

5. Reducing Methane Emissions

Introduction

U.S. anthropogenic (human-caused) methane emissions totaled an estimated 26.6 million metric tons in 2001, 4.6 million metric tons less than in 1990. Estimated emissions from landfills—the largest single anthropogenic source of methane in the United States—dropped from 11.0 million metric tons in 1990 to 6.9 million metric tons in 2002⁴⁹ as a result of a rapid increase in methane recovery at landfills. Three factors contributed to the increase in methane recovery: the now-expired Section 29 tax credit for alternative fuels, the implementation of EPA's New Source Performance Standards and Emission Guidelines,⁵⁰ and higher natural gas prices that made landfill gas more competitive as an energy fuel.⁵¹ Overall, methane recovery at landfills grew from about 1.1 million metric tons in 1990 to 5.9 million metric tons in 2002.⁵² 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 2002 data year, reduction activities were reported on Form EIA-1605 for at least 321 separate landfills, up from 307 in 2001.⁵³

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 are estimated to have declined from 4.2 million metric tons in 1990 to 2.9 million metric tons in 2002.⁵⁴ 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 2002. The Voluntary Reporting Program received reports on 18 emission reduction projects at coal mines for 2002, up from 16 for 2001. The 18 projects reported total direct methane emission reductions of 567,088 metric tons (13.0 million metric tons carbon dioxide equivalent) in 2002, up from

538,285 metric tons methane (12.4 million metric tons carbon dioxide equivalent) in 2001.

Although U.S. methane emissions from the production, transmission, and distribution of natural gas and from agricultural activities both are estimated to have increased between 1990 and 2002 (by 15.5 percent and 5.0 percent, respectively), some entities reported reductions in emissions from these sources. Reduced emissions from the natural gas system were reported for 21 projects, and reduced emissions from agricultural activities were reported for 3 projects.

Overview of Projects Reported

For the 2002 data year, 69 organizations reported a total of 445 projects to reduce methane emissions, a 3.7-percent increase from the 2001 data year⁵⁵ and nearly a 16-fold increase from the first (1994) reporting cycle (Table 16). Fifty-one of the projects were reported for the first time in the 2002 reporting cycle, either because they began achieving reductions in 2002 or because they were reported by one of three new reporters. Some projects reported for previous years were not reported for 2002.

Direct reductions of methane emissions reported on Form EIA-1605 for all project types in 2002 totaled 3,481,385 metric tons methane, down from 3,546,480 metric tons reported for 2001 (Table 17). Of the total for 2002, 70.4 percent was attributable to 403 waste treatment projects that reported an average of 6,240 metric tons direct methane emission reductions per project. The 202 projects reported by Waste Management, Incorporated, resulted in a reported reduction of 1,308,096 metric tons methane (30,086,208 metric tons carbon dioxide equivalent), or 36.8 percent of total reported direct reductions of methane emissions.

⁴⁹Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2002*, DOE/EIA-0573(2002) (Washington, DC, October 2003), web site www.eia.doe.gov/oiaf/1605/1605a.html.

⁵⁰The 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 20 in this chapter).

⁵¹B. Guzzone, U.S. Environmental Protection Agency, Landfill Methane Outreach Program, "Fluctuating Energy Prices: Boom or Bust for the LFG Energy Markets?," presented at SWANA WASTECON 2002 (Long Beach, CA, October 29-31, 2002).

⁵²Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2002*, DOE/EIA-0573(2002) (Washington, DC, October 2003), web site www.eia.doe.gov/oiaf/1605/1605a.html.

⁵³The 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.

⁵⁴Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2002*, DOE/EIA-0573(2002) (Washington, DC, October 2003), web site www.eia.doe.gov/oiaf/1605/1605a.html.

⁵⁵Excluding late reporters from the 2000 total, the decrease was much smaller (7 percent).

Projects to reduce methane emissions from coal mines and natural gas systems generally yielded much larger direct reductions per project (Figure 13), averaging 20,440 metric tons methane. Total direct emission reductions of 567,088 metric tons methane were reported for coal mining projects in 2002, accounting for 16 percent of the direct methane emission reductions reported for 2002. The 21 natural gas system projects reported for 2002 reduced direct emissions by a total of 230,066 metric tons methane, or about 6 percent of all reported direct methane emission reductions.

Indirect methane emission reductions from waste treatment and disposal projects totaled 1,003,323 metric tons, or 94 percent of all indirect methane emission reductions reported on Form EIA-1605. This total included two very large projects reported by DTE Energy and the Integrated Waste Services Association (IWSA). DTE Energy reported 227,092 metric tons of indirect reductions from multiple landfill gas-to-energy systems reported as one large project, and IWSA reported indirect reductions of 341,705 metric tons from the waste-to-energy facilities of its members. Overall, reported indirect reductions continued to grow in 2002, due primarily to the nearly increase in reported reductions (75,985 metric tons) attributed to the IWSA waste-to-energy project. After dropping between 1996 and 1997 due to an improvement in the estimation methods used by IWSA, reported indirect reductions have continued to grow as a result of

increased reporting of landfill gas capture and use projects.

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 methane is piped to a second party for use in a boiler. In such cases, the party that captures the methane may report a direct emission reduction and the gas or electricity purchaser an indirect reduction. Where double reporting does occur, however, double counting is avoided because electricity producers report methane reductions as indirect unless they have an ownership stake in the landfill or its gas resource, whereas landfill gas developers report methane reductions as direct. Although there may be two reports of the same reduction from a single project, the reduction is unlikely to be counted more than once, because the reductions would be accounted for separately as part of either direct or indirect totals. As an example, Waste Management, Incorporated, and FirstEnergy reported projects on the same landfill. Waste Management recovered methane at the Lake View landfill and used it to generate electricity. FirstEnergy purchased the electricity. Waste management reported more than 5,000 metric tons of direct methane reductions, and FirstEnergy reported

Table 16. Projects Reported on Form EIA-1605 with Methane Reductions as the Principal Outcome by Project Type, Data Years 1994-2002

Project Type	1994	1995	1996	1997	1998	1999	2000	2001 ^(R)	2002
Waste Management and Disposal	17	23	44	53	90	153	350	391	403
Landfill Gas Recovery.....	14	19	40	48	80	139	337	381	390
Wastewater Treatment.....	2	2	2	3	5	6	8	4	7
Other.....	1	2	2	2	5	8	5	6	6
Agriculture	3	3	3	3	4	4	5	3	3
Energy Production and Consumption	8	11	13	15	28	28	28	35	39
Coal Mining.....	2	3	4	5	17	15	14	16	18
Natural Gas Production, Transmission, and Distribution ..	6	8	9	10	11	13	14	19	21
Total	28	37	60	71	122	185	383	429	445

(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.

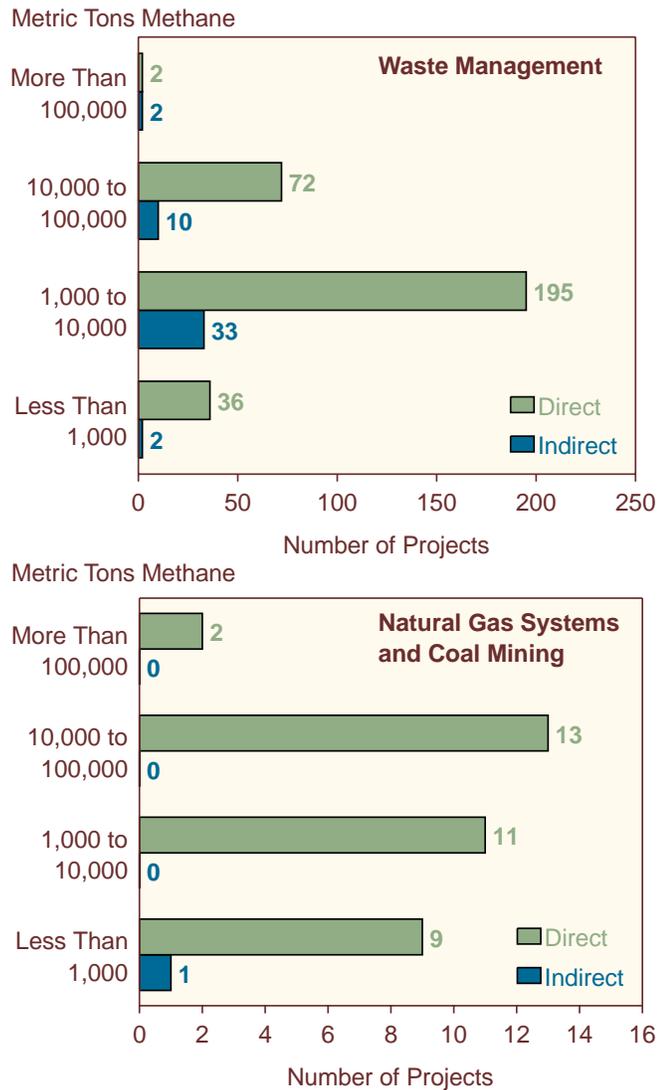
Table 17. Total Methane Emission Reductions Reported on Form EIA-1605, All Project Types, Data Years 1994-2002 (Metric Tons Methane)

Type of Reduction	1994	1995	1996	1997	1998	1999	2000	2001 ^(R)	2002
Direct.....	25,079	8,450	409,176	378,494	1,379,162	1,564,958	2,693,295	3,546,480	3,481,385
Indirect.....	102,641	1,077,272	1,157,048	505,663	658,811	827,294	897,465	1,009,400	1,067,643

(R) = revised.

Source: Energy Information Administration, Form EIA-1605.

Figure 13. Methane Emission Reduction Projects Reported on Form EIA-1605 by Type and Size of Reduction, Data Year 2002



Source: Energy Information Administration, Form EIA-1605.

more than 5,000 metric tons of indirect methane reductions.

Additional instances of double reporting may occur if a project is reported by two or more entities with ownership interests in it. Again, because reporters are instructed to report only the portion of overall 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, because the landfill gas developer or energy purchaser will not count flared gas in biogas recovery totals.

For 2002 there were 37 landfills for which more than one entity reported emission reductions, or 11 percent of the landfills for which reduction activities were reported on Form EIA-1605. Double reporting can also occur when a single entity reports methane flaring and methane recovery for energy at the same landfill as separate projects. There were 37 such cases among the Form EIA-1605 reports for 2002.

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 2002. The number of such projects reported on Form EIA-1605 for 2021 (403) made up 91 percent of all the methane emission reduction projects reported for the year. This was 12 more projects than were reported for 2001 (excluding late reports) and almost 24 times the number (17) reported for 1994, the first year of the Voluntary reporting Program. The principal reported method for reducing methane emissions from waste treatment 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 403 waste treatment and disposal projects reported for 2002 accounted for 2,514,696 metric tons of direct methane emission reductions and 1,003,323 metric tons of indirect reductions (Table 18). Of the 403 projects reported, 390 achieved methane emission reductions at landfills by capturing methane from landfill gas generated at waste disposal sites, 6 lowered emissions through diversion of wastes that would have emitted methane during decomposition, and 7 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 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 390 landfill gas recovery projects reported for 2002, reported direct methane emission reductions totaled 2,476,935 metric tons and indirect reductions totaled 623,757 metric tons methane. Of the projects reported, 167 recovered landfill methane for energy, 170 simply flared the gas, 51 included both recovery for energy and flaring, and 2 reported other activities.

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. Six such projects were submitted to the Voluntary Reporting Program on Form EIA-1605 for 2002 under the category of waste treatment and disposal. The preponderance of the methane emission reductions reported for waste diversion 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 six projects were 366,496 metric tons methane. 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 2002 was 341,705 metric tons. 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 53).

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 2002, with total reported direct reductions of 38,512 metric tons methane and indirect reductions of 13,070 metric tons methane. Ninety-eight percent of the direct reductions were reported for a Los Angeles County Sanitation District project, and all the 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 the coal itself and in cracks and fractures in the coalbed.

Table 18. Methane Emission Reductions from Waste Treatment and Disposal Projects Reported on Form EIA-1605, Data Years 1994-2002
(Metric Tons Methane)

Reduction and Project Type	1994	1995	1996	1997	1998	1999	2000	2001 ^(R)	2002
Direct Reductions	*	619	128,449	135,639	484,673	966,785	2,171,501	2,117,166	2,514,696
Landfill Gas Recovery . . .	*	619	128,449	135,340	451,445	921,666	2,134,007	2,079,613	2,476,935
Wastewater Treatment . .	—	—	—	298	33,267	40,763	37,532	37,591	38,512
Waste Combustion	—	—	—	—	-39	4,356	-38	-38	-751
Indirect Reductions	99,431	1,061,691	1,142,877	449,595	644,739	815,344	884,484	1,003,287	1,003,323
Landfill Gas Recovery . . .	99,431	111,293	250,480	298,335	470,880	575,484	612,862	701,901	623,757
Wastewater Treatment . .	—	1	*	—	4,714	19,648	12,662	13,060	13,070
Waste Combustion	0	950,397	892,397	151,259	169,145	220,212	258,960	288,326	366,496

*Less than 0.5 metric ton.

(R) = revised.

Source: Energy Information Administration, Form EIA-1605.

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.

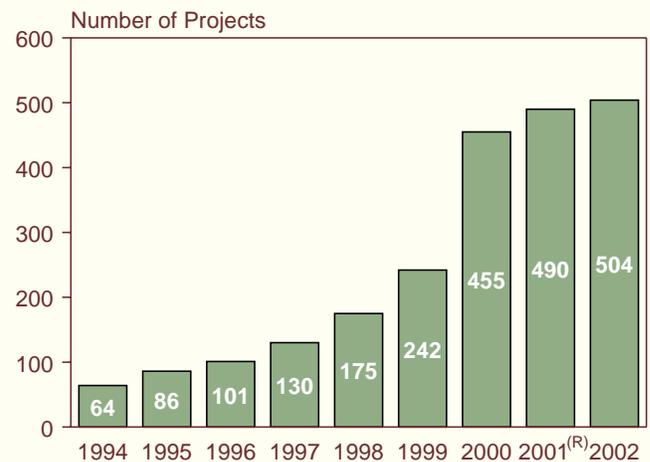
Reporting of materials management activities on Form EIA-1605 increased more than sevenfold from 1994 to 2002. A total of 504 projects were reported for 2002, 3 percent more than were reported for 2001 (see figure).

Landfill gas recovery accounted for most (77 percent) of the 504 materials management projects reported for 2002. In addition to 14 other methane emission

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

The emission reductions reported for materials management projects are shown in the table below. For 2002, 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 49.9 million metric tons carbon dioxide equivalent, representing 63 percent of the total indirect reductions reported. Most of the reductions (98 percent of the direct and 81 percent of the indirect reductions) are associated with methane avoidance activities discussed in this chapter.

Materials Management Projects Reported on Form EIA-1605, Data Years 1994-2002



Source: Energy Information Administration, Form EIA-1605.

Reported Emission Reductions from Materials Management Projects by Project Type and Type of Reduction, Data Year 2002
(Metric Tons Carbon Dioxide Equivalent)

Project Type	Number of Projects	Direct Reductions	Indirect Reductions
Biomass Burning	16	507,226	107,631
Methane Emission Avoidance			
Landfill Gas Recovery	390	56,776,317	15,833,637
Municipal Waste Combustion	6	-9,476,666	24,062,371
Wastewater Treatment	7	885,603	380,384
Agricultural Waste	1	180	1,489
Total	404	48,185,433	40,277,881
Halogenated Substances	18	1,578,631	127
Recycling and Source Reduction of Solid Waste . .	33	83,743	3,939,043
Coal Ash Reuse	33	0	5,579,042
Total	504	50,355,034	49,903,724

Source: Energy Information Administration, Form EIA-1605.

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 2002, 18 projects to reduce methane emissions from coal mines were reported on Form EIA-1605, with total direct emission reductions of 567,088 metric tons and indirect reductions of 96 metric tons methane (Table 19). Jim Walters Resources reported direct reductions of 129,551 metric tons methane from gob well degasification, and U.S. Steel Mining Company reported direct methane reductions of 116,750 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. Twenty-one such projects were reported for 2002, with total direct emission reductions of 230,066 metric tons methane. No indirect reductions were reported. Two of NIPSCO's Natural Gas STAR projects were responsible for 169,255 metric tons of direct

methane emission reductions, or 74 percent of the total for natural gas projects.

Reducing Emissions from Agriculture

Three projects reported for 2002 focused on reducing methane emissions from agricultural activities, but only two of them reported emission reductions. As the purchaser of the electricity from one project, FirstEnergy reported indirect methane emission reductions of 73 metric tons from Mason Dixon Farms. AES reported an indirect reduction of 919 metric tons methane from improving feed supplements for cattle in India and reducing emissions from enteric fermentation. The remaining project was a study on reducing emissions from rice cultivation, financed by Reliant Energy (formerly Houston Lighting and Power Company), for which reductions were not estimated.

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 is 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 more than 13-fold since 1994, with a particularly large increase in the number of projects associated with the LMOP. Of the 403 waste treatment and disposal projects reported to the Voluntary Reporting Program for 2002, 307 (76 percent) were associated with the LMOP (Table 20).

Table 19. Methane Emission Reductions from Natural Gas Systems and Coal Mining Reported on Form EIA-1605, Data Years 1994-2002
(Metric Tons Methane)

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

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

Table 20. Number of Reported Methane Reduction Projects Associated with Other Federal Voluntary Programs, Data Years 1994-2002

Voluntary Program	1994	1995	1996	1997	1998	1999	2000	2001^(R)	2002
Climate Challenge	22	27	32	36	34	39	42	34	34
Landfill Methane Outreach Program	6	8	29	32	90	116	309	359	307
Coalbed Methane Outreach Program	1	1	2	2	10	11	6	9	9
Natural Gas STAR	7	9	11	6	5	7	7	14	17
Other	0	6	2	2	1	3	4	5	6
Total.....	30	42	64	65	132	164	354	407	405

(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.

