2. Reducing Emissions from Electric Power

Electric Power Industry

The electric power industry emitted approximately 2,279.3 million metric tons of carbon dioxide in 2003, 38.8 percent of total U.S. carbon dioxide emissions.[24] Carbon dioxide emissions result from the combustion of fossil fuels—coal, oil, and natural gas—during electricity generation. For example, coal, which accounted for 83.5 percent of electric power industry carbon dioxide emissions in 2003, is the primary energy source for U.S. electricity generation (providing 51 percent of total generation in 2003) and has the highest rate of carbon dioxide emissions per unit of energy used among fossil fuels.[25]

Since 1990, carbon dioxide emissions from the electric power industry have increased by 491.4 million metric tons or 27.5 percent, a trend that reflects U.S. economic growth (gross domestic product grew by about 46 percent between 1990 and 2003) and corresponding increases in fossil energy consumption in the electric power sector. From 2002 to 2003, carbon dioxide emissions from the electric power industry increased by 1.0 percent. Contributing to the increase in emissions in 2003 were a 0.6-percent increase in total electricity generation and a 1.8-percent increase in emissions from coal-fired generation.

Projects Reported

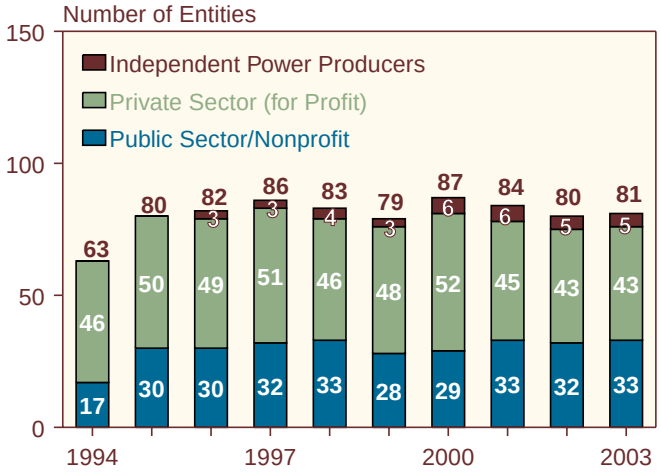
For the 2003 reporting year, 81 electric power providers reported to the Voluntary Reporting Program on Form EIA-1605 (Figure 4)—a decrease from the peak of 87 electric power providers reporting on the long form in 2000 but a 29-percent increase from the 63 reporters for the first reporting year, 1994. Since 1997, merger activity in the electric power industry has reduced the pool of electric utilities able to report to the Voluntary Reporting Program.[26]

Electric power providers made up 46 percent of the total 178 project-level reporters for data year 2003. Of the 81 electric power industry reporters, 48 were private-sector organizations, including 43 investor-owned utilities (IOUs) and 5 independent power producers (IPPs); and 33 were public-sector or nonprofit organizations, including electric cooperatives, municipal utilities, and other public-sector entities, such as the Tennessee Valley Authority (TVA).

The 485 electric power projects reported for 2003 (Figure 5) represent a 16-percent increase from the 2002 reporting year total of 417 and a 155-percent increase from the 190 projects reported for 1994. Electric power projects were the most numerous project type reported to the Voluntary Reporting Program, accounting for 25 percent of all projects reported on Form EIA-1605 for 2003.

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 includes

Figure 4. Number of Electric Power Providers Reporting on Form EIA-1605, by Entity Type, Data Years 1994-2003



Source: Energy Information Administration, Form EIA-1605.

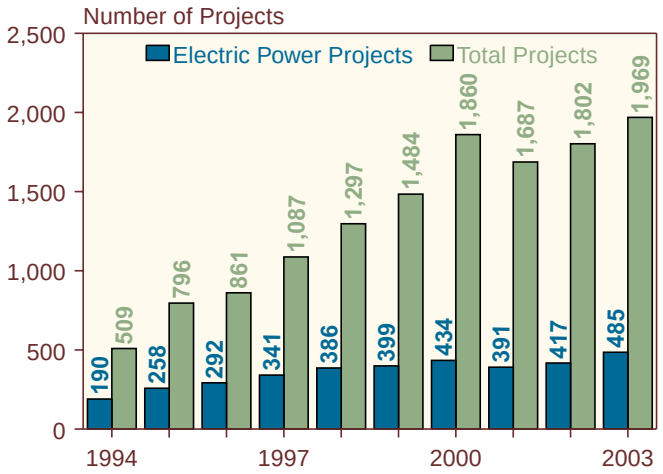
[24]Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004), web site www.eia.doe.gov/oiaf/1605/ggrpt.

[25]Energy Information Administration, *Voluntary Reporting of Greenhouse Gases, Instructions for Form EIA-1605*, DOE/EIA-1605(2004) (Washington, DC, April 2004), Appendix B, web site ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/FormEIA-1605_2003_Instructions.pdf.

[26]There were 141 operating electric utilities in the United States in 2000, compared with 172 in 1992. See Energy Information Administration, *The Changing Structure of the Electric Power Industry 2000: An Update*, DOE/EIA-0562(00) (Washington, DC, October 2000), web site www.eia.doe.gov/cneaf/electricity/chg_stru_update/update2000.html.

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. In 2003, 257 carbon content reduction projects were reported, and 255 projects for increased energy efficiency in generation, transmission, and distribution were reported.[27]

Figure 5. Electric Power Projects and Total Projects Reported on Form EIA-1605, Data Years 1994-2003



Source: Energy Information Administration, Form EIA-1605.

Reductions Reported

Total reported emission reductions from the 485 electric power projects reported for data year 2003 (Table 9) included 158.0 million metric tons carbon dioxide equivalent from direct sources and 17.8 million metric tons from indirect sources. The 257 projects in the category "reducing carbon content" reported emission reductions of 146.9 million metric tons carbon dioxide equivalent from direct sources and 13.5 million metric tons from indirect sources. The 255 projects included in the category "increasing energy efficiency in generation, transmission, and distribution" reported emission reductions of 15.5 million metric tons carbon dioxide equivalent from direct sources and 4.1 million metric tons from indirect sources.

Many of the largest projects reported to the Voluntary Reporting Program are electric power projects. In 2003, 27 electric power projects reported direct reductions of 1 million metric tons carbon dioxide equivalent or more, representing 55 percent of all the projects that reported direct emission reductions exceeding 1 million metric tons carbon dioxide equivalent. About three-fourths of those reported electric power projects were related to nuclear power.

Table 9. Number of Electric Power Projects and Emission Reductions Reported on Form EIA-1605 by Project Type and Reduction Type, Data Year 2003

Reduction Objective and Project Type	Number of Projects Reported	Emission Reductions Reported (Metric Tons Carbon Dioxide Equivalent)	
		Direct	Indirect
Reducing Carbon Content	**257**	**146,857,049**	**13,482,222**
Availability Improvements	44	70,235,626	7,407,809
Fuel Switching	47	17,655,099	14,605
Increases in Lower Emitting Capacity	115	62,051,111	6,756,833
Other Carbon Reductions	65	29,134,810	1,016,534
Increasing Energy Efficiency	**255**	**15,532,986**	**4,099,254**
Generation	*191*	*11,383,129*	*3,817,029*
Efficiency Improvements	170	11,219,307	657,944
Cogeneration and Waste Heat Recovery	21	163,821	3,159,085
Transmission and Distribution	*65*	*4,160,221*	*282,225*
High-Efficiency Transformers	31	1,811,477	247,990
Reconductoring	27	1,847,515	240,686
Distribution Voltage Upgrades	28	2,645,519	189,695
Other Transmission and Distribution	15	1,740,398	72,550
Total Electric Power Projects	**485**	**158,007,281**	**17,825,248**

Note: Project totals may not equal sum of components because some projects may be counted in more than one category.
Source: Energy Information Administration, Form EIA-1605.

[27] More than one project type may be assigned to a single project; therefore, the sums of projects and reductions by project type category may exceed the total numbers of projects and the total reductions reported.

Reducing the Carbon Content of Energy Sources

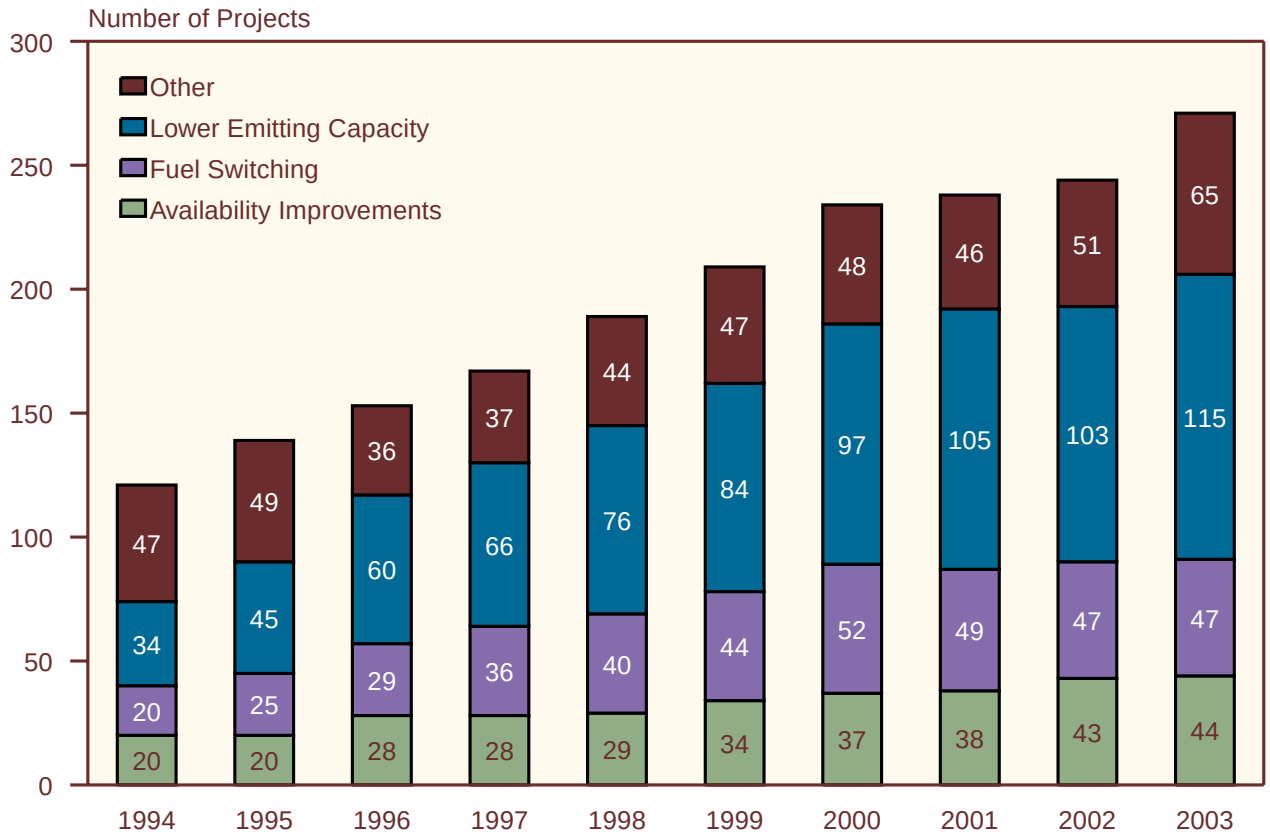
Projects involving fuel switching, power plant availability improvements for lower than average carbon-emitting plants, increases in low- or zero-emitting generation capacity, and other similar activities typically reduce the amount of carbon consumed to generate a unit of electricity. For 2003, 257 such projects were reported, 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 2003 totaled 146.9 million metric tons carbon dioxide equivalent from direct sources and 13.5 million metric tons from indirect sources. Some carbon content reduction projects are in fact "hybrids," combining efficiency improvements with measures such as availability improvements or increases in lower emitting capacity (see box on page 23).

Availability Improvements

There were 44 availability improvement projects reported for data year 2003—1 more than the 43 reported for 2002 and 24 more than the 20 reported for 1994. Availability improvement projects accounted for emission reductions of 70.2 million metric tons carbon dioxide equivalent from direct sources and 7.4 million metric tons from indirect sources in 2003. Of the 44 availability improvement projects reported, 33 involved nuclear power plants. As in previous reporting years, availability improvement projects, especially those undertaken at nuclear facilities, produced some of the largest reported reductions in carbon dioxide emissions. Mainly through significant advances in operating, maintenance, and refueling procedures, capacity factors at some nuclear plants have increased and, thus, have displaced some fossil-fuel-based power generation that would have been used in the absence of the availability improvements.

Because nuclear power plants are invariably large baseload facilities, even a fairly small improvement in plant availability can lead to a sizable reduction in carbon dioxide emissions through the displacement of fossil-fueled generation. For example, the Southern Company is committed to the continued enhancement of operational performance and efficiency improvements at Plant Vogtle. These improvements are targeted

Figure 6. Electric Power Projects Reported on Form EIA-1605 Reducing the Carbon Content of Energy Sources, by Project Type, Data Years 1994-2003



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, Form EIA-1605.

to safely reducing costs and increasing capacity factors by reducing outage lengths and forced outages. To achieve these improvements, a complex strategy consisting of many operational, maintenance, and outage-related activities continues to be implemented at the plants. Steam generator instrumentation upgrades at Southern Company's nuclear plants have minimized incidents in which a unit is automatically taken out of service. The results have been dramatic at the Vogtle plant, where megawatthours generated have increased and outage lengths have decreased since the 1990 baseline year of the project.

Several major performance records have been set in the nuclear industry in recent years, and major progress has been made in reducing the length of scheduled refueling outages. Factors that have contributed to the decrease in outage durations include: (1) online maintenance, with some activities that previously were performed during refueling outages now being performed while the unit is online, if it can be done safely; (2) optimum scheduling; and (3) use of robotic inspection equipment for steam generator and reactor inspection activities. Since 1991, total annual generation at the Vogtle plant has risen by approximately 20 percent. For 2003, Southern Company reported that 1,705,088 megawatthours of generation that would have come from fossil fuels was instead generated from nuclear power because of the project, reducing the company's emissions by 1,572,753 metric tons carbon dioxide equivalent. Southern Company has performed similar availability improvements at other nuclear power plants, with similar results.

Fuel Switching

A total of 47 fuel-switching projects were reported for 2003, the same number reported for 2002 and 27 more than the 20 reported for 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 2003 accounted for emission reductions totaling 17.7 million metric tons carbon dioxide equivalent from direct sources and 0.01 million metric tons from indirect sources.

National Energy & Gas Transmission (NEGT), reported a fuel-switching program that added the ability to use natural gas as a boiler fuel for startup and co-firing to three coal-fired units at its Brayton Point Station in Somerset Massachusetts.[28] The plant's Unit No. 1 first used natural gas in June 1994, Unit No. 2 in November 1994, and Unit No. 3 in April 1995. Natural gas is used as a startup fuel (ignition and warmup) and is co-fired with coal to help control emissions of nitrogen oxides from the units. In 2003, the project decreased the plant's coal use by more than 150,000 million British thermal units (Btu) and residual fuel oil use by more than 53,000 million Btu. The fuel switching resulted in a reported reduction in emissions of 7,394 metric tons carbon dioxide equivalent in 2003.

Increases in Lower Carbon 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. For 2003, 115 such projects were reported, up from 103 reported for 2002. Most of the projects reported for 2003 involved increases in nuclear (23 projects), hydropower (18 projects), photovoltaic (21 projects), natural gas (13 projects), and wind capacity (36 projects). Emission reductions reported for increases in lower emitting capacity projects in 2003 totaled 62.1 million metric tons carbon dioxide equivalent from direct sources and 6.8 million metric tons from indirect sources.

For 2003, Exelon Corporation reported on a new project that entails an increase in lower emitting capacity. ComEd (a subsidiary of Exelon), the City of Chicago, the Illinois Department of Commerce and Economic Opportunity, the International Brotherhood of Electrical Workers, Chicago Public Schools, and Spire Solar Chicago have pooled funding and expertise to create the Chicago Solar Partnership to develop solar resources and to help increase the development of solar generation in Chicago. The increase in zero emitting generation will help to offset grid electricity generated from higher emitting sources. The project had 5 major photovoltaic installations in 2001, 8 in 2002, and 8 in 2003, for a total capacity around the city of 524 kilowatts, which translates to 386,849 kilowatthours of generation annually. In 2003, Exelon reported on 41 percent of this project, which equated to reported emission reductions of 287 metric tons carbon dioxide equivalent.

[28]This project was originally sponsored by New England Power Company and reported by its parent, New England Electric System (NEES) Company. In August 1998, USGen New England, Inc. (USGenNE) completed the acquisition of NEES Company's hydroelectric and fossil power generation business previously operated by New England Power. As part of the acquisition, the rights to the emission reductions and carbon sequestration achieved by this and other projects were transferred to USGenNE. For 2000 through 2002, the activities previously reported by USGenNE were incorporated into the report submitted by its parent, PG&E Corporation. For 2003, this project was included in a separate report submitted by NEGT, formerly known as PG&E National Energy Group, a subsidiary of PG&E Corporation.

Other Carbon Reduction Projects

Sixty-five "other carbon reduction" projects were reported for 2003, 14 more than reported for 2002 and 18 more than reported for 1994. The category of "other" projects includes projects that decrease higher emitting capacity, make dispatching changes only, or increase power purchases from lower or zero emitting capacity. In 2003, 34 projects used low or zero emitting power purchases to reduce emissions. This category was added to the Voluntary Reporting Program for the 1999 data year 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 4 projects reported for 2003 involved decreases in higher emitting capacity, and 2 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 2003, reported emission reductions from "other carbon reduction" projects totaled 29.1 million metric tons carbon dioxide equivalent from direct sources. An emission reduction of 1.0 million metric tons carbon dioxide equivalent was reported from indirect sources.

Xcel Energy reported a new project in 2003 to reduce emissions in the Denver metropolitan area through a decrease in high emitting capacity. Units 1 and 2 of the Arapahoe plant were voluntarily retired at the end of December 2002. Their retirement was part of the Xcel Energy commitment to the Denver Metropolitan Emission Reduction Program (MERP), a program established through the Colorado Department of Public Health and Environment. Between 1999 and 2002, the average net generation of Units 1 and 2 was 365,272 megawatthours. Xcel reported a reduction of 607,814 metric tons carbon dioxide equivalent with the removal of these two high emitting generation units.

There were only two projects reported in 2003 that fell into the "dispatching changes only" category. One is the "Merger Dispatch Savings" project reported by Cinergy. The other is the "Renewable Energy Purchases – Small Hydro" project reported by Southern California Edison Company. Southern California Edison's project changed the dispatch order to increase the use of hydroelectric power over natural-gas-fired generation, leading to a reported direct reduction of 1,270 metric tons carbon dioxide equivalent in 2003.

Emission reductions were achieved from Cinergy's project through the economic dispatch of Cinergy's generating facilities. Before the merger of the Cincinnati Gas & Electric Company and PSI Energy, the same generating facilities were dispatched according to the demands of each operating company. After the merger, the units from both operating companies were operated and dispatched in coordination with each other. This method of operation and economic dispatch is estimated to provide a 1-percent efficiency gain in the operation of

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 other effluents, including small quantities of methane and nitrous oxide. Carbon content reduction projects typically reduce greenhouse gas emissions by replacing fuels with relatively high carbon dioxide emissions (such as coal) with fuels that have lower carbon dioxide emissions (such as natural gas) or no net carbon dioxide emissions (such as nuclear power or renewables).

Availability Improvements. By reducing the frequency and length of planned and unplanned power plant outages, availability improvement projects can result in increased use of a power plant. Emissions reductions occur when increasing generation from a lower carbon emitting plant displaces generation from a higher carbon emitting plant. 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. Hence, there is a reduction in carbon dioxide emissions when there is an improvement in the capacity factor of a lower than average carbon emitting plant that results in a reduction in generation of a higher than average carbon emitting plant.

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, switching from a higher carbon content fuel (such as coal) to a lower carbon content fuel (such as natural gas), results in reduced carbon dioxide emissions.

Increases in Generating Capacity With Low or No Net Carbon Dioxide Emissions. By increasing the capacity of an existing generating unit that produces relatively low emissions or no net emissions (e.g., a hydroelectric plant), or by constructing a new unit with low or no net carbon dioxide emissions (e.g., a wind turbine), a power supplier can reduce or avoid reliance on higher emitting plants, thus reducing the combined greenhouse gas emissions from all plants.

the system. The efficiency gain is realized because the more recently built generating units, which are the most efficient units, are the first dispatched to meet customer demands for electricity. Therefore, the most efficient generating units are operating more than the older, less efficient units. In 2003, Cinergy reported a decrease in consumption of 279,165 short tons of bituminous coal and direct emission reductions of 601,736 metric tons carbon dioxide equivalent.

Alliant Energy reported three new "low or zero emitting power purchase" projects in 2003. Although all three of these projects began in 1998, Alliant began reporting them for data year 2003. In two of the projects, Alliant purchased hydroelectric energy and transmitted it to Iowa and Wisconsin. Total hydroelectric power purchased for these two projects was 90,691 megawatthours. In the third project, Alliant purchased power produced from biomass by BFC Gas & Electric in Cedar Rapids, Iowa, which converts industrial, agricultural, and construction waste into renewable energy. The facility recycles the biomass materials into a low-Btu biogas through gasification. Some of the materials recycled include sawmill waste; light paper mill rejects; construction demolition wood; energy crops, such as switchgrass, sweet sorghum, and poplar trees; crop residues such as corn stalks, corncobs, and seed cord; and unrecyclable low-grade paper. Total electricity purchased from this biomass source in 2003 was 22,576 megawatthours, and total direct reductions for the three "low or zero emitting power purchase" projects were 88,702 metric tons carbon dioxide equivalent.

Increasing Energy Efficiency in Electricity Production and Distribution

Projects involving improvements in the efficiency of electricity generation, transmission, and distribution reported for 2003 produced much smaller emission reductions on average than projects reducing carbon content. 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.

For 2003, 255 "increasing energy efficiency" projects were reported, 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 reduced losses in the delivery of electricity from the power plant to the end user (see box on page 25).

Generation Projects

Efficiency Improvements. Improvements in generating efficiency were the most numerous type of efficiency project reported for 2003. There were 170 such projects undertaken in 2003. 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 marginal. Emission reductions reported for generation efficiency improvement projects in 2003 totaled 11.2 million metric tons carbon dioxide equivalent from direct sources and 0.7 million metric tons from indirect sources.

For 2003, Entergy Services Inc. reported 30 new efficiency improvement projects. The projects included equipment replacement or control system improvements on 14 different units at 7 different facilities. The equipment replacements included air preheater and bypass seal replacements, condenser vacuum pump replacements, neural net installations, cold-end preheater basket replacements, installation of newly designed condenser tube plugs, drip pump and bypass line replacements, and more. Control systems affected by the improvements included burner management systems, temperature control systems, boiler feedwater control systems, RheoVac air in-leakage monitoring systems, and condensate filtration systems. Each improvement was reported as a separate project, for a total of 30 efficiency improvements in all. The projects produced a combined total reduction of 427,695 metric tons carbon dioxide equivalent in 2003.

Cogeneration and Waste Heat Recovery. A total of 21 cogeneration and waste heat recovery projects were reported for 2003, 2 more than the 19 reported in 2002. Emission reductions reported for cogeneration and waste heat recovery projects in 2003 were, on average, larger than those reported for the other types of efficiency improvement projects but less than the average for carbon content reduction projects. Reported end uses of the thermal energy included electricity generation, process heat applications, space heating and cooling, humidification, and cooking. The emission reductions reported for cogeneration and waste heat recovery projects in 2003 totaled 163,821 metric tons carbon dioxide equivalent from direct sources and 3.2 million metric tons from indirect sources.

The direct reductions reported for cogeneration projects are low, because the City of Klamath Falls, Oregon, reported a negative direct reduction (or increase) in emissions of more than 2.3 million metric tons carbon dioxide equivalwent. The increase was attributed to carbon dioxide released during the combustion of natural

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 or useful heat. 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 at electric 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 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 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 due to heating. Reconductoring involves the replacement of existing conductors with larger diameter conductors or reduced resistance materials (i.e., superconductive materials), which not only reduces line losses but also allows for an increase in transmission capacity.

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.

gas in the city's cogeneration plant. Emissions from higher carbon emitting generation sources usually offset these combustion-related emissions; however, according to the City of Klamath Falls, the electricity produced by the plant displaced other natural-gas-fired generation with an equivalent emissions rate. The project still resulted in a net reduction in emissions, because the cogeneration plant also produced steam that reduced indirect emissions by displacing fossil-fired steam production at the steam customer's facility. Without this project, direct reductions associated with the cogeneration projects reported for 2003 would be about 2.5 million metric tons carbon dioxide equivalent.

The Southern Company reported an example of a cogeneration project for a new cogeneration facility that its subsidiary, the Alabama Power Company, began operating in 2000 in Theodore, Alabama. The facility fires only natural gas to produce electricity, for INEOS Phenol, and process steam for Degussa, AG. The cogeneration facility consists of a 170-megawatt combustion turbine with a supplementally fired (duct burner) heat recovery steam generator, a 40-megawatt steam turbine, and two package boilers. The package boilers did not replace any existing boilers. Degussa produces its own steam and supplements it with steam from the Theodore cogeneration facility. The heat rate for the cogeneration facility improved from 7.083 million Btu per megawatthour in 2002 to 6.882 million Btu per megawatthour in 2003, leading to a total direct reduction of 669,857 metric tons carbon dioxide equivalent. In addition, a small indirect reduction probably was also achieved, because the steam supplied to Degussa was produced with newer and more efficient boilers than the older Degussa boiler; however, details about the Degussa boiler are not known.

Another example of a cogeneration project is a turbine-generator owned by Minnesota Power (MP) but located at the SAPPI Ltd paper mill in Cloquet, Minnesota. The MP unit, with 23 megawatts net capacity, was placed in a process steam line where steam previously had been throttled to lower pressure for process use. Consequently, electricity is produced with an overall process efficiency of 83 percent using steam produced from boilers fueled with 50 percent natural gas and 50 percent wood waste (biomass) from mill processes. MP estimates that the cogeneration application heat rate is 4,112 Btu per net kilowatthour of electricity generation. Through 2002, MP assumed that its generator displaced generation that would otherwise have been produced from conventional subbituminous coal. For 2003, MP assumed that the unit displaced generation that would have come from the Mid-Continent Area Power Pool (MAPP). Therefore, a MAPP number of 0.92 metric tons carbon dioxide per megawatthour was used to calculate carbon dioxide reductions. The 0.92 value was provided by the Minnesota Pollution Control Agency. This project was responsible for a direct emission reduction of 87,187 metric tons carbon dioxide equivalent.

Transmission and Distribution Projects

Transmission and distribution projects, although not as numerous as generation projects, were nonetheless reported in significant numbers. For 2003, 65 transmission and distribution projects were reported. 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 2003 were reported as continuations of long-standing projects rather than as new projects.

The national average energy loss from transmission and distribution is about 7 percent of generation. In terms of average emission reductions, transmission and distribution projects typically are somewhat smaller than generation projects; however, reductions can still be significant. There are numerous opportunities for improving efficiencies in the delivery of electricity, but the efficiency gains generally are smaller than those from generation projects.

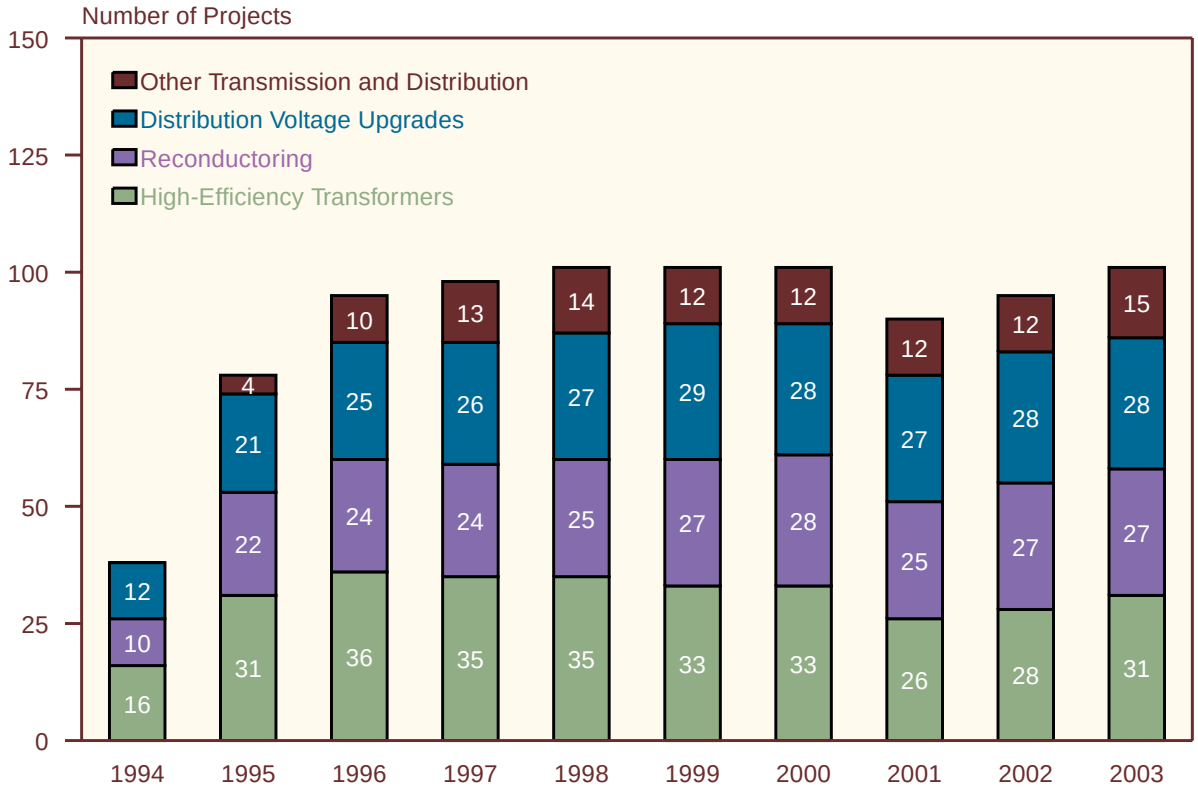
For 2003, the most frequently reported types of transmission and distribution projects (Figure 7) were high-efficiency transformers (including improved silicon steel and amorphous core transformers); reconductoring (replacing existing conductors with large-diameter conductors to reduce line losses); 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 projects that involve more than one type of activity, as well as such activities as transmission line improvements and capacitor installations. In 2003, 31 high-efficiency transformer projects were reported, 3 more than the 28 reported for 2002 and 15 more than the 16 reported for 1994. Many of the reported projects were "hybrids," combining high-efficiency transformer installation with one or more other transmission and distribution activities (e.g., reconductoring).

Another 27 projects involving reconductoring and 28 projects involving distribution voltage upgrades (again, often in combination with other activities) were reported for 2003—the same numbers that were reported in those categories for 2002. The reporters classified 15 projects as "general" or "other" transmission and distribution, 3 more than reported for 2002. Emission reductions reported for transmission and distribution projects in 2003 totaled 4.2 million metric tons carbon dioxide equivalent from direct sources and 0.3 million metric tons from indirect sources.

Xcel Energy reported a new high-efficiency transformer project in 2003. Effective November 1, 2003, Public Service Company of Colorado, a subsidiary of Xcel Energy, reduced transformer losses by 3.5 megawatts when a new transformer configuration was implemented at the Denver Zuni Terminal Substation. With the new configuration in full operation for 2 months of 2003, 5,124 megawatthours of energy was saved, leading to reductions in emissions of carbon dioxide, methane, and nitrous oxide that totaled 4,497 metric tons carbon dioxide equivalent.

American Electric Power, Inc. reported on a continuing project that fits into both the reconductoring and distribution voltage upgrade categories. Typical operation of the American Electric Power distribution system requires that improvements be made on a continuing basis for the purpose of rehabilitation and reinforcement to distribute power efficiently and reliably to customers. Improvements to the distribution system, which increase peak capacity and reduce line losses, include: voltage conversion of stations and circuits; circuit voltage conversions; primary line reconductoring; load transfers between phases to balance circuit loading; primary line additions and multiphasing; installation of more efficient distribution system devices; and installation of shunt capacitors on distribution circuits. For 2003, American Electric Power reported reduced electricity demand of 1,042,179 megawatthours and emission reductions of 835,020 metric tons carbon dioxide equivalent.

Figure 7. Reported Transmission and Distribution Projects Reported on Form EIA-1605 by Type, Data Years 1994-2003



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

Source: Energy Information Administration, Form EIA-1605.