

5. Reducing Methane Emissions

Introduction

U.S. methane emissions totaled an estimated 26.2 million metric tons (601.9 million metric tons carbon dioxide equivalent) in 2003, representing 8.7 percent of total U.S. greenhouse gas emissions. Methane emissions in 2003 were approximately equal to 2002 levels and 4.6 million metric tons lower than 1990 levels.⁵⁸

Methane emissions have been decreasing since 1990. Emissions from waste management and energy sources have been reduced, while emissions from the other primary methane source, agriculture, have remained nearly constant. In the waste management area, estimated emissions from landfills—the second largest source of methane after natural gas systems—have dropped from 10.5 million metric tons in 1990 to 6.3 million metric tons in 2003 as a result of a rapid increase in methane recovery at landfills. Overall, methane recovery at landfills, due to tax credits, regulation, and high natural gas prices have grown from about 1.3 million metric tons in 1990 to 6.3 million metric tons in 2003. Emissions from energy sources have also fallen, as a result of reductions in methane emissions from coal mining. Methane emissions from coal mines are estimated to have declined from 4.2 million metric tons in 1990 to 2.9 million metric tons in 2003. To some extent, the decline is attributable to an increase in methane recovery at coal mines, from 0.3 million metric tons in 1990 to about 0.8 million metric tons in 2003.⁵⁹

The Voluntary Reporting Program has seen a rapid increase in reported methane emission reductions since 1994. The number of waste management projects reported (primarily landfill gas projects) has increased from 17 in 1994 to 425 in 2003. For the 2003 data year, reduction activities were reported on Form EIA-1605 for at least 341 separate landfills, up from 321 in 2002.⁶⁰ Projects reporting methane recovery from energy production (natural gas systems and coal mine methane recovery) have increased from 8 in 1994 to 41 in 2003. Agricultural projects remain a small category, fluctuating from 3 to 5 a year since 1994.

Overview of Projects Reported

For 2003, 71 organizations reported a total of 470 projects to reduce methane emissions, a 5.4-percent increase in projects from 2002 and nearly a 17-fold increase from the first (1994) reporting cycle (Table 17). Of the projects that were reported for 2003, 36 were reported for the first time, either because they began achieving reductions in 2003 or because they were reported by one of the 5 new reporters in the methane emission reduction categories. Some projects reported for previous years were not reported for 2003.

Direct reductions of methane emissions reported on Form EIA-1605 for all project types in 2003 totaled 3.3 million metric tons methane, down from 3.5 million metric tons reported for 2002 (Table 18). Waste treatment projects accounted for 72.8 percent of reported methane reductions. These reductions were derived from 425 waste treatment projects reported, averaging 5,736 metric tons of direct methane emission reductions per project (Figure 13). The 218 projects reported by Waste Management, Inc., resulted in a reported reduction of 1.4 million metric tons methane (33.0 million metric tons carbon dioxide equivalent), or 42.8 percent of total reported direct reductions of methane emissions.

Projects to reduce methane emissions from coal mines and natural gas systems generally yielded much larger direct reductions per project (Figure 13), averaging 22,964 metric tons methane. Total direct emission reductions of 0.4 million metric tons methane were reported for coal mining projects in 2003, accounting for 12.1 percent of the direct methane emission reductions reported for 2003. The 28 natural gas system projects reported for 2003 reduced direct methane emission by a total of 0.5 million metric tons methane, or about 15.9 percent of all reported direct methane emission reductions.

Indirect methane emission reductions from all projects types totaled 1.0 million metric tons for 2003 (Table 18), down slightly from the 1.1 million metric tons reported for 2002. The vast majority (99 percent) of indirect

⁵⁸Energy 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.

⁵⁹Energy 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.

⁶⁰The counts of landfills represent minimum levels, because not all reporters explicitly identified the landfills on which they were reporting. The counts exclude reports received after the close of the reporting cycles, in order to maintain comparability.

methane emission reductions were reported for waste treatment and disposal projects. The waste treatment and disposal category included two very large projects reported by DTE Energy and the Integrated Waste Services Association (IWSA). DTE Energy reported 0.2 million metric tons of indirect reductions from multiple landfill gas-to-energy systems reported as one large project, and IWSA reported indirect reductions of 0.4 million metric tons from the waste-to-energy facilities of its members.

Reducing Methane Emissions from Waste Treatment and Disposal

Reducing emissions from waste treatment and disposal sites was the most frequently reported method for lowering methane emissions in 2003. These projects made up 90 percent of all the methane emission reduction projects reported, with 21 more projects reported for 2003 than for 2002. The principal reported method for reducing methane emissions from waste treatment and disposal was landfill gas recovery (the capture of methane generated during the anaerobic decomposition of

wastes in a landfill). The recovered methane may be flared, piped to an end-use customer to be used as a fuel, or used to generate electricity, which can reduce 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 425 waste treatment and disposal projects reported for 2003 accounted for 2.4 million metric tons of direct methane emission reductions and 1.0 million metric tons of indirect reductions (Table 19). Of the 425 projects reported, 412 achieved methane emission reductions at landfills by capturing methane from landfill gas generated at waste disposal sites, 5 lowered emissions through diversion of wastes that would have emitted methane during decomposition, and 8 captured methane from wastewater treatment facilities.

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

Table 17. Projects Reported on Form EIA-1605 with Methane Reductions as the Principal Outcome by Project Type, Data Years 1994-2003
(Number of Projects)

Project Type	1994	1995	1996	1997	1998	1999	2000	2001	2002 ^(R)	2003
Waste Management and Disposal	17	23	44	53	90	153	350	391	404	425
Landfill Gas Recovery	14	19	40	48	80	139	337	381	391	412
Wastewater Treatment	2	2	2	3	5	6	8	4	7	8
Waste Combustion	1	2	2	2	5	8	5	6	6	5
Agriculture	3	3	3	3	4	4	5	3	3	4
Energy Production and Consumption	8	11	13	15	28	28	28	35	39	41
Coal Mining	2	3	4	5	17	15	14	16	18	13
Natural Gas Production, Transmission, and Distribution	6	8	9	10	11	13	14	19	21	28
Total	28	37	60	71	122	185	383	429	446	470

(R) = revised.

Note: Project totals do not equal sum of components, because some projects are counted in more than one category.

Source: Energy Information Administration, Form EIA-1605.

Table 18. Total Methane Emission Reductions Reported on Form EIA-1605, All Project Types, Data Years 1994-2003
(Metric Tons Methane)

Type of Reduction	1994	1995	1996	1997	1998	1999	2000	2001	2002 ^(R)	2003
Direct	25,079	8,450	409,176	378,494	1,379,162	1,564,958	2,693,295	3,546,480	3,481,465	3,347,511
Indirect	102,641	1,077,272	1,157,048	505,663	658,811	827,294	897,465	1,009,400	1,067,643	1,000,063

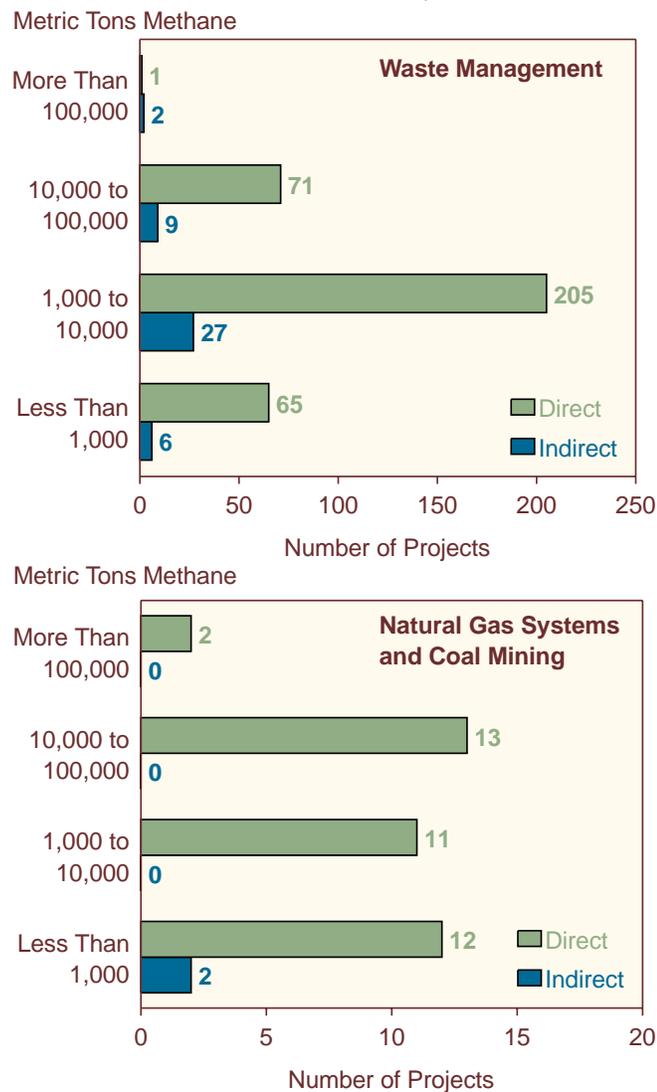
(R) = revised.

Source: Energy Information Administration, Form EIA-1605.

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 then used on site or 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, higher natural gas prices have resulted in an increasing number of projects that involve piping landfill gas for direct use in medium-Btu boilers, which also displaces fossil fuels.

For the 412 landfill gas recovery projects reported for 2003, reported direct methane emission reductions

Figure 13. Methane Emission Reduction Projects Reported on Form EIA-1605 by Type and Size of Reduction, Data Year 2003



Source: Energy Information Administration, Form EIA-1605.

totalled 2.4 million metric tons and indirect reductions totalled 0.6 million metric tons. Of the projects reported, 170 recovered landfill methane for energy, 183 simply flared the gas, 49 included both recovery for energy and flaring, and 10 reported other activities.

Waste Combustion

When waste is diverted from a landfill through waste combustion, methane emissions that would have resulted when the waste decomposed at a landfill are avoided. Five waste combustion projects were reported for 2003. The preponderance of the methane emission reductions reported for waste combustion are indirect, because they typically occur at a landfill where diverted waste would have decomposed to produce methane, rather than at the site of the waste diversion activities. Total indirect reductions for the five projects were 0.4 million metric tons methane (Table 19). The majority of the reductions were reported by IWSA, which reported reductions associated with the combustion of waste at facilities owned by its members across the United States. IWSA's total reported reduction of methane emissions in 2003 was 0.4 million metric tons. Other methods of reducing methane emissions from waste include recycling and source reduction (see box on page 52).

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. Eight projects to capture methane generated from wastewater treatment were reported for 2003, with total reported direct reductions of 60.1 thousand metric tons methane and indirect reductions of 10.7 thousand metric tons methane. Direct reductions of 43.2 thousand metric tons methane were reported for a Los Angeles County Sanitation District project, and Blue Source reported direct reductions of 16.9 thousand metric tons methane. Indirect reductions were reported for two projects sponsored by FirstEnergy.

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

Materials Management Projects

“Materials management” is a crosscutting category that can encompass a variety of greenhouse gas and emission sources, and may include any of the following activities:

- Use of biomass fuels, such as wood waste, which reduces carbon dioxide emissions by displacing fossil fuels
- Avoidance of methane emissions from the decay of waste materials in landfills, wastewater treatment plants, and other waste management systems through activities such as recovery of methane from landfills or from anaerobic digesters treating municipal sewage, agricultural wastes, or animal manure, and diversion of municipal solid waste from landfills to waste-to-energy systems
- Recycling of halogenated substances, such as sulfur hexafluoride, hydrofluorocarbons, chlorofluorocarbons, and hydrochlorofluorocarbons
- Recycling and source reduction of solid waste, which reduce methane emissions from municipal landfills and reduce emissions of carbon dioxide and other gases associated with the production of virgin materials displaced by the materials recycled
- Reuse of coal ash as a substitute for Portland cement in concrete, which reduces carbon dioxide emissions from the manufacture of the cement.

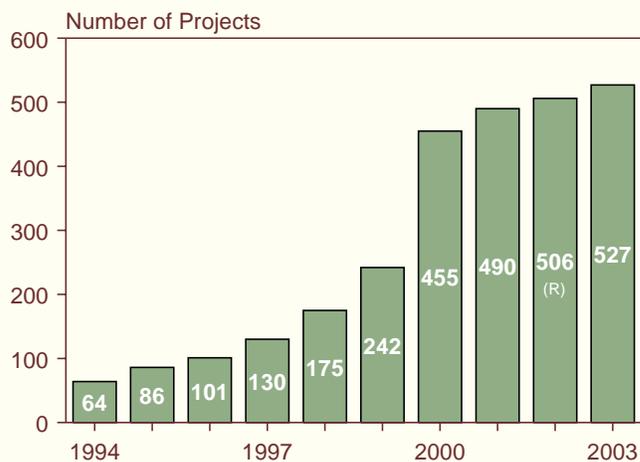
Reporting of materials management activities on Form EIA-1605 increased more than eightfold from 1994 to 2003. A total of 526 projects were reported for 2003, 4 percent more than were reported for 2002 (see figure).

Landfill gas recovery accounted for most (78 percent) of the 526 materials management projects reported for 2003. In addition to 13 other methane emission

avoidance projects reported, other materials management projects included coal ash reuse (33), recycling and source reduction of solid waste (34), recycling of halogenated substances (18), and biomass burning (16).

The emission reductions reported for materials management projects are shown in the table below. For 2003, reported net reductions in direct emissions were 50.4 million metric tons carbon dioxide equivalent, representing 19 percent of the total direct reductions reported. Reported indirect reductions were 52.0 million metric tons carbon dioxide equivalent, representing 64 percent of the total indirect reductions reported. Most of the reductions (99 percent of the direct and 89 percent of the indirect reductions) were associated with methane avoidance activities discussed in this chapter.

Materials Management Projects Reported on Form EIA-1605, Data Years 1994-2003



Source: Energy Information Administration, Form EIA-1605. (R) = revised.

Reported Emission Reductions from Materials Management Projects by Project Type and Type of Reduction, Data Year 2003 (Metric Tons Carbon Dioxide Equivalent)

Project Type	Number of Projects	Direct Reductions	Indirect Reductions
Biomass Burning	16	468,399	91,828
Methane Emission Avoidance			
Landfill Gas Recovery	412	54,659,548	14,923,688
Municipal Waste Combustion	1	-7,933,287	23,750,820
Wastewater Treatment	8	1,360,164	260,765
Agricultural Waste	4	1,616	2,204
Total	425	48,088,042	38,937,478
Halogenated Substances	18	1,633,398	2,224,018
Recycling and Source Reduction of Solid Waste . .	34	217,709	5,540,865
Coal Ash Reuse	33	0	5,233,686
Total	526	50,407,548	52,027,875

Source: Energy Information Administration, Form EIA-1605.

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. Some very gassy mines must also employ degasification wells to remove methane before or after mining so that it does not enter the mine. Because methane is a valuable energy source, most of the mines with degasification systems now inject the methane into gas pipelines or use it to generate electricity or heat.

For 2003, 13 projects to reduce methane emissions from coal mines were reported, with total direct emission reductions of 0.4 million metric tons and indirect reductions of 96 metric tons methane (Table 20). Jim Walters Resources reported direct reductions of 0.2 million metric tons methane from three degasification projects, and CDX reported direct methane reductions of 0.1 million metric tons methane from its two projects.

Reducing Emissions from Natural Gas Production, Transmission, and Distribution

Methane is the principal constituent of natural gas (about 95 percent of the mixture). Methane emissions from natural gas production, processing, transmission, and distribution are generally process related, with normal operations, routine maintenance, and system upsets being the primary contributors. Emissions vary greatly from facility to facility and are largely a function of operation and maintenance procedures and equipment conditions. Thus, methane emissions can be reduced by replacing leaky system components, improving operations and maintenance, and limiting routine venting procedures. For 2003, 28 such projects were reported, with total direct emission reductions of 0.5 million metric tons methane. No indirect reductions were reported. NIPSCO reported 9 projects, associated with the Natural Gas STAR Program, that yielded 0.2 million metric tons of methane emission reductions. Other major reporters included NEGT, which reported one Natural Gas STAR

Table 19. Methane Emission Reductions from Waste Treatment and Disposal Projects Reported on Form EIA-1605, Data Years 1994-2003
(Thousand Metric Tons Methane)

Reduction and Project Type	1994	1995	1996	1997	1998	1999	2000	2001	2002 ^(R)	2003
Direct Reductions	*	0.6	128.4	135.6	484.7	966.8	2,171.5	2,117.2	2,514.7	2,437.7
Landfill Gas Recovery . . .	*	0.6	128.4	135.3	451.4	921.7	2,134.0	2,079.6	2,476.5	2,377.6
Wastewater Treatment . .	—	—	—	0.3	33.3	40.8	37.5	37.6	38.5	60.8
Waste Combustion	—	—	—	—	*	4.4	*	*	-0.8	-0.7
Indirect Reductions	99.4	1,061.7	1,142.9	449.6	644.7	815.3	884.5	1,003.3	1,003.3	988.4
Landfill Gas Recovery . . .	99.4	111.3	250.5	298.3	470.9	575.5	612.9	701.9	623.8	569.1
Wastewater Treatment . .	—	*	*	—	4.7	19.6	12.7	13.1	13.1	10.7
Waste Combustion	*	950.4	892.4	151.3	169.1	220.2	259.0	288.3	366.5	408.6

*Less than 500 metric tons.
(R) = revised.

Source: Energy Information Administration, Form EIA-1605.

Table 20. Methane Emission Reductions from Natural Gas Systems and Coal Mining Reported on Form EIA-1605, Data Years 1994-2003
(Metric Tons Methane)

Reduction and Project Type	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Direct Reductions	19,687	7,714	279,766	242,040	893,927	595,311	518,590	657,894	797,154	941,512
Coal Mining	13,767	4,191	271,549	232,131	885,807	581,307	505,941	538,285	567,088	406,782
Natural Gas Systems . .	5,920	3,522	8,217	9,909	8,121	14,004	12,648	119,609	230,066	534,731
Indirect Reductions	—	3,543	4,039	5,439	7,603	6,565	6,785	96	96	96
Coal Mining	—	278	893	2,285	1,568	528	747	96	96	96
Natural Gas Systems . .	—	3,265	3,146	3,154	6,035	6,036	6,038	0	0	0

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

project with methane emission reductions of 0.2 million metric tons, and BP America, which reported 3 projects with aggregate reductions of 0.1 million metric tons methane.

Reducing Emissions from Agriculture

Four projects reported for 2003 focused on reducing emissions from agricultural activities, but only three of them reported methane emission reductions. FirstEnergy reported indirect methane emission reductions of 109 metric tons as the result of purchases of electricity generated from an anaerobic digester of animal waste at Mason Dixon Farms—an increase from the 73 metric tons reported for 2002. Alliant Energy reported two projects, at Deer Ridge Dairy and Double S Dairy, which reduced carbon dioxide emissions by 1,237 metric tons. The fourth agriculture project, reported by AES, was to improve feed supplements for cattle in India and reduce emissions from enteric fermentation. AES did not report an emission reduction quantity for 2003.

Federal Voluntary Programs To Reduce Methane Emissions

The U.S. Government sponsors a number of voluntary programs specifically targeted to reduce methane emissions. Most frequently cited by reporters to the Voluntary Reporting Program are the U.S. Environmental Protection Agency’s Landfill Methane Outreach Program (LMOP), Coalbed Methane Outreach Program (CMOP), and Natural Gas STAR Program. In addition, reducing methane has been an effective method for meeting the reduction targets adopted by utilities under the U.S. Department of Energy’s Climate Challenge voluntary program. The number of reported methane reduction projects associated with Federal voluntary programs has increased 14-fold since 1994, with a particularly large increase in the number of projects associated with the LMOP. Of the 425 waste treatment and disposal projects reported to the Voluntary Reporting Program for 2003, 365 (86 percent) were associated with the LMOP (Table 21).

Table 21. Number of Reported Methane Reduction Projects Associated with Other Federal Voluntary Programs, Data Years 1994-2003

Voluntary Program	1994	1995	1996	1997	1998	1999	2000	2001	2002 ^(R)	2003
Climate Challenge	22	27	32	36	34	39	42	34	34	36
Landfill Methane Outreach Program . . .	6	8	29	32	90	116	309	359	354	365
Coalbed Methane Outreach Program . .	1	1	2	2	10	11	6	9	9	6
Natural Gas STAR	7	9	11	6	5	7	7	14	17	23
Other	0	6	2	2	1	3	4	5	5	5
Total.	30	42	64	65	132	164	354	407	405	420

(R) = revised.

Note: Totals may not equal sum of components, because some projects are associated with more than one voluntary program.

Source: Energy Information Administration, Form EIA-1605.