

5. Reducing Methane Emissions

U.S. anthropogenic (human-caused) methane emissions totaled 28.8 million metric tons in 1999, nearly 3 million metric tons less than in 1990. Estimated emissions from landfills—the largest single anthropogenic source of methane in the United States—dropped from 11.25 million metric tons in 1990 to 8.94 million metric tons in 1999⁴⁴ as a result of a rapid increase in methane recovery at landfills in response to the expiring Section 29 tax credit for alternative fuels and the implementation of EPA's New Source Performance Standards and Emission Guidelines.⁴⁵ Overall, methane recovery at landfills grew from about 1.0 million metric tons in 1990 to 3.6 million metric tons in 1999.⁴⁶ Although not directly correlated, the increase in activity aimed at capturing methane from landfills is reflected in reports submitted to the Voluntary Reporting Program. For the 1999 data year, reduction activities were reported for 190 separate landfills, up from 93 in 1998 and 79 in 1997.

Another significant component of the overall decline in U.S. methane emissions has been a drop in emissions from coal mining. Methane emissions from coal mines declined from 4.3 million metric tons in 1990 to 2.9 million metric tons in 1999.⁴⁷ To a large extent, the decline is attributable to an increase in methane recovery at coal mines, from 0.25 million metric tons in 1990 to about 1.0 million metric tons in 1999. The Voluntary Reporting Program received reports on 18 emission reduction projects at coal mines. Four projects reported reductions from the White Oak Creek property, and three reported reductions from Oak Grove mine.⁴⁸ Because reductions representing only the ownership portion of the reporting entity were reported for each of the projects, reductions were not double counted. Together, these 18 projects reported total emission reductions of 584,090 metric tons of methane.

Although U.S. methane emissions from the production, transmission, and distribution of natural gas and from agricultural activities both increased somewhat between 1990 and 1999 (7.4 percent and 8.1 percent, respectively),

some entities reported reductions in emissions from these sources. Reduced emissions from the natural gas system were reported for 13 projects, and reduced emissions from agricultural activities were reported for 4 projects.

Overview of Projects Reported

For the 1999 data year, 67 organizations reported a total of 228 projects to reduce methane emissions, a 40-percent increase from the 1998 data year and a 430-percent increase from the first (1994) reporting cycle (Table 11). Nearly half (105) of the projects were reported for the first time in the 1999 reporting cycle, as compared with 79 projects reported for the first time in 1998. Some projects reported in previous years were not reported in 1999.

Together, the 228 projects for which methane emission reductions were the principal outcome resulted in total reductions of 2,314,973 metric tons of methane (48,614,437 metric tons carbon dioxide equivalent). The average emission reduction per project was 10,153 metric tons of methane (213,221 metric tons carbon dioxide equivalent). In addition, methane emission reductions totaling 9,820 metric tons were reported as secondary results from other projects in 1999, bringing the total methane reductions reported for all project types in 1999 to 2,324,794 metric tons of methane (Table 12).

The average reduction per project for the 228 projects specifically aimed at reducing methane emissions in 1999 was skewed upward by several large projects. The 65 waste-to-energy plants operated by members of the Integrated Waste Services Association (IWSA) burned municipal solid waste (MSW) rather than sending it to landfills, achieving reported reductions of 194,500 metric tons of methane emissions. Several other projects combined recovery activities at multiple landfill sites. And finally, methane emission reduction projects at a

⁴⁴Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000), <http://www.eia.doe.gov/oiaf/1605/ggrpt/index.html>.

⁴⁵The EPA's Landfill Methane Outreach Program (LMOP) has also contributed to the increase in methane recovery from landfills, as reflected by the large percentage of landfill gas-to-energy project developers who reported participation in LMOP as part of their submissions to the Voluntary Reporting of Greenhouse Gases Program (see Table 15, page 42, in this chapter).

⁴⁶Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000), <http://www.eia.doe.gov/oiaf/1605/ggrpt/index.html>.

⁴⁷Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000), <http://www.eia.doe.gov/oiaf/1605/ggrpt/index.html>.

⁴⁸The White Oak Creek property is owned by USX Corporation, which leases a portion to Drummond Coal for mining at the Shoal Creek mine. The Oak Grove mine is owned by U.S. Steel Mining Corporation.

Table 11. Projects Reported with Methane Reductions as the Principal Outcome by Project Type, Data Years 1994-1999

Project Type	1994	1995	1996	1997	1998	1999
Waste Management and Disposal	27	39	65	81	129	193
Landfill Gas Recovery	24	35	60	74	118	180
Wastewater Treatment	2	2	3	5	6	5
Other	1	2	2	2	5	8
Agriculture	3	3	3	3	4	4
Energy Production and Consumption	13	16	22	19	30	31
Coal Mining	2	2	4	6	19	18
Natural Gas Production, Transmission, and Distribution . .	11	14	18	13	11	13
Total	43	58	90	103	163	228

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

Table 12. Total Reported Methane Emission Reductions, All Project Types, Data Years 1994-1999 (Metric Tons Methane)

Reporting Form	1994	1995	1996	1997	1998	1999
EIA-1605						
Direct Reductions	25,079	8,450	409,176	378,494	1,379,162	1,355,157
Indirect Reductions	102,641	1,077,272	1,157,048	505,663	658,811	827,294
EIA-1605EZ (Direct Reductions)	24,522	50,554	53,573	79,364	126,905	142,343
Total	152,242	1,136,276	1,619,797	963,521	2,164,879	2,324,794

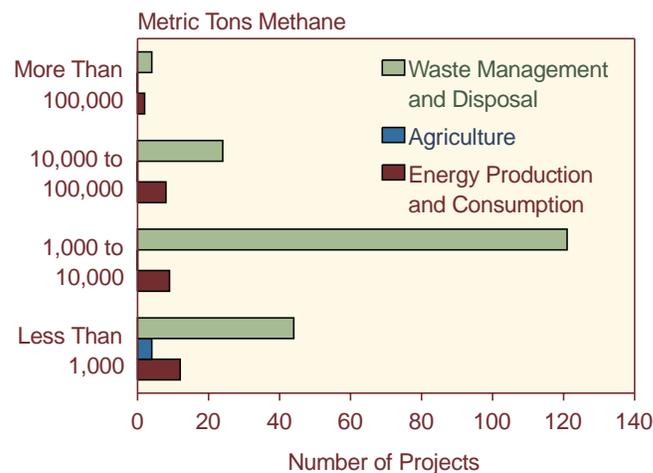
Source: Energy Information Administration, Forms EIA-1605 and EIA-1605EZ.

few very gassy coal mines were substantially larger than most of the other methane emission reduction projects reported (Figure 14). In 1999, the average reported methane reduction achieved by gas recovery projects at coal mines was 32,394 metric tons.

Methane reduction projects are more prone to double reporting than are most other greenhouse gas reduction projects (with the exception of demand-side management programs), because electricity generated from methane recovery at a landfill, coal mine, or animal waste management facility is often sold to a second party, or recovered gas is piped to a second party for use in a boiler. In such cases, the party that captures the gas may report a direct reduction and the gas or electricity purchaser an indirect reduction. Where double reporting does occur, however, double counting is avoided because electricity producers report reductions as indirect unless they have an ownership stake in the landfill or its gas resource, whereas landfill gas developers report reductions as direct. Although there may be multiple reports of the same reduction from a single project, the reduction is unlikely to be double counted, because the reductions would be accounted for separately as part of either direct or indirect totals.

Additional instances of double reporting may occur if a project is reported by two or more entities with ownership interests. Again, however, because reporters are instructed to report only the portion of overall

Figure 14. Methane Projects Reported, by Size of Methane Emission Reduction, Data Year 1999



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

reductions equal to their ownership share, double counting should not occur. Finally, in instances where both biogas flaring and biogas recovery for energy occur at the same landfill, the projects may be reported more than once; however, the total reductions reported should not exceed the reductions actually achieved.

For the 1999 data year, nine cases were found in which both the entity that captured methane and the purchaser

of the methane or of the electricity generated from the methane also reported emission reductions. In addition, for 14 landfill projects, both methane flaring and recovery for energy were reported separately; and in three instances multiple owners of a single coal mine methane capture project reported their respective shares of the resulting emission reductions.

Reducing Methane Emissions from Waste Treatment and Disposal

Reducing emissions from waste treatment and disposal sites was by far the most frequently reported method for lowering methane emissions in 1999. The number of such projects reported for 1999 (193) was 50 percent higher than the number (129) reported for 1998 and 7 times the number (27) reported for 1994. The principal reported method for reducing methane emissions from waste management and disposal was the capture of methane generated during the anaerobic decomposition of wastes in a landfill. The methane may be flared, piped to an end-use customer, or used to generate electricity, reducing the need for generation from other, more carbon-intensive fuels. Other methods of lowering emissions from waste treatment and disposal include reducing the volume of waste reaching landfills through combustion or recycling, and capturing methane generated during anaerobic decomposition of organic material in wastewater.

The 193 waste treatment and disposal projects reported for 1999 accounted for 1,710,662 metric tons of methane emission reductions in 1999 (Table 13), or about 72 percent of all the methane reductions reported. Of the total methane reductions reported for waste treatment and disposal projects, 815,344 metric tons was reported as indirect (i.e., occurring at facilities not owned by the reporter). For 186 of the 193 projects reported, methane emission reductions were achieved at landfills, including 8 projects that lowered emissions through diversion of wastes that would have emitted methane during decomposition and 178 that captured methane from landfill gas generated at waste disposal sites.

Recovery of Landfill Gas

As waste decomposes in a landfill it produces a biogas that is approximately 50 percent carbon dioxide and 50 percent methane. As a result, landfill gas is a potentially valuable source of energy, with a heat content of about 500 British thermal units (Btu) per cubic foot, or about half that of commercially marketed natural gas. Because of its relatively low Btu content and the presence of several impurities, the typical method for using landfill gas is to burn it for electricity generation rather than upgrading it for sale to a pipeline. The electricity generated is sold to the grid. The process lowers methane emissions and reduces consumption of other fuels for electricity generation. When the electricity generated displaces oil- or coal-fired generation, carbon dioxide emissions are reduced. More recently, an increasing number of projects have involved piping landfill gas for direct use in medium-Btu boilers, thus displacing fossil fuels.

Table 13. Reported Methane Emission Reductions for Waste Treatment and Disposal Projects, Data Years 1994-1999
(Metric Tons Methane)

Reporting Form and Project Type	1994	1995	1996	1997	1998	1999
EIA-1605						
Direct Reductions	*	619	128,449	135,639	484,673	756,984
Landfill Gas Recovery	*	619	128,449	135,341	451,445	756,551
Wastewater Treatment	0	0	0	298	33,267	475
Waste Combustion	0	0	0	0	-39	-42
Indirect Reductions	99,431	1,061,691	1,142,877	449,595	644,739	815,344
Landfill Gas Recovery	99,431	112,293	250,481	298,336	480,374	474,618
Wastewater Treatment	0	1	*	0	4,714	10,352
Waste Combustion	0	950,397	892,396	151,259	159,651	330,374
EIA-1605EZ (Direct Reductions)	24,388	50,324	53,006	78,624	123,958	138,334
Landfill Gas Recovery	24,388	50,324	53,006	58,434	78,447	95,003
Wastewater Treatment	0	0	0	0	0	0
Waste Combustion	0	0	*	20,190	45,511	43,331
Total	123,819	1,112,634	1,324,333	663,857	1,253,371	1,710,662

*Less than 0.5 metric ton.

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

For the 178 landfill gas recovery projects reported for 1999, total methane emission reductions (57 percent of which were reported as direct reductions) were 1,326,171 metric tons of methane. The average reduction per project was 7,450 metric tons. Of the projects reported, 88 recovered landfill methane for energy, 41 simply flared the gas, and 49 included both recovery for energy and flaring. One of the most active participants in the Voluntary Reporting of Greenhouse Gases Program is Ecogas, which reported methane emission reductions from its share of ownership in 18 separate landfill gas recovery projects. One of them, the Mountaingate project, recovers 4 million cubic feet of landfill gas from approximately 375 acres, containing 21 million tons of solid waste. The gas is drawn from 125 wells (ranging from 60 to 100 feet deep), cleaned, compressed, and transported 4.5 miles through a dedicated pipeline to a 40-megawatt cogeneration facility at the University of California Los Angeles (UCLA) campus.

Waste Diversion

When waste is diverted from a landfill through recycling, source reduction, or waste combustion, methane emissions that would have resulted when the waste decomposed at a landfill are avoided. Eight such projects were submitted to the Voluntary Reporting Program for 1999 under the category of waste treatment and disposal. Together, those eight projects reduced methane emissions by a total of 373,663 metric tons. The Integrated Waste Services Association (IWSA) reported reductions associated with the combustion of waste at facilities owned by its members across the United States. Because the project covered 65 waste-to-energy facilities, IWSA reported a very large reduction of 194,495 metric tons of methane in 1999. Public Service Enterprise Group also reported a waste-to-energy project that reduced emissions by 101,864 metric tons of methane. There were also many recycling projects reported under project types other than waste treatment and disposal that showed reductions in methane emissions (see box on page 41).

Reducing Methane Emissions from Wastewater Treatment Plants

When wastewater is treated under anaerobic conditions, the decomposition of its organic portion yields methane. Like methane generated from waste at landfills, the methane generated from wastewater treatment may be captured and either flared or used as an energy resource. Because captured methane has value as an energy resource, operators may use an anaerobic digester to treat the wastewater and maximize methane generation. Seven projects to capture methane generated from wastewater treatment were reported for 1999, with total reported reductions of 10,828 metric tons of methane emissions.

Three of the seven projects to reduce methane emissions from wastewater treatment were reported by the Platte River Power Authority and its four owner cities. At the Loveland wastewater treatment facility in Colorado, Platte River reported using biogas produced in an anaerobic digester to displace natural gas used in boilers and to generate electricity. At the Longmont facility in Colorado, biogas was used to maintain the operating temperature of sludge digesters. At the Drake Water facility in Fort Collins, CO, the gas was used in a boiler to meet the facility's fuel needs.

Reducing Emissions from Energy Production and Consumption

Reducing Emissions from Coal Mines

As coal is formed from organic material by natural chemical and physical processes, methane is also created. The methane is stored in the pores (open spaces) of the coal itself and in cracks and fractures in the coalbed. As coal is mined, the pressure surrounding the stored methane decreases, allowing much of it to be released into the operating coal mine. Because methane in concentrations of 5 to 15 percent is explosive, mine operators use large fans to provide a steady airflow across the mine face and ventilate the mine shaft. Because the methane is valuable as an energy resource, mine operators may also employ degasification wells to capture methane and either inject it into gas pipelines or use it to generate electricity.

For 1999, 18 projects to reduce methane emissions from coal mines were reported, with total emission reductions of 584,090 metric tons of methane (Table 14). Three projects were reported by Black Warrior Methane Corporation, which operated degasification activities at some of the gassiest mines in the Warrior Basin of Alabama. The three projects resulted in reported reductions of 243,252 metric tons of methane emissions in 1999. An additional aggregate reduction of 216,070 metric tons of methane was reported in portions, as part of four separate projects at the White Oak Creek field (owned by USX corporation) in Alabama.

When a mine is closed it may continue to have significant although slowly declining emissions over many years. Northwest Fuel Development reported methane emission reductions of 633 metric tons in 1999 from a project to use methane recovered from abandoned coal mines to generate electricity. As the purchaser of electricity from the project, PacifiCorp also reported associated indirect reductions of 528 metric tons.

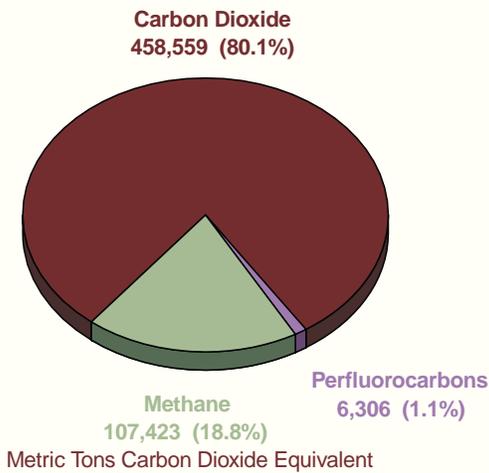
Recycling and Source Reduction Projects

The Voluntary Reporting Program has received reports on three types of waste management projects: waste diversion, recycling, and source reduction. Of the 37 recycling and source reduction projects reported for 1999, only 4 involved source reduction, and 2 of those included a combination of recycling and source reduction activities. Recycling and source reduction projects reported to the Voluntary Reporting Program for 1999 were estimated to have resulted in the avoidance of a total 711,602 metric tons of waste that would otherwise have been placed in landfills, for a combined emission reduction of 572,288 metric tons carbon dioxide equivalent. The emissions reduced included carbon

dioxide (458,559 metric tons or 80 percent of the total), methane (107,423 metric tons carbon dioxide equivalent), and perfluorocarbons (PFCs) (6,306 metric tons carbon dioxide equivalent).

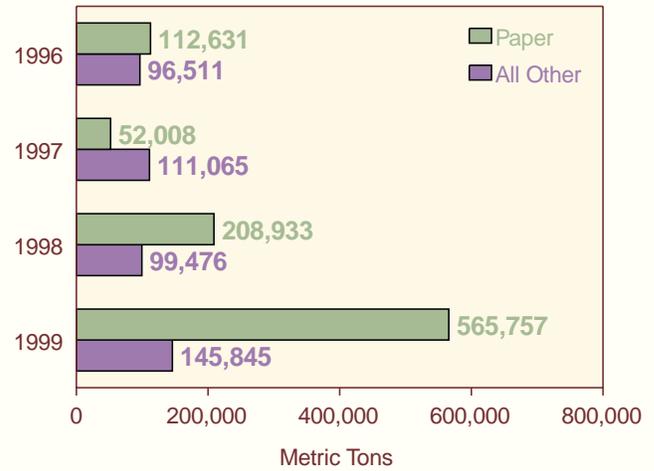
Paper made up most of the waste reported to have been recycled in the projects, as it has consistently since the 1996 reporting year. The WasteWiSe recycling project reported by Public Service Enterprise Group was one of the most comprehensive recycling programs in 1999, involving recycling and source reduction of a wide variety of materials, including wood, rubber, oil and batteries, metals, and paper.

Reported Emission Reductions from Recycling and Source Reduction Projects, Data Year 1999



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

Materials Recycled or Source Reduced: Paper and All Other Materials, Data Years 1996-1999



Notes: Other materials may include unspecified paper. No recycling projects were reported before data year 1996.

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

Table 14. Reported Methane Emission Reductions from Energy Production and Consumption, Data Years 1994-1999
(Metric Tons Methane)

Reporting Form and Project Type	1994	1995	1996	1997	1998	1999
EIA-1605						
Direct Reductions	19,687	7,714	279,766	242,040	893,927	595,311
Coal Mining	11,767	3,620	270,967	232,132	877,819	581,307
Natural Gas Systems	7,920	4,094	8,799	9,908	16,108	13,683
Indirect Reductions	0	3,543	4,039	5,439	7,603	6,565
Coal Mining	0	278	893	2,285	1,568	528
Natural Gas Systems	0	3,265	3,146	3,150	6,035	6,036
EIA-1605EZ	135	230	567	741	2,393	2,255
Coal Mining	0	0	22	188	2,393	2,255
Natural Gas Systems	135	230	544	553	0	0
Total	19,822	11,486	284,371	248,220	903,923	604,132

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

Reducing Emissions from Natural Gas Production, Transmission, and Distribution

Methane is the principal constituent of natural gas (about 95 percent of the mixture). Natural gas is released at several stages of gas production, from the transmission and distribution system through leakage, during normal maintenance, and, rarely, as a result of accidents. Thus, methane emissions can be reduced by replacing leaky system components, improving operations and maintenance, and limiting routine venting procedures. Thirteen such projects were reported for 1999, with an average reduction of 1,542 metric tons of methane per project. The five largest projects reported represented 90 percent of the reductions reported for this source. Western Resources reported a project that reduced methane emissions by 6,024 metric tons, Public Service Company of New Mexico submitted a project with a reduction of 3,693 metric tons methane, CMS Energy reported a reduction of 3,608 metric tons methane, and NiSource reported two projects that lowered methane emissions by a total of 4,674 metric tons.

Reducing Emissions from Agriculture

Four projects reported for 1999 focused on reducing methane emissions from agricultural activities. In three

cases, methane was recovered from the decomposition of animal waste in anaerobic digesters and used to generate electricity. As the purchaser of the electricity from two projects, General Public Utilities reported methane reductions of 55 metric tons. PP&L reported reductions of 124 metric tons from a biogas project at Rocky Knolls/Keener Farm. The third project was a study on reducing emissions from rice cultivation, financed by Reliant Energy (formerly Houston Lighting and Power Company).

Federal Voluntary Programs To Reduce Methane Emissions

The U.S. Government sponsors a number of voluntary programs specifically targeted to reduce methane emissions. Most prominent are the Landfill Methane Outreach Program (LMOP), the Coalbed Methane Outreach Program (CMOP), and the Natural Gas STAR Program. In addition, reducing methane is an effective method for meeting the reduction targets utilities have adopted under the Climate Challenge Voluntary program. The number of reported methane reduction projects associated with Federal voluntary programs has increased nearly fivefold since 1994, with a particularly large increase in the number of projects associated with the LMOP. Of the 193 waste treatment and disposal projects reported to the Voluntary Reporting Program for 1999, 115 were associated with the LMOP (Table 15).

Table 15. Number of Methane Reduction Projects Reported to Voluntary Reporting of Greenhouse Gas Program Associated with Other Federal Voluntary Programs, Data Years 1994-1999

Voluntary Program	1994	1995	1996	1997	1998	1999
Climate Challenge	22	27	32	36	34	39
Landfill Methane Outreach Program	6	8	29	32	90	115
Coalbed Methane Outreach Program	1	1	2	2	10	11
Natural Gas STAR	7	9	11	6	5	7
Other	0	6	2	2	1	3
Total.	30	42	70	67	133	165

Note: Totals may not equal sum of components, because some projects are associated with more than one voluntary program. Source: Energy Information Administration, Forms EIA-1605 and EIA-1605EZ.