American Gas Association

Energy Analysis

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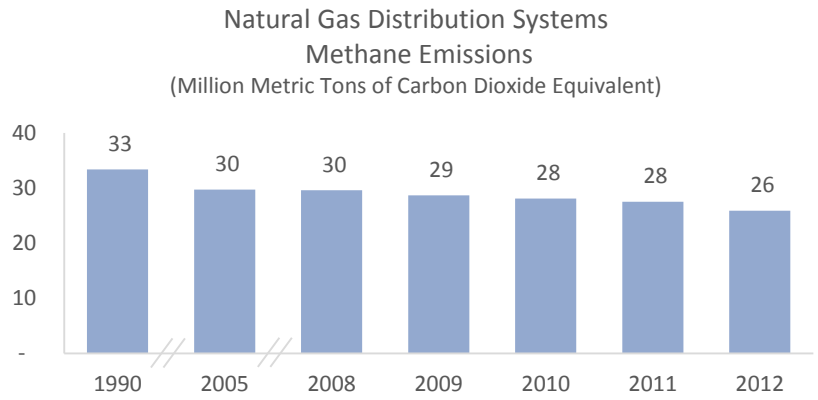
UPDATING THE FACTS: EMISSIONS FROM NATURAL GAS SYSTEMS

Natural gas remains a fuel of choice for consumers because of its low cost, efficient end uses, and environmental attributes. This domestically produced energy source is poised to serve as a foundation fuel for the US economy for years to come.

This potential has focused public attention on how the increased use of natural gas can reduce the environmental footprint of our energy usage. The use of natural gas results in far less carbon dioxide than coal or oil for the same amount of beneficial energy derived, and natural gas technologies serve as an effective complement to renewable energy. Better understanding of natural gas emissions released from production and delivery systems will further clarify how greater use of natural gas may achieve greater environmental benefits.

In April 2014, the Environmental Protection Agency (EPA) once again released its annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (Inventory) with updated estimates for natural gas emissions. The EPA Inventory is the most comprehensive assessment of emissions from natural gas systems.

It reveals that the natural gas distribution systems have a small emissions footprint shaped by a declining trend. Using EPA estimates, only 0.24 percent of produced natural gas is emitted from distribution systems owned and operated by local natural gas utilities. These emissions have declined 22 percent since 1990 even as natural gas utility companies added 600,000 miles of pipeline to serve 17.5 million more customers, an increase of more than 30 percent in both cases. This exceptional record can be traced to safety as the top priority for gas utilities who continue to be vigilant and deeply committed to systematically upgrading infrastructure through risk-based integrity management programs.



Source: *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2012*, Environmental Protection Agency

KEY FINDINGS FROM AGA ANALYSIS OF EPA GHG INVENTORY

- Methane emissions from the natural gas value chain, which includes field production, processing, transmissions and storage, and distribution, result in an effective 1.3 percent emissions rate of produced natural gas.

- Natural gas utility distribution systems methane emissions amount to an emissions rate of 0.24 percent of produced natural gas in 2012.

- Natural gas system methane emissions were 130 million metric tons of carbon dioxide equivalent (MMTe) in 2012, a decline of 17 percent from 1990 levels and 15 percent below 2005.

- Distribution system methane emissions were 26 MMTe in 2012 and have shrunk 22 percent between 1990 and 2012, even as the industry added 600,000 miles of total pipe (service and main lines) to serve 17.5 million more customers, an increase of 32 percent in both cases.

- Nearly 90 percent of the historical drop in methane emissions from distribution systems since 1990 are a direct result of pipeline upgrades to modern plastic and protected steel.

- Natural gas systems account for 23 percent of all methane emissions in the United States, a lower share than agricultural methane emissions.

- Natural gas emission reductions are leading the way toward reducing the nation's methane footprint. Reductions in natural gas system methane emissions are responsible for more than half (56 percent) of all annual methane emissions decline since 2008.

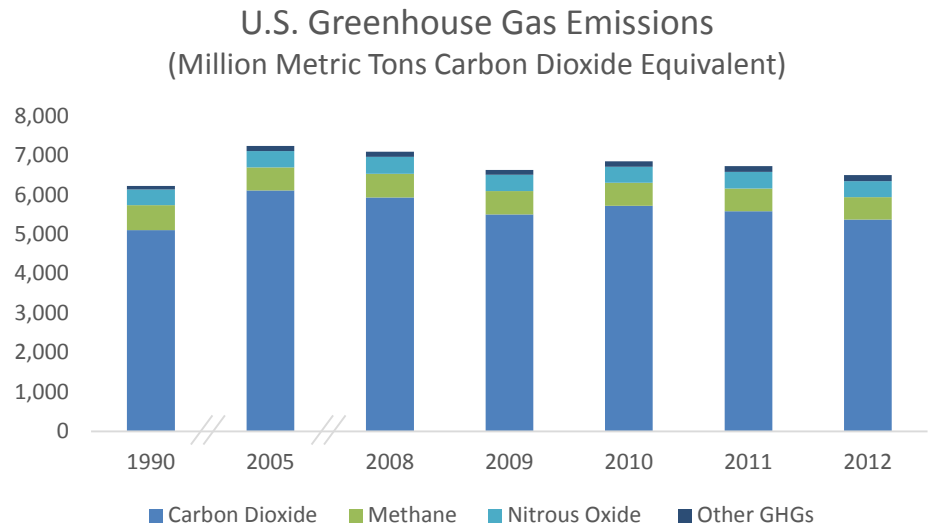
- Methane released from natural gas systems account for 2.0 percent of all U.S. greenhouse gas (GHG). Methane from distribution systems accounted for less than one half of one percent of U.S. GHGs in 2012.

SUMMARY AND ANALYSIS OF EPA INVENTORY

For almost two decades, the Environmental Protection Agency (EPA) has developed and published estimates of greenhouse gas (GHG) emissions in its annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (Inventory). It is the most comprehensive assessment of U.S. greenhouse gas emissions available.

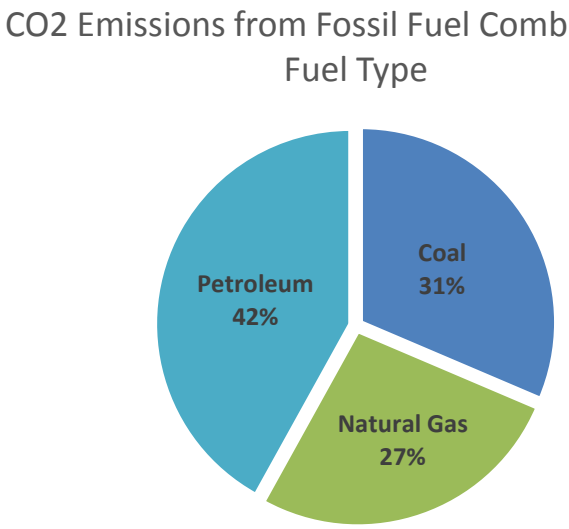
The Inventory covers all major and minor greenhouse gases, including carbon dioxide (CO_2), methane, nitrous oxides, and other lesser gases. EPA reports all emissions in units of CO_2-equivalence by weighting different air emissions by their respective global warming potentials relative to CO_2 over a 100-year time horizon, thus accounting for varying levels of radiative forcing of each gas. For methane, the EPA uses a global warming potential of 21, which remains unchanged for this analysis.[1]

In 2012, United States greenhouse gas emissions totaled 6,526 million metric tons of carbon dioxide equivalent (MMTe), down 3.4 percent from 2011. Total GHG includes contributions from carbon dioxide, methane, and all other greenhouse gases. Carbon dioxide from fossil fuel combustion constitutes 82 percent of the total and accounts for the vast majority of annual GHG emissions.

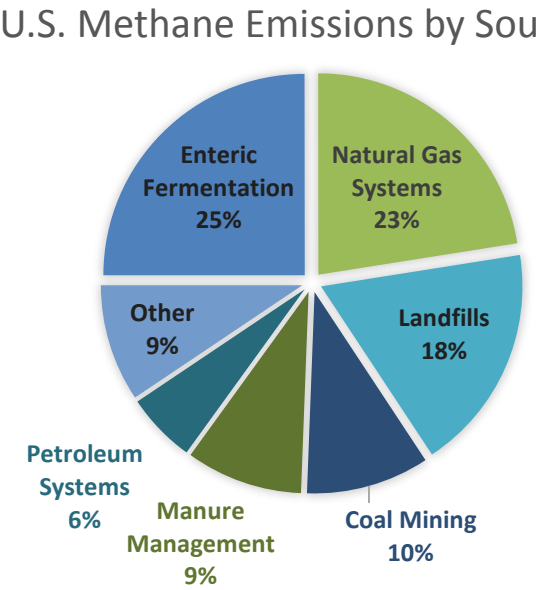


Total CO2 emissions from fossil fuel combustion equal 5,072 MMTe in 2012, which is 12 percent below 2005 levels. Petroleum combustion accounts for the largest amount of energy-related CO_2 emissions with a 42 percent share. Coal ranks second among the fossil fuels in this category at 31 percent, followed by natural gas at 27 percent.

[1] The EPA uses a global warming potential of 21 for methane 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 the third, fourth, and fifth Assessment Reports from the IPCC. Using these higher factors would increase the contribution of methane to total greenhouse gases relative to CO_2. Nevertheless, given the overwhelming contribution of CO_2 emissions in the natural gas life cycle, even a significant upward change in methane's global warming potential would not undermine the GHG benefits of using natural gas relative to other fossil energy sources.



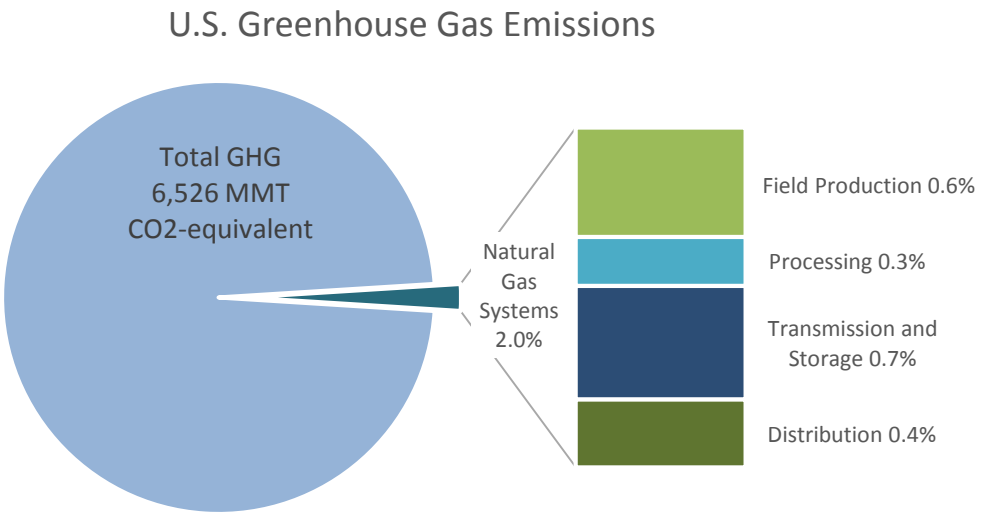
Methane is the second largest contributor to greenhouse gas emissions after CO_2. Major economic sectors that produce methane emissions are agricultural processes including livestock management and rice cultivation, and natural gas systems. Other major contributors include landfills, petroleum production, and coal mining. In 2012, methane emissions were 567 MMTe and accounted for 9 percent of all U.S. GHG emissions.



Nitrous oxide (N_2O) is the third largest contributor and results primarily from agricultural soil management and mobile and stationary combustion. N_2O emissions accounted for 6 percent of total GHGs in 2012. Other GHGs are include hydroflourocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) and collectively account for slightly less than 3 percent of total U.S. GHG.

Natural Gas System Methane Emissions

The U.S. natural gas system is comprised of thousands of well and drilling rigs, well completion equipment, numerous processing facilities, trillions of cubic feet of underground storage capacity, millions of meters, and an extensive transmission and distribution network comprised of 2.4 million miles of pipeline. The EPA categorizes the natural gas system into four distinct stages: production, processing, transmission and storage, and distribution. Methane and, to a lesser extent, CO2 are two the principal emissions related to the operation of natural gas systems. Methane emissions from natural gas systems represent the second largest source category for methane in the United States, constituting 23 percent of all methane released. In 2012, natural gas system methane emissions equaled 130 MMTe or 2.0 percent of total U.S. greenhouse gases.



The largest share of natural gas system methane emissions stems from field production at 31 percent. The transmission and storage stage at 34 percent, distribution at 20 percent, and processing at 15 percent. Historical emissions for natural gas systems are listed in Table 1.

Table 1
Methane Emissions from Natural Gas Systems
(million metric tons of CO_2 equivalent)

Stage	1990	2005	2008	2009	2010	2011	2012	Change 1990 - 2012
Field Production	56	67	64	54	48	43	42	-25%
Processing	18	14	15	16	15	18	19	4%
Transmission and Storage	49	41	43	44	43	45	44	-12%
Distribution	33	30	30	29	28	28	26	-22%
Total	156	152	152	143	135	133	130	-17%

Source: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012*, Environmental Protection Agency

Natural gas system performance has improved significantly during the past two decades in terms of methane released. New control technologies and better industry practices have contributed to significant emissions reductions, even as annual natural gas production and consumption have hit all-time record highs. Since 1990, absolute methane emissions have declined 17 percent, even as gross natural gas withdrawals climbed 37 percent. Emissions hit their all-time peak in 2007 and have fallen since.

Distribution System Methane Emissions

Natural gas distribution systems owned and operated by natural gas utilities deliver natural gas to consumers each year. Gas utilities serve predominantly households and businesses, along with about one quarter of natural gas to electricity generation. In all, natural gas utilities delivered 57 percent of all natural gas consumed across the country in 2012.

The regular operation and maintenance of natural gas systems along with emissions releases from accidents account for approximately one-fifth of estimated emissions from the whole natural gas industry. Distribution stage methane emissions, as evaluated by EPA, includes emissions from natural gas pipelines, meters and regulators at city gates, customer meters, upsets (mishaps such as excavation damage), and routine maintenance. Voluntary reductions by gas utility companies reduce these potential emissions each year and are reported to the EPA through its Natural gas STAR program.

Overall, emissions from distribution systems have been improving over time, even as the size of the system has grown significantly. Methane emissions from distribution systems were 26 MMTe in 2012, a decline of 22 percent from 1990 levels. This drop occurred even as the industry added 300,000 miles of distribution mains and an additional 300,000 miles of service lines (approximately 600,000 miles total) to serve 17.5 million more customers, a 32 percent increase in both cases.

Table 2: Potential Methane Emission Estimates from the Natural Gas Distribution Stage and Reductions from the Natural STAR Program (2012)

	Gg	MMTe	Share
Pipeline leaks	631	13	49.5%
Meter/Regulator (City Gates)	503	11	39.4%
Customer Meters	103	2	8.0%
Routine Maintenance	4	0	0.3%
Upsets	35	1	2.8%
Potential Emissions Subtotal	1,276	27	100.0%
Voluntary Reductions	(45)	(1)	
Net Emissions	1,231	26	

Source: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012*, Annex 3, Table A-140

The vast majority of distribution emissions take place via two activities: pipeline emissions and meter/regulator operation. Slightly less than half, 49.5 percent, of

estimated distribution system potential methane emissions are associated with pipeline leaks, and 39.4 percent result from the operation of gas meter and regulators at city gates, which connects the transmission system with the distribution network, as well as customer meters on site.[2]

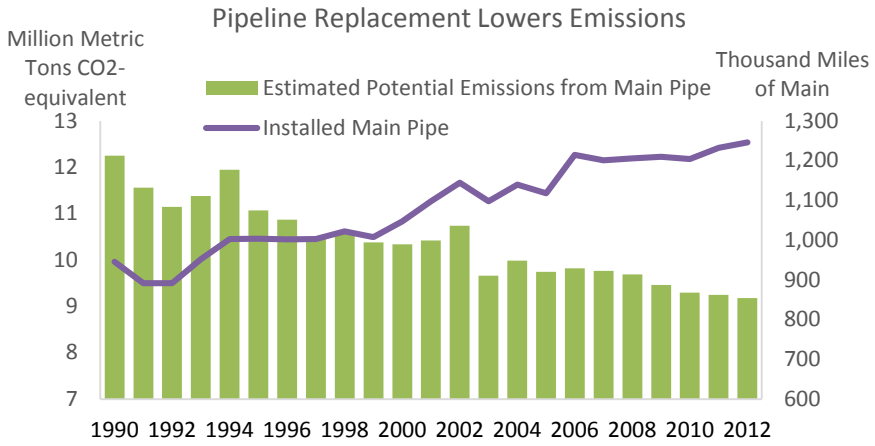
While most distribution stage methane emissions are a result of pipeline leaks, most of the historical reductions in distribution emissions are the direct result of gas utilities upgrading the pipeline system with more modern materials. Reduction of pipeline leaks accounts for nearly 90 percent of potential methane emissions from distribution systems since 1990, a direct result of the increased use of plastic and protected steel pipe.

Table 3: Potential Methane Emission Estimates from the Natural Gas Distribution Stage (Gg)

	1990	2012	Change	Share of Decline
Pipeline Leaks	915	631	283	90%
Meters, Regulators, and Other	677	645	32	10%
Total Potential Emissions	1,591	1,276	315	100%

Source: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012*, Annex 3, Table A-140

These reductions have been explicitly estimated and reported in the EPA Inventory. This analysis reproduces the EPA estimates below using EPA emissions factors for pipeline main and data from the Department of Transportation on miles of pipeline in operation. The graphic below shows potential emissions from pipeline main. Although this analysis focuses solely on pipeline main, a similar analysis can be done on emissions from service lines.



[2] Pipeline leaks are typically classified by the severity of the leak and the 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 to 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.

The number of miles of installed main has increased 32 percent since 1990 and in 2012 totaled 1.25 million miles. Even with this tremendous growth in distribution main pipe, estimated potential emissions declined 25 percent during this period, a consequence of increased removal of unprotected steel and cast iron pipe and replaced with plastic and protected steel.[3] Potential emissions associated with unprotected steel and cast iron pipelines in particular declined 4.5 MMTe from 1990 to 2012. These declines are offset by an increase of 1.4 MMTe in estimated emissions from plastic- and protected steel pipe. All told, ninety percent of the reductions in distribution system emissions have come from the increased use of plastic and protected steel pipe replacing unprotected steel and cast iron.

This exceptional record is because safety is the top priority for gas utilities who continue to be vigilant and deeply committed to systematically upgrading infrastructure through risk-based integrity management programs. Today, there is a growing effort to accelerate the replacement of pipelines no longer fit for service. Thirty-eight states have some form of accelerated infrastructure replacement program, which is helping reduce emissions. It is because of these continuing efforts to modernize infrastructure and to enhance pipeline safety that natural gas emissions from distribution are expected to continue to decline.

CALCULATION OF METHANE EMISSIONS RATE

What do these levels of natural gas system methane emissions mean in the context of rapidly growing production? The following analysis calculates an effective *emissions rate of production*, or the amount of methane released for each unit of natural gas produced at the wellhead. This metric has been used by a number of groups as a benchmark for natural gas system performance. The calculation can be made using EPA estimates for methane emissions from natural gas systems and statistics on annual natural gas production volumes from the U.S. Energy Information Administration (EIA). The section that follows will step through these calculations and derive a value for the emissions rate of production and examine how it has changed over time.

Using the EPA Inventory, natural gas systems released 6,186 Gg of methane in 2012, which is equivalent to 323 Bcf. This value includes emissions from natural gas wells only. However, associated natural gas production from oil wells accounted for 17 percent of gross natural gas withdrawals in 2012, so it is appropriate to account for methane emissions from these petroleum sources also. We attribute a portion of methane emissions from petroleum production to the natural gas value chain based on the ratio of natural gas to other produced liquids and gases from oil wells.[4] The natural gas

[3] Potential emissions are calculated estimates using an emissions factor multiplied by a corresponding activity factor. These estimates therefore excludes voluntary reductions reported to the EPA Natural Gas STAR program, a consideration that's incorporated into the final emissions reported in the EPA Inventory.

[4] This analysis assigns a portion of petroleum system methane emissions from natural gas production out of oil wells to the natural gas system. This contribution is small compared with combustion-related CO_2. Furthermore, these emissions should be considered an upper bound since it is not clear that the petroleum system methane emissions would not have occurred otherwise if marketable natural gas was

fraction of total energy content (oil plus natural gas) from oil wells was 27 percent in 2012.[5] Applying this factor to total petroleum system methane emissions, we can attribute 21 Bcf of methane from petroleum production to the natural gas value chain. Using EIA data for U.S. gross natural gas withdrawals of 29,542 Bcf in 2011 and assuming a conservative methane content of 90 percent for natural gas, we calculate:

$$[\ (323\ \text{Bcf} + 21\ \text{Bcf}\ )\ /\ 29{,}542\ \text{Bcf}\ ]\ *\ (1\ /\ 90\%) = 1.27\%$$

The calculated emissions rate of 1.3 percent is far below earlier estimates of 2.2 to 2.4 percent derived using data from prior EPA Inventories, and far below other studies that peg emissions rate even higher.

Table 4
Historical Natural Gas Emissions Rate of Production

Natural Gas Emissions Rate of Production						
1990	2005	2008	2009	2010	2011	2012
2.1%	1.9%	1.7%	1.6%	1.5%	1.4%	1.3%

Source: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012*
Energy Information Administration & AGA

Applying this methodology using data from prior years, one can see that the emissions rate of production has steadily decreased during the past two decades, down from 2.1 percent in 1990 (see Table 4). This implies the natural gas system has improved nearly 40 percent during the last two decades in terms of the methane released for each unit of natural gas produced, processed, transported, and delivered to consumers. Part of this improvement is the result of improvements to practices, advances in technology, and investments in lower emitting equipment and infrastructure. This evolution toward better practices is further evidenced by the shift toward unconventional resource production, which has spurred the use of new extraction and control technologies. Furthermore, wider industry participation in EPA's voluntary program Natural Gas STAR has been instrumental in advancing cost effective technologies and practices to control methane emissions. We anticipate that control technologies for methane emissions will continue to improve and proliferate over time.

The distribution system share of industry wide emissions is 20 percent. Therefore, an effective emissions rate of production for distribution system natural gas emissions is 0.24%.

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not part of the oil well production. In many cases, the oil well would likely still be produced and the non-marketed natural gas would have been vented or flared, thus contributing to the petroleum system footprint and not the natural gas value chain.

[5] Calculated using the gas fraction of total energy from oil wells. Gross natural gas withdrawal from oil wells was 5.0 Tcf in 2012. Crude oil production was 2.4 billion barrels. Energy equivalency conversions assumed: 1,027 cf / MMbtu for natural gas and 5.8 MMBtu / bbl.

The industry and many of its observers routinely reference a natural gas emissions rate of production as the preferred metric by which to account for emissions in relation to industry activity. As such, it is entirely appropriate to use a similar metric for distribution systems in order to maintain consistency with metrics applied to the entire value chain. However, there are other metrics, some of which are laid out below. For example, an alternative approach would be to take the ratio of distribution system emissions and LDC throughput. A series of emissions ratios are laid out below and details behind the calculations can be found in the Appendix.

Table 5: Distribution System Emissions Ratios

Natural Gas System Emissions as % of	
Production	0.24%
Consumption	0.28%
Volumes to Consumers	0.31%
LDC Volumes to Consumers	0.54%

CONCLUSION

This analysis characterized new estimates for methane emissions and the implications for the GHG profile of natural gas. The EPA Inventory affirms a low methane emissions profile for natural gas systems shaped by a declining trend. But the picture of emissions from natural gas systems is continuously evolving and becoming more refine. Improved science and systematic data collection is 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 greenhouse gas emissions.

The EPA Inventory is a continuous work in progress. Trends in natural gas system emissions should be viewed as 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 and will offer to industry, the public, and policymakers a better understanding where emissions occur and the levels of released methane. Better information helps focus attention on cost effective opportunities identified by the data.

AGA and its members are committed to supporting studies to collect accurate measurements of emissions from natural gas utility operations. Since 2013, a group of 13 natural gas utilities have been engaged with a research team from the Washington State University on a project to collect new data on distribution system emissions. The work is meant to identify and quantify equipment-specific leaks to develop, results that may be able to be incorporated into future EPA Inventories. In addition to this critical work, other studies are examining emissions from other stages of the natural gas value chain. Ongoing data collection and analysis from government, academia, and industry will help to better refine public understanding of natural gas methane emissions and the role natural gas plays in reducing emissions and addressing climate.

In addition to improvements in estimated emissions from natural gas systems, actual reductions are expected to continue. EPA air standards mandating industry adoption of reduced emission completions (RECs) goes into effect in 2015 and will improve capture of methane at the wellhead. During the interim, fractured and refractured wells without RECs will be required to combust methane not captured, suggesting further progress in reducing the production GHG footprint will be made prior to the effective date of the rule.

All told, because of improvements in technology, ongoing science, and understanding of existing the trends reported by EPA, signs point to a 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.

APPENDIX

A.1 CALCULATION OF EMISSIONS RATES

Emissions Rates Calculations Based on EPA Inventory (2012)			Relevant Source
[A]	CH4 Natural Gas Systems (Bcf)	323	EPA
[B]	NG Fraction of Total Energy Content from Oil & Gas Production	27%	EIA
[C]	NG Fraction of CH4 from Petroleum Production (Bcf)	21	EIA, EPA
[D]	U.S. Gross Natural Gas Production (Bcf)	29,542	EIA
[E]	Methane Content of U.S. Pipeline NG	90.0%	AGA Estimate
([A]+[C])/([D]*[E])	Natural Gas Leakage - NG System as % of Total NG Production	1.27%	Calculation
[F]	Methane Emissions - Distribution Systems (Bcf)	64	EPA
[G]	U.S. Natural Gas Consumption (Bcf)	25,533	EIA
[H]	U.S. Natural Gas Volumes Delivered to Consumers (Bcf)	23,394	
[I]	LDC Natural Gas Volumes Delivered to Consumers (Bcf)	13,333	
[K]	Methane Content of Distribution System Natural Gas	90.0%	AGA Estimate
	Natural Gas Leakage - Distribution Systems as % of		
[F] / ([D] * [K])	Production	0.24%	Calculation
[F] / ([G] * [K])	Consumption	0.28%	
[F] / ([H] * [K])	Volumes Delivered to Consumers	0.31%	
[F] / ([I] * [K])	LDC Volumes Delivered to Consumers	0.54%	

A.2 EPA METHANE EMISSIONS FACTORS AND ESTIMATED EMISSIONS

2012 Data and CH4 Emissions (Mg) for the Natural Gas Distribution Stage

		Activity Data		Emission Factor (Potential)aa	**Calculated Potential Emissions (Mg)**
Pipeline Leaks					
Mains—Cast Iron	32,418	miles a,1	239	Mscf/mile-yrb	149,037
Mains—Unprotected steel	63,727	miles a,1	110	Mscf/mile-yrb	135,245
Mains—Protected steel	487,225	miles a,1	3	Mscf/mile-yrb	28,780
Mains—Plastic	661,100	miles a,1	10	Mscf/mile-yrc	126,182
Services—Unprotected steel	3,916,353	services a,1	2	Mscf/serviceb	128,287
Services Protected steel	14,951,473	services a,1	0	Mscf/serviceb	50,825
Services—Plastic	45,147,410	services a,1	0	Mscf/serviceb	8,085
Services—Copper	1,009,255	services a,1	0	Mscf/serviceb	4,944
Meter/Regulator (City Gates)					
M&R >300	3,465	stations d,2	180	scfh/stationb	105,101
M&R 100-300	12,644	stations d,2	96	scfh/stationb	203,936
M&R <100	6,758	stations d,2	4	scfh/stationb	4,914
Reg >300	3,788	stations d,2	162	scfh/stationb	103,468
R-Vault >300	2,225	stations d,2	1	scfh/stationb	488
Reg 100-300	11,459	stations d,2	41	scfh/stationb	78,301
R-Vault 100-300	5,148	stations d,2	0	scfh/stationb	156
Reg 40-100	34,387	stations d,2	1	scfh/stationb	6,034
R-Vault 40-100	30,494	stations d,2	0	scfh/stationb	445
Reg <40	14,581	stations d,2	0	scfh/stationb	327
Customer Meters					
Residential	35,693,769	outdoor meters b,2	143	scfy/meterb	98,493
Commercial/Industry	4,481,003	meters b,2	48	scfy/meterb	4,134
Routine Maintenance					
Pressure Relief Valve Releases	1,244,470	mile main a,1	0	Mscf/mileb	1,198
Pipeline Blowdown	1,156,453	miles b,2	0	Mscfy/mileb	2,272
Upsets					
Mishaps (Dig-ins)	1,156,453	miles b,2	2	Mscfy/mileb	35,415
Regulatory Reductions (Gg)					**-**
Voluntary Reductions (Gg)					**(45)**
Total Reductions (Gg)					**(45)**
Total Potential Emissions (Gg)					**1,276**
Total Net Emissions (Gg)					**1,231**

a Pipeline and Hazardous Materials Safety Administration (PHMSA), Office of Pipeline Safety (OPS) (2012)
b EPA/GRI (1996), Methane Emissions from the Natural Gas Industry
c ICF (2005), Plastic Pipe Emission Factors
d ICF (2008), Natural Gas Model Activity Factor Basis Change
aa Emission factors listed in this table are for potential emissions (unless otherwise indicated in a footnote). For many of these sources, emission reductions are subtracted from potential emissions to calculate net emissions. For this reason, emission factors presented in these tables cannot be used to directly estimate net emissions from these sources. See detailed explanation of methodology above.
1 Activity data for 2012 available from source.
2 Ratios relating other factors for which activity data are available.

A.3 – Estimated Emissions from Distribution Main Pipeline Calculations

Table 6: Miles of Distribution Main Pipeline

Year	Steel Unprotected Bare	Steel Unprotected Coated	Steel Cathodically Protected Bare	Steel Cathodically Protected Coated	Plastic	Cast/Wrought Iron	Total Miles
1990	74,212	34,729	26,353	439,185	311,386	58,292	945,964
1991	74,142	28,674	20,455	453,272	255,681	56,158	891,352
1992	72,279	27,340	23,657	445,449	267,283	52,917	892,014
1993	72,215	27,120	22,768	458,934	293,547	54,190	951,750
1994	73,834	25,390	24,280	485,021	333,689	58,148	1,002,669
1995	71,060	22,998	23,613	479,675	353,735	50,625	1,003,798
1996	66,489	21,923	41,705	442,821	350,699	51,542	1,001,771
1997	63,630	21,536	19,637	459,641	385,373	47,669	1,003,085
1998	65,273	21,366	30,530	454,433	400,627	47,587	1,022,086
1999	62,795	21,739	14,891	444,407	415,210	45,865	1,007,459
2000	62,124	20,731	14,874	454,432	447,586	44,726	1,046,790
2001	62,062	19,164	16,482	456,796	496,504	44,270	1,097,623
2002	64,662	17,948	15,338	472,152	525,815	45,523	1,144,665
2003	53,754	17,727	15,141	466,749	501,278	40,588	1,097,911
2004	57,297	18,554	18,682	470,417	531,365	40,581	1,139,663
2005	54,655	17,715	14,817	452,957	535,338	39,758	1,117,784
2006	52,683	19,111	14,651	468,174	619,427	37,129	1,214,342
2007	51,772	19,020	13,650	474,925	601,947	37,669	1,201,138
2008	51,077	19,247	12,923	472,994	610,832	36,815	1,205,991
2009	47,740	19,528	13,147	470,813	620,610	35,429	1,209,486
2010	49,639	16,205	17,303	465,832	619,360	34,462	1,204,432
2011	48,155	15,937	14,176	474,002	644,749	33,586	1,232,278
2012	47,692	16,037	13,647	473,545	661,139	32,418	1,246,251

Source: *Department of Transportation Form 7100*

Table 7: EPA Emissions Factors for Distribution Pipelines by Material (per mile)

	Standard cubic feet per hour per mile	Metric Ton CO2-eq per year
Unprotected Steel	12.8	44.4
Cast Iron	26.7	96.1
Plastic Pipe	1.2	4.0
Protected Steel	0.4	1.2

Source: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012*

Table 8: Installed Pipeline Main and Estimated Potential Emissions from Main Pipe

	Installed Main Pipe (thousand miles)	Estimated Potential Emissions from Main Pipe (MMTe)
1990	946	12.25
1991	891	11.56
1992	892	11.15
1993	952	11.38
1994	1,003	11.95
1995	1,004	11.07
1996	1,002	10.87
1997	1,003	10.49
1998	1,022	10.61
1999	1,007	10.38
2000	1,047	10.34
2001	1,098	10.42
2002	1,145	10.74
2003	1,098	9.67
2004	1,140	9.99
2005	1,118	9.74
2006	1,214	9.82
2007	1,201	9.76
2008	1,206	9.69
2009	1,209	9.46
2010	1,204	9.30
2011	1,232	9.24
2012	1,246	9.18

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