UNDERSTANDING GREENHOUSE GAS EMISSIONS FROM NATURAL GAS (EPA INVENTORY)

October 2022

American Gas Association

INTRODUCTION

Climate change is a defining challenge across the globe, and natural gas, natural gas utilities, and the delivery infrastructure are essential to meeting our nation's greenhouse gas emissions reduction goals, including pathways to achieve net-zero emissions.

Natural gas is a fuel of choice for consumers because of its low cost, efficient end uses, and environmental attributes. Natural gas is a domestically produced and abundant energy source that presents the U.S. with an opportunity to address our energy, economic, and environmental objectives while serving as a foundational fuel for the U.S. economy for years to come. This potential has focused public attention on the environmental footprint of energy production, transportation, distribution, and end-use.

Efficient natural gas technologies serve as low-cost, low-emission options for building energy needs, home comfort, industrial processes, and electricity generation. Natural gas is a low-carbon fuel relative to coal and oil, resulting in less carbon dioxide (CO_2) for the same amount of valuable energy. A better understanding of methane (CH_4) emissions released from production and delivery systems will further clarify how using natural gas may deliver greater environmental benefits.

The Environmental Protection Agency (EPA) made further updates to its estimates of CH_4 emissions in its *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020 (Inventory)*, released in April 2022. The *Inventory* incorporates new data from greenhouse gas (GHG) emissions studies and the EPA's Greenhouse Gas Reporting Program (GHGRP). The updated *Inventory* includes a new post-meter segment within the natural gas systems category incorporating emissions of CH_4 leaks from residential and commercial appliances, industrial facilities and powerplants, and natural gas-fueled vehicles.

"Natural gas distribution systems have a small emissions footprint shaped by a declining trend."

Distribution systems owned and operated by local natural gas utilities emit 8.4 percent of natural gas system CH_4 emissions. These annual emissions declined more than 69 percent from 1990 to 2020, as natural gas utility companies invested an average of $95 million daily in infrastructure upgrades to add more than 815,100 miles of pipelines to serve 22.3 million more customers over that period, increases of 56 percent and 41 percent, respectively.[1]

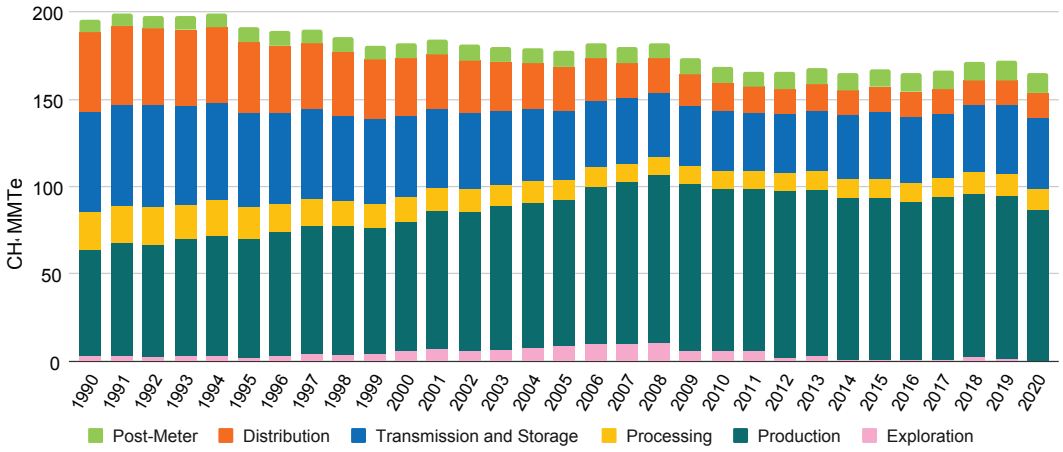
[1] Miles of pipeline includes pipeline main and services. The average service line length for companies is 75 based on reported and average national data.

This exceptional record can be traced to gas utilities continuing to make safety their top priority while remaining deeply committed to systematically upgrading infrastructure through risk-based integrity management programs. Additionally, AGA and the natural gas utility industry have collectively committed to reduce greenhouse gas emissions while improving the safety and environmental profile of the natural gas system. The industry can point to many metrics demonstrating investment and progress on reducing greenhouse gas emissions including CH_4.

As companies and the country continue to modernize the natural gas infrastructure base and connect homes and businesses, there will be new opportunities to achieve low-cost carbon emissions reductions by leveraging existing infrastructure, the nation's abundant natural gas resource, and renewable fuels such as hydrogen and renewable natural gas.

Figure 1 illustrates the trend in CH_4 emissions over the 1990 to 2020 time series in terms of million metric tons carbon dioxide equivalent (CO_2e) (MMTe).

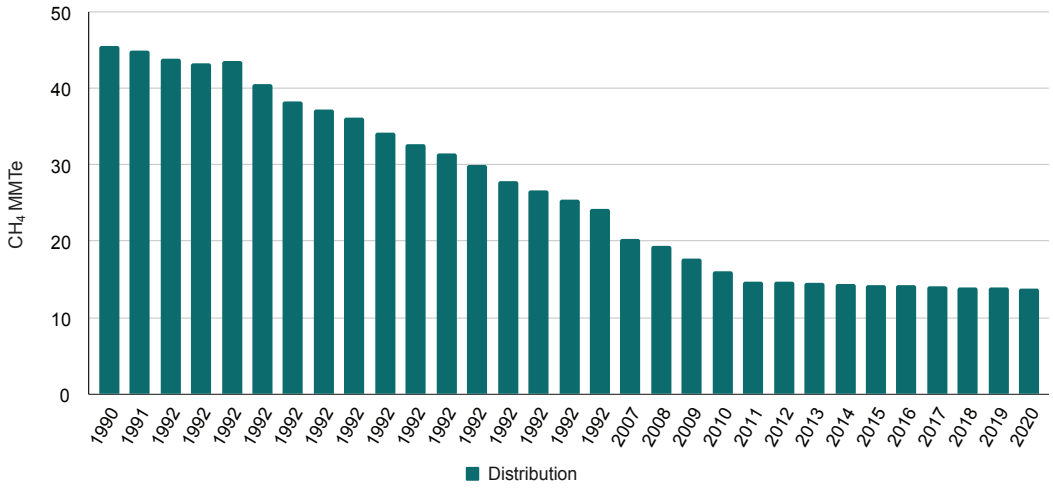
Figure 1: CH_4 Emissions from Natural Gas Systems 1990–2020, Million Metric Tons CO_2- equivalent (MMTe)



Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Annex Table 3.6-1 Environmental Protection Agency

Trends in CH_4 emissions (MMTe) from the distribution and post-meter segments are illustrated in Figure 2.

Figure 2: CH_4 Emissions from Natural Gas Distribution (MMTe)



Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Annex Table 3.6-1 Environmental Protection Agency

KEY FINDINGS

- Gross U.S. GHG emissions totaled 5,981 MMTe in 2020, representing a 9% decrease from 2019.
- The primary driver for the decrease in U.S. GHG emissions was an 11% decrease in CO_2 emissions from fossil fuel combustion resulting from a 13% decrease in transportation emissions driven by decreased demand due to the ongoing COVID-19 pandemic.
- Electric power sector emissions also decreased by 10%, reflecting a slight decrease in demand from the COVID-19 pandemic and a continued shift from coal to less carbon-intensive natural gas and renewables.
- CO_2 emissions from natural gas and petroleum systems increased by 24.0 MMTe (57.9%) from 1990 to 2020 due primarily to increases in the production segment, where flaring emissions from associated gas flaring, tanks, and miscellaneous production flaring have increased over time.
- GHG emissions, including CH_4, CO_2, and nitrous oxide (N_2O), from natural gas systems in 2020 totaled 200.3 MMTe, a decrease of 12% from 1990 and a decrease of 5% from 2019, both primarily due to decreases in CH_4 emissions.

- Of the overall GHG emissions from natural gas systems (200.3 MMTe), 82% are CH_4 emissions (164.9 MMTe), 18% are CO_2 emissions (35.4 MMTe), and less than 0.01% are N_2O emissions (0.01 MMTe).
- Natural gas systems emitted 164.9 MMTe of CH_4 in 2020, a 16% decrease compared to 1990 emissions and 4% decrease compared to 2019 emissions. The decrease is attributed to reductions in emissions from distribution and transmission and storage.
- For non-combustion CO_2, a total of 35.4 MMTe was emitted from natural gas systems in 2020, an 11% increase compared to 1990 emissions, and a 9% decrease compared to 2019.
- 2020 CH_4 emissions from the natural gas distribution segment (13.9 MMTe) declined 69.5% from 1990 to 2020 and remained steady compared with 2019 emissions.
- 2020 CH_4 emissions from the post-meter segment totaled 11.5 MMTe, with the majority of emissions coming from the residential (42%) and industrial and power plants (53%) segments.
- Recalculated post-meter CH_4 emissions increased annually with the number of U.S. residential natural gas houses and commercial natural gas appliances over the 1990 to 2020 time series. The CH_4 emission factors are population count-based and not activity-based, so estimated emissions will be expected to increase annually.
- The CH_4 intensity of the distribution segment expressed as the total mass of CH_4 emitted by the segment (MMT) divided by the total mass of CH_4 throughput (MMT) is 0.1% for 2020.
- The 2020 CH_4 emissions intensity for natural gas systems is 0.66% as a percentage of natural gas gross withdrawals. This emissions intensity was developed using the methods of the Natural Gas Sustainability Protocol v.1.0.

RECALCULATIONS IN THE 2022 INVENTORY

Several estimates of emissions and sinks in the *Inventory* are recalculated and revised each year. EPA periodically updates data and calculation methods for specific source estimates to improve quality, including transparency, completeness, consistency, and overall usefulness of the report. In addition, the recalculated *Inventory* includes new categories not included in the previous *Inventory* that improve the completeness of the national estimates. In general, and per the *2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories*, when methodological changes have been implemented, or new categories are added, the previous *Inventory*'s time series (i.e., 1990 to 2020) is recalculated to reflect the change.

Recalculations to natural gas systems in the 2022 *Inventory* include:

- The addition of post-meter emissions, including leak emissions from residential and commercial appliances, industrial facilities and power plants, and natural gas-fueled vehicles
    - The recalculations and inclusion of post-meter estimates resulted in an average increase in CH_4 emission estimates across the 1990 through 2019 time series, compared to the previous *Inventory* of 13.2 MMTe, or 8.1%. Table 1 provides CH_4 emissions from the post-meter segment in terms of MMTe.

- Reassessment of the Gas STAR reductions data and incorporating CH_4 Challenge data
- Adding well blowout emissions, and
- Updating underground storage well counts using Pipeline and Hazardous Materials Safety Administration (PHMSA) data.

Table 1: CH_4 Emissions for the Post-Meter Segment (MMTe) From Previous Year (Net MMTe)

Source	1990	2005	2016	2017	2018	2019	2020
Residential	3.6	4.2	4.7	4.7	4.7	4.8	4.8
Commercial	0.4	0.5	0.5	0.5	0.6	0.6	0.6
Industrial & Power Plants	3.3	3.8	5.5	5.3	5.9	6.1	6.1
Natural Gas Vehicles	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**7.2**	**8.6**	**10.7**	**10.6**	**11.1**	**11.4**	**11.5**

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Environmental Protection Agency

SUMMARY OF UPDATES

The EPA routinely updates its CH_4 emissions estimates using data from the EPA GHGRP, data from new studies, and new methodological approaches. The most notable change to the 2022 *Inventory* is the addition of post-meter emissions. The combined impact of revisions to 2019 natural gas system emissions, compared to the previous *Inventory*, is an increase from 157.6 to 172.1 MMTe, a 9.2% increase from year-end 2019 estimates, as shown in detail in Table 2.

Table 2: Summary of Changes to Natural Gas System CH_4 Emissions From Previous Year (Net MMTe)

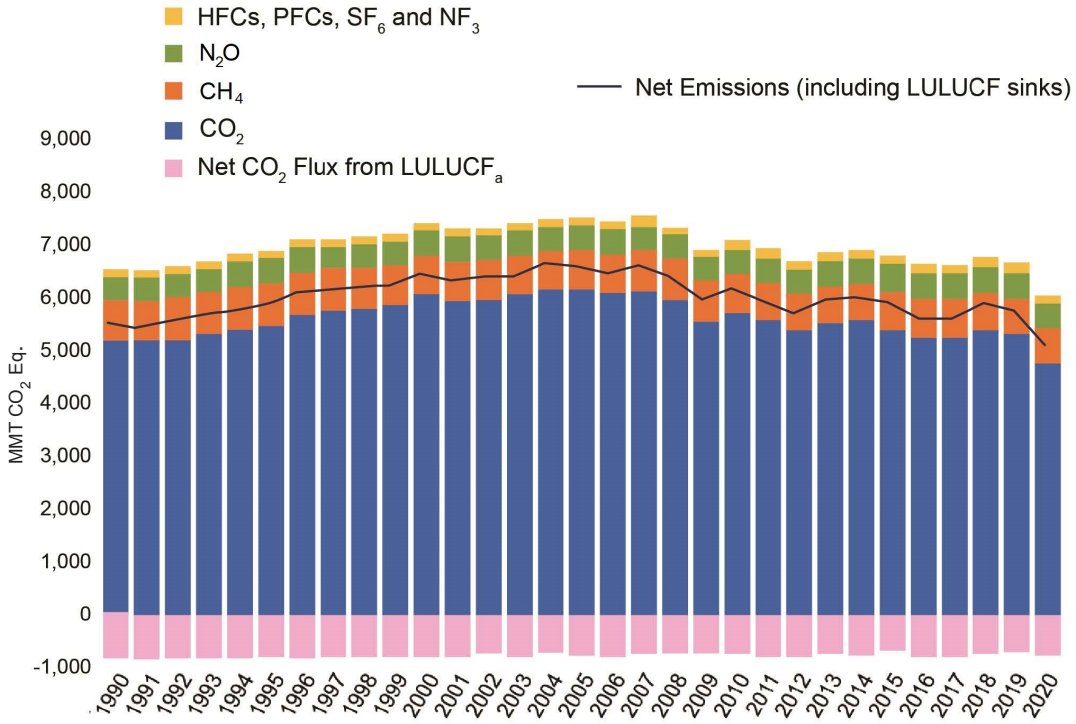
Stage	Prior Inventory (2019 Base Year)	New Inventory (2019 in 2020 Inventory)	Change
Exploration	0.5	1.9	259%
Production	93.7	92.8	-1.0%
Processing	12.4	12.6	1.5%
Transmission and Storage	37.0	39.6	7.1%
Distribution	14.0	13.9	-0.8%
Post-Meter	NA	11.4	NA
Total	**157.6**	**172.1**	**9.2%**

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Environmental Protection Agency

SUMMARY AND ANALYSIS OF EPA INVENTORY

For three decades, the EPA has developed and published estimates of GHG emissions in its annual *Inventory of U.S. Greenhouse gas Emissions and Sinks* (referenced throughout as the *Inventory*). It is the most comprehensive assessment of U.S. GHG emissions available. The *Inventory* covers the most important GHGs emitted by human activity, including CO_2, CH_4, N_2O, and several fluorine-containing halogenated substances. EPA reports all GHG emissions in units of CO_2e by weighting different air emissions by their respective global warming potentials to account for varying levels of radiative forces of each gas relative to CO_2 over a 100-year time horizon. For CH_4, the EPA uses a global warming potential of 25, consistent with UNFCCC reporting guidelines.[2] The trends in U.S. GHG emissions by gas for the 1990 through 2020 time series are illustrated in Figure 3 in terms of MMTe.

Figure 3: U.S. GHG Emissions by Gas (MMTe)



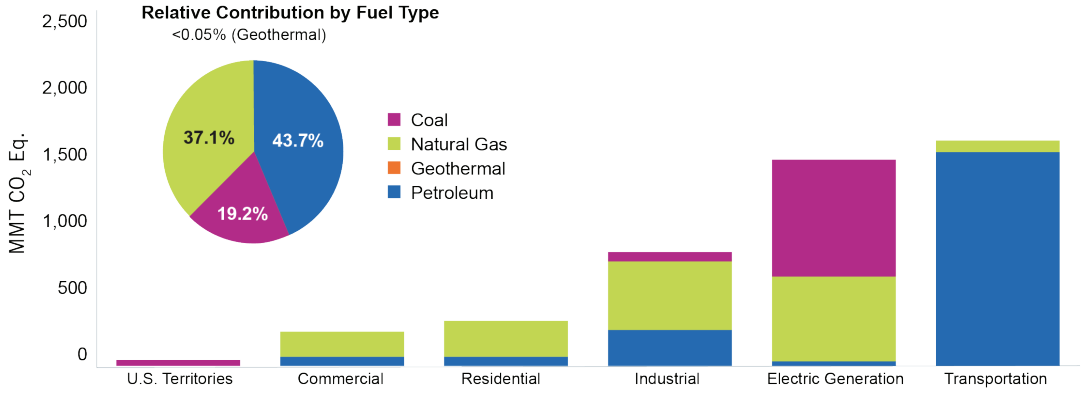
Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Environmental Protection Agency

[2] United Nations Framework Convention of Climate Change. The EPA uses a global warming potential of 25 for CH_4 in accordance with the International Panel on Climate Change (IPCC) national *Inventory* reporting guidelines. Higher global warming potentials have been published in the literature, including in fifth Assessment Reports from the IPCC. Using these higher factors would increase the contribution of CH_4 to total greenhouse gases relative to CO_2.

In 2020, U.S. GHG emissions totaled 5,981.4 MMTe, down 9% from 2019 and 20% from 2005. CO_2 from fossil fuel combustion accounts for most annual GHG emissions, constituting 72.6% of the total GHG emissions.

Total CO_2 emissions from fossil fuel combustion equaled 4,342.7 MMTe in 2020, which is 10.5% lower than in 2019. Petroleum combustion accounts for 44% of energy-related CO_2 emissions, the largest share of all fuels. Natural gas ranked second among the fossil fuels in this category at 37%, followed by coal at 19%. Figure 4 illustrates CO_2 Emissions from Fossil Fuel Combustion by Sector and Fuel Type for 2020.

Figure 4: 2020 CO_2 Emissions from Fossil Fuel Combustion by Sector and Fuel Type (MMTe)

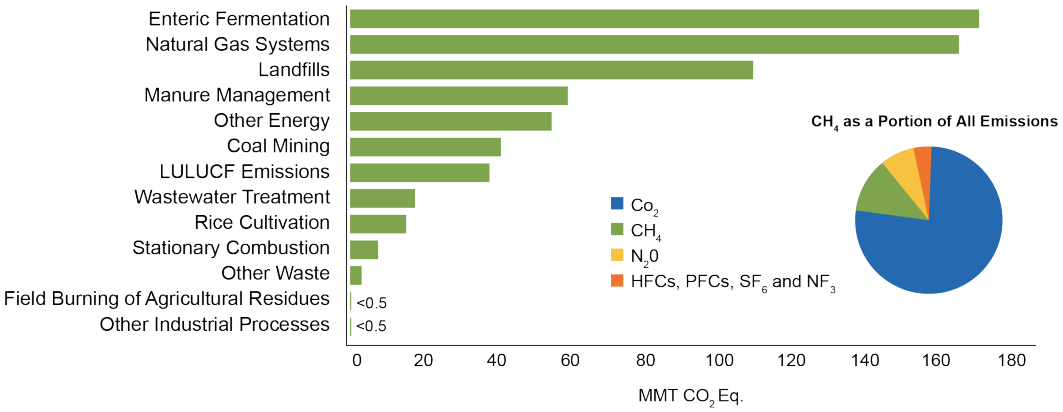


Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Environmental Protection Agency

Because the natural gas share of fossil fuel consumption has increased relative to coal and given the lower carbon emissions per unit of energy relative to coal, overall CO_2 emissions since 2005 have trended downward.

CH_4 is the second-largest contributor to U.S. GHG emissions after CO_2. Within the U.S., the primary anthropogenic sources of CH_4 include enteric fermentation from domestic livestock, natural gas systems, landfills, domestic livestock manure management, coal mining, and petroleum systems – see Figure 5. In 2020, CH_4 emissions were 650.4 MMTe, accounting for 10.9% of all U.S. GHG emissions.

Figure 5: Sources of CH_4 Emissions 2020 (MMTe)



Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Environmental Protection Agency

N_2O is the third-largest contributor to GHG emissions in the U.S., accounting for 7% of total GHGs in 2020. Primary sources of N_2O are agricultural soil management and mobile and stationary combustion.

Other GHGs include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6), and nitrogen trifluoride (NF_3). Emissions of these gases together accounted for 3.2% of total U.S. GHG emissions in 2020.

NATURAL GAS SYSTEM CH_4 EMISSIONS

The U.S. natural gas system is comprised of hundreds of thousands of producing wells, hundreds of operating drilling rigs, well completion equipment, numerous processing facilities, trillions of cubic feet of underground storage capacity, millions of customer meters, and an extensive transmission and distribution network of 2.6 million miles of pipeline.

With the addition of the post-meter segment, the EPA now categorizes the natural gas system into six stages: exploration, production (includes gathering and boosting), processing, transmission and storage, distribution, and post-meter. CH_4, CO_2, and, to a lesser extent N_2O, are the three principal GHGs emitted from natural gas systems. Total GHG emissions (CH_4, CO_2, and N_2O) from natural gas systems in 2020 were 200.3 MMTe, representing a decrease of 12% from 1990 and a decrease of 5% from 2019. Of the overall GHG emissions (200.3 MMTe), 82% are CH_4 emissions (164.9 MMTe), 18% are CO_2 emissions (35.4 MMTe), and less than 0.01% are N_2O emissions (0.01 MMTe).

By the categorical conventions used in the *Inventory*, natural gas systems represent the second largest source category for CH_4 in the U.S., accounting for 25.4% of all CH_4 emissions in 2020.
In 2020, natural gas system CH_4 emissions equaled 164.9 MMTe or 2.8% of total U.S. GHGs.

In 2020, the largest share of natural gas system CH_4 emissions stems from field production, which accounts for 52.4%. The processing stage accounts for 7.5%, transmission and storage 24.6%, distribution 8.4%, and the newly added post-meter category 7%. Historical CH_4 emissions for natural gas systems are listed in Table 3.

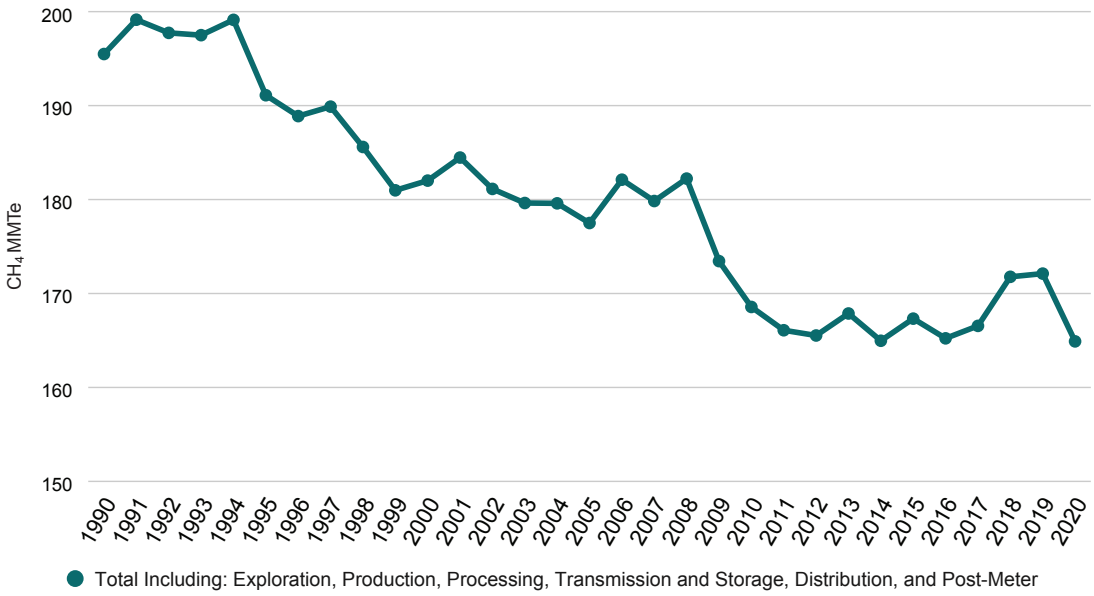
Table 3: CH_4 Emissions from Natural Gas Systems (MMTe)

Stage	1990	2005	2016	2017	2018	2019	2020	1990-2020	Share of Natural Gas System Emissions, 2020
Exploration	3.0	9.0	0.7	1.2	2.3	1.9	0.2	-93%	0.1%
Production	61.3	83.4	90.1	92.6	93.8	92.8	86.4	41%	52.4%
Onshore Production	37.5	56.8	52.6	53.4	54.3	51.6	47.6	27%	28.9%
Gathering and Boosting	18.5	24.0	36.4	38.3	38.7	39.9	37.5	103%	22.7%
Offshore Production	4.3	1.8	0.8	0.7	0.8	0.8	1.0	-77%	0.6%
Processing	21.3	11.6	11.2	11.5	12.1	12.6	12.4	-42%	7.5%
Transmission and Storage	57.2	39.5	38.3	36.5	38.4	39.6	40.6	-29%	24.6%
Distribution	45.5	25.5	14.2	14.1	14.0	13.9	13.9	-69%	8.4%
Post-Meter	7.2	8.6	10.7	10.6	11.1	11.4	11.5	60%	7.0%
Total	**195.5**	**177.5**	**165.2**	**166.6**	**171.8**	**172.1**	**164.9**	**-16%**	**100%**

Note: Totals may not sum due to independent rounding

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Environmental Protection Agency

Figure 6: Trends in CH_4 Emissions from Natural Gas Systems (MMTe)



Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020,
Derived from Annex Table 3.6-1 Environmental Protection Agency

NATURAL GAS SYSTEM CO_2 AND N_2O EMISSIONS

Certain subsegments of natural gas systems emit CO_2 and N_2O. Sources of non-combustion CO_2 emissions from natural gas systems include those resulting from normal operations, routine maintenance, and system upsets. For natural gas system segments, the *Inventory* excludes all combustion CO_2 emissions except flaring CO_2 emissions. All combustion CO_2 emissions (except flaring) are accounted for in Section 3.1 of the *Inventory - CO_2 from Fossil Fuel Combustion*. CO_2 and N_2O from flaring activities within natural gas systems are included in the *Inventory*, with most of the emissions occurring in the processing and production segments.

Emissions of both CO_2 and N_2O from natural gas systems are minimal. Non-combustion CO_2 emission levels from natural gas systems have increased from 31.9 to 35.4 MMTe, an 11% rise from 1990 to 2020. N_2O emissions are 37% lower than their peak in 2015 and 15% lower than in 2019. Tables 5 and 6 summarize CO_2 and N_2O emissions across the time series from 1990 to 2020.

The increased use of plastic materials for gas distribution pipelines has helped reduce CH_4 and CO_2 emissions in the natural gas distribution systems stage. CO_2 emissions from this sector are less than 0.1 MMT CO_2e across the time series. The combined impact of revisions to 2018 natural gas sector CO_2 emissions due to recalculations resulted in a decrease of 3% in non-combustion CO_2 emissions from natural gas systems from 1990 to 2018 compared to the previous *Inventory*.

Table 4: CO_2 Emissions from Natural Gas Systems (MMTe)

Stage	1990	2005	2015	2019	2020
Exploration	0.3	1.4	0.3	0.2	0.1
Production	3.0	4.5	7.6	10.9	7.7
Processing	28.3	18.8	21.0	26.4	25.5
Transmission and Storage	0.2	0.2	0.2	1.2	2.0
Distribution	0.1	0.03	0.02	0.02	0.02
Post-Meter	0.001	0.001	0.002	0.002	0.002
Total	**31.9**	**24.9**	**29.1**	**38.7**	**35.4**

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Annex Table 3.6-101 Environmental Protection Agency

Table 5: N_2O Emissions from Natural Gas Systems (MMTe)

Stage	1990	2005	2015	2019	2020
Exploration	0.0004	0.001	0.003	0.0001	0.00005
Production	0.004	0.006	0.010	0.006	0.004
Processing	NE	0.003	0.006	0.006	0.005
Transmission and Storage	0.003	0.0003	0.0003	0.001	0.001
Distribution	NE	NE	NE	NE	NE
Post-Meter	NE	NE	NE	NE	NE
Total	**0.005**	**0.011**	**0.019**	**0.012**	**0.010**

NE = not emitted or zero

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Annex Table 3.6-141 Environmental Protection Agency

DISTRIBUTION SYSTEM CH_4 EMISSIONS

Natural gas distribution systems, owned and operated by natural gas utilities, deliver natural gas to consumers through an extensive infrastructure of 2.3 million miles of pipeline, compressor stations, meter and regulating facilities, and other related equipment. Gas utilities predominantly serve households and businesses and provide about one-quarter of natural gas volumes consumed for electricity generation. In 2020, natural gas utilities delivered 53% of the natural gas consumed across the country.

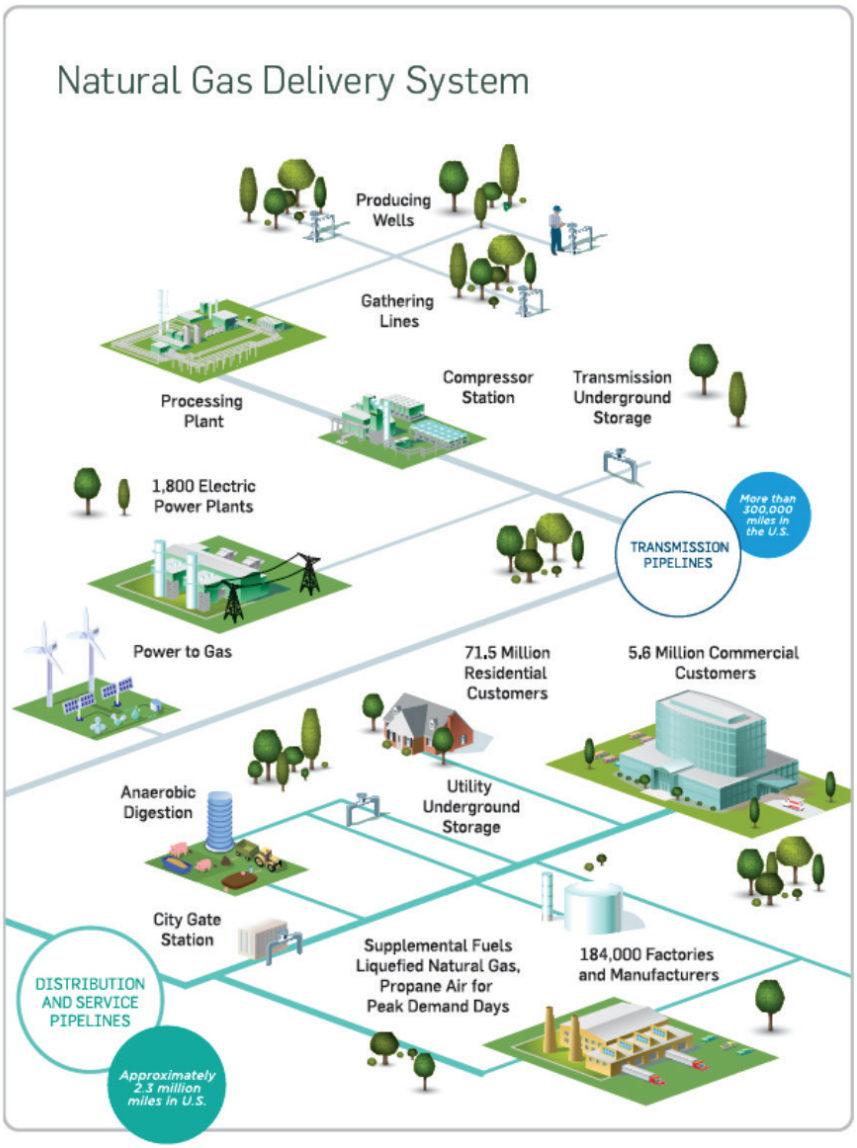
The distribution stage, which includes the regular operation and maintenance of natural gas delivery infrastructure along with emissions released from accidents, accounts for 8.4% of estimated CH_4 emissions from the natural gas system. Categories of distribution CH_4 emission sources include leaks from natural gas pipelines, meters and regulators (M&R) stations, customer meters, upsets (mishaps such as excavation damage), and releases during routine maintenance.

Gas utility companies reduce CH_4 emissions each year through voluntary measures, including those reported to the EPA through its Natural Gas STAR and CH_4 Challenge programs.

Overall, CH_4 emissions from the distribution segment have been declining since 1990, even as the size of the system has grown significantly. CH_4 emissions from distribution systems were 13.9 MMTe in 2020, a decline of 69.5% from 1990 levels. This drop occurred as the industry added 815,100 miles of pipelines to serve 22.3 million more customers.

Three segments of the natural gas industry are involved in delivering natural gas from the point of production to the consumer. Production companies explore, drill, and extract natural gas from the ground. Transmission companies operate the pipelines that link the gas fields to major consuming areas. Distribution companies are the local utilities that deliver natural gas to the customer.

Figure 7: U.S. Natural Gas Delivery System



Source: AGA 2022 Playbook

Table 6: CH_4 Emissions from the Natural Gas Distribution Stage, 2020

Distribution	MMTe	Share
Pipeline Leaks	5.1	37%
Meter/Regulator (City Gates)	1.1	8%
Customer Meters	5.9	42%
Routine Maintenance	0.1	1%
Upsets	1.7	12%
Net Total Emissions	**13.9**	**100%**

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Annex Table 3.6-1, Environmental Protection Agency, *These values represent net emissions for these sources

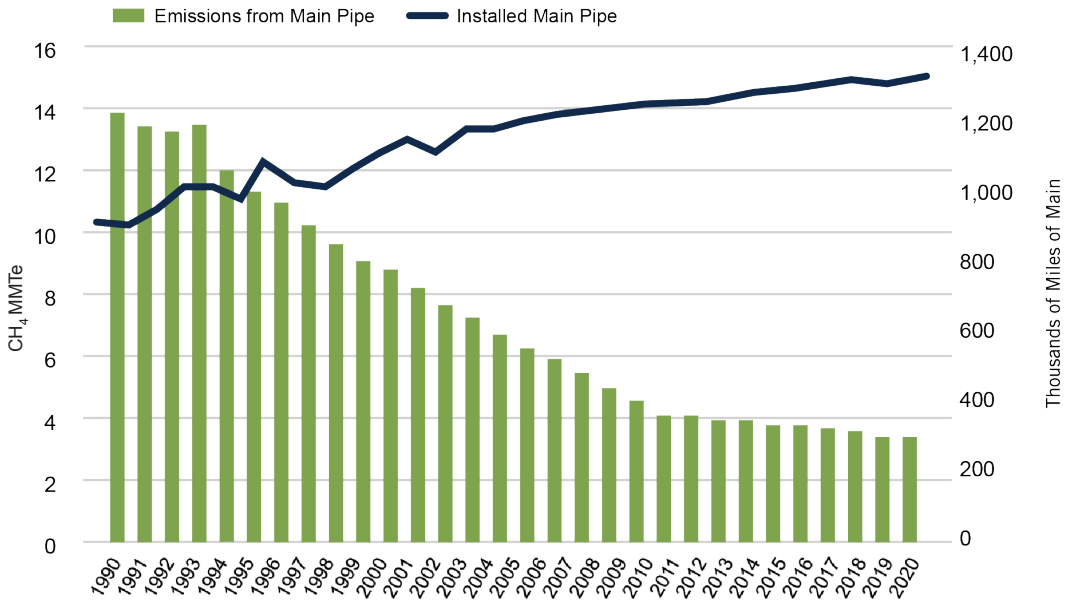
Table 6 summarizes the breakdown in distribution-stage CH_4 emissions by source category. The majority of distribution emissions are from pipeline leaks and meter/regulator operation. Less than half, 37%, of distribution system CH_4 emissions are associated with pipeline leaks, and 8% of CH_4 emissions result from the operation of gas meters and regulators at city gates, which connects the transmission system with the distribution network. Customer meters account for 42% of CH_4 emissions, and upsets and routine maintenance comprise 13%.[3]

The historical reductions in this sector result from gas utility upgrades to distribution infrastructure, Improved leak surveys, and modernized designs. Pipeline networks have been expanded and replaced with modern materials such as protected steel and plastic, which have lower emissions than other pipe materials. Additionally, operators have made significant upgrades and rebuilds to equipment at M&R stations.

Figure 8 reproduces the EPA estimates for pipeline leaks using EPA emission factors for pipeline main and activity (mileage) data from the U.S. Department of Transportation. The same figure shows the increasing trend in miles of installed main and the simultaneous decreasing trend in emissions from the main pipeline. It illustrates the environmental footprint for the natural gas industry's expanding service territory.

[3] Pipeline leaks are typically classified by the severity of the leak and location to determine whether it represents an actionable condition for immediate repair. Grade 1 leaks require prompt action to protect life and property. Grade 2 leaks should be repaired within a set amount of time, typically on the order of one year. Grade 3 leaks are flagged to be reevaluated during survey schedules or until the leak Is regarded or no longer results in a reading.

Figure 8: 2020 CH_4 Emissions from Distribution System Main Pipeline - Emissions and Activity



Source: Department of Transportation Form 7100, *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990- 2020, Annex Table 3.6-1 and Table 3.6-7, AGA Calculation

POST-METER CH_4 EMISSIONS

Post-meter emissions were included in the 2019 Refinement to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories under natural gas systems ("IPCC 2019"). The post-meter subsegments include CH_4 emissions from:

- Residential and commercial appliances – Leakage from natural gas-fired furnaces, water heaters, stoves and ovens, and barbeques/grills
- Leakage from internal piping at industrial plants and power stations
- Natural gas-fueled vehicles – Releases during fueling and depressurization of high-pressure systems

Post-meter CH_4 emissions are estimated using activity-based emission factors listed in Table 7. The emission factors were held constant over the 1990-2020 time series. In 2020, estimated CH_4 emissions from all post-meter sources totaled 11.5 MMTe.

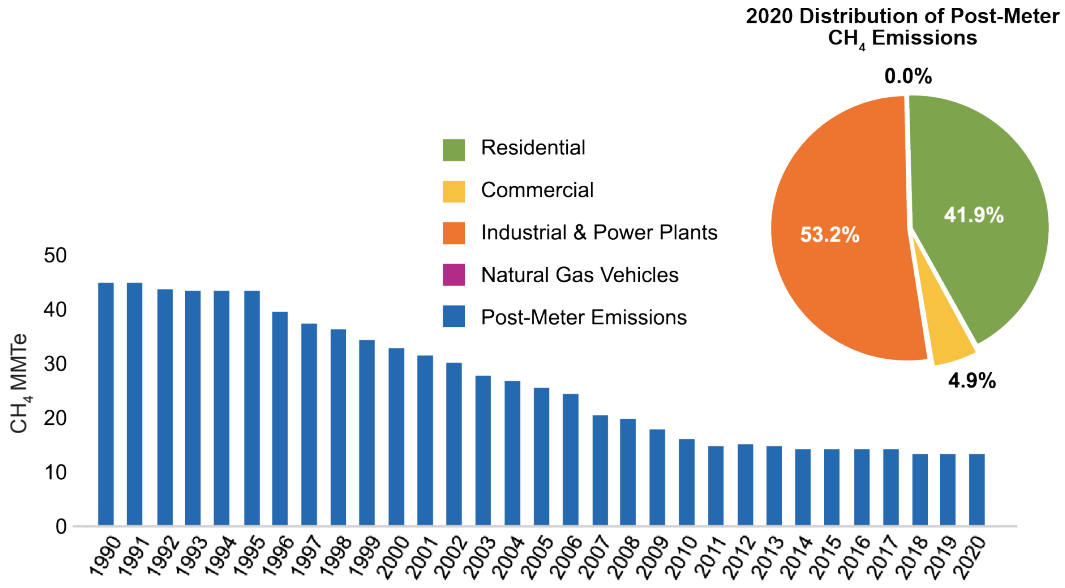
Table 7: 2020 National CH_4 Emission Factors and Emissions for the Post-Meter Segment

Post-Meter Subsegment	Activity	CH_4 Emission Factor	EF Data Source	CH_4 MMTe
Residential	84,726,000 NG houses	2.3 kg/NG House	CARB/Fischer et al. (2018)	4.8[4]
Commercial	5,626,925 appliances	4.0 kg/appliance	IPCC 2019	0.6
Industrial and Power Plants	21,571 Bcf	11,326.7 kg/Bcf	IPCC 2019	6.1
Natural Gas Vehicles	107,519 vehicles	0.3 kg/vehicle	IPCC 2019	0.001
Total				**11.5**

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020 - Updates for Post-Meter Emissions (April 2022), Annex Table 3.6-1, Environmental Protection Agency

Post-meter CH_4 emissions accounted for approximately 8% of emissions from natural gas systems in 2020. Leak emissions from residential appliances, industrial facilities, and power plants account for the majority (95%) of post-meter CH_4 emissions. CH_4 emissions from all post-meter sources increased by 58% from 1990 to 2020 and 1% from 2019 to 2020 due to increases in the number of residential homes using natural gas (NG houses) and increased natural gas consumption at industrial facilities and power plants. Trends in CH_4 emissions from the distribution and post-meter segments over the 1990 to 2020 time series are illustrated in Figure 9.

Figure 9: Trends in CH_4 Emissions from Post-Meter Segments (MMTe)



Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990- 2020, Annex Table 3.6-1, Environmental Protection Agency

[4] Incorporates a deduction of 23,005 MT CH_4 for residential natural gas combustion.

Fugitive emissions from residential appliances, which account for 42% of total post-meter CH_4 emissions in 2020, were estimated using an emission factor extracted from a single limited study conducted in California (Fischer et al.). The California study may not represent national activity for the residential appliance subsegment. EPA noted in the *Inventory* that it would continue to track studies that may include data that could be used to update the emission factor for residential post-meter emissions and to use instead of IPCC default values for commercial, industrial, and vehicle post-meter emissions. EPA may consider changes in emissions rates over the time series, such as applying default IPCC factors for residential emissions for earlier years.

CH_4 AND N_2O EMISSIONS FROM STATIONARY GAS COMBUSTION

The direct combustion of fuels by stationary sources in the electric power, industrial, commercial, and residential sectors represents the greatest share of U.S. GHG emissions. Combustion of fossil fuels, including coal, fuel oil, and natural gas, primarily results in emissions of CO_2, but CH_4 and N_2O are also emitted. N_2O is a product of combustion. The combustion of natural gas may result in emissions of unburned CH_4 ("CH_4 slip"). CH_4 may also form in combustion reactions. CH_4 and N_2O emissions from combustion are a function of fuel characteristics, size and vintage of the combustion technology, pollution control equipment, and operation and maintenance of the combustion equipment. CH_4 emissions from stationary combustion are primarily a function of the CH_4 content of the fuel and combustion efficiency of the appliance.

In 2020, CH_4 emissions from natural gas stationary combustion accounted for 13.3% and 33.3% of the direct fossil fuel (including natural gas, coal, fuel oil, and wood) emissions from the residential and commercial sectors, respectively. CH_4 emissions from natural gas combustion in the residential and commercial sectors in 2020 increased by 20% and 33%, respectively, from 1990 and registered no change from 2019. More detailed emissions from natural gas combustion can be found in Table 8 and Figure 10 below. In 2020, estimated CH_4 emissions from natural gas stationary combustion represented 1.5% of total natural gas system CH_4 emissions.

Table 8: 2020 CH_4 Emissions from Stationary Combustion (MMTe)

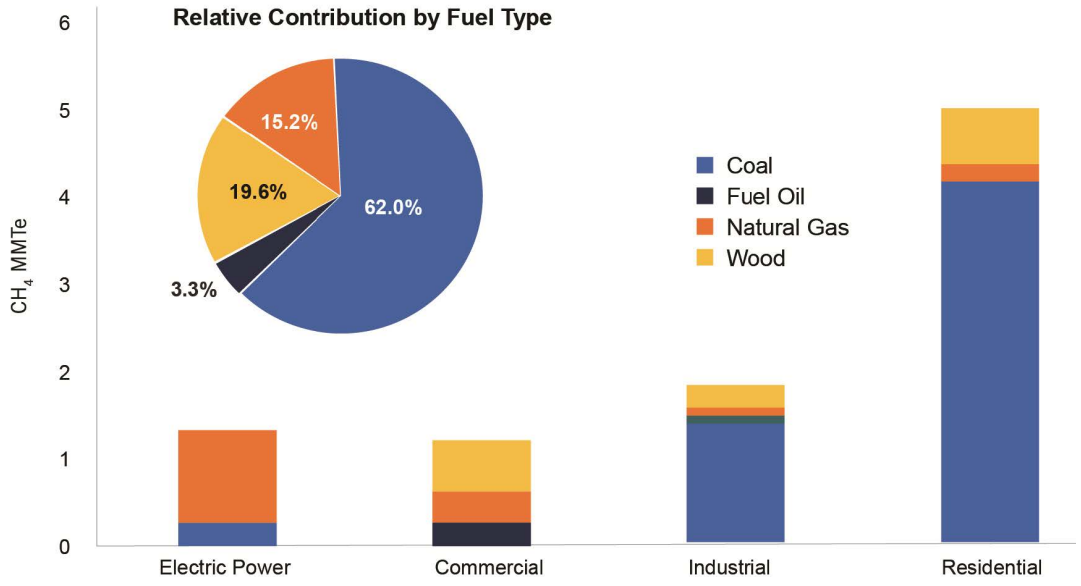
Sector/Fuel Type	1990	2005	2016	2017	2018	2019	2020
Electric Power	**0.4**	**0.9**	**1.2**	**1.1**	**1.2**	**1.3**	**1.2**
Coal	0.3	0.4	0.2	0.2	0.2	0.2	0.2
Fuel Oil	+	+	+	+	+	+	+
Natural gas	0.1	0.5	0.9	0.9	1.0	1.1	1.1
Wood	+	+	+	+	+	+	+
Industrial	**1.8**	**1.7**	**1.6**	**1.5**	**1.5**	**1.5**	**1.4**
Coal	0.4	0.3	0.2	0.2	0.1	0.1	0.1
Fuel Oil	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Natural gas	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Wood	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Commercial	**1.1**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**
Coal	+	+	+	+	+	+	+
Fuel Oil	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Natural gas	0.3	0.4	0.4	0.4	0.4	0.4	0.4
Wood	0.5	0.5	0.6	0.6	0.6	0.6	0.6
Residential	**5.2**	**4.1**	**3.9**	**3.8**	**4.6**	**4.7**	**4.1**
Coal	0.2	0.1	0.0	0.0	0.0	0.0	0.0
Fuel Oil	0.3	0.3	0.2	0.2	0.2	0.2	0.2
Natural Gas	0.5	0.6	0.5	0.5	0.6	0.6	0.6
Wood	4.1	3.1	3.2	3.1	3.7	3.9	3.3
U.S. Territories	**+**	**0.1**	**+**	**+**	**+**	**+**	**+**
Coal	+	+	+	+	+	+	+
Fuel Oil	+	0.1	+	+	+	+	+
Natural Gas	NO	+	+	+	+	+	+
Wood	NE	NE	NE	NE	NE	NE	NE
Total	**8.6**	**7.8**	**7.9**	**7.7**	**8.6**	**8.8**	**7.9**
Natural gas contribution	13%	22%	25%	26%	26%	26%	29%

NE = not emitted or zero

Totals may not sum due to independent rounding.

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Environmental Protection Agency Note: Totals may not sum due to independent rounding

Figure 10: 2020 CH_4 Emissions Fossil Fuel Combustion by Sector and Fuel Type (MMTe)



Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Environmental Protection Agency

CALCULATION OF CH_4 INTENSITY

CH_4 emissions intensity is a measure of CH_4 emissions from a company asset or a natural gas supply chain segment relative to the natural gas (or CH_4) throughput for that asset or segment. The Natural Gas Sustainability Initiative (NGSI) CH_4 Emissions Intensity Protocol, Version 1.0, February 2021 (NGSI Protocol) details a methodology for companies to calculate and report CH_4 emissions intensity consistently. The NGSI initiative is the result of a collaborative effort spearheaded by the AGA and Edison Electric Institute (EEI) with the investor community and experts from upstream, midstream, and downstream natural gas companies. The NGSI Protocol is intended to support voluntary reporting by companies operating within the natural gas supply chain in the United States from onshore production through distribution. NGSI is a voluntary, industry-led initiative to advance innovative efforts to address environmental, social, and governance (ESG) issues throughout the natural gas supply chain.

The NGSI Protocol may be used to estimate CH_4 intensity for an entire segment based on segment total CH_4 emissions and CH_4 throughput. The CH_4 intensity metric for a segment is determined in terms of percent as follows:

$$CH_4\,Intensity\ (\%) = \frac{CH_4\ Emissions\ from\ Natural\ Gas}{Methane\ Content\ of\ the\ Natural\ Gas\ Throughput}$$

The numerator of the CH_4 intensity equation is the annual total CH_4 volume or mass emissions reported in the *Inventory* for the system or segment/source. Mass emissions of CH_4 reported in the *Inventory* in terms of mass (kt or MMT) may be converted to volume basis using the density of CH_4 (0.0192 MMT/Bcf). In any case, the numerator and denominator must be in like units (mass or volume of CH_4). CH_4 emissions used in the numerator of the equation are not converted to CO_2e.

For natural gas systems, the portion of total CH_4 emissions is allocated to natural gas production, as opposed to other hydrocarbons that may be produced (e.g., crude oil, condensate), on an energy basis.

Annual natural gas throughput for natural gas systems, including the distribution and post-meter segments, is reported to and tracked by the Energy Information Administration (EIA). Data is available from 1997 through 2021.

Table 9: CH_4 Intensity for the Distribution and Post-Meter Segments, 2020

Segment/Source	Source of Natural Gas VolumeThroughput (EIA)	[1] 2020 CH_4 Volume Emissions (Bcf)	[2] Gas Ratio (GR) Energy Basis (dimensionless)	[3] 2020 CH4 Volume Throughput (Bcf)	[3]=[1]*[2]/[3] 2020 CH_4 Emissions Intensity (%)
Natural Gas System	U.S. Natural Gas Gross Withdrawals (MMcf)	343.5	0.66	34,237	0.66%
Natural Gas System, Excluding Post-Meter	U.S. Natural Gas Gross Withdrawals (MMcf)	319.6	0.66	34,237	0.62%
Distribution	Total Natural Gas Delivered to LDCs in the U.S. (1000 cf)	28.9	n/a	23,403	0.12%
Post-Meter		23.9	n/a	23,403	0.10%
Residential	U.S. Residential Volume (1000 cf)	10.0	n/a	3,940	0.25%
Commercial	U.S. Commercial Volume (1000 cf)	1.2	n/a	2,672	0.04%
Industrial & Power	U.S. Industrial & Power Volume (1000 cf)	12.7	n/a	16,751	0.08%
Natural Gas Vehicles	U.S. Natural Gas Vehicle Volume (1000 cf)	0.0017	n/a	6,871	0.00002%

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Environmental Protection Agency; U.S. Energy Information Administration; and NGSI Protocol v.1.

The annual U.S. natural gas volume throughput for each segment, million standard cubic feet (MMscf), compiled by EIA was converted to a CH_4 volume throughput (Bcf) using an assumed CH_4 volume fraction of natural gas (84.3%v CH_4) following the NGSI Protocol. The annual CH_4 volume throughput quantity (divisor in the intensity equation) was calculated in terms of Bcf CH_4. CH_4 intensity calculated for natural gas systems and the distribution and post-meter segments using the NGSI Protocol methods are summarized in Appendix A1.

CONCLUSION

The analysis characterized new estimates for CH_4 emissions and the implications for the GHG profile of natural gas. The EPA *Inventory* affirms a low CH_4 emissions profile for natural gas distribution systems shaped by a declining trend. The *Inventory* now includes estimates of CH_4 emissions from the post-meter segment, most prominently represented by leaks from residential appliances, industrial facilities, and power plants. The post-meter emissions have reshaped the CH_4 emissions profile for natural gas systems. Annual post-meter CH_4 emissions are determined using population-based emission factors (e.g., the number of natural gas homes). Consequently, CH_4 emissions from the post-meter segment would be expected to rise annually, with no net reductions in emissions that may be achieved over time, for example, with improvements in appliance technology.

The picture of GHG emissions from natural gas systems is continuously evolving and becoming more refined. Improved science and systematic data collection are essential to inform the public debate about the effect of natural gas use on the climate and to support recognition of the benefits of using natural gas to reduce GHG emissions.

The EPA *Inventory* is a continuous work in progress. Trends in natural gas system emissions are markers that signify directionally how new information better informs understanding of the GHG profile of natural gas production and use. New information will continue to refine the emissions estimates in the *Inventory*. It will offer industry, the public, and policymakers a better understanding of where emissions occur and the levels of released CH_4. Better information helps focus attention on cost-effective opportunities identified in the data.

AGA and the natural gas industry are committed to reducing CH_4 emissions and improving the safety and environmental profile of the natural gas system. These collective commitments are formalized in the AGA Climate Change Position Statement and include:[5]

- Further reducing CH_4 emissions from gas utility systems
- Encourage and support energy efficiency
- Increase efficiencies in operating facilities
- Scale-up and deploy advanced natural gas applications
- Invest in research, development,deployment of new emissions mitigation, delivery, and end-use technologies
- Supporting renewable natural gas development and use and assessing the potential of renewable power to gas
- Modernize pipeline and other natural gas utility infrastructure
- Encourage and support third-party damage prevention programs
- Utilitize recognized best practices to reduce CH_4 and transparently report emissions data
- Encourage and increase collaboration with natural gas producers and pipeline operators to help ensure that natural gas resources are developed and transported sustainably and responsibly

In addition to improvements in estimated emissions from natural gas systems, actual reductions are expected to continue. The natural gas utility industry invests on average $95 million daily in infrastructure upgrades and energy efficiency that are driving down greenhouse gas emissions from gas utility systems. Forty-two states and the District of Columbia have a program to facilitate accelerated replacement and modernization of natural gas distribution pipelines no longer fit for service.

[5] "Climate Change Position Statement," American Gas Association, January 2020,
Accessed at: https://www.aga.org/globalassets/aga_climate-change-document_final.pdf

EPA's CH_4 Challenge program, set up to transparently report systematic and comprehensive actions to reduce CH_4 emissions, has natural gas distribution utility partners that represent more than 80% of all U.S. natural gas customers. EPA's Natural Gas STAR program encourages natural gas and oil companies to adopt proven, cost-effective technologies and practices that improve operational efficiency and reduce CH_4 emissions.

Furthermore, certified or responsible natural gas offerings have expanded rapidly in 2022, including producers that have calculated the CH_4 intensity of their operations and had their superior performance certified by independent auditors. Certified gas is geologic natural gas differentiated by environmental performance criteria across the value chain.[6] EPA air standards mandating Industry adoption of reduced emission completions (RECs) went into effect in 2015 and will improve the capture of CH_4 at the wellhead.

AGA and the natural gas industry are committed to supporting studies to collect accurate measurements of CH_4 emissions from natural gas system operations. Additional studies are needed to quantify CH_4 emissions from the post-meter segment, as the emission factors supporting the *Inventory* are based on limited data from a single focused study. Further ongoing data collection and analysis from the government, academia, and industry will help inform public understanding of natural gas CH_4 emissions and the role natural gas plays in reducing emissions and addressing climate.

Improvements in technology, ongoing science, and understanding of existing trends reported by EPA point to the continuously improving emissions profile of the natural gas industry and help lay the foundation for natural gas as a critical component of the energy mix for years to come.

[6] Natural Gas Utility Industy Climate Change Commitments Industry Progress," American Gas Association, August 2022, Accessed at: https://www.aga.org/globalassets/research--insights/reports/aga_icfstudy_climatechangeposition_updated_08.22.2022.pdf

Appendix A.1

Table A.1: Calculation of CH_4 Intensity

	2020	*Source*
CH_4 Emissions from Natural Gas Systems (MMT)	6.60	*EPA GHGI 2022*
CH_4 Emissions from Distribution Segment (MMT)	0.55	*EPA GHGI 2022*
CH_4 Emissions from Post-Meter Segment (MMT)	0.46	*EPA GHGI 2022*
Residential (MMT)	0.19	*EPA GHGI 2022*
Commercial(MMT)	0.02	*EPA GHGI 2022*
Industrial & Power Plants (MMT)	0.24	*EPA GHGI 2022*
Natural Gas Vehicles (MMT)	3.23E-05	*EPA GHGI 2022*
CH_4 Emissions from Natural Gas Systems, excluding Post-Meter (MMT)	**6.14**	
CH_4 Emissions from Natural Gas Systems (Bcf)	343.5	*EPA GHGI 2022*
CH_4 Emissions from Distribution Segment (Bcf)	28.9	*EPA GHGI 2022*
CH_4 Emissions from Post-Meter Segment (Bcf)	23.9	*EPA GHGI 2022*
Residential (Bcf)	10.0	*EPA GHGI 2022*
Commercial (Bcf)	1.2	*EPA GHGI 2022*
Industrial & Power Plants (Bcf)	12.7	*EPA GHGI 2022*
Natural Gas Vehicles (Bcf)	1.68E-03	*EPA GHGI 2022*
CH_4 Emissions from Natural Gas Systems, excluding Post-Meter (Bcf)	**319.6**	
U.S. Natural Gas Gross Withdrawals (Bcf)	40,614	*EIA 2020*
Crude Oil Production (1,000s bbls)	4,129,563	*EIA 2020*
Lease Condensate Production (million bbls)	308	*EIA 2020*
U.S. Natural Gas Total Consumption (Bcf)	30,472	*EIA 2020*
Natural Gas Delivered to Consumers in the U.S. (Bcf)	27,660	*EIA 2020*
Natural Gas Delivered to LDCs in the U.S. (Bcf)	27,762	*EIA 2020*
Natural Gas Delivered to LDCs in the U.S.: Residential (Bcf)	4,674	*EIA 2020*
Natural Gas Delivered to LDCs in the U.S.: Commercial (Bcf)	3,170	*EIA 2020*
Natural Gas Delivered to LDCs in the U.S.: Industrial & Power (Bcf)	19,870	*EIA 2020*
Natural Gas Delivered to LDCs in the U.S.: Natural Gas Vehicles (Bcf)	8,151	*EIA 2020*
CH_4 Delivered to LDCs in the U.S. (Bcf)	23,403	*NGSI Protocol v.1*
CH_4 Delivered to LDCs in the U.S.: Residential (Bcf)	3,940	*NGSI Protocol v.1*
CH_4 Delivered to LDCs in the U.S.: Commercial (Bcf)	2,672	*NGSI Protocol v.1*
CH_4 Delivered to LDCs in the U.S.: Industrial & Power Plants (Bcf)	16,751	*NGSI Protocol v.1*
CH_4 Delivered to LDCs in the U.S.: Natural Gas Vehicles (Bcf)	6,871	*NGSI Protocol v.1*
BTU equivalent for U.S. Natural Gas Gross Withdrawals (MMBtu)	50,158,002,245	*NGSI Protocol v.1*
BTU equivalent for U.S. crude oil production (MMBtu)	23,951,465,400	*NGSI Protocol v.1*
BTU equivalent for lease condensate (MMBtu)	1,786,400,000	*NGSI Protocol v.1*
Gas Ratio (GR) energy basis (dimensionless)	0.66	*NGSI Protocol v.1*
CH_4 emissions intensity (%), Natural Gas Systems (Production)	0.66%	*NGSI Protocol v.1*
CH_4 emissions intensity (%), Distribution	0.12%	*NGSI Protocol v.1*
CH_4 emissions intensity (%), Post-Meter	0.10%	*NGSI Protocol v.1*
CH_4 emissions intensity (%), Post-Meter: Residential	0.25%	*NGSI Protocol v.1*
CH_4 emissions intensity (%), Post-Meter: Commercial	0.04%	*NGSI Protocol v.1*
CH_4 emissions intensity (%), Post-Meter: Industrial & Power	0.08%	*NGSI Protocol v.1*
CH_4 emissions intensity (%), Post-Meter: Natural Gas Vehicles	0.00002%	*NGSI Protocol v.1*
CH_4 emissions intensity (%), Natural Gas Systems (Production), excluding Post-Meter	**0.62%**	***NGSI Protocol v.1***

Source: EPA *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Energy Information Administration (2020); and Natural Gas Sustainability Initiative (NGSI) CH_4 Emissions Intensity Protocol, version 1.0 (2021).

Appendix A.2

Table A.2: 2020 CH_4 Emission Factors and Activity Data for the Natural Gas Distribution and Post-Meter Segments

Distribution and Post-Meter (2020)	Emission Factors	Activity Data
Normal Fugitives		
Pipeline Leaks		
Mains - Cast Iron	1,157.3 kg/mile	19,980 Miles
Mains - Unprotected Steel	861.3 kg/mile	48,244 Miles
Mains - Protected Steel	96.7 kg/mile	460,708 Miles
Mains - Plastic	28.8 kg/mile	787,868 Miles
Services - Unprotected Steel	14.5 kg/service	2,615,703 Services
Services - Protected Steel	1.3 kg/service	12,297,772 Services
Services - Plastic	0.3 kg/service	52,272,704 Services
Services - Copper	4.9 kg/service	655,762 Services
Meter/Regulator (City Gates)		
M&R > 300	2,142.7 kg/station	4,175 Stations
M&R 100-300	995.4 kg/station	15,235 Stations
M&R < 100	727.2 kg/station	8,143 Stations
Reg > 300	868.9 kg/station	4,564 Stations
R-Vault > 300	50.6 kg/station	3,972 Stations
Reg 100-300	143.4 kg/station	13,808 Stations
R-Vault 100-300	50.6 kg/station	12,491 Stations
Reg 40-100	163.7 kg/station	41,435 Stations
R-Vault 40-100	50.6 kg/station	8,897 Stations
Reg < 40	22.4 kg/station	17,570 Stations
Customer Meters		
Residential	1.5 kg/meter	56,719,359 Outdoor meters
Commercial	23.4 kg/meter	5,626,925 Meters
Industrial	105.0 kg/meter	184,011 Meters
Routine Maintenance		
Pressure Relief/Valve Relief	1.0 kg/mile	1,316,800 Miles main
Pipeline Blowdown	2.0 kg/mile	2,284,348 Miles
Upsets		
Mishaps	30.6 kg/mile	2,284,348 Miles

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Annex Tables 3.6-2, 3,6-7, Environmental Protection Agency

Appendix A.3

Table A.3: Activity Data and Data Sources/Methodology for Natural Gas Systems Distribution and Post-Meter Segments

Segment/Source	Units	Data Source(s)/Methodology
Distribution		
Pipeline Leaks		
Mains - Cast Iron	Miles	Material-specific mileage of distribution mains in year N (PHMSA 2021b). Refer to EPA 2016 d for additional details.
Mains - Unprotected Steel	Miles	
Mains - Protected Steel	Miles	
Mains - Plastic	Miles	
Total Pipeline Miles	Miles	Total miles of mains (all pipeline material types)
Services - Unprotected Steel	Services	Material-specific counts of distribution services in year N (PHMSA 2021b). Refer to EPA 2016d for additional details.
Services - Protected Steel	Services	
Services - Plastic	Services	
Services - Copper	Services	
Total Services	Services	Total services (all pipeline material type)
Meter/Regulator (City Gates)		
M&R > 300	Stations	1990-2006: [Base year 1992 estimate of stations per mile in each category (GRI/EPA 1996)] * [total miles of distribution pipeline in year N]. 2007-2010: [Base year 1992 estimate of stations per mile In each category scaled by residential gas consumption in year N (EIA 2020d) compared to base year] * [total miles of distribution pipeline in year N]. 2011-2020: Year specific GHGRP subpart W reported station count in each category scaled by total miles of mains compared to reported miles of mains. Refer to EPA 2016d for additional detail.
M&R 100-300	Stations	
M&R < 100	Stations	
Reg > 300	Stations	
R-Vault > 300	Stations	
Reg 100-300	Stations	
R-Vault 100-300	Stations	
Reg 40-100	Stations	
R-Vault 40-100	Stations	

Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Annex Tables 3.6-2, 3,6-7, Environmental Protection Agency

Table A.3: Activity Data and Data Sources/Methodology for Natural Gas Systems Distribution and Post-Meter Segments (continued)

Segment/Source	Units	Data Source(s)/Methodology
Reg < 40	Stations	
Customer Meters		
Residential	Outdoor meters	[Number of residential natural gas consumers in year N (EIA 2021g)] * [Weighted average percentage of meters outdoors (GRI/EPA 1996)]. Refer to EPA 2016d for additional detail.
Commercial	Meters	Total number of commercial and industrial natural gas consumers in year N (EIA 2021g). Refer to EPA 2021a for additional detail.
Industrial	Meters	
Routine Maintenance		
Pressure Relief/Valve Relief Releases	Miles main	Total miles of mains (all pipeline material types)
Pipeline Blowdown	Miles	Total miles of distribution pipelines (mains + services) (PHMSA 2020b)
Upsets		
Mishaps (Dig-ins)	Miles	Total miles of distribution pipelines (mains + services) (PHMSA 2020b)
Post-Meter		
Residential	NG houses	National counts of residential housing units that use natural gas as a fuel in year N (U.S. Census Bureau 2021).
Commercial	Appliances	Total number of commercial natural gas consumers in year N (EIA 2021g) * Average appliances per commercial meter (EIA 2021i).
Industrial & EGUs	BCF	Annual natural gas consumption in the industrial and power utilities sectors (EIA 2021d).
NG Vehicles	CNG vehicles	National counts of CNG vehicles from MOVE3 (EPA 2021d).

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020,
Annex Table 3.6-8, Environmental Protection Agency

Appendix A.4

Table A.4: Installed Pipeline Main and CH_4 Emissions from Main Pipe, 1990-2020

Year	Installed Main Pipe (Thousand Miles)	Emissions from Main Pipe (MMTe)
1990	944.2	14.65
1991	888.4	13.83
1992	888.9	13.34
1993	928.8	13.16
1994	1000.4	13.34
1995	1001.7	11.93
1996	975.2	11.28
1997	1068.8	10.85
1998	1019.8	10.17
1999	1004.9	9.52
2000	1048.5	9.08
2001	1099.1	8.72
2002	1133.6	8.13
2003	1104.7	7.46
2004	1158.2	7.21
2005	1162.6	6.67
2006	1185.3	6.26
2007	1201.1	5.81
2008	1207.6	5.37
2009	1218.1	4.89
2010	1228.3	4.48
2011	1237.5	4.02
2012	1246.0	3.97
2013	1253.7	3.86
2014	1264.9	3.78
2015	1275.2	3.69
2016	1284.9	3.67
2017	1294.8	3.58
2018	1305.7	3.49
2019	1306.4	3.38
2020	1316.8	3.30

Source: *Inventory* of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, Annex Table 3.6-1 and Table 3.6-7

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