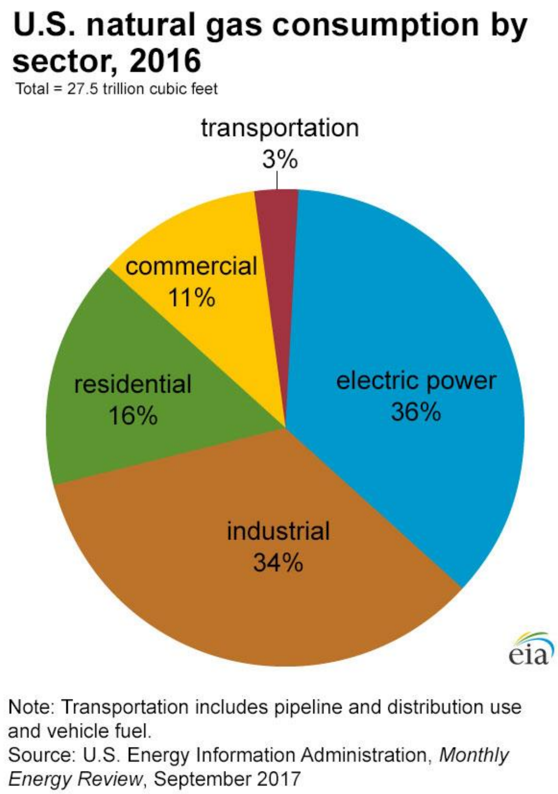
Improving Methane Emissions from Natural Gas Transmission and Storage

Natural gas plays an important role in our modern lives. Natural gas helps diversify the nation's energy portfolio by providing a reliable source of energy generation that complements renewable sources that have variable generation. It is also used for heating homes, cooking, drying clothes and as a chemical feedstock to manufacture plastics, fertilizer, and other chemicals and products.[1] As shown in Graph 1 below, there are three roughly equal segments of natural gas consumption: about one-third for electric power generation, another third for industrial/manufacturing uses, and the remaining third for a combination of residential, commercial and transportation use.



Graph 1

Pipelines serve as a reliable and indispensable link between natural gas producers and consumers. For example, INGAA member companies move natural gas through interstate natural gas pipelines,[2] which supply 68.4 million homes and 5.5 million commercial businesses with natural gas for heating and other resources.[3]

As major transporters of natural gas, INGAA member companies are committed to minimizing methane emissions from natural gas transmission and storage facilities. In 2018, INGAA member companies developed voluntary methane emissions commitments for their interstate natural gas transmission and storage facilities.[4]

This white paper supplements those commitments by explaining the sources of methane emissions for the interstate natural gas transmission and storage sector, which is comprised of a network of high-pressure pipelines, compressor

[1] U.S. Energy Information Administration Natural Gas Explained: Use of Natural Gas, https://www.eia.gov/energyexplained/index.cfm?page=natural_gas_use.
[2] Interstate natural gas pipelines are long-distance, wide-diameter (20"-48") pipelines that cross state boundaries.
[3] U.S. EIA, Number of Natural Gas Consumers, https://www.eia.gov/dnav/ng/ng_cons_num_dcu_nus_a.htm.
[4] *See* Methane Emissions Commitments.

stations, and storage assets (salt caverns and reservoirs), as well as the basis for the methane emissions commitments that INGAA members voluntarily adopted.

When developing methane commitments, INGAA members recognized that flexibility is essential to a successful voluntary methane emission reduction program. Providing flexibility affords operators the ability to focus their resources on opportunities to minimize methane emissions in a cost-effective manner rather than strictly adhering to prescribed criteria.

METHANE EMISSIONS

Natural gas is a mixture of several types of hydrocarbon gases, the primary component of which is methane.[5] The natural gas transmission sector transports pipeline-grade natural gas that meets certain requirements and is typically over 90 percent methane.[6] Methane is a greenhouse gas (GHG) with a global warming potential (GWP) that is 25 times more potent than carbon dioxide (CO_2) over a 100-year horizon.[7]

GHG emissions come from a variety of sources, including electricity generation, transportation, industrial activities, commercial and residential activities, and agriculture. *See* Graph 2. Electricity generation and transportation are the two largest sources of GHGs in the U.S., each contributing 28 percent of the U.S.'s emissions. *See* Graph 2. In recent years, electricity generation using natural gas has increased, often replacing coal-fired generation, and, as a result, CO_2 emissions in the U.S. have decreased.[8] This trend is projected to likely continue.[9] As shown in Graph 3, CO_2 accounts for over 80 percent of GHGs; at only 10 percent, methane comprises a much smaller percentage of U.S. GHGs.[10] Emissions from "industry" are the third largest source of U.S. GHGs. *See* Graph 2. Emissions from the oil and gas sector are a subset of the GHG emissions reported by "industry." GHG emissions from "industry" are from a wide variety of sources, including but not limited to: fossil fuel combustion, natural gas systems,[11] petroleum systems,[12] and the production of various products such as iron, steel, cement, petrochemicals, ammonia, and glass.[13] As shown in Graph 4, emissions caused by fossil fuel combustion account for over half of the emissions from industry. Natural gas and petroleum systems together account for about 18 percent of industry emissions.

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[5] Naturalgas.org, http://naturalgas.org/overview/background; *see also* U.S. EPA, Options for Reducing Methane Emissions From Pneumatic Devices in the Natural Gas Industry (Oct. 2006) at 7, https://www.epa.gov/sites/production/files/2016-06/documents/ll_pneumatics.pdf.

[6] *See* U.S. EPA, Natural Gas Star Program, Overview of the Oil and Natural Gas Industry, https://www.epa.gov/natural-gas-star-program/overview-oil-and-natural-gas-industry; Demirbas, Ayhan, *Methane Gas Hydrate* 58 (Springer 2010), *available at* https://www.springer.com/cda/content/document/cda_downloaddocument/9781848828711-c1.pdf?SGWID=0-0-45-862344-p173918930.

[7] U.S. EPA, Greenhouse Gas Emissions, https://www.epa.gov/ghgemissions/overview-greenhouse-gases (citing IPCC (2007) *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. [S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press. Cambridge, United Kingdom). Note that the GWP of a gas depends on the timeframe used in the analysis. *See* U.S. EPA, Greenhouse Gas Emissions - Understanding Global Warming Potentials, https://www.epa.gov/ghgemissions/understanding-global-warming-potentials#Learn%20why (explaining that the GWP for methane is different for 100 years versus 20 years).

[8] U.S. EPA, Sources of Greenhouse Gas Emissions, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

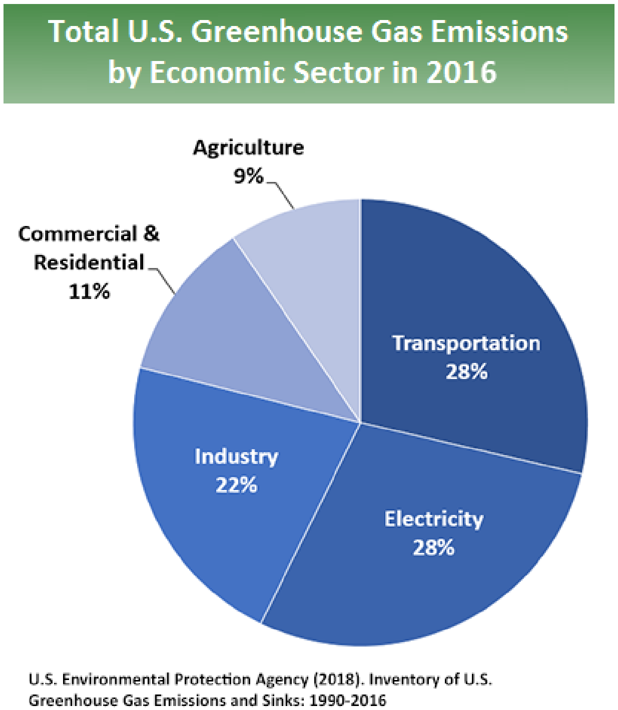
[9] *See* U.S. EIA, *EIA forecasts natural gas to remain primary energy source for electricity generation* (Jan. 22, 2018), https://www.eia.gov/todayinenergy/detail.php?id=34612; *see also* U.S. EIA, *Future U.S. electricity generation mix will depend largely on natural gas prices*, https://www.eia.gov/todayinenergy/detail.php?id=34852.

[10] U.S. EPA, Greenhouse Gas Emissions, Inventory of U.S. Greenhouse Gas Emissions and Sinks (1990-2016), https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.

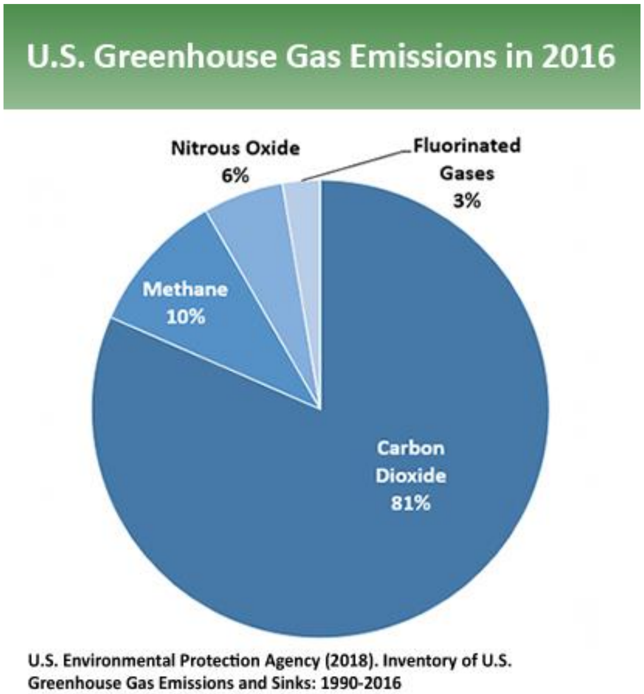
[11] The category "natural gas systems" covers the exploration, production (including gathering and boosting), processing, transmission and storage, and distribution of natural gas. *See* U.S. EPA, Greenhouse Gas Emissions, Inventory of U.S. Greenhouse Gas Emissions and Sinks (1990-2016), https://www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf at 3-78 to 3-79 (hereinafter "*2016 Inventory*").

[12] The category "petroleum systems" covers onshore and offshore crude oil production, transportation, and refining operations. *See id.* at 3-63.

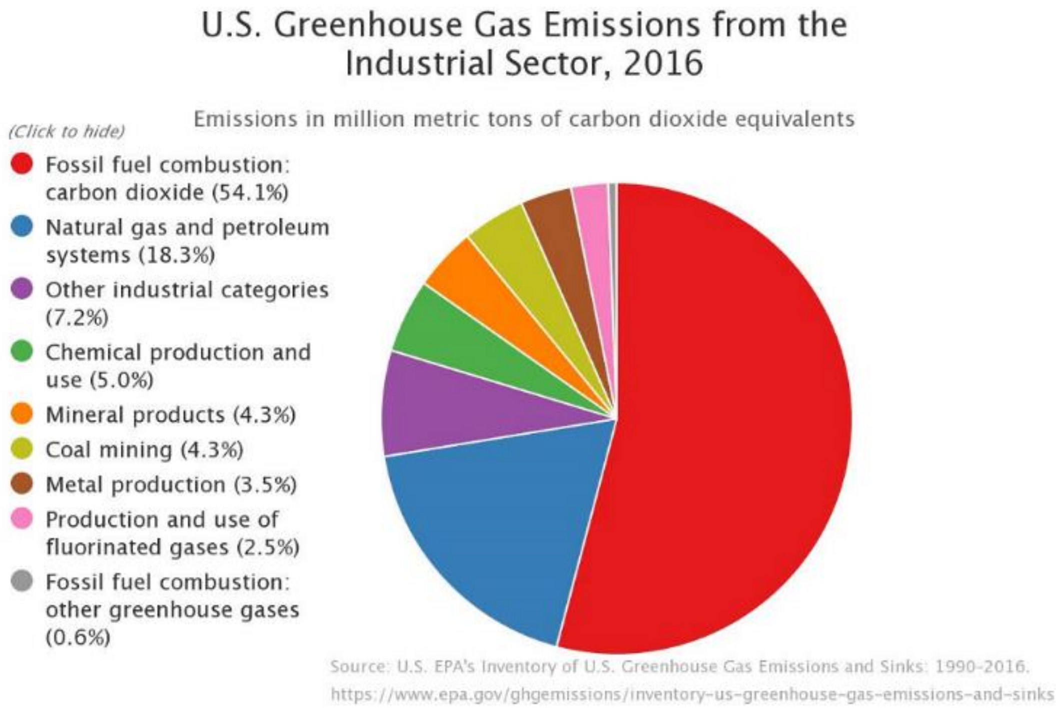
[13] *See id.* at 2-25 to 2-26.



Graph 2



Graph 3



Graph 4

THE NATURAL GAS TRANSMISSION AND STORAGE SECTOR'S METHANE REDUCTION HISTORY

Since 1993, the U.S. Environmental Protection Agency (EPA) has collaborated with the U.S. oil and natural gas industry on its voluntary Natural Gas STAR Program.[14] The program "provides a framework for partner companies to implement methane-reducing technologies and practices and document their voluntary emission reduction activities."[15] "Through this work, the oil and natural gas industry has pioneered some of the most widely used, innovative technologies and practices that reduce methane emissions."[16]

By measuring, monitoring and reducing the transmission and storage sector's methane emissions for over two decades, INGAA member companies have gained knowledge regarding the sources of methane emissions.[17] This experience has enabled the industry to target the most significant sources and identify the most cost-effective methane emission reduction strategies. To reduce methane emissions, the natural gas transmission and storage sector has taken steps such as:

- evaluating improvements to the energy efficiency of facilities (e.g., compressor stations, underground storage, etc.);
- monitoring leaks from compressors;
- implementing inspection and maintenance methods to reduce equipment leaks;
- using pneumatic devices that have low or no methane emissions; and
- employing advanced technologies and management practices that reduce the amount of methane released during maintenance and inspections.

As a result, the natural gas transmission and storage sector has significantly reduced its methane emissions. Some of these successes include:

- Decreasing the methane emissions from transmission and storage facilities by 44 percent from 1990 to 2016 due to reduced compressor station and fugitive emissions,[18] despite a 43 percent increase in U.S. natural gas *consumption* during the same time frame.[19] Methane emission reduction measures taken by the natural gas transmission and storage sector played a significant role in decreasing methane emissions from natural gas systems, with emissions from the overall natural gas value chain decreasing by 16 percent[20] since 1990, even while U.S. natural gas *production* increased by 45 percent.[21] While industry is proud of these reductions, the data reported to EPA may not show the full story regarding emissions from transmission and storage facilities. A recent report from the Pipeline Research Council International (PRCI)[22] analyzed over 14,000 measurements conducted at transmission and storage facilities for Subpart W of the GHG Reporting Program.[23] The PRCI study

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[14] U.S. EPA, Natural Gas STAR Program – About EPA's Oil and Gas Methane Partnerships, https://www.epa.gov/natural-gas-star-program/about-epas-oil-and-gas-methane-partnerships. The Natural Gas Star Program provides various options and flexibility to reduce methane emissions. Companies decide what actions to undertake based on their own economic decisions.

[15] *Id.*

[16] *Id.*

[17] INGAA's efforts have included collaboration with Colorado State University, Carnegie Mellon University and the Environmental Defense Fund.

[18] *2016 Inventory*, *supra* n.11 at 3-77.

[19] U.S. EIA, Natural Gas, U.S. Natural Gas Total Consumption, https://www.eia.gov/dnav/ng/hist/n9140us2a.htm (showing that total U.S. natural gas consumption increased from 19.2 Tcf in 1990 to 27.5 Tcf in 2016).

[20] *2016 Inventory*, *supra* n.11 at 3-77.

[21] *See* U.S. EIA, U.S. Natural Gas Marketed Production, https://www.eia.gov/dnav/ng/hist/n9050us2m.htm (comparing January 1990 to January 2016).

[22] Pipeline Research Council International, "GHG Emission Factor Development for Natural Gas Compressors," Catalogue No. PR-312-16202-R02, April 2018 (hereinafter "*PRCI Report*").

[23] "The GHG Reporting Program includes data from facilities that emit 25,000 metric tons of carbon dioxide equivalent (CO2e) per year as well as facilities that inject CO2 underground and suppliers of certain fossil fuels and industrial gases. It does not include emissions from agriculture, land use, or direct emissions from sources that have annual emissions of less than 25,000 metric tons of CO2e. It also does not include sinks of GHGs." EPA, FAQ, GHG Data and Publication, Q406, https://ccdsupport.com/confluence/pages/viewpage.action?pageId=141983782. Sources in 41 source categories are required to report to EPA emissions over the 25,000 ton per year threshold. *See* EPA, FAQ, GHG Data and Publication, Q409,

indicates that the average transmission and storage facility leak emissions are 37 percent lower than EPA's estimates of facility leak emissions.[24]

- Using pipeline integrity and maintenance programs to reduce the number of natural gas pipeline emission leaks by approximately 90 percent from 1986-2016.[25]
- Voluntarily participating in EPA's Natural Gas STAR Program and reducing methane emissions by 293.5 billion cubic feet since 1990.[26] In 2015 alone, 10.3 billion cubic feet of methane emissions reductions were reported.[27]

Additional actions that INGAA member companies have taken to reduce methane emissions include:

- Engaging with the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) to ensure new natural gas pipeline safety and storage regulations consider methane emissions.
  - PHMSA's Interim Final Rule on Underground Natural Gas Storage[28] was the result of collaboration between regulatory agencies, industry, and other stakeholders to develop widely accepted recommended practices designed to prevent and mitigate integrity breaches, leaks and failures at natural gas storage facilities. PHMSA largely adopted those recommended practices as regulations that are now applicable to over 400 storage fields with a combined working capacity of 4800 billion cubic feet (BCF) of natural gas.[29] The regulations provide design, construction, operation and reporting requirements for natural gas storage. These requirements were adopted with a goal of keeping natural gas safely confined within storage facilities.
  - Likewise, INGAA members have voluntarily committed to applying risk management programs used to prevent and detect pipeline defects and leaks to cover more pipeline mileage than required by existing regulations.[30] Industry is also working with PHMSA to encourage the adoption of advanced inspection technologies and to allow integrity management practices when new structures are built near a pipeline. Such practices may be preferable to replacing pipelines because pipeline replacement requires removing all of the natural gas from the pipeline (a practice commonly referred to as a "blowdown").
- Conducting leak inspections and measurements at transmission and storage facilities that are subject to U.S. EPA's Greenhouse Gas Reporting Program (40 C.F.R. Part 98).
- Working with EPA on concepts related to leak detection, which influenced the best management practices identified in EPA's Methane Challenge Program.
- Participating in research programs and studies to identify additional methods for detecting, quantifying and reducing methane emissions.[31]
- Analyzing the data reported under EPA's Greenhouse Gas Mandatory Reporting Rule to improve this information and identify additional opportunities to reduce methane emissions.

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https://ccdsupport.com/confluence/pages/viewpage.action?pageId=322699300. Emissions from petroleum and natural gas systems are reported under Subpart W of the GHG Reporting Program. *See id.*

[24] *Id.*

[25] *See* PHMSA Gas Transmission and Gas Gathering Annual Report data, 1986 – 2016, *available at* https://www.phmsa.dot.gov/data-and-statistics/pipeline/distribution-transmission-gathering-lng-and-liquid-accident-and-incident-data.

[26] *See* U.S. EPA, 2015 Natural Gas STAR Program Accomplishments, https://www.epa.gov/natural-gas-star-program/2015-natural-gas-star-program-accomplishments.

[27] *See id.*

[28] 81 Fed. Reg. 91,860 (Dec. 19, 2016).

[29] *See* U.S. EIA, Underground Natural Gas Storage Capacity, https://www.eia.gov/dnav/ng/ng_stor_cap_dcu_nus_a.htm (Apr. 2018).

[30] *See* INGAA Comments on PHMSA Advanced Notice of Proposed Rulemaking for Safety of Gas Transmission Pipelines at 3 (Jan. 20, 2012), http://www.ingaa.org/File.aspx?id=17587.

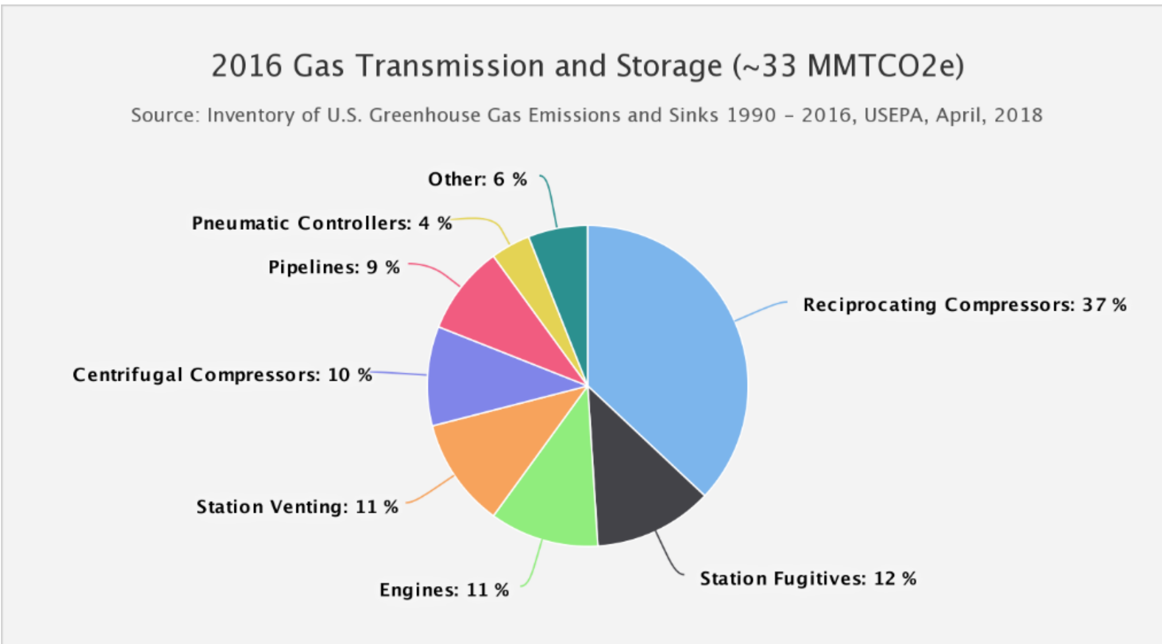
[31] *See, e.g.,* Collaboratory to Advance Methane Science (CAMS), https://methanecollaboratory.com (an industry-led collaborative research consortium conducting studies that focus on detection, measurement, and quantification of methane emissions with the goal of finding opportunities for reduction"). INGAA member companies also serve on the Industry Advisory Board for the natural gas emissions test facility for the ARPA-E MONITOR Program. *See* ARPA-E, Monitor Field Test Site, https://arpa-e.energy.gov/?q=slick-sheet-project/monitor-field-test-site.

SOURCES OF METHANE EMISSIONS FROM THE TRANSMISSION AND STORAGE SECTOR

Within the natural gas transmission and storage sector, emissions broadly fall into two categories: facility (e.g., compressor stations, underground storage facilities, etc.) or pipeline. There are three main categories of emissions from facilities and pipelines:

(1) **Compressor stations**: emissions that occur during maintenance, compressor startups, compressor shutdowns, and emergencies.
(2) **Controlled venting**: emissions associated with maintenance or other site activities (i.e., blowdowns, pneumatic controllers, etc.). These emissions occur by design and are part of normal operational practices.
(3) **Fugitive emissions and leaks**: unintended emissions from equipment that occur from components such as flanges, connectors, seals, valves, and meters.

According to EPA's annual GHG Inventory, the transmission and storage sector accounts for approximately 20 percent of the total methane emissions from the oil and natural gas industry.[32] In 2016, the largest sources of methane emissions from this sector were: reciprocating and centrifugal compressors leaks; other compressor station leaks; engine exhaust; natural gas pipeline venting; compressor station venting; and releases from pneumatic controllers. A combination of other sources accounted for 6 percent of emissions.[33] *See* Graph 5 below.



Graph 5

In EPA's annual GHG Inventory and Graph 5 above, "reciprocating compressors" includes methane emissions from rod packing and leakage through compressor blowdown valves and isolation valves. "Centrifugal compressors" includes methane emissions from wet and dry seals, and leakage through compressor blowdown valves and isolation valves.

[32] 2016 Inventory, *supra* n.11 at 3-79.
[33] U.S. EPA, Natural Gas Star Program, Overview of the Oil and Natural Gas Industry, https://www.epa.gov/natural-gas-star-program/overview-oil-and-natural-gas-industry#sources.

Further details about the methane emissions from each of these source types are provided below.

COMPRESSOR STATION EMISSIONS

According to the information collected pursuant to EPA's annual GHG Inventory, the majority of the methane emissions from the natural gas transmission and storage sector come from the processes at compressor stations.[34] For this reason, INGAA member companies made several voluntary commitments to reduce methane emissions from natural gas transmission and storage compressor stations.

The natural gas transmission and storage sector uses compressors to increase the pressure of natural gas so it can move along the pipeline. The majority of the methane emissions at a compressor station generally come from four types of sources: reciprocating compressors, centrifugal compressors, compressor station fugitive emissions, and venting. Within those broad categories, emission sources can be further broken down as follows:

- Reciprocating compressors – rod packing and valve leakage
- Centrifugal compressors – wet seal degassing vents and valve leakage
- Compressor station fugitives – connectors, valves, open-ended lines, pressure relief valves, meters
- Venting – emissions that occur when depressurizing compressors; these emissions are released by design through engineered pathways

Rod packing on reciprocating compressors. Reciprocating compressors use packing systems "to maintain a tight seal around the piston rod, preventing the gas compressed to high pressure in the compressor cylinder from leaking, while allowing the rod to move freely."[35] *See* Diagram 1, below. Even when rod packing is new, it is designed to leak at a low rate when the compressor is operating (i.e., when the rod is moving back and forth).[36] As the rod packing on reciprocating compressors wears, leak rates increase. To reduce these emissions, the rod packing on reciprocating compressors must be replaced periodically. California, for example, has adopted a methane regulation that allows a leak rate of 2 standard cubic feet (scf) per minute (or 120 scf per hour) before maintenance is required.[37]

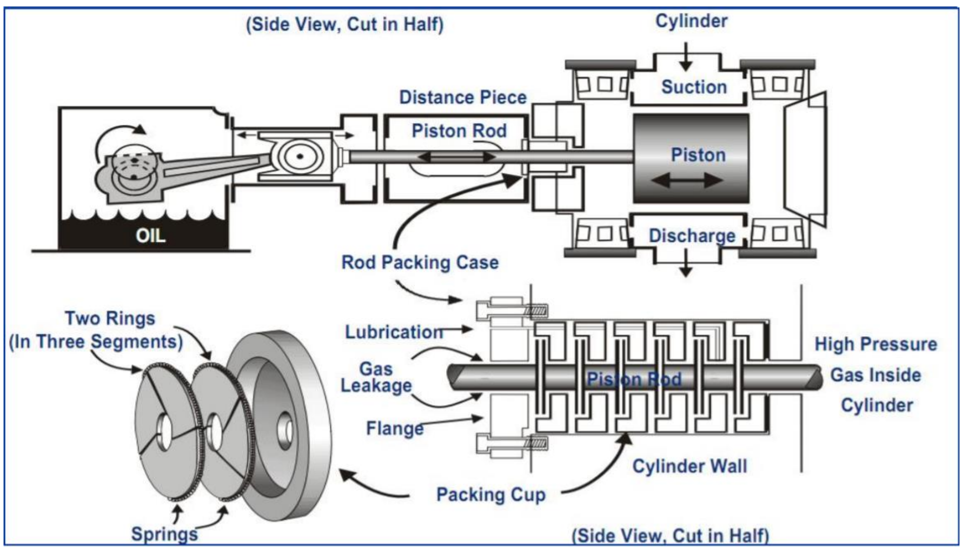


Diagram 1. Source: U.S. EPA, "Reducing Methane Emissions from Compressor Rod Packing Systems," EPA Natural Gas STAR Lessons Learned (Oct. 2006).

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[34] *See* Graph 5 *supra* (showing that 81 percent of emissions come from reciprocating and centrifugal compressors, compressor station fugitive emissions, engines, and compressor station venting).

[35] U.S. EPA, "Reducing Methane Emissions from Compressor Rod Packing Systems," EPA Natural Gas STAR Lessons Learned (Oct. 2006), https://www.epa.gov/sites/production/files/2016-06/documents/ll_rodpack.pdf at 1 (hereinafter "*Rod Packing Emissions*").

[36] *Id*.

[37] *See* 17 C.C.R. § 95668(c)(4)(D).

Reliability studies have shown that many different mechanisms can affect the need for maintenance or contribute to the failure of a component (e.g., packing wear that increases emissions). The oil and gas industry's new source performance standard for methane (NSPS OOOOa) prescribes maintenance intervals to replace rod packing on sources that are new or reconstructed after September 18, 2015, but this prescriptive approach is not necessarily preferable.[38] Changing rod packing at a prescribed interval poses the risk of scheduling an additional maintenance window to clear the natural gas from the equipment, which may potentially increase methane emissions beyond those from the leaking rod packing. An alternative approach is predictive or condition-based maintenance, in which operating conditions are monitored and maintenance decisions are based on either performance or defined conditions, rather than adopting a specific frequency for maintenance.[39]

Condition-based maintenance practices may extend the operation of functional rod packing and preclude premature and wasteful rod packing maintenance/replacement. In other cases, condition-based maintenance may identify rod packing that requires replacement on a more frequent basis than the prescribed interval.

As part of the voluntary EPA Natural Gas STAR program, EPA issued a "lessons learned" document entitled "Reducing Methane Emissions from Compressor Rod Packing System,"[40] which provides examples of conditioned-based maintenance practices.

Fugitive emissions from isolation valves and blowdown valves associated with reciprocating compressors are discussed below.

<u>Wet or dry seals on centrifugal compressors</u>. Centrifugal compressors have seals located on the rotating shafts to prevent natural gas from leaking from the point where the shaft exits the compressor casing.[41] "Wet" seals that circulated high-pressure oil were commonly used in the past on centrifugal compressors to form a barrier against leakage.[42] *See* Diagram 2. In 2006, EPA reported that ninety percent of all new centrifugal compressors use dry seal systems.[43] *See* Diagram 3 (showing dry seals).

Dry seals have numerous benefits over wet seals; among other benefits, dry seals have lower gas leak rates and are mechanically simpler than wet seals (requiring less elaborate components, resulting in improved reliability and less compressor downtime).[44]

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[38] 81 Fed. Reg. 38,524 (Aug. 3, 2016); 40 C.F.R. § 60.5385a (requiring that rod packing be replaced on new or reconstructed sources every 26,000 hours or 36 months).
[39] *See* 17 C.C.R. § 95668(c)(4)(D).
[40] *See Rod Packing Emissions, supra* n.35.
[41] U.S. EPA, Replacing Wet Seals with Dry Seals in Centrifugal Compressors (Oct. 2006), https://www.epa.gov/sites/production/files/2016-06/documents/ll_wetseals.pdf at 1.
[42] *Id.*
[43] *Id.* at 3.
[44] *Id*. A recent PRCI report that analyzed Subpart W measurement data indicates that EPA has significantly over-estimated emissions from wet seal degassing vents. *See PRCI Report, supra* n.22.

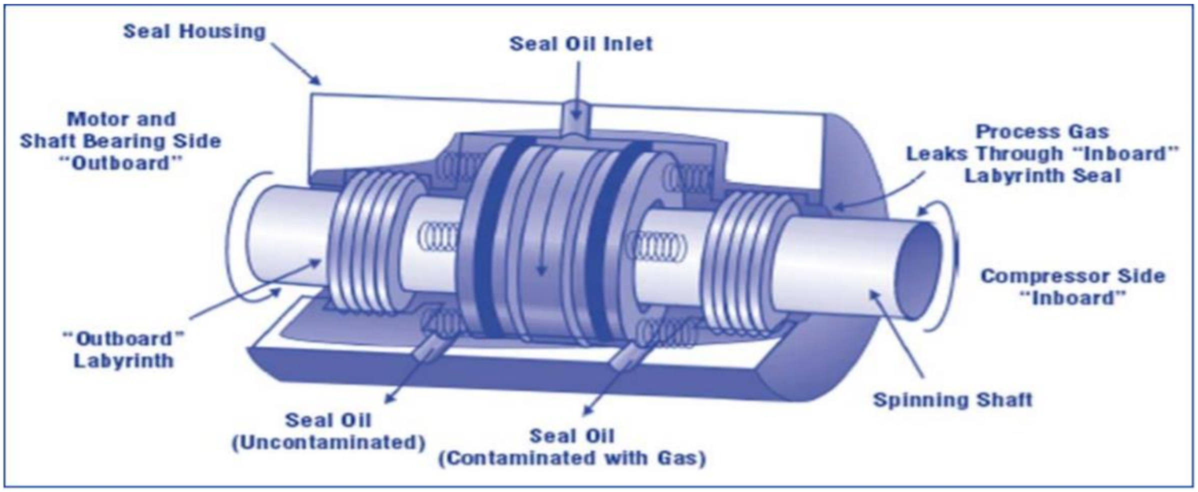

Diagram 2. Source: U.S. EPA, Replacing Wet Seals with Dry Seals in Centrifugal Compressors (Oct. 2006).

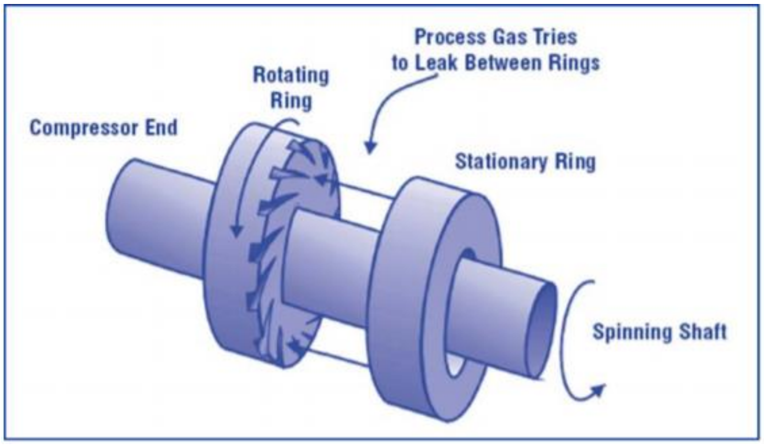

Diagram 3. Source: U.S. EPA, Replacing Wet Seals with Dry Seals in Centrifugal Compressors (Oct. 2006).

Given that dry seals have been the industry standard on centrifugal compressors for well over a decade, INGAA member companies concluded that it was unproductive to focus on emissions from centrifugal compressors. Furthermore, installing vapor recovery systems, thermal oxidizers or flares for seal oil degassing vents is not a common practice within the natural gas transmission and storage sector. This technology is not yet a proven technology for widespread use outside a few limited situations (e.g., Alaskan operations).

Fugitive emissions from isolation valves and blowdown valves associated with centrifugal compressors are discussed below.

Compressor station fugitive emissions. Equipment fugitive emissions (i.e., leaks) are unintentional releases of natural gas from piping and process equipment. Components that may leak at a compressor station include flanges, valves, and fittings on compressors. The annual EPA GHG Inventory indicates that the majority of leak emissions are from reciprocating and centrifugal compressors.[45] In the Inventory, "reciprocating compressors" includes methane emissions from rod packing, and leakage through compressor blowdown valves and isolation valves. "Centrifugal

[45] EPA, Annex 3.6, https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems-ghg-inventory-additional-information-1990-2016-ghg. "The Inventory of U.S. Greenhouse Gas Emissions and Sinks (Inventory) is a national assessment of total GHG emissions from man-made sources in the U.S. This annual report fulfills U.S. Government commitments to the United Nations Framework Convention on Climate Change (UNFCCC). To develop the Inventory, EPA uses national energy data and other national statistics." EPA, FAQ, GHG Data and Publication, Q411, https://ccdsupport.com/confluence/pages/viewpage.action?pageId=141983790.

compressors" includes methane emissions from wet and dry seals, and leakage through compressor blowdown valves and isolation valves. EPA's GHG Reporting Program requires measurement of compressor leaks, and data from Subpart W of the GHG Reporting Program further validates the conclusion that other station fugitive emissions (e.g., from yard piping) are typically small compared with typical emissions from leaks associated with compressors.

An equipment leak may only represent a small percentage of overall losses; yet, leaks are often the subject of intense focus by outside parties. However, not all leaks are created equal. For example, some leaks are larger than others. In fact, a relatively small percentage of leaks contribute the vast majority of emissions for natural gas operations – i.e., 95 percent of methane emissions from equipment leaks are from a mere 20 percent of the leaks at compressor stations.[46]

PRCI's report reviewing Subpart W measurements showed that mitigating less than 3 percent (by count) of the leaks associated with compressor seals, isolation valves, and blowdown valves could reduce total compressor station leak emissions by 60 percent relative to EPA's most recent estimate of facility leak emissions.[47] Furthermore, some leaks are more complicated to repair than others (e.g., there may be issues associated with elevated components, availability of replacement parts, additional methane may need to be vented to repair or replace the leaking component, specialized labor or technical expertise may be required for repair or replacement, repairing the leak may require a downtime which could cause impacts to upstream or downstream operations and customers, etc.). Repairing all leaks is not always prudent because methane emissions associated with making the repair or the cost of the repair may exceed the benefit of addressing a small leak.[48]

Leak surveys are often useful to identify leaking components at a compressor station. There are various technologies available to detect methane leaks, such as EPA Method 21 or an Optical Gas Imaging camera.

<u>Controlled venting</u>. A pipeline company may release gas at a compressor station when shutting down a compressor to conduct either planned or unplanned maintenance work, due to abnormal operations (i.e., for safety reasons, to prevent potential over-pressure of the pipeline), or if the compressor is temporarily shut down due to low demand for natural gas. These emissions are often commonly referred to as blowdowns. Isolation valves are closed and a blowdown valve is opened when the compressor is taken off-line and depressurized. Pipeline companies maintain compressor station vent logs that record these events, which are reported to U.S. EPA in an annual facility report pursuant to the requirements in the U.S. EPA Greenhouse Gas Reporting Program.

When conducting maintenance or repairs at the compressor station, it is neither practical nor economical to install portable flares to combust residual gas once the operating pressure at the station has been reduced using existing or temporary compression.

<u>Opportunities to reduce emissions from compressor stations</u>. Methane emissions from compressor stations are reduced through various measures, including: replacing rod packing on reciprocating compressors; conducting leak surveys to identify leaking components and taking corrective measures; and where practical, minimizing releases prior to conducting planned maintenance. INGAA member companies commit to minimizing emissions from natural gas transmission and storage compressor stations, where practical, prior to conducting planned maintenance.

INGAA member companies commit to minimizing methane emissions from rod packing seals on all reciprocating compressors at transmission and storage facilities. They agree to replace rod packing on all transmission and storage reciprocating compressors by using one of the following replacement options: (1) a condition-based approach, (2) every 26,000 hours of operation or (3) 36 months from the date of the most recent rod packing replacement.

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[46] U.S. EPA, "Directed Inspection and Maintenance at Compressor Stations." U.S. EPA Natural Gas STAR Lessons Learned, EPA430-B-03-008 (Oct. 2003), https://www.epa.gov/sites/production/files/2016-06/documents/ll_dimcompstat.pdf at 1.
[47] *See PRCI Report, supra* n.22.
[48] "Methane Emissions from Natural Gas Transmission and Storage Facilities: Review of Available Data on Leak Emission Estimates and Mitigation Using Leak Detection and Repair," *Innovative Environmental Solutions,* June 8, 2018.

INGAA member companies also commit to conducting leak surveys at transmission and storage compressor stations to reduce emissions by evaluating leaks and taking corrective actions. INGAA member companies will survey all transmission and storage compressor stations owned and operated by INGAA member companies by 2022.

PIPELINE EMISSIONS

Venting. To maintain safe operations, natural gas may be released from pipelines to the atmosphere during operations such as maintenance, inspection, repair, replacement or emergency work. These releases from a pipeline segment are typically intentional releases that occur while depressurizing the pipeline. For example, a pipeline operator may intentionally release gas from a pipeline segment to conduct integrity management testing to comply with pipeline safety regulations. The volume of emissions released during these activities depends on the pipeline's internal volume, frequency of blowdown events, operating temperature, as well as pre- and post-blowdown pressures.[49]

The ability to reduce pipeline pressure to minimize venting is limited by the pipeline configuration (i.e., single pipeline or multiple pipelines adjacent to each other), available compression (i.e., existing pipeline compression or temporary rental compression), the timeframe available to draw down the pressure, potential impacts to customers, weather, and multiple other factors. Pipeline operators cannot always control the timing and need for pipeline venting, such as in urgent repair situations when they must also maintain pipeline integrity and ensure safety. For these reasons, INGAA members have not committed to reducing pipeline venting (or blowdowns) by a certain percentage. Instead, INGAA member companies are committed to decreasing such emissions to the extent reasonably practicable, taking safety and other factors into consideration.

Because these releases are required for reasons such as maintenance, inspections and other safety considerations, widespread replacement of interstate natural gas pipelines is not the answer to reduce methane emissions from the transmission sector (in contrast, such replacement may be necessary for the distribution sector[50]). Rather, various maintenance methods and technologies are available to minimize pipeline and storage venting to maintain pipeline integrity and minimize adverse customer impacts. For example, inline inspection (ILI) technologies that can measure the material strength of pipelines as effectively as, or better than, hydrostatic testing and can reduce methane emissions that would otherwise result from conducting hydrostatic testing as part of integrity management programs. ILI technology involves running a sensor through the inside of the pipeline, while the natural gas is still flowing, to analyze the actual material condition of the pipe. This precise tool allows pipeline operators to identify specific pipeline sections that may require additional evaluation or repair, without needing to clear the natural gas from an entire pipeline segment to conduct a hydrotest.

When pipeline repairs need to be made, maintenance methods such as hot tapping or engineered sleeves may offer a safe and effective alternative to venting and removing the pipe.

Fugitive emissions/leaks. "Meter and pressure regulating stations are used in natural gas transmission to measure flow of gas at a custody transfer point, and/or to reduce and regulate pressure and flow into a downstream pipeline system."[51] Metering and regulating stations are also located at points where natural gas is exchanged with other

[49] "Nomenclature for Natural Gas Transmission and Storage Greenhouse Gas Emissions," *Innovative Environmental Solutions*, May 22, 2012.
[50] *See generally* U.S. Dept. of Energy, Natural Gas Infrastructure Modernization Programs at Local Distribution Companies: Key Issues and Considerations (Jan. 2017), https://www.energy.gov/sites/prod/files/2017/01/f34/Natural%20Gas%20Infrastructure%20Modernization%20Programs%20at%20Local%20Distribution%20Companies--Key%20Issues%20and%20Considerations.pdf; *id.* at 5 ("Many LDCs have been working for decades to replace older natural gas infrastructure, as some types of older infrastructure can be leak-prone and at higher risk for failure.").
[51] GRI and EPA, Methane Emissions from the Natural Gas Industry, Vol. 10: Metering and Pressure Regulating Stations in Natural Gas Transmission and Distribution (June 1996), https://www.epa.gov/sites/production/files/2016-08/documents/10_metering.pdf at 4.

transmission companies or where they deliver gas to local distribution companies.[52] Various types of meters can be used to measure natural gas, including: orifice meters; turbine meters; ultrasonic meters; and positive displacement meters.[53] Fugitive emissions can occur from flanges and other connectors along pipelines and at metering and pressure regulating stations.

Incidents. While extremely rare, a natural gas pipeline may unintentionally release methane in the event of a "dig in" (a third-party "hit") or another type of pipeline incident. A pipeline company may subsequently release natural gas intentionally to control the incident and protect the safety of the system, its employees, and the public in the affected area. Federal regulations issued by the U.S. Department of Transportation (DOT) require natural gas pipelines to report these incidents if the unintended gas loss is estimated to exceed three million cubic feet.[54]

Opportunities to reduce emissions from pipelines. Operators can reduce methane emissions from natural gas pipelines by implementing practices that minimize releases during maintenance, repair or replacement, while also taking into consideration maintaining pipeline integrity, safe operations, and minimizing adverse customer and community impacts. To that end, INGAA member companies commit to evaluating and implementing voluntary practices, such as those found in the U.S. Environmental Protection Agency's Natural Gas Star Program. Members will address fugitive emissions from metering and pressure regulating stations through the commitment to conduct leak surveys at transmission and storage compressor stations. As noted above, INGAA member companies will survey all transmission and storage compressor stations owned and operated by INGAA member companies by 2022.

PNEUMATIC DEVICE EMISSIONS

Natural gas-driven pneumatic controllers are used on pipelines and at compressor stations to actuate equipment (e.g., to maintain operations such as a certain operating pressure). Pneumatic devices release natural gas into the atmosphere as part of their normal operations. These devices are used on equipment such as compressor start motors, chemical injection and odorization pumps, instrument control loops, valve actuators and some types of glycol circulation pumps.

Using low-bleed devices (those with a bleed rate of less than or equal to 6 standard cubic feet per hour (scfh)) or intermittent or air-driven pneumatic devices can reduce methane emissions. However, in certain situations, due to safety concerns, these lower emitting options cannot be installed.

Pneumatic devices were once considered a significant source of emissions from the oil and gas sector but are not a significant source of methane emissions from the transmission and storage sector.[55] High-bleed pneumatic devices are now rarely installed on new equipment. Under the EPA Greenhouse Gas Reporting Program, natural gas pipelines must report pneumatic system device venting at compressor stations and storage facilities. These data show that emissions from pneumatic devices have greatly declined.[56] Emissions from natural gas-powered pneumatic devices have decreased over the past decade as operators have replaced existing and installed new devices with "low bleed" (i.e., lower venting) pneumatic devices or migrated to air driven rather than natural gas driven systems.

Operators infrequently opt to install devices that are electric-driven because controllers operated by natural gas may provide greater capability, reliability and safety.

Opportunities to reduce emissions from pneumatic devices. Installing low-bleed, intermittent or air-driven pneumatic devices can reduce methane emissions from pneumatic devices. INGAA member companies commit to installing air-driven, low-bleed, or intermittent pneumatic controllers, when installing new pneumatic controllers, unless a different

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[52] GRI and EPA, Methane Emissions from the Natural Gas Industry, Vol. 3: General Methodology (June 1996) (hereinafter "*1996 GRI/EPA Report*"), https://www.epa.gov/sites/production/files/2016-08/documents/3_generalmeth.pdf at 10.
[53] INGAA, Metering Stations and Mainline Valves, www.ingaa.org/Pipelines101/Operations/25918.aspx.
[54] *See* 49 C.F.R. § 191.3 (definition of "incident").
[55] *See* Graph 5, *supra.*
[56] *2016 Inventory, supra* n.11 at 3-93.

device is required for safe operations. For existing high-bleed pneumatic controllers, INGAA member companies will evaluate the feasibility of replacing them with air-driven, low-bleed or intermittent controllers.

NATURAL GAS STORAGE EMISSIONS

Natural gas storage facilities are used to store natural gas that is produced during off-peak times so that it is available during periods of peak demand, such as in the winter.[57] Most natural gas is stored below-ground.[58] Below-ground facilities compress and store the natural gas (as a gas, not a liquid) in one of several formations: (1) depleted gas production fields, (2) aquifers, or (3) salt caverns.[59]

According to EPA, "underground storage is not a major source of methane emissions compared to emissions from natural gas transmission pipelines and compressor stations."[60] Fugitive emissions sources from natural gas storage include leaks from:[61]

- Piping, valves, compressor seals, flanges, fittings, and other components
- Improperly plugged and abandoned wells

Natural gas storage facilities also have continuous and intermittent venting sources:

- Vents from pneumatic devices
- Compressor startup
- Compressor shutdown
- Gas dehydration
- Condensate storage tank venting
- Equipment depressurization

The methane emissions reduction strategies at storage facilities often include the methods discussed above for compressor stations and pneumatic devices.[62]

According to U.S. EPA data, compressors and other facility leaks are the largest sources of emissions from natural gas storage facilities.[63] Therefore, the voluntary compressor station commitments that INGAA member companies have adopted apply to the compressor stations located at INGAA member companies' natural gas storage facilities.

At natural gas storage facilities, INGAA member companies maintain risk management programs and monitoring systems for well and reservoir integrity and deliverability. In 2016, PHMSA issued federal interim final standards for underground

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[57] *1996 GRI/EPA Report*, *supra* n.52 at 10.
[58] *Id.* at 13.
[59] *Id.*
[60] Gazprom – EPA Technical Seminar on Methane Emission Mitigation, Reducing Methane Emissions from Underground Natural Gas Storage Operations (Oct. 2008), https://www.epa.gov/sites/production/files/2017-07/documents/underground_storage_razvilka_2008.pdf at 2.
[61] *Id.* at 4. To a lesser extent, leaks may also come from the geologic formation due to over-pressurizing. *Id.*
[62] *Id.* 6-7.
[63] *See 2016 Inventory*, *supra* n.11 at 3-78. Although the 2016 Inventory report states that dehydrators are a large source of emissions from storage facilities, a review of the underlying data shows this is not the case. *Compare id.* to EPA, Annex 3.6: https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems-ghg-inventory-additional-information-1990-2016-ghg (showing that methane emissions from reciprocating storage compressors in 2016 were 103.4 kt and fugitive emissions from storage compressor stations were 24.6 kt, whereas emissions from storage dehydrator vents were 4.2 kt).

natural gas storage facilities.[64] These rules were adopted following the serious leak at Southern California Gas Company's Aliso Canyon natural gas storage facility in California in 2015.[65]

Several INGAA member companies participate in a joint industry task force regarding the development of national standards to support the federal regulation of natural gas storage facilities. Members of this task force contributed to technical papers presented in joint DOE and PHMSA hearings, as well as collaborative meetings with various non-governmental organizations developing an understanding of storage facilities, operations, and emissions and safety technologies.

Opportunities to reduce emissions from storage facilities. In addition to the practices discussed above for compressor stations and pneumatic devices, methane emissions from natural gas storage facilities can be reduced by undertaking proactive maintenance on storage wells. Many INGAA member companies often utilize state-of-the-art technology to assess pipeline and storage well integrity and to conduct maintenance, including downhole logging, a technology that allows operators to detect potential defects and leaks and prioritize wells for further evaluation and remediation. INGAA member companies commit to surveying all natural gas storage wells owned and operated by INGAA member companies by 2025.

RESEARCH AND DEVELOPMENT AND INFORMATION SHARING

In addition, INGAA member companies are committed to developing effective methane reduction practices and sharing information, as well as transparently reporting their methane emissions. INGAA member companies will also continue to collaborate within the membership and with other organizations on research and development to identify effective practices to detect and reduce methane emissions.

CONCLUSION

INGAA member companies are committed to minimizing methane emissions from their interstate natural gas transmission and storage operations. To that end, in 2018, INGAA member companies have committed to minimize methane emissions from their interstate natural gas pipelines, pneumatic controllers, and storage and compressor stations in a prudent and environmentally responsible manner. They are also committed to developing effective practices and sharing information about their methane emissions. Please refer to the Methane Emissions Commitments for further details.

The following companies made this voluntary commitment:

- Alliance Pipeline
- Boardwalk Pipelines, LP
- Cheniere Energy
- Con Edison Transmission
- Dominion Energy
- DTE Midstream
- Enable Midstream Partners
- Enbridge
- EQT Corp.
- Iroquois
- Kinder Morgan
- Millennium Pipeline Company
- National Fuel Gas Company

[64] 81 Fed. Reg. 91,860 (Dec. 19, 2016).
[65] *See* Southern Coast Air Quality Management District Settlement Agreement with Southern California Gas Co., *available at* http://www.aqmd.gov/docs/default-source/compliance/settlement-agreement---signed-2-7-17-final-_redacted.pdf?sfvrsn=0.

- National Grid
- NextEra Energy Resources
- ONEOK, Inc.
- Pacific Gas & Electric
- Piedmont Natural Gas
- Sempra LNG & Midstream
- Southern Company Gas
- Southern Star Central Gas
- Tallgrass Energy
- TransCanada Corp.
- UGI Energy Services
- WBI Energy
- The Williams Companies