and reductions in many project type categories exceed the total numbers of projects and reductions reported.

[25]Unspecified reductions represent quantities reported on Form EIA-1605EZ, which does not distinguish between direct and indirect emission reductions.

direct emission reductions exceeding 1 million metric tons carbon dioxide equivalent. About three-quarters of the reported electric power projects were related to nuclear power.

Reducing the Carbon Content of Energy Sources

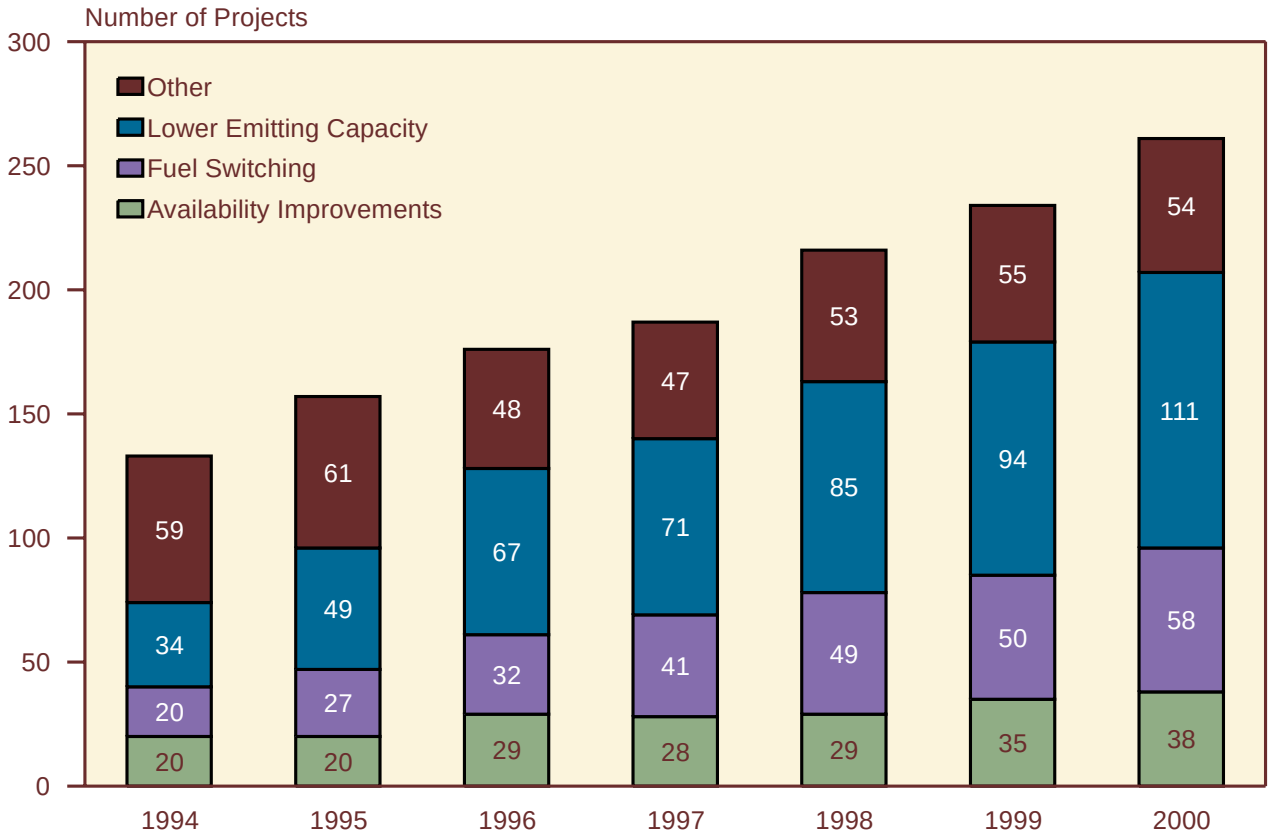
Projects involving fuel switching, power plant availability improvements, increases in low- or zero-emitting generation capacity, and other similar activities typically reduce the amount of carbon consumed to generate a unit of electricity. A total of 249 such projects were reported for 2000, including some of the largest projects reported to the Voluntary Reporting Program (Figure 6). The emission reductions reported for "carbon content reduction" electric power projects in 2000 totaled 120.4 million metric tons carbon dioxide equivalent from direct sources, 6.9 million metric tons from indirect sources, and 6.8 million metric tons from unspecified sources. Some carbon content reduction projects are in fact "hybrids," combining efficiency improvements with measures such as availability improvements or increases in low-emitting capacity (see box on page 24).

Availability Improvements

By increasing generation from lower emitting power plants, availability improvement projects provide a commensurate reduction in the amount of generation supplied by higher emitting plants. The number of availability improvement projects reported for 2000 was 38—3 more than the 35 reported for 1999. Availability improvement projects accounted for reported emission reductions in 2000 totaling 73.7 million metric tons carbon dioxide equivalent from direct sources, 2.7 million metric tons from indirect sources, and 2.0 million metric tons from unspecified sources. As for previous reporting years, availability improvement projects, especially those undertaken at nuclear facilities, produced some of the largest reductions in carbon dioxide emissions reported. Of the 38 availability improvement projects reported, almost three-quarters involved nuclear power plants. Mainly through significant advances in operating, maintenance, and refueling procedures, capacity factors at nuclear plants were increased, displacing some fossil-fuel-based power generation.

Because nuclear power plants are invariably large baseload facilities, even a fairly small improvement in

Figure 6. Electric Power Projects Reducing the Carbon Content of Energy Sources by Project Type, Data Years 1994-2000



Note: The sum of projects in many project categories exceeds the total number of projects reported, because more than one project type may be assigned to a single project.

Source: Energy Information Administration, Forms EIA-1605 and EIA-1605EZ.

Electricity Supply Carbon Reduction Projects: Definitions and Terminology

The combustion of fossil fuels to produce heat for electricity generation causes greenhouse gas emissions. In addition to substantial releases of carbon dioxide, fossil fuel combustion also emits small quantities of methane and nitrous oxide. Carbon content reduction projects typically reduce greenhouse gas emissions by replacing higher emitting fuels (such as coal) with lower emitting fuels (such as natural gas) or non-emitting energy sources (such as nuclear power or renewables). Projects that reduce the carbon content of electricity supply include the following.

Availability Improvements. By reducing the frequency and length of planned and unplanned power plant outages, availability improvement projects can result in increased use of the affected plant. This is particularly true if the plant is a *baseload* plant (i.e., a plant that is generally used on an around-the-clock basis except during plant outages), but it may hold true for other types of plants as well. If the resulting increase in generation from the affected plant displaces generation that otherwise would have been produced by a higher emitting plant, emission reductions will result. Power plant utilization is measured by the plant's *capacity factor*, defined as the ratio of the average load on the plant over a given period to its total capacity. For example, if a 200-megawatt plant operates (on average) at 75 percent of its rated capacity (i.e., at a load of 150 megawatts) over a period of a year, the plant's capacity factor is 75 percent for that year.

Fuel Switching. The amount of carbon contained in fossil fuels and released in the form of carbon dioxide during combustion varies, depending on the type of fuel. Thus, carbon dioxide emissions from a power plant can be reduced by switching from a higher emitting fuel (such as coal) to a lower emitting fuel (such as natural gas).

Increases in Lower Emitting Capacity. By increasing the capacity of an existing lower emitting or non-emitting plant (e.g., a hydroelectric plant), or by constructing new generating capacity (e.g., wind turbines), a utility can reduce or avoid reliance on higher emitting plants. The result will be a reduction in greenhouse gas emissions from the displaced plants.

plant availability can lead to a sizable reduction in fossil fuel consumption. For example, Carolina Power & Light Company reported that it increased the level of production at its nuclear power plants through a combination of initiatives over the 1992-2000 period, achieving 9.0 million metric tons carbon dioxide equivalent of direct emission reductions. The initiatives included adoption of improved technology, implementation of industry best practices, and plant modifications to improve reliability and increase production.

Fuel Switching

Fifty-eight fuel-switching projects were reported in 2000, 8 more than the 50 reported in 1999 and 38 more than the 20 reported in 1994. Switching from coal or oil to natural gas lowers carbon dioxide emissions because of the lower carbon content of natural gas relative to other fossil fuels. For example, switching from bituminous coal to natural gas can reduce carbon dioxide emissions per unit of energy consumed by approximately 43 percent. Although other reported actions, such as switching from oil to gas, may not lead to reductions of the same magnitude, they also reduce greenhouse gas emissions. The fuel-switching projects reported for 2000 accounted for emission reductions totaling 1.8 million metric tons carbon dioxide equivalent from direct sources, 4.1 million metric tons from indirect sources, and 1.3 million metric tons from unspecified sources.

An example of a fuel-switching project is the DTE Energy / Detroit Edison Greenwood Energy Center Fuel Switching project at the 785-megawatt Greenwood Energy Center in Michigan. Before 1991, Greenwood Energy Center burned mostly No. 6 fuel oil and some No. 2 oil. In 1991, Greenwood started to burn natural gas in place of a large amount of the No. 6 oil. In 2000, a reduction of 10,143,136 million Btu of residual fuel use, which was replaced with natural gas, was reported for this activity. DTE Energy / Detroit Edison reported direct emission reductions of 317,677 metric tons carbon dioxide.

Increases in Lower Emitting Capacity

Projects involving the construction of new, lower emitting power plants or increases in the capacity of existing lower emitting plants were among the most numerous electricity supply projects reported. A total of 111 such projects were reported for 2000, up from 94 reported for 1999 and 34 for 1994. Most involved increases in nuclear (19 projects), hydropower (19 projects), photovoltaic (19 projects), and wind capacity (30 projects) and other system efficiency improvements—increasing the output of power sources with essentially no greenhouse gas emissions. Emission reductions reported for increases in low-emitting capacity projects in 2000 totaled 49.3 million metric tons carbon dioxide equivalent from direct sources, 3.9 million metric tons from indirect sources, and 3.2 million metric tons from unspecified sources.

The Tennessee Valley Authority (TVA) reported that it began implementing a system-wide modernization program for its hydropower units, which is expected to increase the efficiency and / or capacity of many of

TVA's existing hydroelectric units. Additional units will be modernized in this program over the next several years. TVA reported that direct carbon dioxide emissions were reduced by 282,413 metric tons carbon dioxide equivalent in 2000. In calculating reported reductions, TVA used its net electricity generation (in megawatthours), net average system heat rate (in Btu per kilowatthour), and fuel emissions factor. TVA assumed that the power it sold to other utilities was generated at coal-fired facilities operating at the average heat rate for TVA's coal-fired power plants for the given year.

Another example of a project involving an increase in lower emitting capacity project is the Unocal Salak/Wayang Windu geothermal project. Geothermal energy is produced by using natural hot water contained in the Earth's crust to power turbines at electricity generation facilities. Wells drilled deep into the Earth to access water heated by the volcanic magma can produce steam that replaces the heat or steam typically produced by burning fossil fuels, thereby reducing greenhouse gas emissions from the electricity generation process. Unocal's Indonesian subsidiary, Unocal Geothermal Indonesia (UGI), currently operates two geothermal power plants in Salak and Wayang Windu (Java) and is seeking to maintain and expand those sites and to develop new geothermal generation facilities throughout Indonesia, beginning in Sarulla, North Sumatra. Electricity generation in Indonesia is primarily from subsidized fossil fuel systems. In 2000, the projects in Salak and Wayang Windu were reported to have replaced 3.6 million megawatthours of electricity generation from fossil fuels with geothermal generation, resulting in indirect carbon dioxide emission reductions totaling 3.7 million metric tons. The two facilities are estimated to have 23 and 29 years of geothermal energy resources remaining, respectively.

Other Carbon Reduction Projects

Fifty-four "other carbon reduction" projects were reported for 2000. This category of "other" projects includes projects that decrease high-emitting capacity, make dispatching changes only, or increase low- or zero-emitting capacity. In 2000, 24 projects used low- or zero-emitting power purchases to reduce emissions. This category was added to the Voluntary Reporting Program in 1999 to classify electric power producer/supplier purchases of power from low- or zero-emitting generation sources for resale, replacing generation or purchases of power from more carbon-intensive generation sources. Another 6 projects reported for 2000 involved decreases in higher emitting capacity, and 7 involved changes in the dispatching of power plants. Changes in dispatch order can reduce carbon dioxide emissions if lower emitting plants are used more frequently. For 2000, reported emission reductions from "other carbon reduction" projects totaled 24.1 million metric tons carbon dioxide equivalent from direct sources and 0.3 million metric tons from unspecified sources. An emissions increase of 13,806 metric tons carbon dioxide equivalent was reported from indirect sources.

In 2000, Southern California Edison Company (SCE) reported direct emission reductions of 607,824 metric tons carbon dioxide from three renewable energy purchase projects classified as zero- or low-emission power purchases. These projects decreased consumption of natural gas by replacing it with energy from wind, biomass, and geothermal sources. Energy purchases were converted to carbon dioxide emissions reductions using an emissions factor of 600 short tons of carbon dioxide per gigawatthour of generation. Use of this emission factor assumes that purchases of renewable energy displace generation from natural-gas-fired generating stations, the marginal generating resource in Southern California. SCE used an average heat rate of 10,500 Btu per kilowatthour for these stations and natural gas energy content of 1,050 Btu per standard cubic foot to calculate the amount of natural gas saved. For the biomass power purchase, SCE assumed that the fuel for the facility using agricultural waste was 40 percent crop residue or waste, 40 percent construction waste, and 20 percent petroleum coke. SCE also assumed that biomass generation produces no net carbon dioxide emissions.

Xcel Energy reported a landfill gas purchase project. Methane is produced in sanitary landfills as a direct result of decomposition of the solid waste. Because landfill gas is 40 to 60 percent methane, it can be recovered and used as a fuel. In this case, purchasing landfill gas allows displacement of emissions from coal combustion. Xcel categorized this project as a zero/low emission power purchase. In 2000, Xcel reported replacing 100,743 megawatthours of electricity with landfill gas, resulting in direct reductions of 0.54 metric tons of methane emissions, 72,566 metric tons of carbon dioxide emissions, and 1.2 metric tons of nitrogen oxide emissions.

Increasing Energy Efficiency in Electricity Production and Distribution

Projects involving improvements in the efficiency of electricity generation, transmission, and distribution were more numerous than the other electric power projects reported for 2000 but produced smaller emission reductions on average. Efficiency improvement tends to be an ongoing effort by electricity suppliers, yielding a continuous stream of small, incremental improvements rather than one-time dramatic increases in efficiency. For example, heat rate improvement projects often are undertaken in response to normal plant deterioration.

As power plants age, efficiency tends to erode gradually. Operators seek to maintain heat rates by replacing or refurbishing old, worn-out equipment. Similarly, new energy-efficient transformers are often installed gradually over a period of years, as old transformers fail.

A total of 259 "increasing energy efficiency" projects were reported for 2000, including some hybrid projects that combined efficiency improvements with measures such as availability improvements. The efficiency improvement projects fall into two main categories: (1) generation, involving efficiency improvements in the conversion of fossil fuels and other energy sources into electricity; and (2) transmission and distribution, involving improvements in the delivery of electricity from the power plant to the end user (see box on page 27).

Generation Projects

Efficiency Improvements. Improvements in generating efficiency were the most numerous type of efficiency project reported for 2000. A total of 160 such projects were undertaken in 2000, up by 1 project from the number reported for 1999 and nearly double the 85 projects reported for 1994. Heat rate improvements at coal-fired power plants are a commonly reported means of increasing efficiency and reducing carbon dioxide emissions. There are numerous opportunities for improving efficiency at existing power plants, but the efficiency gains, and hence reductions in fuel consumption and emissions, are limited by technology and tend to be small. Emission reductions reported for generation efficiency improvement projects in 2000 totaled 10.3 million metric tons carbon dioxide equivalent from direct sources, 0.3 million metric tons from indirect sources, and 1.0 million metric tons from unspecified sources.

Ameren Corporation reported on an efficiency improvement project initiated in 1993 to convert a wet fly ash handling system to a dry system at a coal-fired power plant. The conversion was necessitated by a switch to Powder River Basin coal as the fuel for the plant. The original wet system would have been inadequate for transporting the ash generated from the western coal due to its high calcium content. Ameren would have had to reduce load or take the unit out of service in order to perform frequent maintenance on the ash conveyor systems. The replacement vacuum dry ash handling system uses less energy than the hydraulic system, which relied on pumping large quantities of water. Ameren reported a direct emissions reduction of 18,631 metric tons carbon dioxide in 2000.

Cogeneration and Waste Heat Recovery. A total of 18 cogeneration and waste heat recovery projects were reported in 2000, as compared with 4 projects reported for 1994. Emission reductions reported for cogeneration and waste heat recovery projects in 2000 were on average greater than those reported for any of the other types of efficiency improvement projects but less than the average for carbon content reduction projects. Industrial partners in the cogeneration projects reported for 2000 include a greenhouse, steel mills, and a heating plant in the Czech Republic. Reported end uses of the thermal energy include electricity generation, process heat applications, and space heating and cooling. The emission reductions reported for cogeneration and waste heat recovery projects in 2000 totaled 2.1 million metric tons carbon dioxide equivalent from direct sources and 1.2 million metric tons from indirect sources.

In 1998, NiSource's Primary Energy subsidiary partnered with Ispat/Inland to install an energy facility named Coke Energy. The facility included 16 heat recovery steam boilers and a 94-megawatt steam turbine/generator, cooling towers, and a flue gas desulfurization system. Coke Energy recovers heat from four "non-recovery" coke batteries (67 ovens per battery) to produce steam for the turbine generator. Emission reductions were reported from the savings in coal-fired generation used for process heating replaced by coke energy heat recovery boilers and the steam turbine/generator. In 2000, NiSource reported direct emission reductions for this project totaling 509,107 metric tons of carbon dioxide.

BP reported a waste heat recovery project involving various thermal process efficiency improvements that began operation in June 1991. The project is dispersed throughout Louisiana, Texas, and locations along the Gulf of Mexico. It includes optimization and improvements in process controls to recover and reuse waste heat energy in BP's full range of operations: crude oil refining process, crude oil exploration and production, and chemical manufacturing. Specifics include heat exchanger optimization, heater efficiency control, and waste heat recovery. BP reported that total energy savings through recovering waste heat from hot flue gases for industrial process heat was 4,039 billion Btu for 2000, which reduced direct emissions of carbon dioxide by 219,592 metric tons. BP bases engineering estimates of energy savings on measured crude heat content, crude throughput, and reduced fuel gas firing rates and uses its company "Protocol for the Calculation of Carbon Dioxide Emissions" for emission calculations. BP also reports that this protocol and its internal greenhouse gas reporting have been validated by external auditing to ensure compliance by all BP facilities.

Transmission and Distribution Projects

Transmission and distribution projects, although not as numerous as generation projects, were nonetheless reported in significant numbers. In 2000, 82 transmission and distribution projects were reported, down by

Efficiency Projects: Definitions and Terminology

Generation Projects

It is neither theoretically nor practically possible to convert all the thermal or other energy produced in, or consumed by, a power plant into electrical energy. In fact, much of the energy is lost rather than converted. Typically, U.S. steam-electric generating plants operate at efficiencies of about 33 percent, meaning that two-thirds of the thermal energy produced is lost. Some more advanced power plants have higher efficiencies, but even new combined-cycle plants (in which the waste heat from a gas turbine is recovered to produce steam to drive a turbine) typically have efficiencies of only 50 to 60 percent. Generation projects seek to improve power plant efficiencies either by reducing the amount of energy lost during the conversion process or by recovering the lost energy for subsequent application.

Efficiency Improvements. By increasing the efficiency of the generation process, efficiency improvement projects at fossil-fuel-fired power plants reduce the plants' *heat rate*, defined as the amount of fossil energy (measured in Btu) needed to produce each kilowatthour of electricity. The result is a reduction in the amount of fuel that must be burned to meet generation requirements, and hence a reduction in carbon dioxide (and other greenhouse gas) emissions. Efficiency improvements at nonfossil (e.g., hydroelectric) power plants can also reduce greenhouse gas emissions. Emission reductions occur if the efficiency improvement leads to an increase in the amount of electricity generated by the affected plant, with a consequent reduction in the amount of electricity that must be generated by other (fossil fuel) plants to meet demand.

Cogeneration. Only a portion of the heat generated during the combustion of fossil fuels can be converted into electrical energy; the remainder is generally lost. Cogeneration involves the recovery of thermal energy for use in subsequent applications. Cogeneration facilities typically employ either topping or bottoming cycles. In a *topping cycle*, thermal energy is first used to produce electricity and then recovered for subsequent applications. Topping cycles are widely used in industry as well as utility power plants that sell electricity and steam to customers. In a *bottoming cycle*, the thermal energy is first used to provide process heat, from which waste heat is subsequently recovered to generate electricity. Bottoming cycle applications are less common, usually associated with high-temperature industrial processes. Because cogeneration involves the recovery and use of thermal energy that would otherwise be wasted, it reduces the amount of fossil fuel that must be burned to meet electrical and thermal energy requirements, hence reducing greenhouse gas emissions.

Transmission and Distribution Projects

The purpose of the electricity transmission and distribution system is to deliver electrical energy from the power plant to the end user. Resistance to the flow of electrical current in cables, transformers, and other components of the transmission and distribution system causes a portion of the energy (typically about 7 percent) to be lost in the form of heat. Improving the efficiency of the various system components can decrease such line losses, reducing the amount of generation required to meet end-use demand and, thus, power plant fossil fuel consumption and greenhouse gas emissions.

High-Efficiency Transformers. Transformers, used to change the voltage between different segments of the transmission and distribution system, are a major source of system losses. Transformer losses occur as a result of impedance to the flow of current in the transformer windings and because of hysteresis and eddy currents in the steel core of the transformer. When existing transformers are replaced with high-efficiency transformers (including improved silicon steel transformers and amorphous core transformers), losses are reduced.

Reconductoring. Like transformers, conductors (including feeders and transmission lines) are a major source of transmission and distribution system losses. In general, the smaller the diameter of the conductor, the greater its resistance to the flow of electric current and the greater the consequent line losses. Reconductoring involves the replacement of existing conductors with larger diameter conductors.

Distribution Voltage Upgrades. Line losses are dependent, in part, on the voltage at which the various segments of the transmission and distribution system operate. Upgrading the voltage of any segment can reduce line losses.

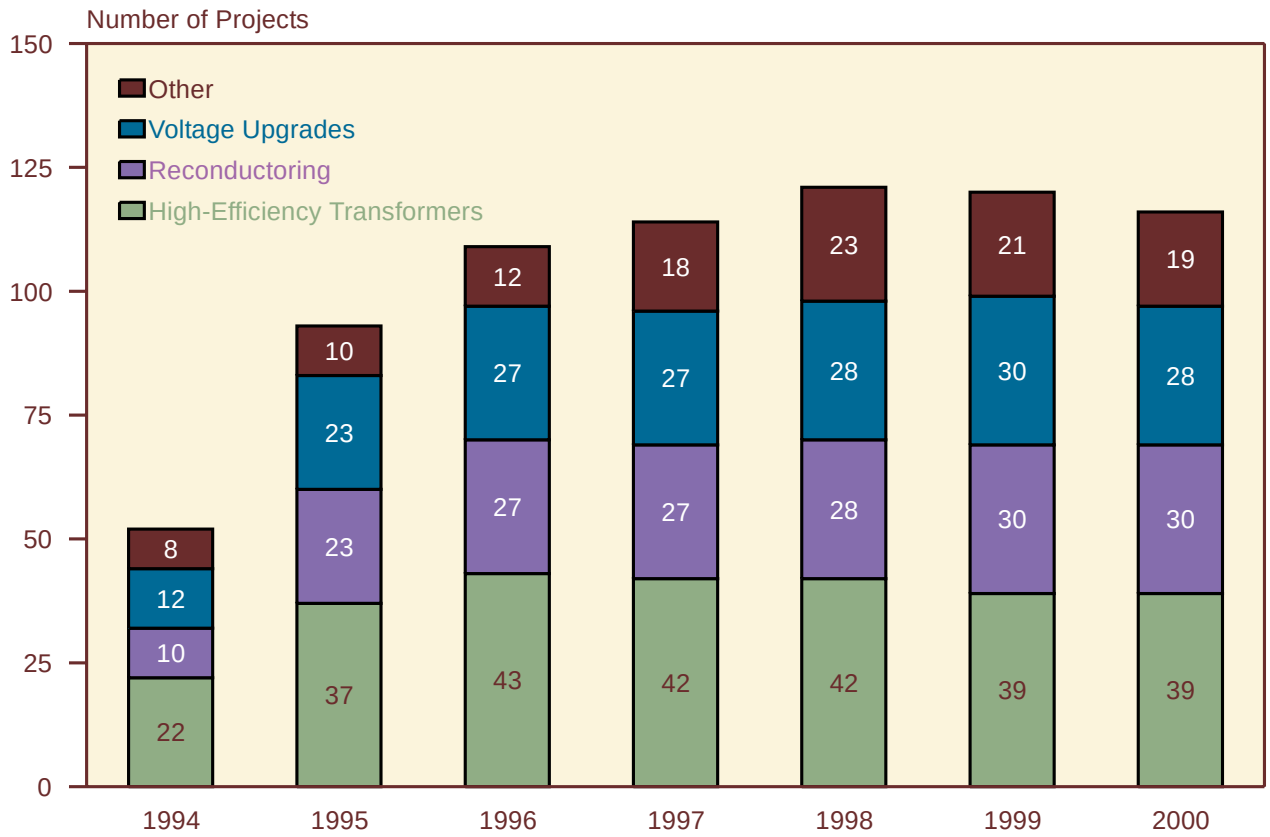
2 percent from 1999 but up by 82 percent from 1994. Unlike generation projects, which typically have discrete start and completion dates, efforts such as upgrading conductors and replacing transformers are ongoing activities by electric power producers. Consequently, most of the transmission and distribution efficiency improvements reported for 2000 were reported as continuations of long-standing projects rather than as new projects.

In terms of average emission reductions, transmission and distribution projects typically are somewhat smaller than generation projects. There are numerous opportunities for improving efficiencies in the delivery of electricity, but the magnitude of the efficiency gains that can be realized is limited.

In 2000, the most frequently reported types of transmission and distribution projects (Figure 7) were high-efficiency transformers (including improved silicon steel and amorphous core transformers); reconductoring (replacing existing conductors with large-diameter conductors to reduce line losses); and distribution voltage upgrades (increasing the voltage at which the various segments of the system operate to reduce line losses). The other transmission and distribution project category includes general transmission and distribution projects reported on the short form (Form EIA-1605EZ) that involve more than one type of activity, as well as such activities as transmission line improvements and capacitor installations. A total of 39 high-efficiency transformer projects were reported for 2000 (the same number as reported for 1999), making it the most frequently reported type of transmission and distribution project. Many of the reported projects were "hybrid" projects, combining high-efficiency transformer installation with one or more other transmission and distribution activities (e.g., reconductoring).

Another 30 projects involving reconductoring and 28 projects involving distribution voltage upgrades (again, often in combination with other activities) were reported for 2000. The reporters classified 19 projects as "general" or "other" transmission and distribution, down from 21 in 1999. Emission reductions reported for transmission and distribution projects in 2000 totaled 3.2 million metric tons carbon dioxide equivalent from direct sources, 0.2 million metric tons from indirect sources, and 90,378 metric tons from unspecified sources.

Figure 7. Reported Transmission and Distribution Projects by Type, Data Years 1994-2000



Note: The sum of projects in many project categories exceeds the total number of projects reported, because more than one project type may be assigned to a single project.

Source: Energy Information Administration, Forms EIA-1605 and EIA-1605EZ.

An example of a project reported in 2000 in the other transmission and distribution project category is Allegheny Power's Energy Star Transformer Program. Allegheny Power reported that it joined the Program in September 1995. The first year that all Energy Star Transformers were reported by Allegheny Power for the entire year was 1996. Allegheny Power calculated the megawatthour savings by comparing the Energy Star Transformers with non-evaluated transformer bids submitted by transformer manufacturers. Allegheny estimated the reported direct emission reduction for 2000 (90,864 metric tons carbon dioxide) by multiplying the electricity saved by a system average emissions factor (1.02 short tons of carbon dioxide per megawatthour) and dividing by a delivery factor of 0.95164 to account for losses in the system.