Greenhouse Gas Reporting Program

Industrial Profile: Waste Sector

September 2019

CONTENTS

WASTE SECTOR

Highlights

All emissions presented here are as of 8/19/2018 and exclude biogenic carbon dioxide (CO_2), unless otherwise noted. All GHG emission data displayed in units of carbon dioxide equivalent (CO_2e) reflect the global warming potential (GWP) values from Table A-1 of 40 CFR 98, which are generally based on the Intergovernmental Panel on Climate Change's Fourth Assessment Report (IPCC AR4).

- The most prevalent greenhouse gas (GHG) emitted by the Waste Sector is methane (CH_4), and municipal solid waste (MSW) landfills are the largest emitter of CH_4 in this sector.

- Reported emissions from the Waste Sector have decreased from 2011 to 2017. Emissions in 2017 were 5.5% lower than in 2014, and 8.1% lower than in 2011. The decrease in emissions is primarily driven by MSW landfills. Methodological changes to the emission calculation procedures for MSW landfills were implemented in 2013 and 2016, and are a primary factor in these emission reductions.

- The three states with the most CH_4 emissions from MSW landfills (and across the Waste Sector) are Texas, California, and Florida. The three states with the largest number of MSW landfills are California, Texas, and Illinois.

- Seventy-four percent of the MSW landfills that reported have landfill gas collection and control systems (GCCSs), compared to less than 1% of industrial waste landfills.

Emissions from industrial waste landfills, industrial wastewater treatment, and solid waste combustion were lower in 2017 than in 2011, though the decrease during this timeframe was not constant for any of these subsectors.

About this Sector

The Waste Sector comprises MSW landfills, industrial waste landfills, industrial wastewater treatment systems, and solid waste combustion at waste-to-energy facilities.

- **MSW landfills** are landfills that dispose or have disposed of MSW. MSW includes, among other components, solid-phase household, commercial/retail, and institutional wastes. MSW landfills may also dispose of non-MSW wastes, including construction and demolition debris and other inert materials. This subsector excludes dedicated industrial, hazardous waste, and construction and demolition landfills. An MSW landfill comprises the landfill, the landfill GCCS, and combustion devices that are used to control landfill gas emissions.

- **Industrial waste landfills** are landfills that accept or have accepted primarily industrial wastes. This subsector excludes landfills that accept hazardous waste and those that receive only construction and demolition or other inert wastes. An industrial waste landfill includes the landfill, the landfill GCCS, and combustion devices that are used to control landfill gas emissions. Less than 1% of facilities reporting under this Subpart have landfill GCCSs. The organic composition of waste streams disposed of at industrial landfills tends to be similar over time, leading to a relatively consistent emission rate, while the waste streams at MSW landfills may fluctuate seasonally and/or annually.

- **Industrial wastewater treatment systems** comprise anaerobic lagoons, reactors, and anaerobic sludge digesters at facilities that perform pulp and paper manufacturing, food processing, ethanol production, and petroleum refining. This subsector does not include anaerobic processes used to treat wastewater and wastewater treatment sludge at other industrial facilities. It also does not include emissions from municipal wastewater treatment plants, separate treatment of sanitary wastewater at industrial facilities, oil and/or water separators, or aerobic and anoxic treatment of industrial wastewater.

- **Solid waste combustion at waste-to-energy facilities** comprise combustors and incinerators at facilities under North American Industry Classification System (NAICS) code 562213 that burn non-hazardous solid waste either to recover energy or to reduce the volume of waste.

Who Reports?

For Reporting Year (RY) 2017, 1,496 facilities in the Waste Sector reported emissions of 105.6 million metric tons (MMT) CO_2e. In 2017, the Waste Sector represented 3.6% of the facilities reporting direct emissions to the Greenhouse Gas Reporting Program (GHGRP) and 1.6% of total U.S. direct emissions.[1] Table 1 includes details of the applicability of each source category, their corresponding reporting schedules, and estimates of the percent of facilities and emissions covered by the GHGRP. Table 2 shows the number of GHGRP reporters by source category and year.

Table 1: Waste Sector – Reporting Schedule and GHGRP Coverage by Subpart (2017)

Subpart	Source Category	Applicability	First Reporting Year	Estimated % of Industry Facilities Covered	Estimated % of Industry Emissions Covered
HH	MSW landfills	Facilities that accepted waste after January 1, 1980, and that generate CH_4 that is equivalent to ≥ 25,000 metric tons (MT) CO_2e per year	2010	74%[a, b]	93.2%[c]
II	Industrial wastewater treatment	Facilities operating an anaerobic process to treat industrial wastewater and/or industrial wastewater treatment sludge, and meeting one of the following:			
		Petroleum refineries: Facilities subject to reporting under Subpart Y (Petroleum Refineries)[d]	2011	–	–
		Pulp and paper manufacturing: Facilities subject to reporting under Subpart AA (Pulp and Paper Manufacturing)		5%[e]	3.7%[f]
		Ethanol production: Facilities that emit ≥ 25,000 MT CO_2e per year		45%[e]	12.7%[f]
		Food processing facilities (as defined in Subpart II) that emit ≥ 25,000 MT CO_2e per year		1%[e]	38.8%[f]

1. Total U.S. GHG emissions for 2017 were 6,456.7 MMT CO_2e, as reported in the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2017. EPA 430-R-19-001. U.S. Environmental Protection Agency. Available: https://www.epa.gov/ghgemissions/overview-greenhouse-gases.6456.7.

Subpart	Source Category	Applicability	First Reporting Year	Estimated % of Industry Facilities Covered	Estimated % of Industry Emissions Covered
TT	Industrial waste landfills	Accepted waste after January 1, 1980; design capacity ≥ 300,000 MT and located at a facility that emits ≥ 25,000 MT CO_2e per year	2011	7.%[a, g]	51%[h]
C	Solid waste combustion	Facilities that reported only under Subpart C (Stationary Fuel Combustion) and reported NAICS code 562213 (Solid Waste Combustors and Incinerators) Such facilities that emit ≥ 25,000 MT CO_2e per year	2010	95%[i]	83%[j]

[a] Industry coverage estimates for MSW and industrial waste landfills are uncertain because the exact number of MSW and industrial waste landfills in the United States is not known.

[b] Estimate of the size of the industry is based on the Environmental Research and Education (EREF) Municipal Solid Waste Management in the U.S. 2010 & 2013 report published in 2016. Based on analysis of these data, an estimate of 1,540 MSW landfills is used here (the 2013 count).

[c] Estimate of total industry emissions is from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2017*. EPA 430-R-19-001. U.S. Environmental Protection Agency. Available: https://www.epa.gov/ghgemissions/overview-greenhouse-gases. Emissions were estimated to be 92.8 MMT CO_2e.

[d] No petroleum refineries reported industrial wastewater emissions.

[e] Number of facilities covered by the GHGRP for this subsector were determined using the 2007 U.S. economic census (food processing), the Renewable Fuel Association's list of facilities from January 2013 (ethanol), and the U.S. Environmental Protection Agency's (EPA's) Office of Air Quality Planning and Standards Information Collection Requests conducted in 2011 for purposes of the National Emission Standards for Hazardous Air Pollutants for pulp and paper, along with GHGRP data as of February 2016.

[f] Emissions covered by the GHGRP were calculated using the U.S. GHG Inventory values for industrial wastewater(*Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2017*. EPA 430-R-19-001. U.S. Environmental Protection Agency. Available: https://www.epa.gov/ghgemissions/overview-greenhouse-gases) and RY 2017 emissions for Subpart II.

[g] Estimated size of the industry based on 2,322 industrial waste landfills in the 1988 Report to Congress: Solid Waste Disposal in the United States (U.S. EPA, 1988) for the year 1985. While the data from this report are from over 25 years ago, it is the only comprehensive, published data source available on industrial waste landfills in the United States.

[h] Estimated size of industry emissions based on the industrial waste landfill emissions estimates from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2017*. EPA 430-R-19-001. U.S. Environmental Protection Agency. Available: https://www.epa.gov/ghgemissions/overview-greenhouse-gases. These emission estimates are based on nationwide estimated amounts of annual waste generation and are not facility-specific emission estimates.

[i] 64 GHGRP facilities were classified as meeting the criteria for the Solid Waste Combustion subsector in 2015. MSW combustion also takes place at facilities classified under the MSW Landfill subsector and Power Plant sector. According to data provided by the Energy Recovery Council (ERC) (http://energyrecoverycouncil.org/wp-content/uploads/2016/06/ERC-2016-directory.pdf), there were 77 operating waste-to-energy facilities in the U.S. in 2016, with one starting operation in 2015. Three additional waste-to-energy facilities operated in 2015 but ceased operation in 2016 and were not included in ERC's 2016 directory. In total, 79 facilities were assumed to be operating in 2015; 64 reported to the GHGRP for 2015 and are classified under the Solid Waste Combustion source category, 6 were classified under the Power Plant sector, and 5 were classified under the MSW Landfill source category. Three facilities in the ERC do not report to the GHGRP, and one facility reported waste combustion under subpart D (electricity generation) rather than subpart C (stationary combustion).

[j] Estimate of total U.S. solid waste combustion emissions is from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017*. EPA 430-R-19-001. U.S. Environmental Protection Agency. Available: https://www.epa.gov/ghgemissions/overview-greenhouse-gases. Emissions were estimated to be 11.1 MMT CO_2e.

Table 2: Waste Sector – Number of Reporters (2011–2017)[a]

Source Category	Number of Reporters						
	2011	2012	2013	2014	2015	2016	2017
Total Waste Sector	**1,645**	**1,652**	**1,636**	**1,629**	**1,545**	**1,509**	**1,496**
MSW landfills	1,240	1,252	1,240	1,237	1,166	1,142	1,134
Industrial wastewater treatment	169	162	159	154	148	140	137
Industrial waste landfills	176	176	176	178	174	171	171
Solid waste combustion	68	69	68	67	64	63	61

[a] The total number of reporters may be less than the sum of the number of reporters in each individual source category because some facilities contain more than one source category.

MSW landfills made up the majority of Waste Sector reporters for all reporting years. The number of reporters for MSW landfills decreased by 118 facilities between 2012 and 2017, after increasing slightly from 2011 to 2012. This decrease is a result of facilities that qualified to discontinue reporting (off-ramping from the program).[2] Between 2011 and 2017, the number of reporters for industrial wastewater treatment decreased by 32. The number of reporters for industrial waste landfills had a net decrease of five facilities from 2011 to 2017, with a one-time slight increase in reporters in 2014. The number of solid waste combustion facilities decreased by seven facilities from 2011 to 2017.

Reported Emissions

CH_4 is the primary GHG reported by MSW landfills, industrial waste landfills, and industrial wastewater treatment facilities. CH_4 is generated by the anaerobic decomposition of organic waste in landfills and in anaerobic wastewater treatment systems. Landfill gas typically contains approximately 50% CH_4, 50% CO_2, and less than 1% non-CH_4 organic compounds. Industrial wastewater treatment gas contains about 65--70% CH_4, 25–30% CO_2, and small amounts of N_2, H_2, and other gases. Table 3 shows the reported emissions by subsector by year. Figure 1 shows the breakdown of emissions by subsector in RY 2017. The emissions presented in Table 3 also include CO_2, CH_4, and nitrous oxide (N_2O) from stationary fuel combustion units that are located at the Waste Sector facilities that reported.

Table 3: Waste Sector – Emissions by Subsector (2011–2017)

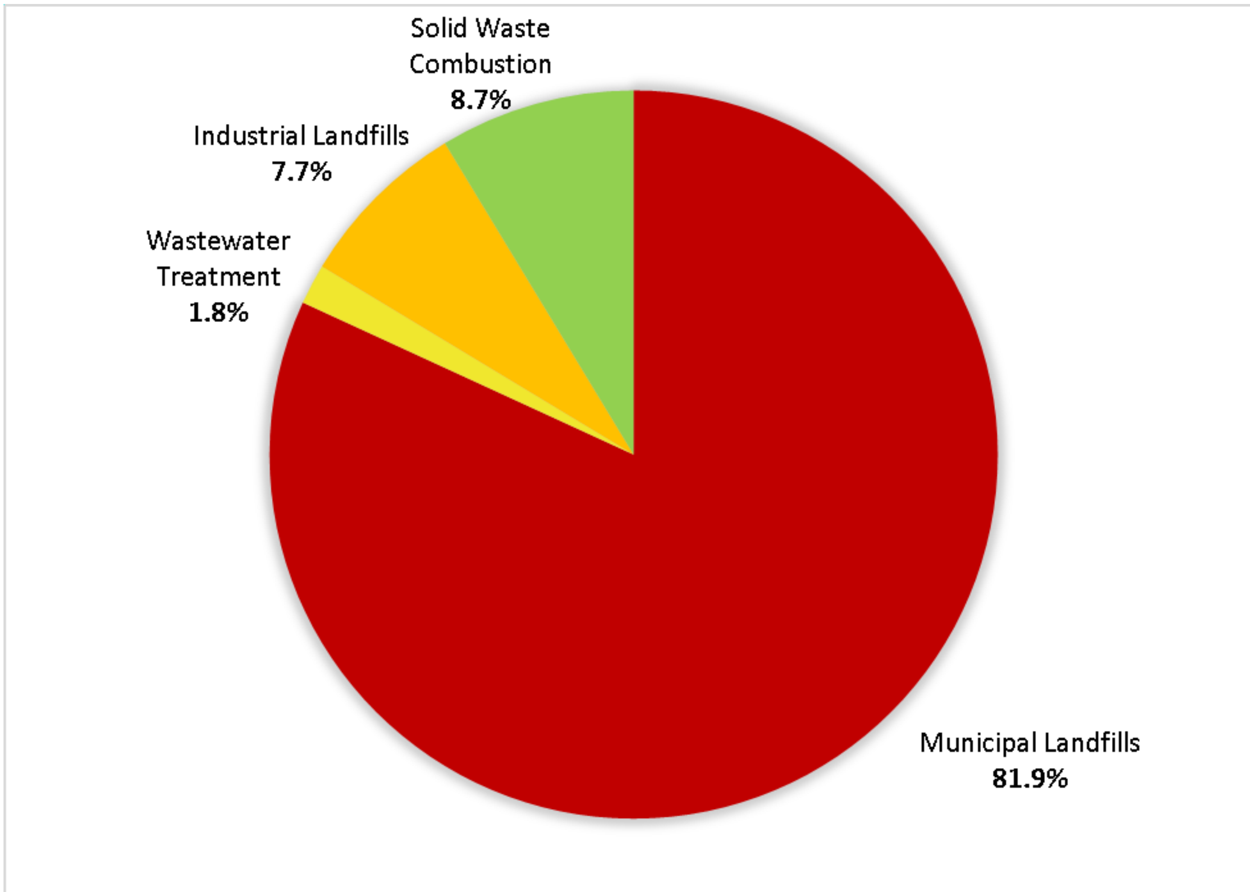
Waste Sector	Emissions (MMT CO_2e)[a, b]						
	2011	2012	2013	2014	2015	2016	2017
Total Waste Sector	**114.9**	**115.0**	**111.2**	**111.8**	**110.3**	**107.6**	**105.6**
MSW landfills	93.8	94.4	91.1	90.8	89.7	86.9	86.5
Industrial wastewater treatment	2.6	2.1	2.2	2.6	2.1	1.9	1.9
Industrial waste landfills	8.9	8.7	8.0	8.5	8.5	8.6	8.1
Solid waste combustion	9.6	9.8	10.0	9.9	10.1	10.2	9.2

[a] Biogenic emissions of CO_2 are not included in the CO_2e emissions in this table. As landfill gas recovered from MSW landfills and industrial waste landfills is considered biogenic, CO_2 emissions from the combustion of landfill gas are not included in the CO_2e emissions in this table. Biogenic CO_2 emissions from the combustion of the biogenic fraction of MSW are also not included in the CO_2e emissions in this table.

[b] Totals may not sum due to independent rounding.

[2] See FAQ: When is a Facility Eligible to Stop Reporting? Available: http://www.ccdsupport.com/confluence/pages/viewpage.action?pageId=243139271.

FIGURE 1: 2017 TOTAL REPORTED EMISSIONS FROM WASTE, BY SUBSECTOR



Biogenic CO_2 emissions result primarily from the combustion of landfill gas, MSW, and other biogenic fuels in reciprocating internal engines, municipal waste combustors, and other combustion units. As shown in Table 4, emissions of biogenic CO_2 at Waste Sector facilities decreased by 1.1 MMT from 18.8 MMT in 2011 to 17.7 MMT in 2017.

Table 4: Waste Sector – Biogenic CO_2 Emissions (2011–2017)

Waste Sector	Biogenic CO_2 Emissions (MMT CO_2)[a]						
	2011	2012	2013	2014	2015	2016	2017
Total biogenic CO_2 emissions	**18.8**	**18.5**	**18.2**	**17.8**	**17.6**	**17.5**	**17.7**
MSW landfills	4.1	4.1	3.9	3.8	3.9	4.0	4.0
Solid waste combustion	14.7	14.4	14.3	14.0	13.7	13.5	13.6

[a] Totals may not sum due to independent rounding.

Figure 1 illustrates the reported non-biogenic emissions by subsector. Figures 2 through 6 show the location and range of emissions in the contiguous United States for the entire Waste Sector (Figure 2) and each subsector individually (Figures 3 through 6). Sizes of each circle correspond to a specified range of emissions in MT of CO_2e reported by that particular facility. Many large industrial waste landfills are in southeastern states and along the coastline of the Gulf of Mexico, which is also where numerous petroleum refineries, pulp and paper, and chemical manufacturing facilities are located. Locations of industrial wastewater treatment facilities are driven primarily by the location of ethanol facilities, which account for more than half of all industrial wastewater treatment reporters and tend to be in the Midwest. Seventy-seven percent of solid waste combustors are in the northeastern states and in Florida, and the remaining facilities are in the Midwest and western states (Figure 7).

Readers can identify the largest emitting facilities by visiting the Facility Level Information on Greenhouse Gases Tool (FLIGHT) website (https://ghgdata.epa.gov/ghgp/main.do#).

FIGURE 2: WASTE SECTOR EMISSIONS BY RANGE AND LOCATION (2017)

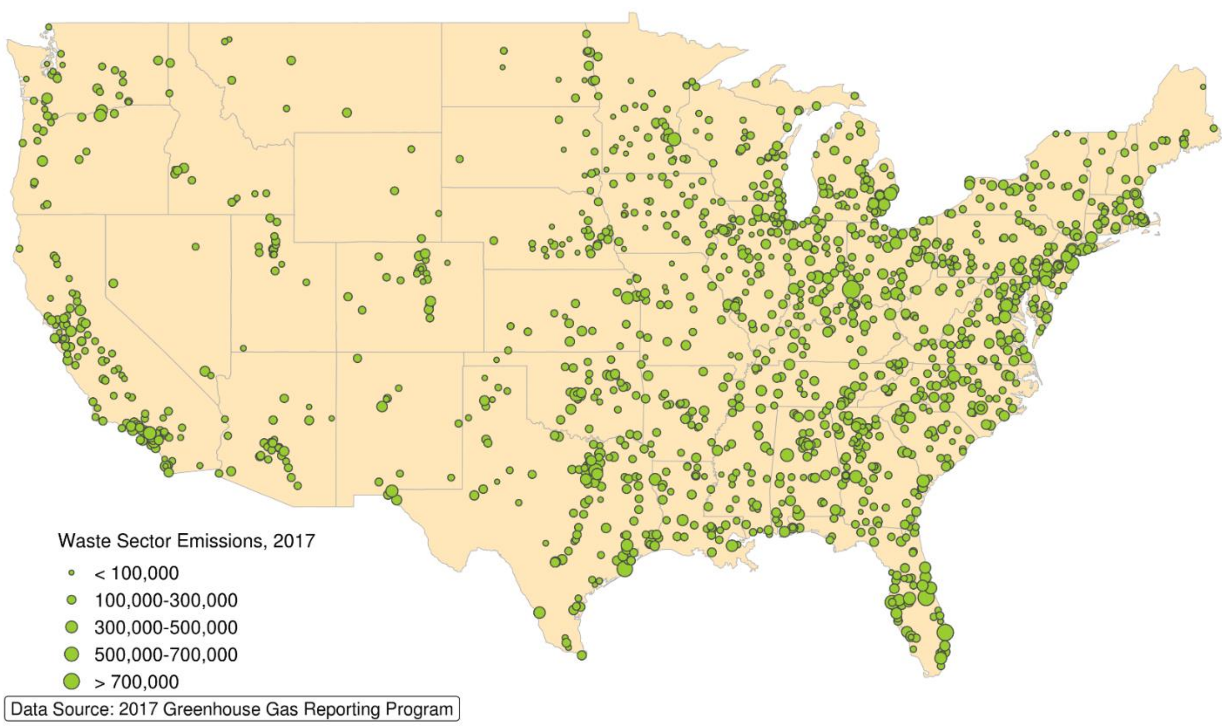


FIGURE 3: MSW LANDFILL SUBSECTOR EMISSIONS BY RANGE AND LOCATION (2017)

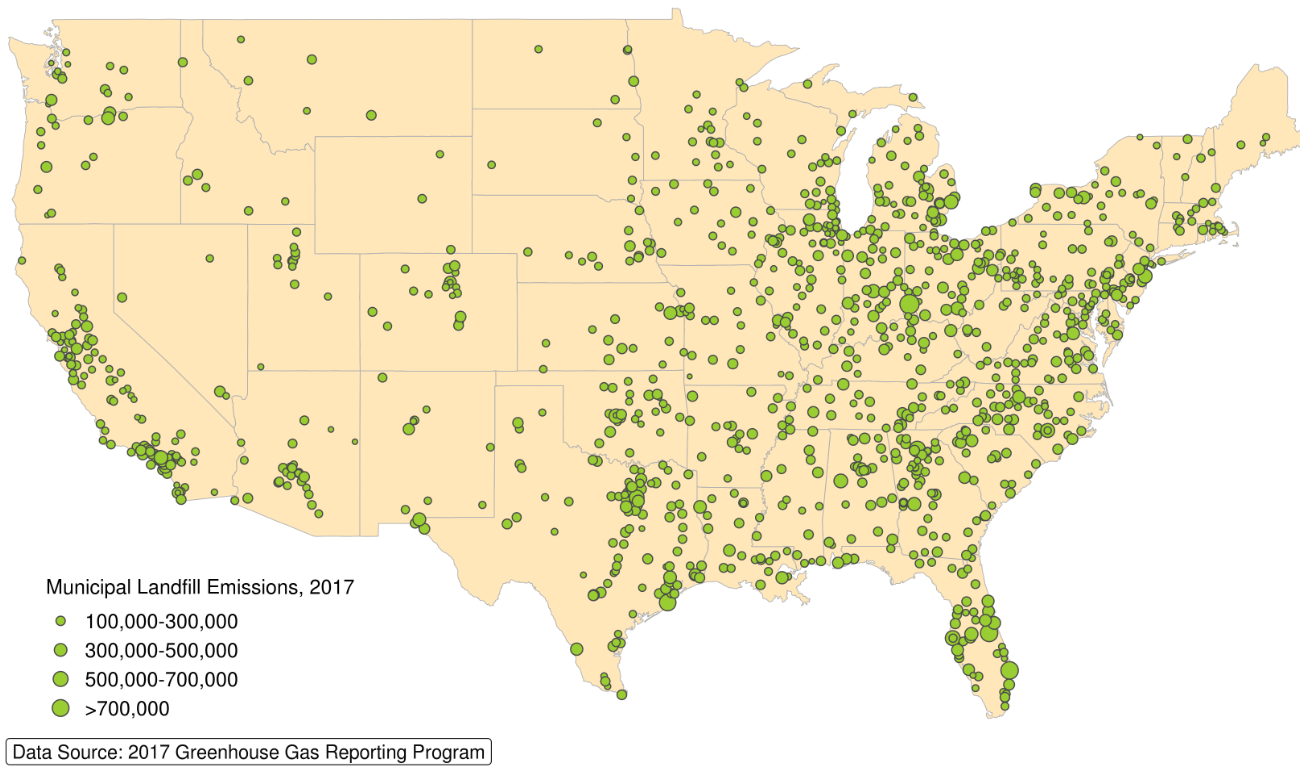


FIGURE 4: INDUSTRIAL WASTEWATER TREATMENT SUBSECTOR EMISSIONS BY RANGE AND LOCATION (2017)

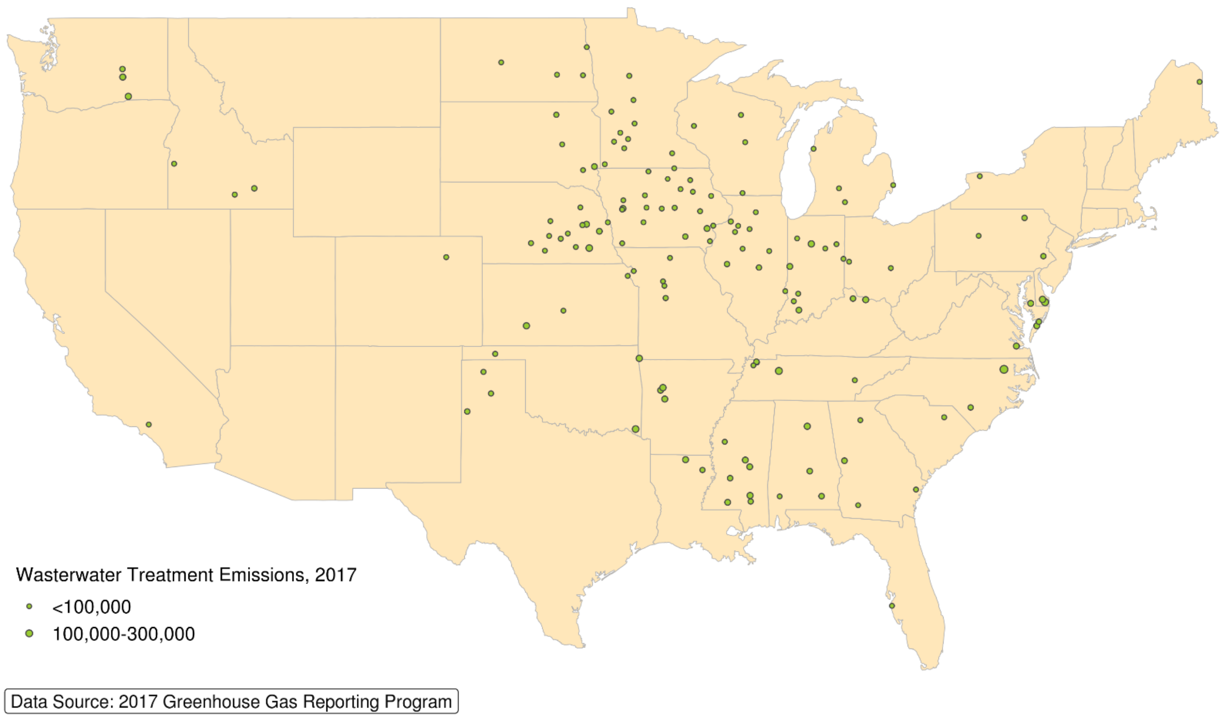


FIGURE 5: INDUSTRIAL WASTE LANDFILL SUBSECTOR EMISSIONS BY RANGE AND LOCATION (2017)

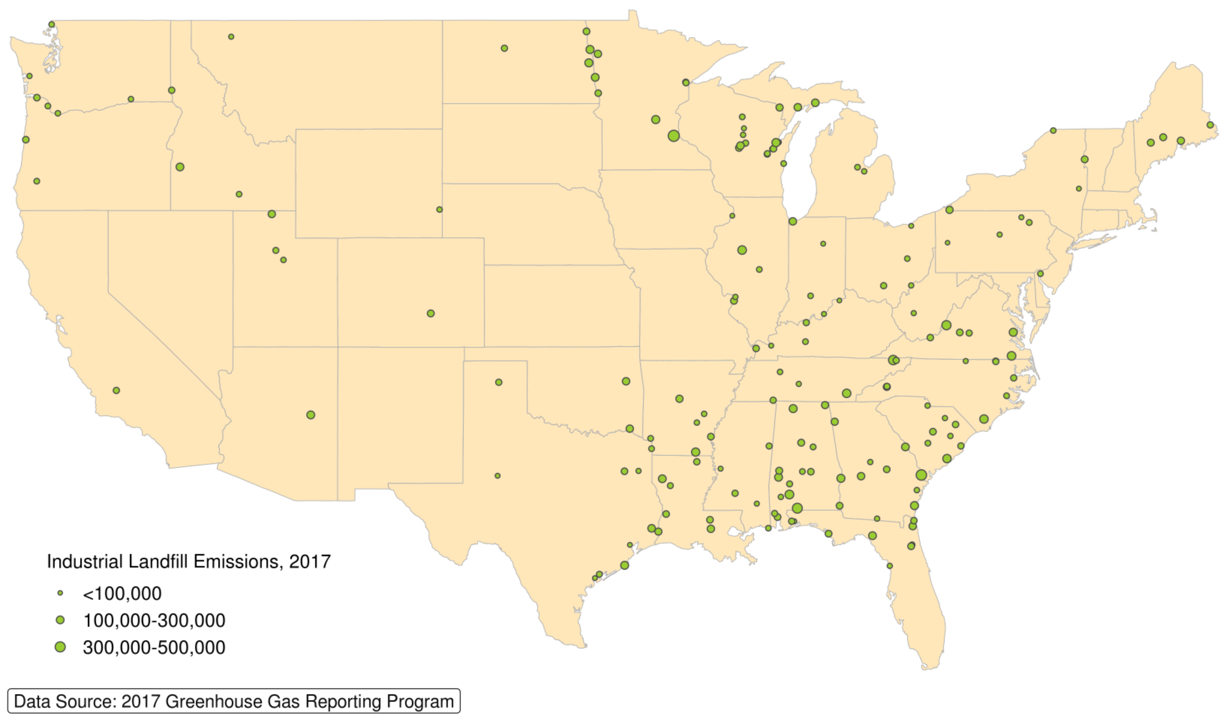
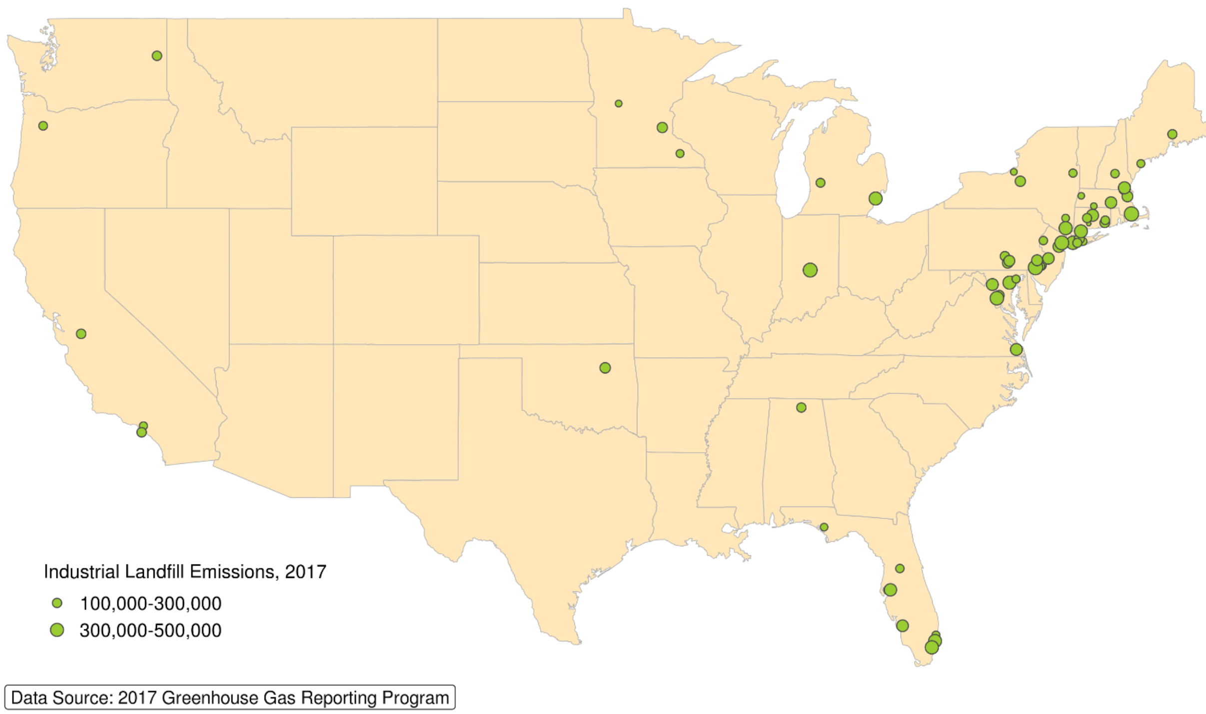


FIGURE 6: SOLID WASTE COMBUSTION SUBSECTOR EMISSIONS BY RANGE AND LOCATION (2017)

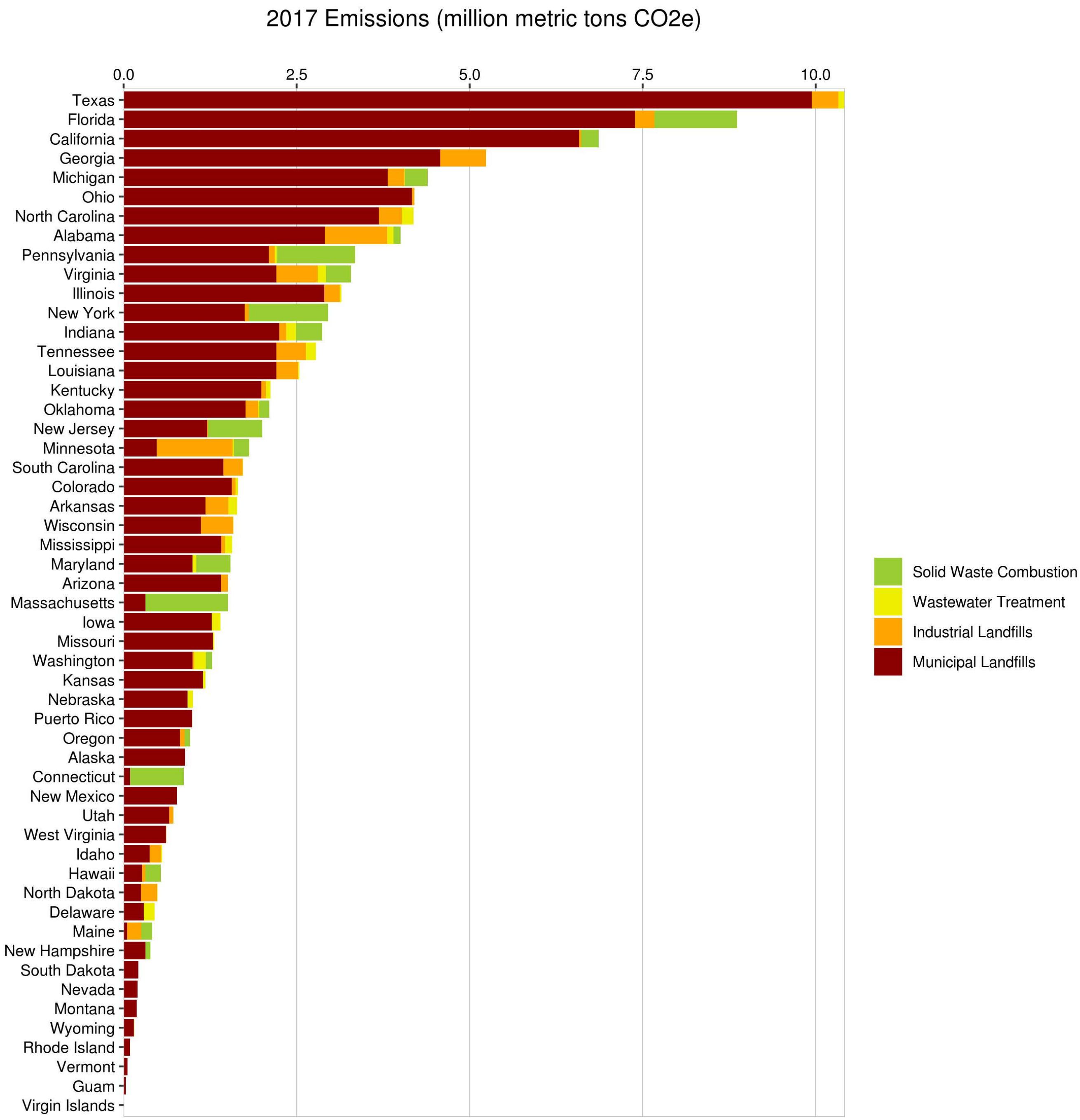


Waste Sector: Emissions Trends, 2011 to 2017

Reported emissions from the Waste Sector have decreased slightly from 114.9 MMT CO_2e in 2011 to 105.6 MMT CO_2e in 2017, a decrease of 8 %. Reported emissions peaked in 2012 at 115.0 MMT CO_2e and then generally decreased through 2017. The largest decrease in emissions (3.3%) occurred between 2012 and 2013. Over 80% of reported emissions from the Waste Sector were reported by MSW landfills in 2017. Changes in MSW landfill emissions were the most important driver of emission trends in the Waste Sector. Figure 8 shows annual reported direct emissions from 2011 to 2017 by subsector.

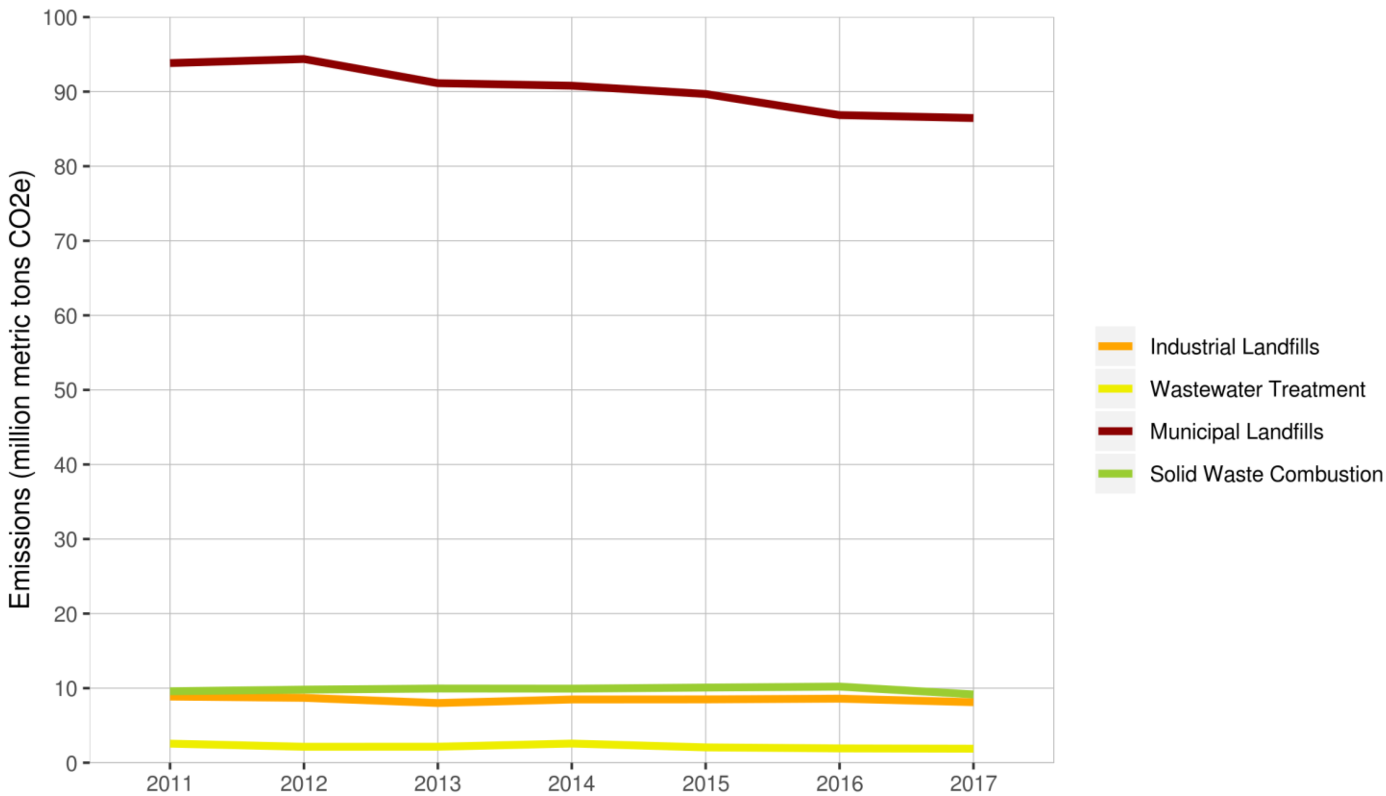
MSW Landfills. Emissions from MSW landfills decreased from 94.4 MMT CO_2e in 2012 to 86.5 MMT CO_2e in 2017. The decrease in emissions from 2012 to 2013 may have been driven by methodological changes in the rule for calculating CH_4 emissions from MSW landfills – in particular, the allowance for facilities to use higher oxidation fractions in their emission calculations, resulting in lower emission values. In 2013, approximately 45% of facilities used these higher oxidation fractions. The number of reporting facilities also had an impact on total reported emissions because it peaked in 2012 and decreased in the years afterward. Of the facilities that stopped reporting, 29 qualified to stop reporting in 2013, 23 qualified to stop reporting in 2014, and 77 qualified to stop reporting in 2015. For these years some landfills began reporting to the GHGRP for the first time, but in each year the number of reporters decreased.

FIGURE 7: DIRECT EMISSIONS BY STATE FROM THE WASTE SECTOR (2017)[a]



[a] Represents total emissions reported to the GHGRP in these industries. Additional emissions may occur at facilities that have not reported (e.g., those below the 25,000 MT CO_2e reporting threshold for industries where the threshold applies). Click here to view the most current information using FLIGHT.

FIGURE 8: ANNUAL REPORTED DIRECT EMISSIONS FROM THE WASTE SECTOR, BY SUBSECTOR (2011 2017)



Industrial Waste Landfills. Reported emissions from industrial waste landfills decreased by 0.7 MMT CO_2e from 2012 to 2013, an 8% decrease. This decrease in emissions may have been driven, in part, by the same methodological change for calculating CH_4 emissions related to oxidation fractions that occurred for MSW landfills. In 2013, approximately 10% of industrial waste landfills used the higher oxidation fractions. Since 2013, emissions from industrial waste landfills increased by 6% from 2013 to 2014 before decreasing by 6% from 2016 to 2017. The latter decrease was driven by revisions that became effective with RY 2017, such that a facility would now be able to further delineate its pulp and paper waste and apply waste stream-specific degradable organic carbon (DOC) content and k values. The revision particularly impacted industrial landfills collecting large amounts of near-inert waste streams (e.g., boiler ash), whose DOC and k values are significantly lower than the previous pulp and paper waste default.

Table 5 shows the emissions by GHG emitted. Table 6 breaks down emissions by Waste Sector processes and fuel combustion. Table 7 breaks down combustion emissions by fuel type.

Table 5: Waste Sector – Emissions by GHG (MMT CO_2e)[a]

Waste Sector	Reporting Year						
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Number of facilities	1,645	1,652	1,636	1,629	1,545	1,509	1,496
Total emissions (MMT CO_2e)	114.9	115.0	111.2	111.8	110.3	107.6	105.6
Emissions by GHG							
CO_2							
MSW landfills[b]	1.0	1.0	1.1	1.2	1.3	1.4	1.4
Solid waste combustion	9.1	9.3	9.4	9.4	9.6	9.7	8.7
CH_4							
MSW landfills	92.8	93.4	90.0	89.6	88.4	85.4	85.0
Solid waste combustion	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Industrial waste landfills	8.9	8.7	8.0	8.5	8.5	8.6	8.1
Industrial wastewater treatment	2.6	2.1	2.2	2.6	2.1	1.9	1.9
N_2O							
MSW landfills[b]	**	**	**	**	**	**	**
Solid waste combustion	0.4	0.4	0.4	0.4	0.4	0.4	0.3

[a] Totals may not sum due to independent rounding.

[b] Emissions shown for CO_2 and N_2O result from the combustion of fossil fuels and the non-biogenic portion of MSW that is combusted.

** Total reported emissions are less than 0.05 MMT CO_2e.

Table 6: Waste Sector – Emissions from Waste Sector Processes and Fuel Combustion

Waste Sector	Emissions (MMT CO_2e)[a, b, c]						
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total Waste Sector	**114.9**	**115.0**	**111.2**	**111.8**	**110.3**	**107.6**	**105.6**
MSW landfills	**93.8**	**94.4**	**91.1**	**90.8**	**89.7**	**86.9**	**86.5**
Fuel combustion	1.1	1.0	1.2	1.2	1.3	1.5	1.4
Waste Sector processes	92.7	93.3	90.0	89.6	88.4	85.4	85.0
Industrial wastewater treatment	**2.6**	**2.1**	**2.2**	**2.6**	**2.1**	**1.9**	**1.9**
Waste Sector processes	2.6	2.1	2.2	2.6	2.1	1.9	1.9
Industrial waste landfills	**8.9**	**8.7**	**8.0**	**8.5**	**8.5**	**8.6**	**8.1**
Waste Sector processes	8.9	8.7	8.0	8.5	8.5	8.6	8.1
Solid waste combustion	**9.6**	**9.8**	**10.0**	**9.9**	**10.1**	**10.2**	**9.2**
Fuel combustion	9.6	9.8	10.0	9.9	10.1	10.2	9.2

[a] These values represent total emissions reported to the GHGRP in these industry sectors. Additional emissions may occur at facilities that have not reported (e.g., those below the reporting threshold).

[b] Totals may not sum due to independent rounding.

[c] Emissions from fuel combustion are defined here as emissions reported under Subpart C.

Table 7: Waste Sector – Combustion Emissions by Fuel Type

Fuel Type	Emissions (MMT CO_2e)[a, b, c]						
	2011	2012	2013	2014	2015	2016	2017
MSW landfills	**1.1**	**1.0**	**1.2**	**1.2**	**1.3**	**1.5**	**1.4**
Coal	0	0	0.1	0.1	0.1	0.1	**
Natural gas	0.4	0.4	0.3	0.3	0.3	0.3	0.3
Petroleum products	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Other fuels[a]	0.5	0.5	0.6	0.7	0.8	1.0	1.0
Solid waste combustion	**9.6**	**9.8**	**10.0**	**9.9**	**10.1**	**10.2**	**9.2**
Natural gas	0.2	0.2	0.1	0.1	0.2	0.1	0.2
Petroleum products	0.1	0.1	**	**	0.1	0.1	0.1
Other fuels[a]	9.5	9.6	9.8	9.7	9.6	9.8	8.8

[a] Excludes biogenic CO_2.

[b] Totals may not sum due to independent rounding.

[c] In cases where CO_2 emissions were reported at the unit level [i.e., Continuous Emissions Monitoring System (CEMS) monitored sources], fuel-level CO_2 emissions were estimated by the EPA based on other data directly reported by facilities, as well as default emission factors. Fuel-level emission values presented may differ slightly from other publicly available GHGRP data due to minor differences in the calculation methodology.

** Total reported emissions are less than 0.05 MMT CO_2e.

Figure 9 shows the average emissions per reporter from the waste subsectors compared with average emissions from all GHGRP reporters. Figure 10 and Table 8 show the percentage and number of reporters within each emission range, respectively.

FIGURE 9: AVERAGE EMISSIONS PER REPORTER FROM THE WASTE SECTOR (2017)

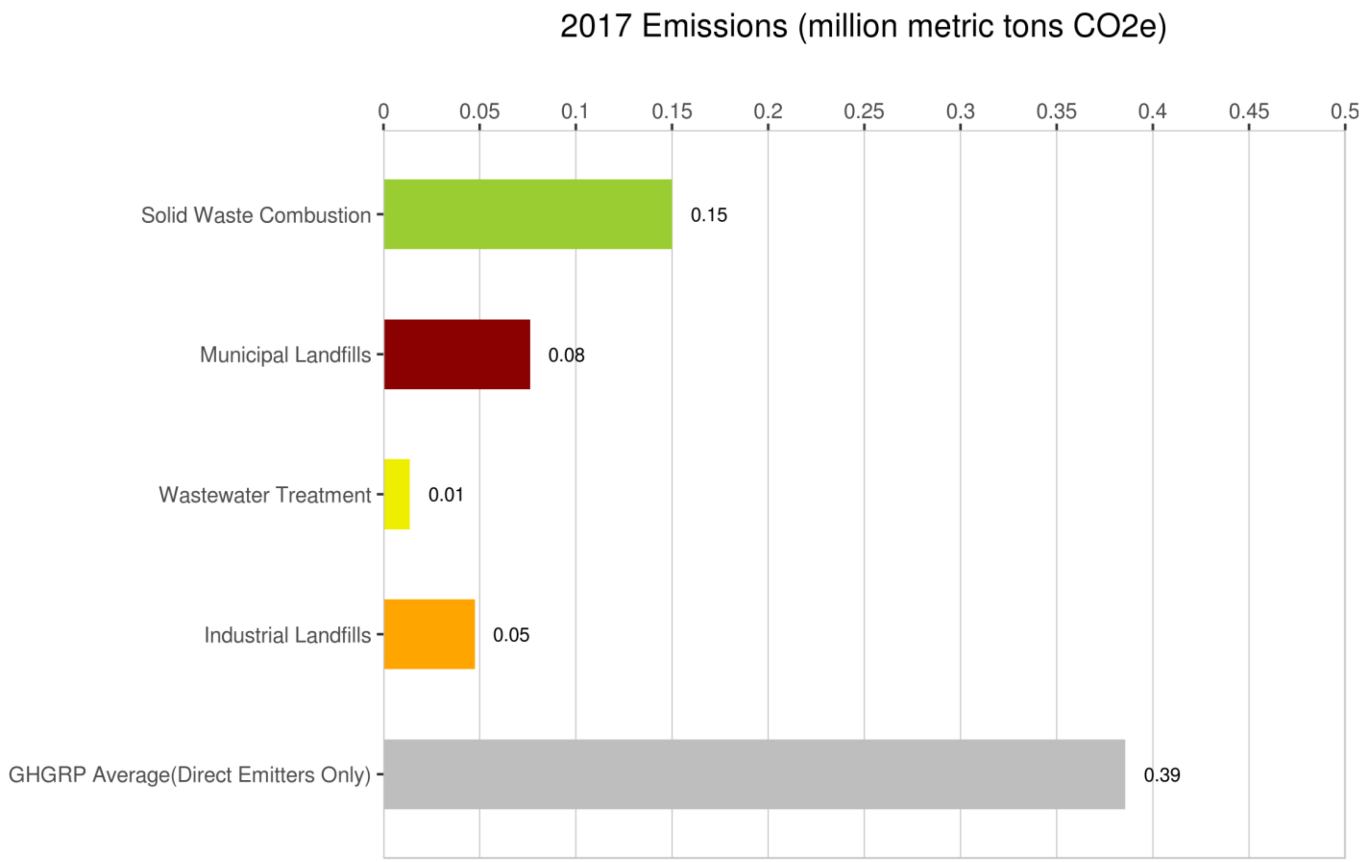


FIGURE 10: PERCENTAGE OF FACILITIES IN THE WASTE SECTOR AT VARIOUS EMISSION RANGES (2017)

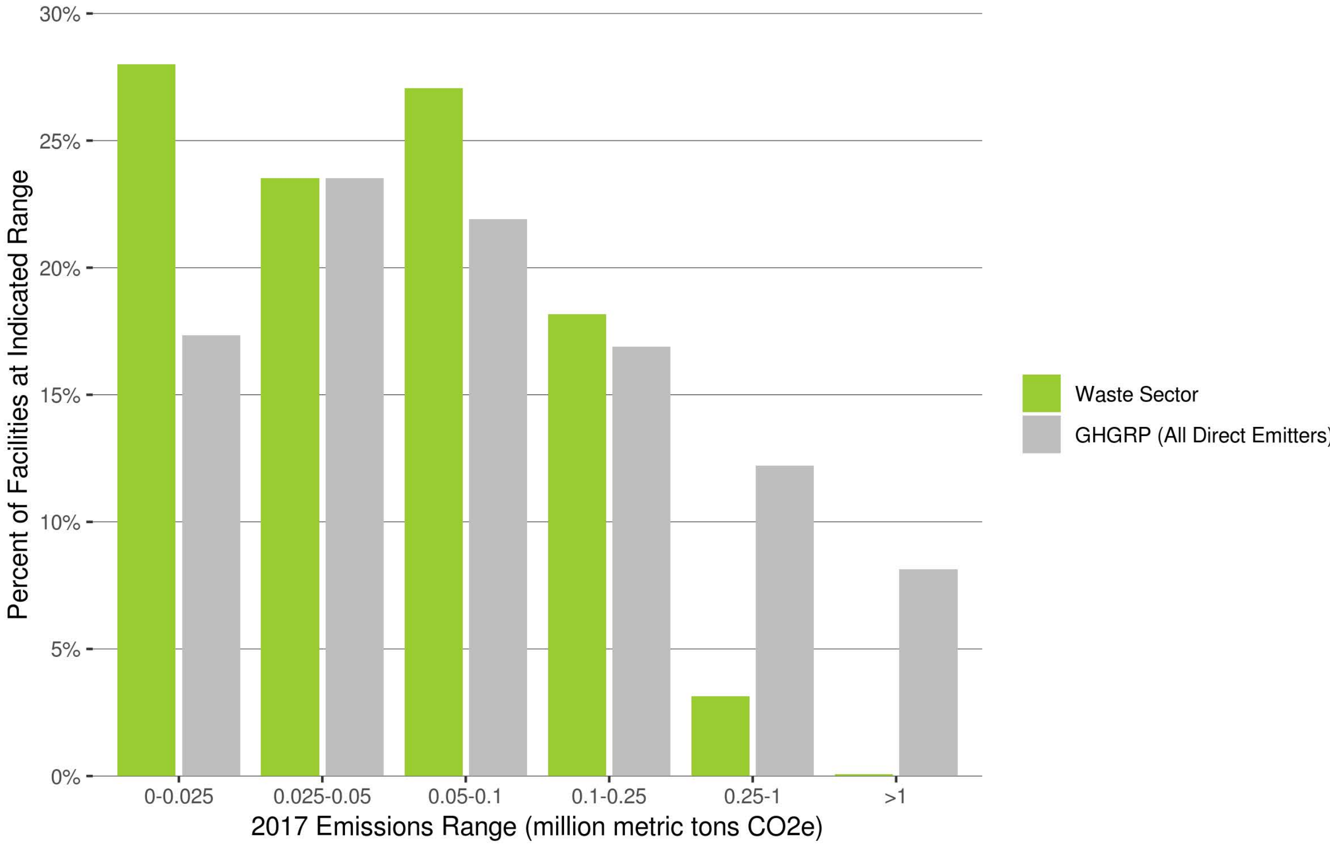


Table 8: Waste Sector – Number of Reporters by Emissions Range (2017)

Waste Sector	Number of Facilities within Emissions Range (MMT CO_2e)[a]					
	0–0.025	**0.025–0.05**	**0.05–0.1**	**0.1–0.25**	**0.25–1**	**> 1**
Total Waste Sector	**419**	**352**	**405**	**272**	**47**	**1**
Industrial landfills	79	39	28	24	1	0
Municipal landfills	236	291	353	219	34	1
Solid waste combustion	0	8	15	26	12	0
Wastewater treatment	111	15	8	3	0	0

[a] Within this table, the total number of facilities shown in the Total Waste Sector row represents the number of unique facilities. The totals in this row may not equal the sum of the rows below due to facilities reporting under multiple industry types.

Table 9 shows the characteristics of MSW landfills in 2017, and Table 10 shows emissions by type of MSW landfill.

MSW Landfill Details

Table 9: Characteristics of MSW Landfills in 2017

Operational Characteristic	2011	2012	2013	2014	2015	2016	2017
Number of reporting facilities	**1,240**	**1,252**	**1,240**	**1,237**	**1,166**	**1,142**	**1,134**
Number of open landfills	958	964	968	969	943	937	939
Number of closed landfills	282	288	272	268	223	205	195
Number of landfills with gas collection	915	926	926	923	863	848	843
Number of landfills without gas collection	325	326	314	314	303	294	291

Facilities are required to report under Subpart HH if their CH_4 generation value meets or exceeds 25,000 MT of CO_2e. However, these facilities can cease reporting if their emissions are under 25,000 MT CO_2e for five consecutive years, or under 15,000 MT CO_2e for three consecutive years. Nearly 40% of the facilities in 2017 that have ceased reporting in 2016 under Subpart HH are closed landfills with a gas collection system in place.

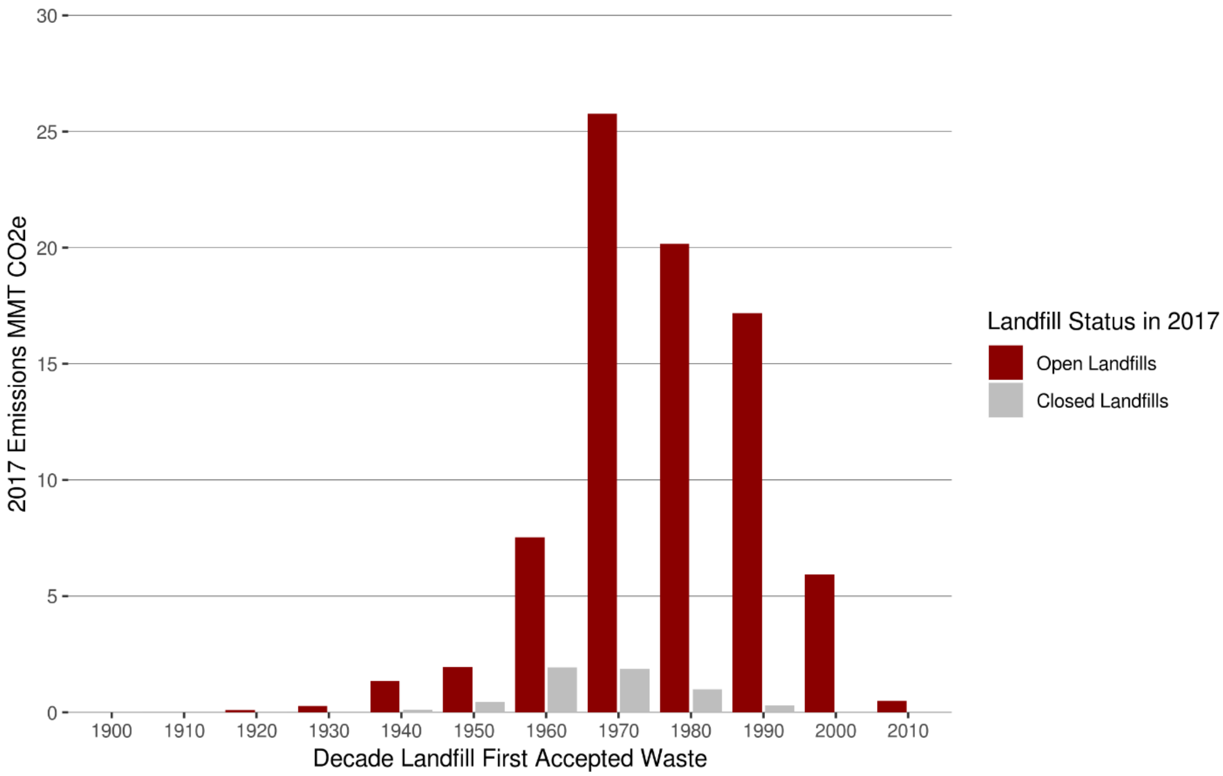
Table 10: CH_4 Emissions by Type of MSW Landfill in 2011–2017 (MMT CO_2e)

Operational Characteristic	2011	2012	2013	2014	2015	2016	2017
Total emissions[a]	**93.8**	**94.4**	**91.1**	**90.8**	**89.7**	**86.9**	**86.5**
Emissions for open landfills	84.5	85.1	82.6	82.4	81.9	80.1	80.8
Emissions for closed landfills	9.3	9.3	8.5	8.4	7.7	6.8	5.7
Emissions for landfills with gas collection	70.1	70.9	69.2	69.1	68.1	65.7	66.2
Emissions for landfills without gas collection	23.6	23.5	21.9	21.7	21.6	21.1	20.2

[a] Totals may not sum due to independent rounding.

Figure 11 displays total CH_4 emissions (in MMT CO_2e) and the operational status of the landfill (i.e., open and closed) in 2017, grouped by the decade the landfill first accepted waste. The Waste Sector is unique because emissions in the current RY are heavily impacted by the quantity of waste already in place at the landfills and the age of that waste (i.e., the year, or decade in this case, that the waste was first disposed of in the landfill). Figure 11 shows that most emissions in the current RY result from landfills that first accepted waste between the 1970s and 1990s, and are still open in 2017. The largest number of reporting landfills first opened and started accepting waste in the 1970s. More than 300 of these landfills still accept waste in 2017, which explains why the 1970s-era landfills contributed the most to current CH_4 emissions.

FIGURE 11: MSW LANDFILL EMISSIONS (2017)



Tables 11 through 13 show details of the industrial wastewater subsector. Table 11 shows characteristics of the subsector from 2011 to 2017. Table 12 lists CH_4 emissions from 2011 to 2017, grouped by processes with and without biogas recovery. Table 13 shows facility counts and emissions by NAICS codes. Tables 14 and 15 show additional details on the industrial landfills subsector.

Industrial Wastewater Treatment Details

Table 11: Characteristics of Industrial Wastewater Treatment in 2011–2017[a]

Data	2011	2012	2013	2014	2015	2016	2017
Number of processes with biogas recovery	161	130	136	130	121	116	113
Number of processes without biogas recovery	50	50	57	56	57	54	56
Number of lagoons	81	81	90	88	86	81	84
Number of reactors	124	93	100	93	86	82	75
Number of digesters[b]	6	6	3	5	6	7	10

[a] Facilities that report industrial wastewater treatment may report more than one industrial wastewater treatment process (lagoon, reactor, or digester) at their facility.

[b] Assumes that all digesters for industrial wastewater treatment plants have biogas recovery.

Table 12: CH_4 Emissions from Industrial Wastewater Treatment in 2011–2017 (MMT CO_2e)

Emission Type[a]	2011[c]	2012[c]	2013	2014	2015	2016	2017
Total Emissions[b]	**2.6**	**2.1**	**2.2**	**2.6**	**2.1**	**1.9**	**1.9**
Emissions from processes with biogas recovery	0.9	0.5	0.4	0.5	0.3	0.3	0.3
Emissions from processes without biogas recovery	1.7	1.7	1.7	2.1	1.8	1.7	1.6

[a] Subpart II does not account for facilities where the wastewater treatment is not co-located with the industrial facility or digesters without biogas recovery, which may result in underestimated emissions.

[b] Totals may not sum due to independent rounding.
[c] Data from 2011 and 2012 represent data as of 1/10/2017.

Table 13: Major NAICS Codes and Emissions for Industrial Wastewater Treatment in 2017

Major NAICS Code	Industry	Facility Count	Facility Percent	Emissions (MMT CO_2e)	Emission Percent
3114	Fruits and vegetables	14	10%	0.12	6%
3116, 112340	Meat and poultry	55	40%	1.51	80%
221112, 311221, 311222, 312120, 312140, 325193, 325199	Ethanol	58	42%	0.03	2%
322110, 322121, 322130	Pulp and paper	10	7%	0.23	12%
Total		**137**	**100%**	**1.89**	**100%**

Industrial Waste Landfill Details

Table 14: Characteristics of Industrial Waste Landfills in 2011–2017

Data	2011	2012	2013	2014	2015	2016	2017
Number of reporting landfills	**176**	**176**	**176**	**178**	**174**	**171**	**171**
Number of open landfills	144	142	140	143	141	140	139
Number of closed landfills	32	34	36	35	33	31	32
Number of landfills with gas collection	2	2	2	2	1	1	1
Number of landfills without gas collection	174	174	174	176	173	170	170

Table 15: CH_4 Emissions for Industrial Waste Landfills in 2011–2017 (MMT CO_2e)[a]

Data	2011	2012	2013	2014	2015	2016	2017
Total emissions	**8.9**	**8.7**	**8.0**	**8.5**	**8.5**	**8.6**	**8.1**
Total emissions for open landfills	8.1	8.0	7.4	7.9	7.9	8.0	7.5
Total emissions for closed landfills	0.8	0.7	0.7	0.6	0.6	0.5	0.6
Total emissions for landfills with gas collection	0.4	0.4	0.4	0.5	0.3	0.3	0.2
Total emissions for landfills without gas collection	8.5	8.3	7.6	8.0	8.2	8.3	7.9

[a] Totals may not sum due to independent rounding.

FIGURE 12: INDUSTRIAL WASTE LANDFILL EMISSIONS (2017)

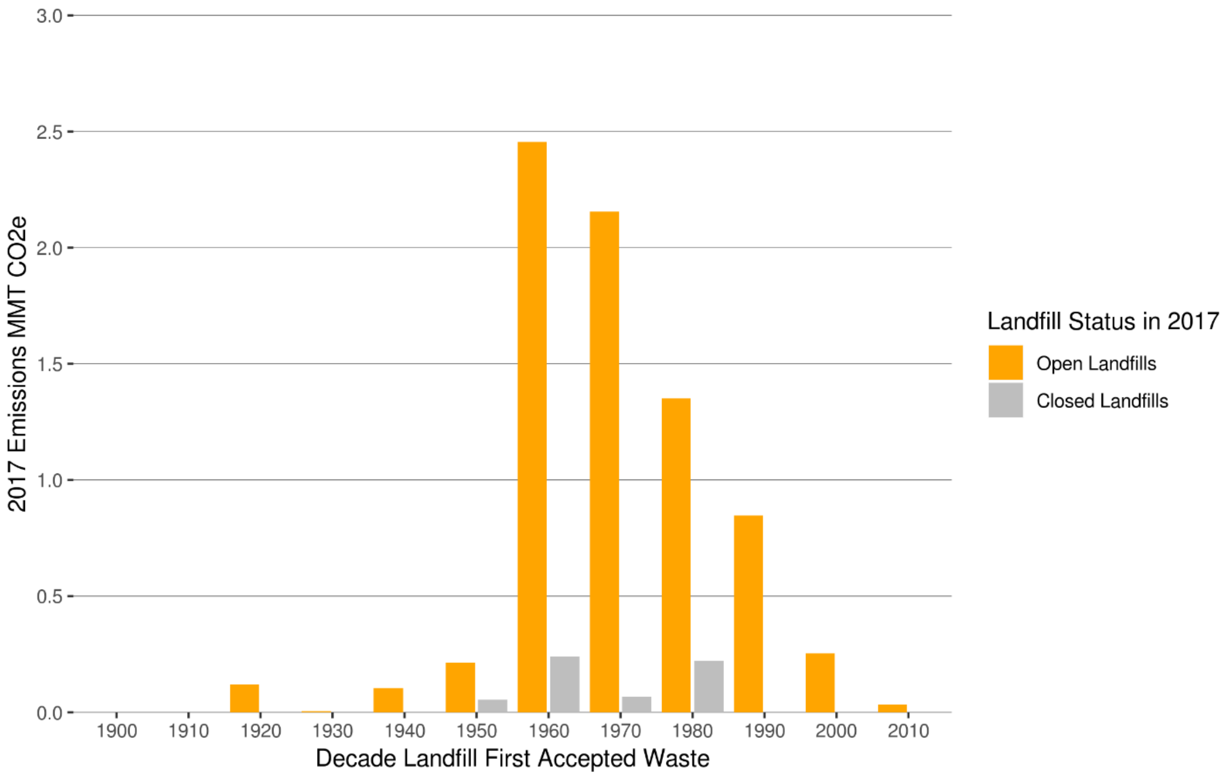


Figure 12 displays total CH_4 emissions (in MMT CO_2e) and the operational status of industrial waste landfills in 2017 (i.e., open and closed) by the decade the landfill first accepted waste. The majority of 2017 emissions result from landfills that first accepted waste between the 1960s and 1980s, and are still open in 2017. There are significantly more open landfills than closed landfills contributing to total emissions in the current RY. Forty-six of the landfills that opened in the 1960s were still accepting waste in 2017, which is why emissions from landfills that opened in that decade are higher than in other decades.

Table 16 shows total emissions in the industrial waste landfill subsector and the number of facilities (unique and combined) grouped by major NAICS code.

Table 16: Major NAICS Code Groups Represented by Reporting Industrial Waste Landfills (2017)

Major NAICS Code	NAICS Code Description	Combined Facility Count[a]	Unique Facility Count	Percent of Total Facilities	Emissions (MMT CO_2e)[b]	Percent of Total Emissions
111	Crop production	1	0	0%	c	c
112	Animal production and aquaculture	1	1	0.58%	0.05	0.59%
212	Mining (except oil and gas)	1	1	0.58%	0.02	0.23%

Major NAICS Code	NAICS Code Description	Combined Facility Count[a]	Unique Facility Count	Percent of Total Facilities	Emissions (MMT CO_2e)[b]	Percent of Total Emissions
221	Utilities	9	5	2.92%	0.19	2.34%
311	Food manufacturing	12	12	7.02%	0.66	8.16%
321	Wood product manufacturing	4	2	1.17%	0.02	0.19%
322	Paper manufacturing	121	90	52.63%	4.52	55.71%
324	Petroleum and coal products manufacturing	4	4	2.34%	0.05	0.63%
325	Chemical manufacturing	29	17	9.94%	0.53	6.60%
327	Nonmetallic mineral product manufacturing	1	0	0%	[c]	[c]
331	Primary metal manufacturing	20	18	10.53%	0.58	7.11%
332	Fabricated metal product manufacturing	1	1	0.58%	< 0.01	0.01%
333	Machinery manufacturing	1	0	0%	[c]	[c]
335	Electrical Equipment, Appliance, and Component Manufacturing	1	1	0.58%	0.004	0.05%
562	Waste management and remediation services	21	19	11.11%	1.50	18.42%
Total		**227**	**171**	**100%**	**8.12**	**100%**

[a] Facilities may report multiple NAICS codes based on operations conducted at their facilities. The counts presented in this column include all facilities that reported the relevant NAICS code as a primary, secondary, or additional NAICS code.

[b] The data presented in this column represent the total emissions for facilities that reported the relevant NAICS code as their primary code so as not to double-count emissions. This column does not sum emissions from facilities that reported their respective NAICS codes as secondary or additional.

[c] No facilities reported NAICS code 327 as their primary business.

The majority of industrial facilities that report emissions under the industrial waste landfill subsector have dedicated onsite landfills. These landfills are presumed to only accept waste generated by that particular facility. Some industrial waste landfills are not associated with any particular industrial sector (i.e., NAICS code 562), and these facilities accept mixed industrial waste from various industries.

Paper manufacturing facilities contributed the majority of industrial waste landfill emissions in 2017 (5.10 MMT CO_2e or 59.9%). Waste management and remediation facilities (1.27 MMT CO_2e or 14.9%) and primary metal manufacturing sector facilities (0.62 MMT CO_2e or 7.3%) comprise the next largest shares.

Calculation Methods Available for Use

Facilities in the Waste Sector emit CH_4 from the decomposition of organic matter in wastes and emit CO_2, CH_4, and N_2O from the combustion of solid wastes, captured CH_4, and other fuels.

Emission Calculation Methodology from Stationary Fuel Combustion Units

For MSW and industrial landfills, emissions from the combustion of any collected biogas are included with emissions for the landfill facility if the landfill is not co-located with a process in another industry sector that is covered by the reporting rule (e.g., a petroleum refinery or pulp and paper facility). If the landfill is co-located, then the combustion emissions are included with the emissions from the co-located industry sector. For industrial wastewater, combustion emissions are included with the emissions from the pulp and paper, ethanol manufacturing, food processing, or petroleum refining industry sector, as appropriate. The calculation methodology for stationary fuel combustion sources (Subpart C) is explained here.

Emission Calculation Methodologies for Process Emissions Sources

MSW Landfill Emission Calculation Methodology

Because there is no internationally agreed-upon and cost-effective approach to directly measure the amount of CH_4 emitted from landfills, the emission estimation methodology uses a combination of gas measurements, models, and calculations. The calculation procedure for MSW landfills depends on whether the landfill has an active landfill GCCS.

- **Landfills without a GCCS**. MSW landfills without an active landfill GCCS must calculate CH_4 generation using a first-order decay model for CH_4 generation in the landfill (Equation HH-1 of the rule, which is based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5). Equation HH-1 uses the quantities and types of wastes disposed in the landfill, a default or measured CH_4 fraction in the landfill gas, and other characteristics of the landfill as model inputs. The CH_4 generation is corrected using Equation HH-5 to account for CH_4 that oxidizes (and therefore is not emitted) as it passes through the landfill cover material.

- **Landfills with an active GCCS**. MSW landfills with an active GCCS must calculate emissions using Equations HH-6 and HH-8 of the rule, and specify which method they consider most accurate for their facility. FLIGHT displays emissions from both methods but uses the facility-specified value to calculate total emissions from the MSW landfills subsector. If the facility does not specify which equation to use, FLIGHT uses the higher value.

    - Equation HH-6 estimates emissions using the modeled CH_4 generation rate (Equation HH-1, described above) minus the measured amount of CH_4 recovered and destroyed. CH_4 generated in excess of the measured CH_4 recovery is corrected to account for CH_4 oxidation in the landfill cover material.

    - Equation HH-8 estimates emissions based on the measured quantity of CH_4 recovered for destruction and an estimated landfill gas collection efficiency, which varies by type of landfill cover material used. This equation back-calculates the quantity of uncollected gas, which is then corrected to account for CH_4 oxidation in the landfill cover material. Emissions from the gas collected and intended for destruction are estimated based on the CH_4 destruction efficiency of the combustion device.

The values resulting from Equations HH-6 and HH-8 may vary significantly, depending on the characteristics of the landfill. For example, the amount of recovered CH_4 can vary by year, and the landfill gas collection efficiency will change yearly for open landfills. The collection efficiency will change yearly because it is estimated using an area-weighted approach that is dependent on the surface area of each stage of cover (daily, intermediate, or final). While Equation HH-8 incorporates more site-specific information, it might not provide the most accurate GHG emission estimate for every landfill due to the many variables that affect landfill GHG emissions.

Until 2013, all landfills were required to use a CH_4 oxidation fraction of 0.10 in their CH_4 emission equations. In 2013, a rule change allowed for the use of different default CH_4 oxidation fractions each year if the facility opted to calculate its landfill CH_4 flux using the provided methodology. A default value of 0.10 must be used if the facility chooses not to calculate landfill CH_4 flux. The results of the CH_4 flux calculations, combined with the extent of soil cover at the landfill, direct the reporter to the appropriate oxidation fraction to use. The CH_4 oxidation fraction values available for use are 0.0, 0.10, 0.25, and 0.35. Using a higher oxidation fraction value results in lower CH_4 emissions than when a lower oxidation fraction value is used.

Beginning in 2013, facilities were required to report the oxidation fraction used for each relevant emission equation. Table 17 shows the oxidation fraction value used in each equation. Approximately 42% of facilities without a GCCS used the higher oxidation fractions of 0.25 or 0.35, and 3% used a value of zero. A larger percentage of facilities with landfill gas collection (51–71%) used the higher oxidation values (25–35%), while approximately 1% used a value of zero.

Table 17: MSW Landfills – CH_4 Oxidation Fraction Values Used by MSW Landfills (2017)

Oxidation Factor Default Value	Emission Equation[a]									
	Without GCCS		With GCCS							
	HH-5		HH-5[a]		HH-6		HH-7[b]		HH-8	
	Count	%	Count	%	Count	%	Count	%	Count	%
0	10	3.4	11	1.3	11	1.3	11	1.3	11	1.3
0.1	159	54.6	401	47.6	263	31.2	353	41.9	237	28.1
0.25	112	38.4	419	49.7	439	52.1	426	50.5	347	41.2
0.35	10	3.4	12	1.4	130	15.4	53	6.3	248	29.4
Total	**291**	**100**	**843**	**100**	**843**	**100**	**843**	**100**	**843**	**100**

[a] Totals may not sum due to independent rounding.

[b] Landfills with GCCSs must report landfill gas generation using both Equations HH-5 and HH-7, in addition to calculating emissions using both Equations HH-6 and HH-8.

Table 18 presents the percentage of emissions monitored by method and type. A larger percentage of process and combustion emissions are emitted by facilities with a GCCS because there are significantly more facilities with a GCCS than without (a 3:1 ratio).

Table 18: MSW Landfills – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by type)					
		2012	2013	2014	2015	2016	2017
Process emissions	Landfills without a GCCS: All landfills without a GCCS use modeled CH_4 generation adjusted for oxidation	34.8%	30.7%	32.4%	32.7%	33.8%	34.0%
	Landfills with a GCCS: Equation HH-6: Modeled CH_4 generation and measured CH_4 collection[a]	40.7%	45.7%	44.2%	43.6%	42.3%	42.9%
	Landfills with a GCCS: Equation HH-8: Measured CH_4 collection and a default factor for collection efficiency[a]	24.5%	23.6%	23.5%	23.7%	23.9%	23.1%

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by type)					
		2012	2013	2014	2015	2016	2017
Combustion emissions	CEMS (Tier 4)[b]	45.6%	38.5%	43.6%	49.9%	56.5%	58.2%
	Measured carbon content and, if applicable, molecular weight (Tier 3)	0%	**	0%	**	0%	0%
	Measured high heating values (HHVs) and default emission factors (Tier 2)	15.4%	13.1%	12.4%	11.3%	10.6%	9.9%
	Default HHVs and emission factors (Tier 1)	39.0%	48.4%	44.0%	38.9%	33.0%	31.9%

[a] Facilities report both measured and modeled emissions, and identified the most accurate emissions value for their facility. For FLIGHT and this report, EPA selected the emission value that was identified by the facility.

[b] CEMS emissions include CO_2 from fossil fuel combustion plus, if applicable, CO_2 from sorbent.

** Total reported emissions are less than 0.05% of the total.

Table 19 presents the number of facilities with a GCCS and the calculation method used (either Equation HH-6 or HH-8) for each RY. Facilities may use the equation they feel is most appropriate based on their facility operations. Facilities are not required to use the same equation across RYs, but most facilities did use the same equation for multiple years. Most facilities used Equation HH-8 for all five reporting years. Equation HH-8 is based on the measured quantity of recovered CH_4, while Equation HH-6 is based on the amount of modeled CH_4 generation.

Table 19: MSW Landfills – Use of Equation HH-6 versus HH-8 by RY[a]

	2012	2013	2014	2015	2016	2017
Facilities with a GCCS	926	926	923	864	849	846
Facilities that used Equation HH-6	271	274	285	274	270	265
Facilities that used Equation HH-8	640	650	633	583	578	579

[a] Updated January 2022 with data as of August 7, 2021.

Industrial Waste Landfills Calculation Methodology

The calculation methodology for industrial waste landfills parallels the methodology for MSW landfills. A change was made in 2013 to add a default factor for DOC content and a decay rate for industrial sludge. These changes directly impact the modeled CH_4 generation and CH_4 emissions for facilities that dispose of industrial sludges. Table 20 shows the percent of emissions by calculation methodology (grouped by type of emission) from 2011 to 2017.

Table 20: Industrial Landfills – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by type)						
		2011	2012	2013	2014	2015	2016	2017
Landfills without a GCCS	All facilities use modeled CH_4 generation adjusted for oxidation	97%	97%	96%	96%	97%	97%	98%
Landfills with a GCCS	Equation HH-6: Modeled CH_4 generation and measured CH_4 collection	3%	3%	4%	4%	3%	3%	2%
	Equation HH-8: Measured CH_4 collection and a default factor for collection efficiency	0%	0%	0%	0%	0%	0%	0%

Note: Only two industrial waste landfills (1% of reporters for that subsector) have a GCCS.

Industrial Wastewater Treatment Calculation Methodology

The calculation procedure of industrial wastewater treatment depends on whether biogas is recovered from the anaerobic reactor(s) or lagoon(s) operating at the facility. All anaerobic sludge digesters are assumed to recover biogas. The methodology for sludge digesters does not include calculating CH_4 generation using chemical oxygen demand (COD) or the five-day biochemical oxygen demand (BOD_5), because it is assumed that all generated CH_4 is recovered.

- **No biogas recovery**. All facilities with anaerobic reactors or lagoons calculate emissions using measurements of the volume of wastewater, measurements of the average weekly concentration of either COD or BOD_5, and a default CH_4 conversion factor. All CH_4 generated during the process is emitted (Equation II-3).
- **With biogas recovery**. All facilities with anaerobic reactors, lagoons, or sludge digesters that recover biogas calculate emissions using measurements of the flow of recovered biogas; CH_4 concentration, temperature, pressure, and moisture; and default values for biogas collection efficiency and CH_4 destruction efficiency. Equation II-4 determines the amount of CH_4 recovered in the process and Equation II-5 uses the collection efficiency to estimate the amount of CH_4 that leaks out of equipment. Equation II-6 determines total CH_4 emissions by summing CH_4 leakage and CH_4 not destroyed in the destruction device.

Table 21 shows the percentage of emissions and calculation methodology by type of industrial wastewater treatment system.

Table 21: Industrial Wastewater – Methodologies and Percentage of Emissions by Type of Treatment System (2017)

Types of Industrial Wastewater Treatment Systems		Percentage of Emissions Monitored by Type	Methodology
No biogas	Anaerobic reactors	0.3%	Monitor either the BOD_5 or the COD of the material entering the reactor or lagoon, and use default values for the CH_4 generation potential and CH_4 conversion factor
	Anaerobic lagoons	82.2%	
With biogas	Anaerobic reactors	2.3%	Monitor biogas flow rate and CH_4 concentration, and use default values for biogas collection efficiency and the efficiency of the biogas destruction device
	Anaerobic lagoons	14.0%	
	Sludge digesters	1.2%	

Solid waste combustion facilities must report under Subpart C, and the reporter generally must use one of four calculation methodologies (tiers) to calculate CO_2 emissions (Table 22), depending on fuel type and unit size. The calculation methodologies for Subpart C are explained in more detail here. Units that are not subject to Subpart D but are required by states to monitor emissions according to Part 75 can report CO_2 emissions under Subpart C using Part 75 calculation methods and monitoring data that they already collect under Part 75 (e.g., heat input and fuel use). CH_4 and N_2O mass emissions are also required to be reported for fuels that are included in Table C-2 of Part 98 and are calculated using either an estimated or measured fuel quantity, default or measured HHV, and default emission factors.

Table 22: Solid Waste Combustion – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by type)						
		2011	2012	2013	2014	2015	2016	2017
Combustion emissions	CEMS (Tier 4)[a]	58.2%	57.5%	59.1%	58.5%	61.3%	61.6%	58.9%
	Measured carbon content and, if applicable, molecular weight (Tier 3)	**	0%	0%	0%	0%	0%	0%
	Measured HHVs and default emission factors (Tier 2)	40.7%	41.5%	38.6%	38.0%	37.7%	37.8%	40.5%
	Default HHVs and emission factors (Tier 1)	1.1%	1.0%	2.2%	3.5%	1.0%	0.6%	0.6%

[a] CEMS emissions include CO_2 from fossil fuel combustion plus, if applicable, CO_2 from sorbent.

** Total reported emissions are less than 0.05% of the total.

Data Verification and Analysis

As a part of the reporting and verification process, EPA evaluates annual GHG reports with electronic checks and staff review as needed. EPA contacts facilities regarding potential substantive errors and facilities resubmit reports as errors are identified. Additional information on EPA's verification process is available here.

Other Information

EPA's Landfill Methane Outreach Program (LMOP) is a voluntary assistance program that promotes the reduction of CH_4 emissions from landfills by encouraging the recovery and beneficial use of landfill gas as an energy resource. By joining LMOP, companies, state agencies, organizations, landfill operators, and communities gain access to a vast network of industry experts and practitioners, as well as various technical and marketing resources that can help with landfill gas energy project development. LMOP maintains a list of candidate landfills where available data indicate that installing a landfill gas-to-energy project is likely to provide financial benefits. LMOP defines a candidate landfill as one that is accepting waste or has been closed for five years or less; has at least one million tons of waste; and does not have an operational, under-construction, or planned landfill gas-to-energy project.

EPA's U.S. Greenhouse Gas Inventory (hereafter referred to as the Inventory) estimates total U.S. GHG emissions from Waste Sector sources. National-level emissions presented in the Inventory report differ from the total emissions reported to the GHGRP for several reasons:

- The Inventory accounts for emissions from all facilities in a given sector. The GHGRP, on the other hand, includes only those facilities that meet the reporting thresholds. The coverage and the emissions methodologies differ between the two programs (see Table 3 for estimated coverage across the Waste Sector).

- The Inventory estimates for MSW landfills are a combination of top-down and bottom-up estimates for certain years in the Inventory time series, representing national emissions that are intended to be inclusive of all facilities within a given sector. The 1990–2017 Inventory for MSW landfills incorporated directly reported CH_4 emissions from facilities reporting to the GHGRP (for years 2010 to 2017), with a scale-up factor to account for emissions from MSW landfills that do not meet GHGRP's reporting threshold.[3]

- The Inventory estimate for industrial waste landfill emissions includes only the pulp and paper and food and beverage sector facilities, whereas subpart TT of the GHGRP covers many more industries. Due to a lack of industrial waste disposal data for all facilities within each industrial sector, the inventory uses proxy data (i.e., annual production data multiplied by a disposal factor) to estimate the amount of waste disposed of by the pulp and paper and food and beverage sectors. The GHGRP uses a bottom-up calculation approach and requires facilities to report the amount of waste disposed.

- The Inventory estimate for industrial wastewater treatment includes aerobic ponds with anaerobic portions, but under the GHGRP, only emissions from strictly anaerobic processes are required to be reported.

- The Inventory does not capture emissions from wastewater sludge digesters or CH4 recovered from anaerobic treatment processes, while the GHGRP does.

Glossary

Anaerobic process refers to a procedure in which organic matter in wastewater, wastewater treatment sludge, or other material is degraded by micro-organisms in the absence of oxygen, resulting in the generation of CO_2 and CH_4. This source category consists of the following: anaerobic reactors, anaerobic lagoons, anaerobic sludge digesters, and biogas destruction devices (e.g., burners, boilers, turbines, flares, or other devices) (40 CFR Part 98.350).

Biogenic CO_2 emissions means carbon dioxide released from the combustion or decomposition of biologically based materials other than fossil fuels.

Continuous emission monitoring system or CEMS means the total equipment required to sample, analyze, measure, and provide, by means of readings recorded at least once every 15 minutes, a permanent record of gas concentrations, pollutant emission rates, or gas volumetric flow rates from stationary sources (40 CFR Part 98.6).

Ethanol production means an operation that produces ethanol from the fermentation of sugar, starch, grain, or cellulosic biomass feedstocks; or the production of ethanol synthetically from petrochemical feedstocks, such as ethylene or other chemicals.

FLIGHT refers to EPA's GHG data publication tool, named the Facility Level Information on Greenhouse Gases Tool (https://ghgdata.epa.gov/ghgp/main.do#).

3. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017. EPA 430-R-19-001. U.S. Environmental Protection Agency. Available: https://www.epa.gov/ghgemissions/overview-greenhouse-gases.6456.7.

Food processing means an operation used to manufacture or process meat, poultry, fruits, and/or vegetables as defined under NAICS 3116 (Meat Product Manufacturing) or NAICS 3114 (Fruit and Vegetable Preserving and Specialty Food Manufacturing). For information on NAICS codes, see http://www.census.gov/eos/www/naics/.

GCCS means a landfill's gas collection and control system.

GHGRP means EPA's Greenhouse Gas Reporting Program (40 CFR Part 98).

GHGRP vs. GHG Inventory: EPA's Greenhouse Gas Reporting Program (GHGRP) collects and disseminates annual GHG data from individual facilities and suppliers across the U.S. economy. EPA also develops the annual Inventory of U.S. Greenhouse Gas Emissions and Sinks (GHG Inventory) to track total national emissions of GHGs to meet U.S. government commitments to the United Nations Framework Convention on Climate Change. The GHGRP and Inventory datasets are complementary; however, there are also important differences in the data and approach. For more information, please see https://www.epa.gov/ghgreporting/greenhouse-gas-reporting-program-and-us-inventory- greenhouse-gas-emissions-and-sinks.

IPCC AR4 refers to the Fourth Assessment Report by the Intergovernmental Panel on Climate Change. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K. and A. Reisinger. (eds.)]. IPCC, Geneva, Switzerland, 2007.* The AR4 values also can be found in the current version of Table A-1 in Subpart A of 40 CFR Part 98.

Industrial wastewater means water containing wastes from an industrial process. Industrial wastewater includes water that comes into direct contact with or results from the storage, production, or use of any raw material, intermediate product, finished product, by-product, or waste product. Examples of industrial wastewater include, but are not limited to, paper mill white water, wastewater from equipment cleaning, wastewater from air pollution control devices, rinse water, contaminated stormwater, and contaminated cooling water.

Industrial waste landfill means any landfill other than a MSW landfill, a Resource Conservation and Recovery Act (RCRA) Subtitle C hazardous waste landfill, or a Toxic Substances Control Act hazardous waste landfill, in which industrial solid waste, such as RCRA Subtitle D wastes (nonhazardous industrial solid waste, defined in §257.2 of this chapter), commercial solid wastes, or conditionally exempt small quantity generator wastes, is placed. An industrial waste landfill includes all disposal areas at the facility.

Industrial wastewater treatment sludge means solid or semi-solid material resulting from the treatment of industrial wastewater, including, but not limited to, biosolids, screenings, grit, scum, and settled solids.

Landfill Methane Outreach Program or LMOP is a voluntary assistance program run by EPA to help reduce CH_4 emissions from landfills by encouraging the recovery and beneficial use of landfill gas as an energy resource (http://www.epa.gov/lmop/).

MT means metric tons.

MMT means million metric tons.

Municipal solid waste landfill, as defined by the GHGRP, means an entire disposal facility in a contiguous geographical space where household waste is placed in or on land. An MSW landfill may also receive other types of RCRA Subtitle D wastes (40 CFR 257.2) such as commercial solid waste, nonhazardous sludge, conditionally exempt small quantity generator waste, and industrial solid waste. Portions of an MSW landfill may be separated by access roads, public roadways, or other public right-of-ways. An MSW landfill may be publicly or privately owned (40 CFR Part 98.6).

NAICS means the North American Industry Classification System, the standard used by federal statistical agencies to classify business establishments into industrial categories for collecting and publishing statistical data related to the U.S. economy.

Wastewater treatment systems are the collection of all processes that treat or remove pollutants and contaminants, such as soluble organic matter, suspended solids, pathogenic organisms, and chemicals from wastewater prior to its reuse or discharge from the facility.