

3. Reducing Carbon Dioxide Emissions from Energy End Use

Reducing Energy Demand at Stationary Sources

Energy use in the residential, commercial, and industrial sectors accounted for 3.7 billion metric tons of carbon dioxide emissions in 1997—about two-thirds of U.S. carbon dioxide emissions. Emissions from energy use included nearly 2 billion metric tons of carbon dioxide from the generation of electricity consumed by each of the three sectors. Industry was the largest of the three sectors in terms of emissions, accounting for nearly half the total; the residential sector accounted for about 28 percent of the total energy-related emissions from stationary sources, and the commercial sector contributed an additional 24 percent.²⁷

Between 1990 and 1997, carbon dioxide emissions associated with industrial, residential, and commercial energy use increased by 10.1 percent. More than half the growth occurred in 1996 and 1997. The commercial sector is the fastest-growing emissions source, having registered a 14.7-percent increase in emissions between 1990 and 1997. Emissions from the residential sector increased by 13.2 percent over the same period, and industrial sector emissions rose by 6.3 percent. The upward trend in emissions for all three sectors reflects U.S. economic growth and corresponding increases in energy consumption, although end-use energy emissions grew at a slower rate than the U.S. economy.²⁸

Projects Reported

Energy end-use projects accounted for 22 percent of all projects reported to the Voluntary Reporting of Greenhouse Gases Program for 1997, third behind electricity supply and carbon sequestration in the number of projects reported. Eighty-seven entities reported energy end-use projects. Most (76) of them were utilities. Most of the other reporters were industrial companies including, for example, a printing company (Quad/Graphics,

Inc.), a pharmaceutical company (Johnson & Johnson), an automobile manufacturer (General Motors), and an oil company (BP America).

Only 9 new energy end-use projects were reported as having begun in 1997, as compared with 9 in 1996, and 26 in 1994. The downward trend in new projects reflects the fact that most of the reported end-use projects are demand-side management (DSM) programs sponsored by electric utilities, usually introduced in the late 1980s and early 1990s. Most DSM projects reported in 1997 were established, ongoing programs. The decline in the total number of energy end-use projects reported for 1997 may indicate the beginning of a decline in utility-sponsored DSM activity (see box on page 23).

Carbon dioxide emission reductions reported for individual energy end-use projects ranged from less than 1 metric ton to more than 1 million metric tons, primarily because of the flexibility allowed in defining the scope of a project. Projects could range from the installation of a compact fluorescent light bulb reported by a household to a system-wide DSM program reported by a large utility. Nonetheless, like other project types, most energy end-use projects (86 percent) fell in the emission reduction range of less than 100,000 metric tons carbon dioxide equivalent (Figure 6). Thirty-one large projects yielded emission reductions between 0.1 and 1 million metric tons, and seven very large projects yielded reductions in excess of 1 million metric tons.

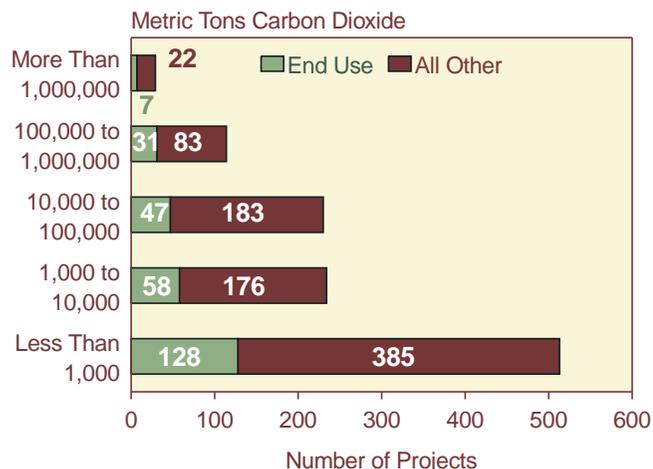
Project Types

Most of the reported projects are “hybrids” that target multiple end uses, particularly, the DSM programs reported by electric utilities. Overall, the most frequent targets of end-use projects were lighting and lighting controls, equipment and appliances, and heating, ventilation, and air conditioning (HVAC) (Figure 7). Their prevalence reflects the importance of those three energy end uses in the United States. HVAC is the primary

²⁷In terms of their contribution to overall energy-related carbon dioxide emissions in 1997, the industrial sector led with a 33-percent share of the total, followed by the residential sector (19 percent) and the commercial sector (16 percent). Transportation, which is considered in the next section of this chapter, accounted for the remaining 32 percent.

²⁸Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1997*, DOE/EIA-0573(97) (Washington, DC, October 1998), pp. 15-21, <http://www.eia.doe.gov/oiaf/1605/1605a.html>.

Figure 6. Reported Energy End-Use Projects Compared to All Other Projects by Size of Carbon Dioxide Reduction or Sequestration, Data Year 1997



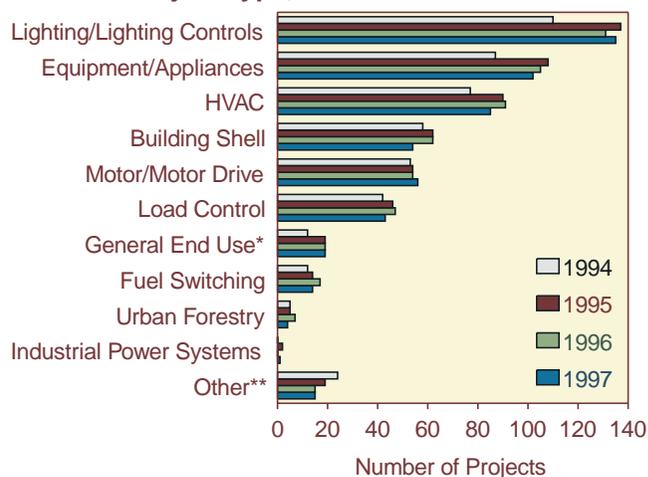
Note: The project sizes shown are only for reported carbon dioxide reductions. "All Other" includes only projects that reported carbon dioxide.

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

energy end use in the residential sector (where it accounts for about 58 percent of total energy use),²⁹ and in the commercial sector it accounts for 33 percent of total energy consumption.³⁰ Furthermore, the potential for reducing the amount of energy consumed by HVAC equipment is considerable. Consider, for example, that new homes (constructed between 1988 and 1993) use only 79 percent of the electricity consumed by old (pre-1988) homes for space heating and only 88 percent of the electricity used by old homes for air conditioning—in part because they are more likely to use high-efficiency HVAC equipment, such as heat pumps.³¹

Energy use for equipment and appliances accounts for 39 percent of the U.S. total in the residential sector and about one-fourth of the total in the commercial sector. Lighting is a less significant energy end use in the residential sector (about 3 percent of the total), but it is important in the commercial sector, where it accounts for 34 percent of total energy consumed.³²

Figure 7. Reported Energy End-use Projects by Project Type, Data Years 1994-1997



*Includes projects reported on Form EIA-1605EZ that encompass more than one project type category. Since Form EIA-1605 requires reporters to identify each project type category encompassed by a project, the General End Use category is specific to Form EIA-1605EZ reporting.

**Includes all projects that cannot meaningfully be included in any of the standard project type categories. Note: Some projects may be counted in more than one category.

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

End-use projects in the residential and commercial sectors in 1997 outnumbered those in the industrial sector, which, in turn, greatly outnumbered agricultural projects (Figure 8). Fewer projects were reported for the residential and industrial sectors than in the previous reporting cycle, two more were reported for the commercial sector, and the number of agricultural projects reported was unchanged at 30. It should be noted that many projects—particularly, utility DSM programs—cover more than one end-use sector and are counted in each applicable sector.

Individual projects in the industrial sector yielded slightly larger carbon dioxide emission reductions than those in the commercial and residential sectors. Industrial sector energy consumption is used mainly for direct process applications, which account for more than half the energy used by the U.S. manufacturing sector.

²⁹Estimated from data contained in Energy Information Administration, *Household Energy Consumption and Expenditures 1993*, DOE/EIA-0321(93) (Washington, DC, October 1995), <http://www.eia.doe.gov/emeu/consumption/>.

³⁰Estimated from data contained in Energy Information Administration, *A Look at Commercial Buildings in 1995: Characteristics, Energy Consumption, and Energy Expenditures*, DOE/EIA-0625(95) (Washington, DC, October 1998), pp. 18-19, <http://www.eia.doe.gov/emeu/consumption/>.

³¹Energy Information Administration, *Household Energy Consumption and Expenditures 1993*, DOE/EIA-0321(93) (Washington, DC, October 1995), p. 15, <http://www.eia.doe.gov/emeu/consumption/>.

³²Estimated from data contained in Energy Information Administration, *Household Energy Consumption and Expenditures 1993*, DOE/EIA-0321(93) (Washington, DC, October 1995), and *A Look at Commercial Buildings in 1995: Characteristics, Energy Consumption, and Energy Expenditures*, DOE/EIA-0625(95) (Washington, DC, October 1998), <http://www.eia.doe.gov/emeu/consumption/>.

Utility Deregulation and Demand-Side Management Programs

Reporting of energy end-use projects has leveled off in the past 2 years. The number of end-use projects reported for 1997 increased only slightly (2 percent) and remained 1 percent below the 1995 high of 276 projects. Only 9 new end-use projects were reported as having begun in 1997 and 9 in 1996, down from 20 in 1995 and 26 in 1994. In contrast, reporting of other project types has doubled since 1994. The onset of deregulation of the electric utility industry may contribute to the slow growth in number of end-use projects reported.

Most of the energy end-use projects reported on Form EIA-1605 are demand-side management (DSM) programs sponsored by electric utilities. In the past, DSM programs have been supported by State public utility commissions as an alternative to the installation of new generating capacity. With deregulation of the electricity generation industry beginning in many States, however, utilities may be freed from their regulatory obligations to continue their DSM programs. Without regulatory impetus, utilities may lack an incentive to pursue the programs, inasmuch as DSM reduces demand for the utilities' product. Recent EIA data indicate that, although energy savings from DSM programs continue to grow, the rate of growth is on the decline. Between 1992 and 1993, total DSM energy savings achieved by U.S. utilities with annual sales of more than 120,000 megawatthours increased by 27 percent. In contrast, between 1995 and 1996 (the most recent year for which data are available), total DSM

savings rose by only 8 percent. On the basis of projections reported to EIA by utilities, DSM energy savings are expected to grow by only 4 percent per year between 1997 and 2001.^a

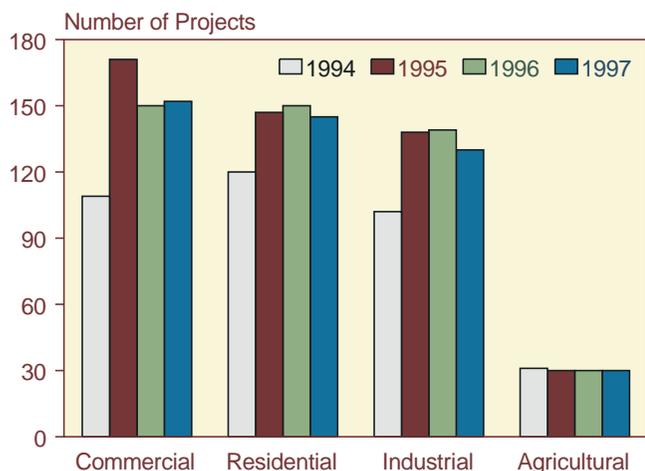
On the other hand, deregulation may lead to the development of competitive markets for DSM services. In a competitive electricity market, customers may be willing to pay for DSM programs designed to adjust energy usage in response to fluctuating electricity prices. Such programs might be offered by utilities as part of a package of services including electricity generation, as a means of retaining and expanding market share. Alternatively, energy service companies (ESCOs) might seek to fill the void left by cutbacks in utility-sponsored DSM services.

Some States are also using Public Benefit Funds to support DSM (along with renewable technologies and low-income support programs), financed through small surcharges collected from customers for each kilowatthour of electricity used.^b Thus, while DSM energy savings are likely to grow at a slower rate in the future, they may continue to play a role in reducing energy consumption and greenhouse gas emissions.

^aEnergy Information Administration, *U.S. Electric Utility Demand-Side Management 1996*, DOE/EIA-0589(96) (Washington, DC, December 1997), p. 8, http://www.eia.doe.gov/cneaf/electricity/dsm/dsm_1996.html.

^bEnergy Information Administration, *Annual Energy Outlook 1999*, DOE/EIA-0383(99) (Washington, DC, December 1998), p. 15, <http://www.eia.doe.gov/oiaf/aeo99/homepage.html>.

Figure 8. Reported Energy End-use Projects by Sector, Data Years 1994-1997



Notes: Excludes energy end-use projects reported on Form EIA-1605EZ. Some projects may be counted in more than one category.

Source: Energy Information Administration, Form EIA-1605.

³³Energy Information Administration, *Manufacturing Consumption of Energy 1991*, DOE/EIA-0512(91) (Washington, DC, December 1994), pp. 18-19, <http://www.eia.doe.gov/emeu/consumption/>.

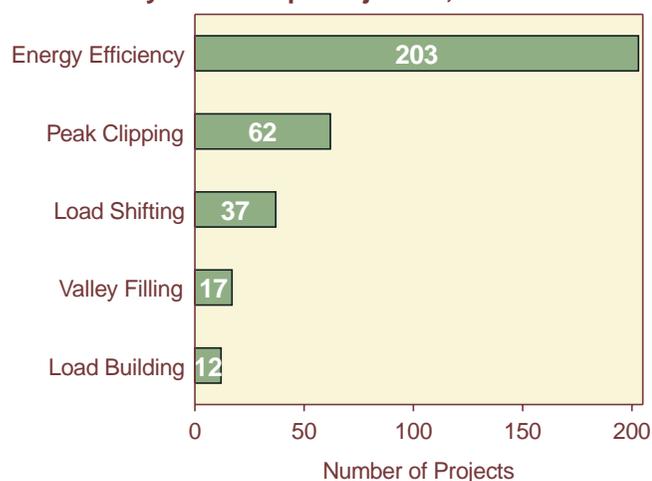
Process heating is the primary direct process application, accounting for more than one-third of the manufacturing energy use. Motors and motor drives are also an important industrial end use, however, with about a 13-percent share of total consumption.³³ Fifty-six projects involving motor and motor drive efficiency improvements were reported for 1997.

Many of the utility DSM programs reported on Form EIA-1605 have multiple load shape objectives (see box on page 24); however, simply improving energy efficiency is at least one of the objectives for a majority of the reported DSM programs (Figure 9). Peak clipping was the second most frequently reported load shape objective, and load shifting was the third.

New Projects and New Reporters

Although relatively few in number, some new energy end-use projects were reported as having begun in 1997. Two reporters accounted for seven of the nine new

Figure 9. Reported Energy End-use Projects by Load Shape Objective, Data Year 1997



Notes: Excludes energy end-use projects reported on Form EIA-1605EZ. Some projects may be counted in more than one category.

Source: Energy Information Administration, Form EIA-1605.

projects reported in 1997. Rochester Institute of Technology led the reporting with four new projects:

- A lighting project to replace magnetic ballasts and T-12 gold lamps with electronic ballasts and T-8 gold lamps in three buildings on the campus
- A project to replace 433 motors, used mostly for fan drives, with premium efficiency TECO motors
- An HVAC project to replace 26 constant air volume boxes with variable air volume (VAV) boxes
- A project to install variable-speed drives in campus buildings.

The Rochester Institute of Technology estimates the total carbon dioxide emission reductions resulting from its four projects at slightly over 900 metric tons in 1997.

The other primary reporter of new projects was CLE Resources, a subsidiary of Central Louisiana Electric that invests in energy demand reduction technologies. CLE Resources reported three projects undertaken in 1997:

- Investment in Active Power, a company that has developed a flywheel energy storage system. The system is designed to replace lead-acid batteries at commercial and industrial facilities with uninterruptible power supply systems. Active Power's flywheel storage system is rated at 100 kilovolt-amperes or higher. The system reduces greenhouse gas emissions by eliminating the need for electricity to cool lead-acid battery storage areas.
- Investment in OK Industries, a developer of industrial application technologies that improve process

Load Shape Objectives of Utility Demand-Side Management Projects

Utility DSM programs may have a number of different objectives beyond simply improving energy efficiency. Some DSM programs have the objective of altering load shapes. For example, programs aimed at peak clipping seek to reduce energy consumption at certain critical times, typically, when demand on the utility system is at its peak. Load shifting programs typically have the objective of shifting energy consumption from peak to off-peak periods. Overall energy consumption is not necessarily reduced by load shifting, but emission reductions may nonetheless occur, depending on the types of fuel used during peak and off-peak periods. For example, load shifting will reduce emissions if hydropower is used to meet baseload demand and natural-gas-fired generators are used as peaking units. Similarly, load building programs, which seek to increase electricity consumption (e.g., through the promotion of industrial electrotechnologies) may reduce emissions if the increased electricity use displaces higher emitting energy sources. Valley filling, which is aimed at increasing off-peak electricity consumption, may also reduce emissions, depending on the energy sources displaced.

efficiencies and lower energy use, including fume extraction equipment, precision dispensing systems, and electronic lighting that increases the energy efficiency of solder/desolder equipment. In addition, OK Industries has developed electronic ballasts for use with fluorescent lighting systems and Metcal griddles that reduce energy consumption by 30 percent.

- Investment in Industrial Devices Corporation (IDC), a developer of motors, motor drives, and electromechanical motion control systems. IDC's products control the speed, force, position, and timing of a machine's movement and combine the mechanical, electronic, and software components into a single package.

CLE Resources estimates the total carbon dioxide emission reductions resulting from its three projects at 390 metric tons in 1997.

Federal Voluntary Programs To Increase End-Use Energy Efficiency

Most of the reported end-use projects were undertaken in conjunction with various Federal voluntary emission reduction programs. The President's Climate Change Action Plan (CCAP) includes 18 different action items aimed at reducing energy demand through efficiency

improvements and conservation. In the industrial sector, 7 action items seek to accelerate efficiency improvements in motors, compressors, pumps, fans, and process technologies, to promote source reduction and recycling (see box below), and to reduce the amount of energy used in the manufacture of fertilizers (by reducing fertilizer usage). In the commercial sector, CCAP includes 5 action items aimed at improving energy efficiency in commercial buildings, demonstrating emerging energy efficiency and renewable technologies, and providing the building industry with information and training on

renewable and energy efficiency options. In the residential sector, 6 action items are designed to improve the efficiency of houses and home appliances.³⁴

The Federal Government sponsors many programs aimed at reducing greenhouse gas emissions by lowering energy consumption. Some were created under the Climate Change Action Plan; others predate CCAP. Energy Star programs administered by the U.S. Environmental Protection Agency (EPA) seek to improve the efficiency of buildings and appliances through such

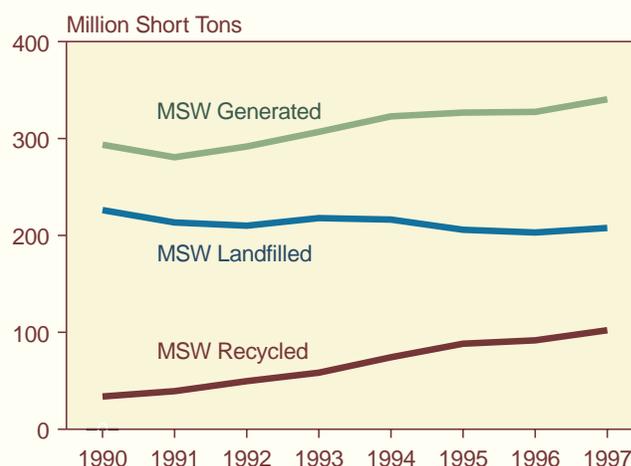
The Role of Recycling in Reducing Greenhouse Gases

In the United States, recycling is second only to landfilling as a waste management technique. Since 1990, the amount of municipal solid waste (MSW) generated has grown by 16 percent. Meanwhile, the amount of recycled MSW tripled from 34 million short tons in 1990 to 102 million short tons in 1997 (see figure). In 1997, 30 percent of the total amount of MSW generated was recycled, compared with 11.5 percent in 1990. The percentage of MSW landfilled decreased from 77 percent in 1990 to 61 percent in 1997, while the percentage of incinerated MSW remained steady at around 10 percent. The growth of recycling has contributed to a 7-percent decrease in U.S. methane emissions from landfills since 1990. In addition, recycling can reduce emissions of other greenhouse gases by affecting energy consumption, carbon sequestration, and non-energy-related emissions from manufacturing processes.

Recycling projects reported to the Voluntary Reporting Program for 1997 were estimated to have resulted in the recycling of a total 162,770 metric tons of waste (less than 0.5 percent of the national total of MSW recycled). In terms of global warming potential, the reported recycling projects reduced about 364,000 metric tons carbon dioxide equivalent. Of the 19 entities that reported, only one—Quad/Graphics, a printing and publishing company—was not an electric utility. The gases reduced from reported recycling projects included carbon dioxide, methane, and perfluorocarbons (PFCs). Reported reductions of carbon dioxide from recycling projects totaled more than 306,000 metric tons. Reported PFC and methane reductions were nearly 4,000 and 49,000 metric tons carbon dioxide equivalent, respectively.

The greatest single emission reduction resulted from the waste paper reduction program reported by Quad/Graphics, which reduced the company's

U.S. Municipal Solid Waste Generated, Landfilled, and Recycled, 1990-1997



Source: "Biocycle Nationwide Survey: The State of Garbage," *Biocycle* (April 1998), Table 2, p. 36.

emissions by more than 102,000 metric tons carbon dioxide equivalent. Niagara Mohawk reported a 92-percent increase in emission reductions over the previous reporting year from its investment recovery project. GPU's recycling project was the most comprehensive, involving the recycling of a wide variety of materials, including asphalt, cement, treated wood, motor oil, and batteries in addition to paper and scrap metal. Most of the reported recycling projects involved paper recycling. Other waste diversion projects are described in Chapter 4 of this report.

In 1998, EIA and the U.S. Environmental Protection Agency's Office of Solid Waste introduced a worksheet and lookup tables for estimating greenhouse gas reductions from source reduction or recycling of selected materials. The worksheet was cited in the Estimation Methods section for 11 reported projects.

³⁴President William J. Clinton, *The Climate Change Action Plan* (Washington, DC, October 1993), "Summary Table of Actions," <http://www.gcric.org/USCCAP/toc.html>.

means as certifying equipment that meets EPA specifications with the Energy Star label. The Energy Star programs include Energy Star Buildings, Energy Star Homes, Energy Star Exit Signs, Energy Star Office Equipment, and Energy Star Residential Heating and Cooling. Eighteen Energy Star Building projects and one Energy Star Computer project were reported to the Voluntary Reporting Program for 1997.

The analog of the Climate Challenge program within the industrial sector is the Climate Wise Recognition Program, jointly supported by the U.S. Department of Energy (DOE) and EPA. Participating companies enter into agreements to reduce greenhouse gas emissions. Specifics of the agreements vary for each participant, but they may, for example, include commitments to undertake specific emission reduction projects, or to reduce overall company emissions to 1990 levels. Current participants include DuPont, General Motors, Johnson & Johnson, and Quad/Graphics, among others. Climate Wise companies are encouraged to report on Form EIA-1605. Twenty-six of the energy end-use (i.e., residential, commercial, and industrial) projects reported for 1997 were Climate Wise projects, and 191 (70 percent of the total) were Climate Challenge projects. The dominance of Climate Challenge projects reflects the fact that the majority of energy end-use projects were reported by electric utilities.

Other voluntary programs include:

- DOE's Building America program, which is aimed at researching and testing systems engineering approaches to improving the energy efficiency of residential buildings (project funding is 50 percent cost-shared with industry participants)
- DOE's Cool Communities program, which encourages the use of lighter wall and roof colors and the planting of shade trees around buildings, through technical assistance and education
- DOE's Rebuild America program, under which participating communities agree to develop and implement action plans for energy-efficient retrofits of existing buildings
- DOE's Energy Efficiency and Renewable Energy Information and Training programs, which are aimed at the building industry
- DOE's Energy Fitness program, which seeks to identify and remove barriers (e.g., information barriers) to increasing the delivery of energy-efficient technologies to energy service companies
- EPA's Green Lights program, under which participants commit to surveying their facilities and upgrading their lighting where profitable within 5

years (24 Green Lights projects were reported to the Voluntary Reporting Program for 1997)

- DOE's Energy Analysis and Diagnostic Centers
- DOE's Motor Challenge program, under which industrial participants showcase energy-efficient motor systems installed with technical assistance from DOE and EPA (10 projects reported)
- The NICE³ Industrial Pollution Prevention Grants program (jointly sponsored by DOE, EPA, and the Department of Agriculture), which provides grants to prevent pollution and improve energy efficiency
- EPA's Waste Wi\$e program, which encourages businesses and State, local, and tribal governments to reduce waste through waste prevention, collection of recyclables, and the purchase of recycled products.

Reducing Transportation Fuel Use

Overview

A total of 62 transportation projects were reported for 1997 by 37 entities, all but three of which were electric utilities or, in the case of CLE Resources, a subsidiary of an electric utility. The three others were an automobile manufacturer (Volvo Cars of North America, Inc.), a printing company (Quad/Graphics, Inc.), and a household. Detailed information was provided for 53 (85 percent) of the projects on the long form (Form EIA-1605). Summary information for the remaining 9 projects was reported on the short form (Form EIA-1605EZ). Forty-seven (76 percent) of the projects reported for 1997 were affiliated with either the Climate Challenge or Climate Wise program.

Table 6 shows the trends in the number of projects and emission reductions reported for transportation projects in the first four reporting cycles of the Voluntary Reporting Program. As in previous reporting cycles, the projects reported for 1997 fell into three broad categories:

- Alternative fuel use (33 projects or 53 percent)
- Travel reduction (22 projects or 35 percent)
- Vehicle efficiency improvements (8 projects or 13 percent).

The primary effect of the transportation projects reported was to reduce emissions of carbon dioxide, although reductions in emissions of nitrous oxide or methane were also reported for 4 projects. For 7 of the 62 projects reported, either reductions did not occur in 1997 or they were not estimated. The total carbon dioxide

Table 6. Number of Projects and Emission Reductions Reported for Transportation Projects by Project Type, Data Years 1994-1997

Project Type	Number of Projects				Emission Reductions (Metric Tons Carbon Dioxide Equivalent)			
	1994	1995	1996	1997	1994	1995	1996	1997
Vehicle Efficiency	2	6	7	8	6,729	54,285	57,250	68,272
Travel Reduction	9	19	18	22	594	20,248	20,531	54,202
Alternative Fuels	22	25	33	33	13,047	12,396	17,255	18,660
Total	33	50	57	62	21,280	86,930	95,036	141,134

Note: Project totals may not equal sum of components because projects may be counted in more than one category. Emission reductions totals may not equal sum of components due to independent rounding.

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

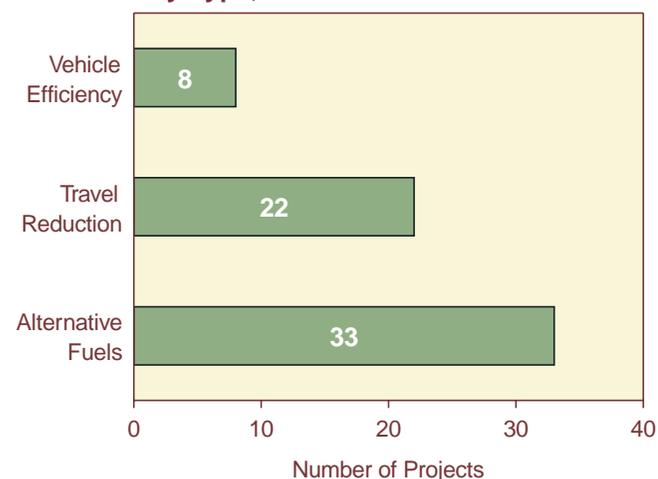
equivalent emission reductions in 1997 reported for the remaining 55 transportation projects was 141,134 metric tons, an increase of 49 percent over the total reported for 1996 and more than six times the 21,280 metric tons reported in the first (1994) reporting cycle. Leaving aside 3 projects that were reported in 1995 but not again until 1997, reported reductions increased by about 16,891 metric tons (18 percent) between 1996 and 1997.³⁵ Large increases in emission reductions were also reported for 4 efficient vehicle projects involving aluminum coal cars and for a vehicle use reduction project conducted by Texas Utilities, with a combined increase of 10,486 metric tons of emission reductions in 1997 over those reported for 1996.

Slightly more than half (53 percent) of the projects reported for 1997 involved alternative fuel vehicles. Although reductions achieved by individual projects were small, these initiatives in total accounted for about 13 percent of the reported transportation in 1997 (Table

6). Vehicle efficiency projects tend to have larger effects individually. The eight projects reported in this category accounted for nearly half (49 percent) of the estimated 1997 emission reductions for transportation. Six projects involving freight transportation accounted for 62 percent of the carbon dioxide emission reductions reported for 1997. On average, freight transportation projects reduced emissions by about 14,660 metric tons, nearly 14 times the average reduction achieved for measures involving passenger travel. The number and mean size of transportation projects reported for 1997 are summarized in Figure 10 and Figure 11, respectively.

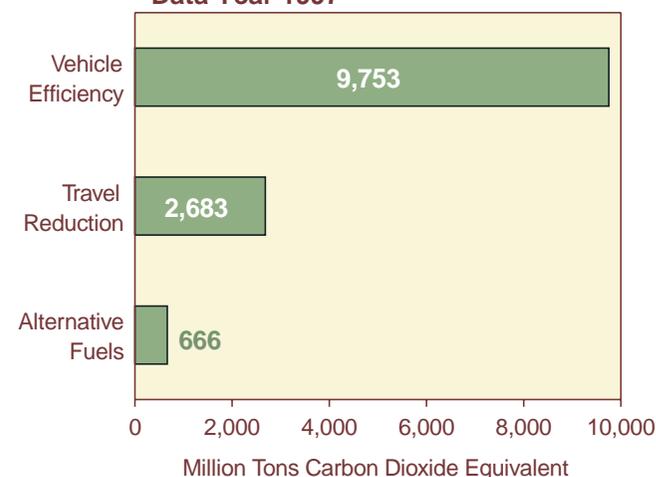
The level of activity necessary for passenger travel projects to reduce emissions by more than 100 metric tons of carbon dioxide is substantial. For example, to achieve a reduction in carbon dioxide emissions of 147 metric tons

Figure 10. Number of Transportation Projects by Type, Data Year 1997



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

Figure 11. Mean Emission Reductions for Transportation Projects by Type, Data Year 1997



Note: Mean emission reductions reflect only those projects for which estimates were reported.

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

³⁵Quad/Graphics, Inc., a printing company that first reported for 1995, reported again for 1997, providing data for both 1996 and 1997. Emission reductions resulting from the reported travel reduction efforts were the largest reported for this type of project.

in 1997, Baltimore Gas & Electric Co. (BG&E) undertook large-scale fuel switching, converting a fleet of 188 vehicles to compressed natural gas instead of gasoline. Although individual transportation initiatives may produce only modest emission reductions, many of the projects reported to the program have wide applicability and could significantly reduce national carbon dioxide emissions if they were duplicated by other companies.

Using Alternative Fuels

Alternative fuel vehicle projects involved a variety of fuels, including natural gas, electricity, propane, and M-85 (a blend of 85 percent methanol and 15 percent gasoline). More than 95 percent of the reductions associated with alternative fuels were attributed to vehicles using natural gas. Fifteen projects included the operation of electric vehicles. Thirteen were exclusively electric vehicle projects. The emission reductions reported for electric vehicle projects in 1997 were relatively small (about 2 percent of the total for alternative fuel vehicles), because all but one were research or pilot programs involving one or two vehicles. The exception was Los Angeles Department of Water and Power (LADWP), which operated 36 electric vehicles in 1997. LADWP estimated that use of the vehicles reduced carbon dioxide emissions by a net 6.1 metric tons, which reflects a fuel-cycle analysis that considered the increased emissions associated with the generation of electricity used by the electric vehicles as well as the reduced emissions associated with avoided gasoline consumption. At least three alternative fuel vehicle projects also included infrastructure improvements, such as the deployment of refueling stations for natural gas vehicles.

Three projects were oriented toward research, development, and demonstration. The Southern Company conducted or sponsored a range of research, development, and demonstration activities, including participation in the United States Advanced Battery Consortium, the Electric Power Research Institute's Electric Transportation Business Unit, and the Electric Vehicle Research Network. Southern Company reported that activities involving the demonstration of electric vehicle technology reduced carbon dioxide emissions by 186 metric tons in 1997. Public Utility District No. 1 of Snohomish County reported its sponsorship of an annual battery- and solar-powered boat race and an electric car race; however, it did not report emission reductions for those activities.

Reducing Vehicle Travel

Travel reduction accounted for 38 percent of the total reduction in carbon dioxide emissions reported for transportation projects for 1997, up from 3 percent for the first year of reporting (1994). Of the 22 travel reduction projects reported, 15 involved employee commute reduction programs, including carpooling, vanpooling, increased use of mass transit, compressed work weeks, and subscription bus service. Six of the seven remaining projects focused on reducing employee travel on company business. The largest of these projects was Texas Utilities Electric Company's efforts to reduce its use of fleet vehicles, which resulted in a reported reduction of 10,255 metric tons of carbon dioxide emissions in 1997.

Two utilities reported on videoconferencing projects that have reduced corporate travel. GPU, Inc., implemented a videoconferencing system in 1991 that reduced employee travel by nearly 2 million miles between 1991 and 1997. Cooperative Power Association used videoconferencing to eliminate employee airline travel, reducing carbon dioxide emissions by an estimated 42 metric tons in 1997.

The largest travel reduction project, reported by Quad/Graphics, involved ensuring that delivery vehicles were diverted to pick up raw materials and supplies on return trips from delivering printed materials to customers. Quad/Graphics estimates that the project reduced carbon dioxide emissions by nearly 20,000 metric tons in 1997, representing 36 percent of the total for all the travel reduction projects reported.

Improving Vehicle Efficiency

Eight projects involving vehicle efficiency improvements were reported, five of which claimed relatively large carbon dioxide emission reductions (more than 5,000 metric tons) in 1997. Four Midwestern utilities reported the use of aluminum railroad cars to transport coal to their plants. UNICOM reduced 1997 carbon dioxide emissions by more than 20,000 metric tons. Substantial reductions were achieved by three other utilities using aluminum coal cars: Kansas City Power & Light (14,880 metric tons), Western Resources, Inc. (13,898 metric tons), and Union Electric Company (14,052 metric tons). CLE Resources, a subsidiary of Central Louisiana Electric Company, reported its investment in a company that developed and commercialized a device for monitoring and adjusting tire pressure on trucks to achieve

Legislative Initiatives May Increase Future Consumption of Alternative Transportation Fuels

The U.S. transportation sector emitted 1.7 billion metric tons of carbon dioxide in 1997, about 32 percent of total emissions from energy consumption.^a Reductions in vehicle carbon dioxide emissions can be achieved by using alternative fuels, such as natural gas, liquefied petroleum gas, ethanol, methanol, and electricity, that are less carbon intensive than petroleum-based transportation fuels. Alternative vehicle fuels accounted for an estimated 2.7 percent of the vehicle fuels consumed in 1997.^b The percentage may climb in the future, however, as legislative initiatives designed primarily to improve air quality begin to take effect.

The Clean Air Act Amendments of 1990 (CAAA90) established the Low Emission Vehicle Program (LEVP) as a pilot program in California, setting sales mandates for three categories of vehicles based on their relative emissions of air pollutants: low emission vehicles (LEVs), ultra-low emission vehicles (ULEVs), and zero emission vehicles (ZEVs). Although the legislation does not dictate that alternative fuels be used, in practice the most cost-effective approach to meeting the ULEV and ZEV standards will involve alternative fuel vehicles.

The LEVP is a voluntary, opt-in program that allows other States to set sales mandates for vehicles meeting the California standards. To date, New York and Massachusetts have opted into the LEVP and have adopted the same mandate as California, which requires that 10 percent of auto company sales must be ZEVs beginning with the 2003 model year.

The Alternative Motor Fuels Act of 1988 required the Federal Government to acquire the maximum practical number of alternative fuel light-duty vehicles for its fleet. It also provides credits toward corporate average fuel economy (CAFE) standards to automobile manufacturers producing alternative fuel vehicles. The Energy Policy Act of 1992 (EPACT) accelerated the Alternative Motor Fuels Act requirements for purchasing alternative fuel vehicles for the Federal fleet. EPACT also expanded mandated purchases of alternative fuel vehicles to non-Federal fleets by requiring minimum purchases for centrally fueled automobile fleets operated by State and local governments and by fuel providers, such as electric and gas utilities.

The Energy Information Administration projects that, with no further legislative or regulatory intervention, alternative fuel vehicle sales will exceed 1.2 million annually by 2020, representing 8 percent of total vehicle sales. By that time, the use of alternative fuel vehicles is expected to reduce carbon dioxide emissions by 3.7 million metric tons annually.^c

^aEnergy Information Administration, *Emissions of Greenhouse Gases in the United States 1997*, DOE/EIA-0573(97) (Washington, DC, October 1998), p. 21, <http://www.eia.doe.gov/oiaf/1605/1605a.html>.

^bEnergy Information Administration, *Alternatives to Traditional Transportation Fuels 1996*, DOE/EIA-0585(96) (Washington, DC, December 1997), p. 20. Alternative transportation fuels accounted for 0.2 percent of vehicle fuels consumed when oxygenates, such as MTBE and the ethanol in gasohol, are excluded.

^cEnergy Information Administration, *Annual Energy Outlook 1999*, DOE/EIA-0383(99) (Washington, DC, December 1998), p. 56, <http://www.eia.doe.gov/oiaf/aeo99/homepage.html>.

optimal fuel efficiency, reducing fuel consumption by about 2.5 percent. CLE Resources reported carbon dioxide emission reductions of 5,383 metric tons of carbon dioxide for its 5-percent share of the project. With truck

travel accounting for emissions of about 250 million metric tons of carbon dioxide in the United States, universal use of the tire pressure device could reduce national emissions by more than 6 million metric tons annually.³⁶

³⁶U.S. Department of Transportation, U.S. Bureau of Transportation Statistics, *National Transportation Statistics 1997*, DOT/VNTSC-BTS-96-4 (Washington, DC, December 1996), Table 4-8, p. 168, <http://www.bts.gov/btsprod/nts/>. Single-unit (2-axle, 6-tire or more) and combination trucks consumed 28,440 gallons of fuel per vehicle in 1995. Assuming an emissions factor of 19 pounds of carbon dioxide per gallon, 249 metric tons of carbon dioxide were emitted.