NGSI Methane Emissions Intensity Protocol

Final Draft

Natural Gas Sustainability Initiative

MJB & A

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This protocol was developed by M.J. Bradley & Associates (MJB&A) on behalf of the Edison Electric Institute (EEI) and the American Gas Association (AGA) in support of the Natural Gas Sustainability Initiative (NGSI). NGSI was initiated by a CEO Natural Gas Task Force organized by EEI and AGA.

About M.J. Bradley & Associates

MJB&A, founded in 1994, is a strategic consulting firm focused on energy and environmental issues. The firm includes a multi-disciplinary team of experts with backgrounds in economics, law, engineering, and policy. The company works with private companies, public agencies, and non-profit organizations to understand and evaluate environmental regulations and policy, facilitate multi-stakeholder initiatives, shape business strategies, and deploy clean energy technologies.

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Executive Summary

This document describes the final draft Natural Gas Sustainability Initiative (NGSI) protocol for companies to consistently calculate and report methane emissions intensity. The protocol is intended to support voluntary reporting by those companies operating within the natural gas supply chain in the United States from the production through distribution segments.

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. Launched by a CEO task force on natural gas issues convened by the Edison Electric Institute (EEI) and the American Gas Association (AGA), NGSI is working to advance a voluntary, industry-wide approach for companies to report methane emissions intensity by the segments of the natural gas supply chain in which they operate.

Methane emissions intensity is a measure of methane emissions relative to natural gas throughput. Investors, customers, environmental groups and other stakeholders are increasingly requesting information on natural gas company performance based on methane emissions intensity. While intensity is becoming a preferred approach for communicating methane emissions data throughout the industry, there is no standard methodology for calculating it. This is an obstacle to managing, tracking and more transparently communicating current voluntary efforts to reduce methane emissions.

The protocol establishes intensity metrics for specific segments of the supply chain because this structure provides the most comparable points of reference between companies, while being responsive to those asking for such a metric. Using the NGSI protocol, companies will calculate and report methane emissions intensity based on total corporate methane emissions and throughput for each segment in which they operate. The methane emissions intensity metric is expressed as a percent of methane emitted.

NGSI Segments	NGSI Metric
• **Production** • **Gathering and Boosting** • **Processing** • **Transmission and Storage** • **Distribution**	$\frac{Methane\ Emissions}{Methane\ Throughput}$

This final draft builds on existing industry approaches for calculating methane emissions intensity and reflects feedback received through an extensive stakeholder process. NGSI welcomes feedback on this final draft as it prepares to release Version 1.0 of the NGSI methane emissions intensity protocol in the first quarter of 2020.

In preparation for the release of Version 1.0, NGSI is working with companies operating across all segments of the natural gas supply chain that plan to calculate and report company-level methane emissions intensity consistent with the new protocol in 2020.

1. Background

The Natural Gas Sustainability Initiative (NGSI) is a voluntary, industry-led initiative to advance efforts to address environmental, social and governance (ESG) issues throughout the natural gas supply chain. NGSI recognizes the critical role of natural gas across the economy and responds to the rising importance of environmental and social goals for customers, as well as the increasing application of ESG metrics by institutional investors, banks and ratings agencies.

The natural gas industry has made important progress in responding to questions about the environmental and social impacts of the supply chain. Nonetheless, NGSI believes a more coordinated effort, including both voluntary reporting and benchmarking of continuous improvement, is needed to show that the entire supply chain manages natural gas in an increasingly safe, environmentally sound and secure manner.

NGSI's agenda for helping advance natural gas supply chain ESG efforts has been shaped by input gained through a robust stakeholder engagement process. NGSI has engaged with numerous companies representing all facets of the natural gas industry, investors and the broader financial community, and environmental non-governmental organizations. Through a series of webinars and a public workshop along with extensive outreach to individual companies and associations, stakeholders have provided valuable direction for NGSI's objectives, guiding principles, structure and the near-term agenda; and in the final draft methane emissions intensity protocol outlined in this document.

Natural Gas Sustainability Initiative

The Natural Gas Sustainability Initiative (NGSI) is an overarching framework to recognize and advance innovative, voluntary programs across the natural gas supply chain.

The NGSI framework is initially focused on methane emissions and will incorporate additional environmental, social and governance topics over time.

NGSI was launched by the EEI-AGA CEO Natural Gas Task Force. M.J. Bradley & Associates (MJB&A) is facilitating the process to develop the program.

NGSI Guiding Principles

NGSI is guided by the following principles:

- NGSI participants are committed to continuous improvement to respond to customer and stakeholder expectations for managing environmental and social issues along the natural gas supply chain.
- Building on existing voluntary programs, NGSI is a voluntary framework to expand and accelerate industry-wide actions and recognize the collective benefits of these actions.
- NGSI supports individual companies' voluntary efforts to manage methane and other ESG issues by promoting consistent approaches for measuring and reporting on key metrics and recognizing industry leadership across all segments.

- NGSI is focused on supporting companies through common tools and metrics to meet environmental and social objectives and promote continuous improvement. All NGSI participants' supplier-related decisions are at the sole discretion of the individual companies.

Why Focus on Methane Emissions Intensity?

NGSI is currently focused on methane emissions from the United States onshore natural gas supply chain for a number of reasons. Methane has a higher global warming potential than carbon dioxide and is the second most significant greenhouse gas emitted from anthropogenic sources in the United States after carbon dioxide. Furthermore, methane emitted from sources along the natural gas supply chain affect the overall greenhouse gas emissions profile (i.e. life cycle emissions) for natural gas use. To address concerns over methane emissions, industry and stakeholders are prioritizing and streamlining efforts to better detect, measure, reduce and communicate methane emissions from natural gas infrastructure.

A key obstacle to managing, tracking and more transparently communicating current voluntary efforts to reduce methane emissions is the absence of a common metric for measuring and reporting methane emissions intensity. While methane emissions intensity is widely used across the industry, there is no standard methodology for calculating it. This document presents a final draft protocol for a consistent industrywide approach to calculating and reporting methane emissions intensity at the company level within each segment of the natural gas supply chain.

Methane emissions intensity is also referred to as the methane emissions rate and is a measure of methane emissions relative natural gas throughput in the natural gas system. Intensity is becoming a preferred approach for communicating methane emissions data throughout the industry for a variety of reasons:

- It enables a comparison of performance between similar business operations within a company or between different companies which is not reflected when simply comparing total methane emissions.
- It normalizes year-to-year fluctuations not directly related to methane performance (e.g. change of assets, varying output).
- It can track performance over time and serve as a baseline for future company-level measurements.

As mentioned above, investors, customers, environmental groups and other stakeholders who are increasingly requesting information on natural gas company performance based on methane emissions intensity. It also builds on efforts by several coalitions and individual companies who have structured voluntary methane emissions reduction goals as methane emissions intensity targets.

While all efforts to develop methane intensity metrics have been constructive, companies that purchase natural gas are interested in further understanding natural gas supplier environmental and social performance. More specifically, NGSI seeks to establish a clear and consistent approach to using methane emissions and natural gas throughput data to calculate methane emissions intensity. Developing common, well-documented metrics will improve the quality of information available from the industry for use by investors and will help companies throughout the natural gas supply chain more effectively track programs to reduce methane emissions and communicate progress. With improved measurement and disclosure, the industry has an opportunity to accelerate programs to reduce methane emissions, further responding to stakeholder interest.

Potential Uses for NGSI Methane Emissions Intensity

NGSI recognizes there are many potential uses of the methane emissions intensity protocol beyond what is outlined in this guidance. In addition to segment-level reporting for U.S. operations, some customers and stakeholders may be interested in location-specific information such as a natural gas producer's methane emissions intensity for operations in a production basin. A company could use this protocol to calculate and report segment-level methane emissions intensity at a regional or more local level.

Some companies have also expressed interest is assessing the methane emissions intensity for their own operations across multiple segments or for their own natural gas supply chain. While this question goes beyond the current scope of the NGSI protocol, NGSI's standardization of emissions and throughput calculations provides a strong foundation for this more customized analysis by supporting the development of a robust dataset that could be further refined to assess specific companies or supply chains.

Opportunities for Advancing the Methane Emissions Intensity Protocol

NGSI recognizes that using spreadsheet calculations based on activity data and emission factors to estimate methane emissions has limitations. The accuracy of the estimates depends on the accuracy of the underlying emission factors. Updating emission factors requires rigorous technical analysis that must be vetted and confirmed over time. Depending on the age and sources used to develop the emission factors, estimates of methane emissions could be biased high or biased low. For example, older emission factors may not capture updates in technology or practices that would result in a lower emission factor. Alternately, ongoing research efforts suggest that a relatively small number of leaks from malfunctioning equipment can contribute a disproportionate share of total methane emissions from natural gas operations. Due to these types of leaks, which are random and hard to capture in a sample of emissions used to develop emission factors, actual emissions could be higher than suggested by an emission factor.

Industry is working in collaboration with government, academia and environmental organizations to advance a range of innovative methane detection and quantification technologies. These technologies enable companies to more quickly detect and fix methane leaks and could help to develop better estimates of methane emissions from operations. For this reason, environmental organizations have requested that NGSI incorporate guidance for including advanced methane emissions detection technologies as a component of the overall methane emissions intensity protocol. While this version of the protocol does not incorporate this type of guidance, NGSI seeks further input on this issue for consideration in future updates.

Additionally, the NGSI protocol leverages existing reporting methodologies developed by U.S. Environmental Protection Agency (EPA) and ONE Future. However, commenters have suggested that EPA and ONE Future do not include all potential sources of emissions in the natural gas supply chain. Future versions of the protocol could incorporate additional sources, NGSI seeks further input on this issue.

Approach to Developing the Protocol

The guidance to estimating methane emissions intensity outlined in this final draft builds on two previous NGSI documents. In April 2019, NGSI released a white paper that summarized existing approaches to calculating and reporting methane emissions intensity and highlighted key decision points in determining a common intensity methodology. Consistent with NGSI's principle of building on existing voluntary programs, the white paper drew from a range of existing protocols and approaches (see the Appendix A for a list of resources reviewed).

Based on extensive engagement by NGSI and feedback received on the white paper, NGSI developed and released an initial draft of the NGSI methane emissions intensity protocol in July 2019. NGSI held a series of webinars for interested stakeholders and received comments from industry and the environmental community. This final draft reflects the feedback received since July. NGSI welcomes feedback on this final draft as it prepares to release Version 1.0 of the NGSI methane emissions intensity protocol in the first quarter of 2020.

Leading up to and following the release of Version 1.0, NGSI plans to work with companies operating across all segments of the natural gas supply chain to support the use of the new protocol in 2020.

2. NGSI Protocol for Calculating Methane Emissions Intensity

The following sections of this document are organized by segment of the natural gas supply chain and provides guidance on the emissions and throughput data for calculating a company's methane emissions intensity for each segment in which it operates. The protocol establishes intensity metrics for specific segments of the supply chain because this structure provides the most comparable points of reference between companies. It also provides guidance on the source of natural gas throughput to be used as the denominator in segment-level methane emissions intensity calculations.

The goal is to provide a metric that enables a useful comparison between similar types of operations.

The protocol addresses five segments of the natural gas supply chain:

- Production,
- Gathering & Boosting,
- Processing,
- Transmission & Storage, and
- Distribution.

In addition to these segments, NGSI has identified liquified natural gas (LNG) import and export as a separate segment. At this time, NGSI is not addressing methane emissions intensity for the LNG import and export segment. Future versions of the protocol could include LNG import and export as well as additional segments.

Key Elements of the NGSI Methane Emissions Intensity Protocol

The guidance for reporting emissions leverages existing reporting protocols developed by the U.S. EPA. For emission sources that are currently reported to EPA as part of the Greenhouse Gas Reporting Program (GHGRP), NGSI has provided a reference to the GHGRP regulatory language and a brief description of the calculation. The NGSI protocol also includes emissions from sources that are not part of the GHGRP but have been identified by EPA through the Greenhouse Gas Emissions Inventory (GHG Inventory) and adopted by ONE Future and EPA as part of the EPA Methane Challenge ONE Future Commitment Option. For these sources, NGSI includes the methodologies and emission factors published as part of the EPA Methane Challenge ONE Future Commitment Option. The NGSI protocol adopts segment definitions that are consistent with EPA's Methane Challenge program, which includes emissions from sources under common ownership or common control including leased, rented, or contracted activities.

While natural gas can be coproduced with heavier hydrocarbons (i.e. associated gas), the end use of the products and the customers for those products are diverse. Natural gas purchasers (e.g. a natural gas distribution company or power company using natural gas for electricity generation) are interested in understanding the impact of emissions associated with natural gas production, gathering, and processing independent of emissions associated with natural gas liquids and crude oil production, gathering, and processing. For these segments, NGSI includes a methodology for allocating emissions to the natural gas supply chain.

The guidance on throughput values is segment specific. Production, processing, and gathering & boosting throughput values are all based on information reported to EPA as part of the GHGRP. To reduce the potential

for double counting throughput, transmission & storage and distribution throughput values are based on information reported to EIA.

Expectations for Company Reporting

Under the NGSI protocol approach, companies will calculate and report methane emissions intensity based on total company emissions and throughput for each segment in which they operate. Within each segment, companies using the NGSI protocol will calculate total methane emissions from the sources included in the protocol and will divide by the methane content of the throughput to arrive at a methane emissions intensity expressed as a percent of methane.

In each section of this document, NGSI provides guidance on the information that a company participating in NGSI would report as part of annual voluntary reporting, for example on a company's website or through other voluntary ESG reporting mechanisms. This information includes the segment-level methane emissions intensity as well as key data elements used to calculate segment-level intensity. Table 1 summarizes the disclosure elements by segment. Each element is described in more detail in the sections of the protocol devoted to each segment.

Table 1. NGSI Disclosure Elements by Segment

Disclosure Element	Production	Gathering & Boosting	Processing	Transmission & Storage	Distribution
Total Methane Emissions	✓	✓	✓	✓	✓
Natural Gas Throughput	✓	✓	✓	✓	✓
Energy Content of Natural Gas*	✓	✓	✓		
Methane Content of Natural Gas	✓	✓	✓	✓	✓
Other Hydrocarbon Throughput*	✓	✓	✓		
Energy Content of Other Hydrocarbons*	✓	✓	✓		
Gas Ratio*	✓	✓	✓		
NGSI Methane Emissions Intensity	✓	✓	✓	✓	✓

* NGSI is focused on the natural gas supply chain, not the supply chain of other hydrocarbons. Since production, gathering & boosting, and processing facilities can handle multiply hydrocarbon streams, the protocol includes a methodology for allocating emissions to the natural gas supply chain on an energy basis. This allocation is not necessary for the transmission & storage or distribution segments. The gas ratio is calculated as the energy content of natural gas divided by the energy content of natural gas plus the energy content of other hydrocarbons

3. Protocol for the Production Segment

For NGSI reporting purposes, the production segment definition is consistent with the definition EPA established for the Methane Challenge Program[1]:

> **Onshore petroleum and natural gas production** means all equipment on a single well-pad or associated with a single well-pad (including but not limited to compressors, generators, dehydrators, storage vessels, engines, boilers, heaters, flares, separation and processing equipment, and portable non-self-propelled equipment, which includes well drilling and completion equipment, workover equipment, and leased, rented or contracted equipment) used in the production, extraction, recovery, lifting, stabilization, separation or treating of petroleum and/or natural gas (including condensate). This equipment also includes associated storage or measurement vessels, all petroleum and natural gas production equipment located on islands, artificial islands, or structures connected by a causeway to land, an island, or an artificial island.
>
> A production facility means all natural gas equipment on a single well-pad or associated with a single well-pad that are under common ownership or common control including leased, rented, or contracted activities by an onshore natural gas production owner or operator and that are located in a single hydrocarbon basin as defined in 40 CFR 98.238. Where a person or entity owns or operates more than one well in a basin, then all onshore natural gas production equipment associated with all wells that the person or entity owns or operates in the basin would be considered one facility.

Production Segment Emissions

Under NGSI, companies will aggregate emissions from all facilities within a segment to estimate total company-level emissions from sources in the segment. Emission sources included in the calculation are listed in Table 2 and Table 3. Table 2 lists sources that are estimated using the GHGRP quantification method. Table 3 lists sources that are estimated using emission factors utilized by EPA in the GHG Inventory.

Table 2. Production Segment Emissions Calculated Using GHGRP Methodology

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Associated Gas Venting	40 CFR 98.233(m)	Subpart W – Calculation using volume of oil produced, gas to oil ratio (GOR), and volume of associated gas sent to sales; accounting for flare control as applicable
Associated Gas Flaring	40 CFR 98.233(n)	Subpart W – Calculation using volume of oil produced, gas to oil ratio (GOR), and volume of associated gas sent to sales; accounting for flare control as applicable
Combustion Units	40 CFR 98.233(z)(1); 40 CFR 98.233(z)(2)	Subpart W, as applicable based on fuel type – Calculation using fuel usage records and measured or estimated composition
Compressors, Centrifugal with wet seal oil degassing vents	40 CFR 98.233(o)(10)	Subpart W – Calculation using default population emission factor for compressors with wet seal oil degassing vents

[1] U.S. EPA, "Methane Challenge Program ONE Future Commitment Option Technical Document," March 15, 2019. Available at: https://www.epa.gov/natural-gas-star-program/methane-challenge-program-one-future-commitment-option-technical-document

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Compressors, Reciprocating	40 CFR 98.233(p)(10)	Subpart W – Calculation using default population emission factor for reciprocating compressors
Dehydrator vents, glycol	40 CFR Part 98.233(e)(1); 40 CFR Part 98.233(e)(5)	Subpart W – Calculation Method 1 using computer modeling for glycol dehydrators
	40 CFR Part 98.233(e)(2); 40 CFR Part 98.233(e)(5)	Subpart W – Calculation Method 2 using emission factors and population counts for glycol dehydrators
Dehydrator vents, desiccant	40 CFR Part 98.233(e)(3);40 CFR Part 98.233(e)(5)	Subpart W – Calculation Method 3 using engineering calculations for desiccant dehydrators
Equipment Leaks	Per Greenhouse Gas Reporting Rule Leak Detection Methodology Revisions	Subpart W – Leak survey and default leaker emission factors for components in gas service, and population counts and default population emission factors
Flare Stacks	40 CFR 98.233(n)(5); 40 CFR 98.233(n)(6)	Subpart W – Calculation using measured or estimated flow and gas composition, and flare combustion efficiency; accounting for feed gas sent to an un-lit flare as applicable
Liquids Unloading	40 CFR 98.233(f)(1)	Subpart W – Calculation Method 1 using direct measurement for each tubing diameter and pressure group with and without plunger lifts
	40 CFR 98.233(f)(2)	Subpart W – Calculation Method 2 using engineering calculations for wells without plunger lifts
	40 CFR 98.233(f)(3)	Subpart W – Calculation Method 3 using engineering calculations for wells with plunger lifts
Pneumatic Device (Controller) Vents), Natural gas	40 CFR 98.233(a)	Subpart W – Calculation using count of devices and default emission factors.
Pneumatic (Chemical Injection) Pump Vents, Natural gas driven	40 CFR 98.233(c)	Subpart W – Calculation using actual count of devices and default emission factors
Storage Vessels, Fixed-roof tanks	40 CFR 98.233(j)(1)	Subpart W – Calculation Method 1 using computer modeling for gas-liquid separators or gathering and boosting non-separator equipment
	40 CFR 98.233(j)(2)	Subpart W – Calculation Method 2 using engineering calculations for gas-liquid separators or gathering and boosting non-separator equipment or wells flowing directly to atmospheric storage tanks
	40 CFR 98.233(j)(3)	Subpart W – Calculation Method 3usingan emission factor and population counts for hydrocarbon liquids flowing togas-liquid separators, non-separator equipment, or directly to atmospheric storage

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Well Venting During Well Completions / Workovers with Hydraulic Fracturing	40 CFR 98.233(g)	Subpart W – Calculation using combined production rate measurement and engineering calculations in Equation W-10A Subpart W – Calculation using measured vented or flared volume from each well in Equation W-10B For oil wells, this calculation is limited to oil wells that have a gas-oil ratio (GOR) of 300 scf/STB or greater
Well Venting During Well Completions / Workovers without Hydraulic Fracturing	40 CFR 98.233(h)	Subpart W, for completions – Calculation using measured production rate Subpart W, for workovers – Calculation using a count of workovers and an emission factor
Well Testing Venting & Flaring	40 CFR 98.233(l)	Subpart W, for oil wells – Calculation using GOR, average annual flow rate, and testing duration in Equation W-17A Subpart W, for gas wells – Calculation using average annual flow rate and testing duration in Equation W-17B

Table 3. Production Segment Emissions Calculated Using GHG Inventory Emission Factors

Emission Source	Description of Quantification Method	GHG Inventory Emission Factor
Blowdowns – Vessel Blowdowns	GHG Inventory emission factor for vessel blowdowns multiplied by number of vessels	1.6 kg/vessel
Compressors, Centrifugal with dry seals	GHG Inventory emission factor multiplied by number of compressors	29,791.1 kg/compressor
Compressor Starts	GHG Inventory emission factor multiplied by number of compressors	173.1 kg/compressor
Pressure Relief Valves, Upsets	GHG Inventory emission factor multiplied by number of valves	0.7 kg/pressure relief valve
Storage Vessels, Floating roof tanks	GHG Inventory emission factor multiplied by floating roof tanks	6,515.8 kg/tank
Well Drilling	GHG Inventory emission factors multiplied by number of wells drilled	52.1 kg/well

*For all sources, EPA published the GHG Inventory emission factors in Appendix A of the *Natural Gas STAR Methane Challenge Program: ONE Future Commitment Option Technical Document*. Available at: https://www.epa.gov/natural-gas-star-program/methane-challenge-program-one-future-commitment-option-technical-document

Allocating Emissions to Natural Gas Production

Under NGSI, companies will identify a portion of total methane emissions to attribute to natural gas production, as opposed to other hydrocarbons that may be produced (e.g. crude oil, condensate). This allocation is on an energy basis. The methodology for calculating methane emissions associated with natural gas production is as follows:

1. Calculate the energy equivalent of produced natural gas (E_{ng}) as the product of the volume of produced gas (V_{ng}) multiplied by the energy content of the gas (EC_{ng}).[2] Estimate V_{ng} and EC_{ng} as:
    - V_{ng}: Volume (thousand standard cubic feet) of produced gas consistent with 98.236(aa)(1)(i)(A) as reported to the GHGRP.
    - EC_{ng}: Assume a default raw gas higher heating value of 1.235 MMBtu per thousand standard cubic feet from Table 3-8 of the API *Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry* (API Compendium) or a company-specific factor.[3]
2. Calculate the energy equivalent of produced liquids (E_{liq}) as the product of the volume of produced liquids for sales (V_{liq}) multiplied by the energy content of the liquids (EC_{liq}). Estimate V_{liq} and EC_{liq} as:
    - V_{liq}: Volume (barrels) of crude and condensate produced for sales consistent with 98.236(aa)(1)(i)(C) as reported to the Greenhouse Gas Reporting Program (GHGRP).
    - EC_{liq}: Assume a default crude oil heating value of 5.8 MMBtu per barrel from API Compendium Table 3-8 or a company-specific factor.
3. Calculate the gas ratio (*GR*) as the energy equivalent of natural gas divided by the total energy equivalent of produced natural gas and liquids, or $\frac{E_{ng}}{E_{ng}+E_{liq}}$
4. Calculate share of emissions allocated to the natural gas supply chain as *GR* multiplied by the estimated segment methane emissions.

Production Segment Throughput

For companies with production operations, segment throughput equates to the volume of gas produced at wells consistent with 98.236(aa)(1)(i)(A) in the GHGRP: The quantity of gas produced in the calendar year from wells, in thousand standard cubic feet. This includes gas that is routed to a pipeline, vented or flared, or used in field operations. This does not include gas injected back into reservoirs or shrinkage resulting from lease condensate production.

Production Segment Methane Emissions Intensity

To convert natural gas production throughput to methane, the reporting company will have to make an assumption about the methane content of produced natural gas. The reporting company can use and disclose its own estimate of the methane content of produced gas or can use a default factor of 83.3 percent.

To calculate production segment intensity, the methane emissions and throughput estimates must be converted to like units of methane. This can be on a mass basis or a volumetric basis. Companies should use a methane

[2] The goal of NGSI is to provide a methodology for calculating methane emissions intensity at the company level for each segment in which a company operates. Depending on the assumptions a company uses for the energy content of natural gas and other hydrocarbons, it may be appropriate to allocate emissions at the basin or facility level before summing emissions to the company and segment level.

[3] American Petroleum Institute (API). Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry. August 2009. Available at: https://www.api.org/~/media/Files/EHS/climate-change/2009_GHG_COMPENDIUM.pdf

density of 0.0192 metric tons per thousand cubic feet, consistent with the methane density used by EPA in the GHGRP (40 CFR 98.233(u)(2)(v)).

For example, a company could calculate its methane emissions intensity for natural gas production as:

$$Methane\ Emissions\ Intensity = \frac{Methane\ Emissions * Gas\ Ratio}{Natural\ Gas\ Throughput * Methane\ Content * \frac{0.0192\ metric\ tons}{thousand\ cubic\ feet}}$$

Alternatively, a company could calculate its methane emissions intensity for natural gas production as:

$$Methane\ Emissions\ Intensity = \frac{Methane\ Emissions * Gas\ Ratio * \frac{thousand\ cubic\ feet}{0.0192\ metric\ tons}}{Natural\ Gas\ Throughput * Methane\ Content}$$

Production Segment Reported Data

Companies with natural gas production operations following the NGSI protocol should publicly report the information described in Table 4. Information should be reported at the company level.

Table 4. NGSI Disclosure Elements for a Company with Natural Gas Production Operations

Disclosure Element	Description
Total Methane Emissions	Methane emissions (metric tons) associated with onshore petroleum and natural gas production, sum of emissions from the sources listed in Tables 1 and 2
Produced Natural Gas	Volume of produced gas (thousand standard cubic feet)
Energy Content of Produced Natural Gas	Raw gas higher heating value (MMBtu per thousand standard cubic feet)
Methane Content of Produced Natural Gas	Methane content of produced natural gas (percent)
Produced Crude Oil	Volume of crude and condensate produced for sales (barrels)
Energy Content of Produced Oil	Crude oil heating value (MMBtu per barrel)
Gas Ratio	Share of natural gas produced on an energy equivalent basis (percent)
NGSI Methane Emissions Intensity	Methane emissions intensity associated with natural gas production (percent)

4. Protocol for the Gathering & Boosting Segment

For NGSI reporting purposes, the gathering & boosting segment definition is consistent with the definitions EPA established for the Methane Challenge Program:

> **Onshore petroleum and natural gas gathering and boosting** means gathering pipelines and other equipment used to collect petroleum and/or natural gas from onshore production gas or oil wells and used to compress, dehydrate, sweeten, or transport the petroleum and/or natural gas to a natural gas processing facility, a natural gas transmission pipeline, or a natural gas distribution pipeline. Gathering and boosting equipment includes, but is not limited to, gathering pipelines, separators, compressors, acid gas removal units, dehydrators, pneumatic devices/pumps, storage vessels, engines, boilers, heaters, and flares. Gathering and boosting equipment does not include equipment reported under any other industry segment defined in Subpart W. Gathering pipelines operating on a vacuum and gathering pipelines with a gas to oil ratio (GOR) less than 300 standard cubic feet per stock tank barrel (scf/STB) are not included in this industry segment (oil here refers to hydrocarbon liquids of all API gravities).
>
> A gathering and boosting facility for purposes of reporting means all gathering pipelines and other equipment located along those pipelines that are under common ownership or common control by a gathering and boosting system owner or operator and that are located in a single hydrocarbon basin as defined in 40 CFR 98.238. Where a person owns or operates more than one gathering and boosting system in a basin (for example, separate gathering lines that are not connected), then all gathering and boosting equipment that the person owns or operates in the basin would be considered one facility. Any gathering and boosting equipment that is associated with a single gathering and boosting system, including leased, rented, or contracted activities, is considered to be under common control of the owner or operator of the gathering and boosting system that contains the pipeline. The facility does not include equipment and pipelines that are part of any other industry segment defined in Subpart W.

Gathering & Boosting Segment Emissions

Under NGSI, companies will aggregate emissions from all facilities within a segment to estimate total company-level emissions from sources in the segment. Emission sources included in the calculation are listed in Table 5 and Table 6. Table 5 lists sources that are estimated using the GHGRP quantification method. Table 6 lists sources that are estimated using emission factors utilized by EPA in the GHG Inventory.

Table 5. Gathering & Boosting Segment Emissions Calculated Using GHGRP Methodology

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Blowdown Vent Stacks	40 CFR 98.233(i)(2)	Subpart W – Calculation method using engineering calculation method by equipment or event type
	40 CFR 98.233(i)(3)	Subpart W – Calculation method using direct measurement of emissions using a flow meter Alternate calculation method using actual event counts multiplied by the average unique physical volumes as calculated from all company-specific Subpart W facility events (for facilities not reporting to Subpart W only)

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Combustion Units	40 CFR 98.233(z)(1); 40 CFR 98.233(z)(2)	Subpart W, as applicable based on fuel type – Calculation using fuel usage records and measured or estimated composition
Compressors, Centrifugal with wet seal oil degassing vents	40 CFR 98.233(o)(10)	Subpart W – Calculation using default population emission factor for compressors with wet seal oil degassing vents
Compressors, Reciprocating	40 CFR 98.233(p)(10)	Subpart W – Calculation using default population emission factor for reciprocating compressors
Dehydrator vents, glycol	40 CFR Part 98.233(e)(1); 40 CFR Part 98.233(e)(5) 40 CFR Part 98.233(e)(2); 40 CFR Part 98.233(e)(5)	Subpart W – Calculation Method 1 using computer modeling for glycol dehydrators Subpart W – Calculation Method 2 using emission factors and population counts for glycol dehydrators
Dehydrator vents, desiccant	40 CFR Part 98.233(e)(3); 40 CFR Part 98.233(e)(5)	Subpart W – Calculation Method 3 using engineering calculations for desiccant dehydrators
Equipment Leaks	Per Greenhouse Gas Reporting Rule Leak Detection Methodology Revisions	Subpart W – Leak survey and default leaker emission factors for components in gas service, and population counts and default population emission factors
Equipment Leaks, Gathering Pipelines	40 CFR 98.233(r)	Subpart W – Calculated using population counts and emission factors
Flare Stacks	40 CFR 98.233(n)(5); 40 CFR 98.233(n)(6)	Subpart W – Calculation using measured or estimated flow and gas composition, and flare combustion efficiency; accounting for feed gas sent to an un-lit flare as applicable
Pneumatic Device (Controller) Vents), Natural gas	40 CFR 98.233(a)	Subpart W – Calculation using count of devices and default emission factors.
Pneumatic (Chemical Injection) Pump Vents, Natural gas driven	40 CFR 98.233(c)	Subpart W – Calculation using actual count of devices and default emission factors
Storage Vessels, Fixed-roof tanks	40 CFR 98.233(j)(1) 40 CFR 98.233(j)(2) 40 CFR 98.233(j)(3)	Subpart W – Calculation Method 1 using computer modeling for gas-liquid separators or gathering and boosting non-separator equipment Subpart W – Calculation Method 2 using engineering calculations for gas-liquid separators or gathering and boosting non-separator equipment or wells flowing directly to atmospheric storage tanks Subpart W – Calculation Method 3usingan emission factor and population counts for hydrocarbon liquids flowing togas-liquid separators, non-separator equipment, or directly to atmospheric storage

Table 6. Gathering & Boosting Segment Emissions Calculated Using GHG Inventory Emission Factors

Emission Source	Description of Quantification Method	GHG Inventory Emission Factor
Compressors, Centrifugal with dry seals	GHG Inventory emission factor multiplied by number of compressors	29,791.1 kg/compressor
Damages (Gathering & Boosting Upsets: Mishaps)	GHG Inventory emission factor multiplied by miles of gathering pipeline	30.6 kg/mile

For all sources, EPA published the GHG Inventory emission factors in Appendix A of the *Natural Gas STAR Methane Challenge Program: ONE Future Commitment Option Technical Document*. Available at: https://www.epa.gov/natural-gas-star-program/methane-challenge-program-one-future-commitment-option-technical-document

Allocating Emissions to Natural Gas Gathering & Boosting

Under NGSI, companies will identify a portion of total methane emissions to attribute to natural gas gathering & boosting, as opposed to other hydrocarbons that may be handled (e.g. crude oil, condensate). This allocation is on an energy basis. The methodology for calculating methane emissions associated with natural gas gathering & boosting is as follows:

1. Calculate the energy equivalent of received natural gas (E_{ng}) as the product of the volume of received gas (V_{ng}) multiplied by the energy content of the gas (EC_{ng}). Estimate V_{ng} and EC_{ng} as:
    - V_{ng}: Volume (thousand standard cubic feet) of received gas consistent with 98.236(aa)(10)(i) as reported to the GHGRP.
    - EC_{ng}: Assume a default raw gas higher heating value of 1.235 MMBtu per thousand standard cubic feet from Table 3-8 of the API Compendium or a company-specific factor.
2. Calculate the energy equivalent of all hydrocarbon liquids received (E_{liq}) as the product of the volume of received liquids (V_{liq}) multiplied by the energy content of the liquids (EC_{liq}). Estimate V_{liq} and EC_{liq} as:
    - V_{liq}: Volume (barrels) of all hydrocarbon liquids received consistent with 98.236(aa)(10)(iii) as reported to the Greenhouse Gas Reporting Program (GHGRP).
    - EC_{liq}: Assume a default heating value of 5.8 MMBtu per barrel (consistent with crude oil) from API Compendium Table 3-8 or a company-specific factor.
3. Calculate the gas ratio (*GR*) as the energy equivalent of received natural gas divided by the total energy equivalent of received natural gas and liquids, or $\frac{E_{ng}}{E_{ng}+E_{liq}}$
4. Calculate share of emissions allocated to the natural gas supply chain as *GR* multiplied by the estimated segment methane emissions.

Gathering & Boosting Segment Throughput

For companies with gathering and boosting operations, segment throughput equates to the total volume of gas received at gathering and boosting facilities during the reporting year consistent with 98.236(aa)(10)(i) in the GHGRP.

Gathering & Boosting Segment Methane Emissions Intensity

To convert gathering and boosting throughput to methane, the reporting company will have to make an assumption about the methane content of received natural gas. The reporting company can use and disclose its own estimate of the methane content of received gas or can use a default factor of 83.3 percent.

To calculate gathering and boosting segment intensity, the emissions and throughput estimates must be converted to like units of methane. This can be on a mass basis or a volumetric basis. Companies reporting methane emissions intensity should use a methane density of 0.0192 metric tons per thousand cubic feet, consistent with the methane density used by EPA in the GHGRP (40 CFR 98.233(u)(2)(v)).

For example, a company could calculate its methane emissions intensity as:

$$Methane\ Emissions\ Intensity = \frac{Methane\ Emissions * Gas\ Ratio}{Natural\ Gas\ Throughput * Methane\ Content * \frac{0.0192\ metric\ tons}{thousand\ cubic\ feet}}$$

Alternatively, a company could calculate its methane emissions intensity as:

$$Methane\ Emissions\ Intensity = \frac{Methane\ Emissions * Gas\ Ratio * \frac{thousand\ cubic\ feet}{0.0192\ metric\ tons}}{Natural\ Gas\ Throughput * Methane\ Content}$$

Gathering & Boosting Segment Reported Data

Companies with natural gas gathering and boosting operations following the NGSI protocol should publicly report the information described in Table 7. Information should be reported at the company level.

Table 7. NGSI Disclosure Elements for a Company with Natural Gas Gathering & Boosting Operations

Disclosure Element	Description
Total Methane Emissions	Methane emissions (metric tons) associated with onshore petroleum and natural gas gathering and boosting, sum of emissions from the sources listed in Tables 4 and 5
Received Natural Gas	Volume of received gas (thousand standard cubic feet)
Energy Content of Received Natural Gas	Raw gas higher heating value (MMBtu per thousand standard cubic feet)
Methane Content of Received Natural Gas	Methane content of produced natural gas (percent)
Received Hydrocarbon Liquids	Volume of hydrocarbon liquids received (barrels)
Energy Content of Received Hydrocarbon Liquids	Received hydrocarbon liquids heating value (MMBtu per barrel)
Gas Ratio	Share of natural gas on an energy equivalent basis (percent)
NGSI Methane Emissions Intensity	Methane emissions intensity associated with natural gas gathering & boosting (percent)

5. Protocol for the Processing Segment

For NGSI reporting purposes, the processing segment definition is consistent with the definitions EPA established for the Methane Challenge Program:

> **Natural gas processing** means the separation of natural gas liquids (NGLs) or non-methane gases from produced natural gas, or the separation of NGLs into one or more component mixtures. Separation includes one or more of the following: forced extraction of natural gas liquids, sulfur and carbon dioxide removal, fractionation of NGLs, or the capture of carbon dioxide separated from natural gas streams. This segment also includes all residue gas compression equipment owned or operated by the natural gas processing plant. This industry segment includes processing plants that fractionate gas liquids, and processing plants that do not fractionate gas liquids but have an annual average throughput of 25 MMscf per day or greater.
>
> A natural gas processing facility for the purposes of reporting is any physical property, plant, building, structure, source, or stationary equipment in the natural gas processing industry segment located on one or more contiguous or adjacent properties in actual physical contact or separated solely by a public roadway or other public right-of-way and under common ownership or common control, that emits or may emit any greenhouse gas. Operators of military installations may classify such installations as more than a single facility based on distinct and independent functional groupings within contiguous military properties.

Processing Segment Emissions

Under NGSI, companies will aggregate emissions from all facilities within the segment to estimate total company-level emissions from sources in the segment. Emission sources included in the calculation are listed in Table 8 and Table 9. Table 8 lists sources that are estimated using the GHGRP quantification method. Table 9 lists sources that are estimated using emission factors utilized by EPA in the GHG Inventory.

Table 8. Processing Segment Emissions Calculated Using GHGRP Methodology

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Blowdown Vent Stacks	40 CFR 98.233(i)(2)	Subpart W – Calculation method using engineering calculation method by equipment or event type
	40 CFR 98.233(i)(3)	Subpart W – Calculation method using direct measurement of emissions using a flow meter Alternate calculation method using actual event counts multiplied by the average unique physical volumes as calculated from all company-specific Subpart W facility events (for facilities not reporting to Subpart W only)

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Combustion Units	40 CFR 98.33(c)	Subpart C methods, as applicable based on fuel type – Calculation using fuel usage as recorded or measured, fuel high heating value (HHV) default value or as calculated from measurements, and fuel-specific emission factors Alternate calculation method using total volume of fuel consumed and the fuel-specific emission factors for methane (for facilities not reporting to Subpart C only)
Compressors, Centrifugal	40 CFR 98.233(o)(1)(i)	Subpart W – Individual compressor source "as found" measurements • Operating mode: blowdown valve leakage • Operating mode: wet seal oil degassing vent • Not-operating-depressurized mode: isolation valve leakage
	40 CFR 98.233(o)(6)	Subpart W – Reporter-specific emission factor for mode-source combinations not measured in the reporting year
	40 CFR 98.233(o)(1)(ii)	Subpart W – Continuous monitoring
	40 CFR 98.233(o)(1)(iii)	Subpart W – Manifolded "as found" measurements Alternate calculation method using average company emission factor based on all company-specific Subpart W centrifugal compressor measurements (for facilities not reporting to Subpart W only)
Compressors, Reciprocating	40 CFR 98.233(p)(1)(i)	Subpart W – Individual compressor source "as found" measurements • Operating mode: blowdown valve leakage and rod packing emissions • Standby-pressurized mode: blowdown valve leakage • Not-operating-depressurized mode: isolation valve leakage
	40 CFR 98.233(p)(6)	Subpart W – Reporter-specific emission factor for mode-source combinations not measured in the reporting year
	40 CFR 98.233(p)(1)(ii)	Subpart W – Continuous monitoring
	40 CFR 98.233(p)(1)(iii)	Subpart W – Manifolded "as found" measurements Alternate calculation method using average company emission factor based on all company-specific Subpart W centrifugal compressor measurements (for facilities not reporting to Subpart W only)
Dehydrator vents, glycol	40 CFR Part 98.233(e)(1); 40 CFR Part 98.233(e)(5)	Subpart W – Calculation Method 1 using computer modeling for glycol dehydrators
	40 CFR Part 98.233(e)(2); 40 CFR Part 98.233(e)(5)	Subpart W – Calculation Method 2 using emission factors and population counts for glycol dehydrators
Dehydrator vents, desiccant	40 CFR Part 98.233(e)(3); 40 CFR Part 98.233(e)(5)	Subpart W – Calculation Method 3 using engineering calculations for desiccant dehydrators

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Equipment Leaks	Per Greenhouse Gas Reporting Rule Leak Detection Methodology Revisions	Subpart W – Leak survey and default leaker emission factors for compressor and non-compressor components in gas service Alternate calculation method using average company emission factor based on all company-specific Subpart W leak surveys (for facilities not reporting to Subpart W only)
Flare Stacks	40 CFR 98.233(n)(5); 40 CFR 98.233(n)(6)	Subpart W – Calculation using measured or estimated flow and gas composition, and flare combustion efficiency; accounting for feed gas sent to an un-lit flare as applicable
Pneumatic Device (Controller) Vents), Natural gas	40 CFR 98.233(a)	Subpart W – Calculation using count of devices and default emission factors. Processing segment reporters with natural gas operated pneumatic devices should use the Transmission Compression segment emission factors from Subpart W to quantify methane emissions.

Table 9. Processing Segment Emissions Calculated Using GHG Inventory Emission Factors

Emission Source	Description of Quantification Method	GHG Inventory Emission Factor
Acid Gas Removal Vents	GHG Inventory emission factor multiplied by number of acid gas removal units	42,762.9 kg/acid gas removal vent

For all sources, EPA published the GHG Inventory emission factors in Appendix A of the *Natural Gas START Methane Challenge Program: ONE Future Commitment Option Technical Document*. Available at: https://www.epa.gov/natural-gas-star-program/methane-challenge-program-one-future-commitment-option-technical-document

Allocating Emissions to Natural Gas Processing

Under NGSI, companies will identify a portion of total methane emissions to attribute to natural gas processing, as opposed to other hydrocarbons that may be processed (e.g. natural gas liquids). This allocation is on an energy basis. The methodology for calculating methane emissions associated with natural gas processing is as follows:

1. Calculate the energy equivalent of received natural gas (E_{ng}) as the product of the volume of received gas (V_{ng}) multiplied by the energy content of the gas (EC_{ng}). Estimate V_{ng} and EC_{ng} as:
    - V_{ng}: Volume (thousand standard cubic feet) of received gas consistent with 98.236(aa)(3)(i) as reported to the GHGRP.
    - EC_{ng}: Assume a default raw gas higher heating value of 1.235 MMBtu per thousand standard cubic feet from Table 3-8 of the API Compendium or a company-specific factor.
2. Calculate the energy equivalent of natural gas liquids received (E_{liq}) as the product of the volume of received natural gas liquids (V_{liq}) multiplied by the energy content of the natural gas liquids (EC_{liq}). Estimate V_{liq} and EC_{liq} as:
    - V_{liq}: Volume (barrels) of natural gas liquids received consistent with 98.236(aa)(3)(iii) as reported to the Greenhouse Gas Reporting Program (GHGRP).

- EC_{liq}: Assume a default heating value of 3.82 MMBtu per barrel (consistent with propane liquids) from API Compendium Table 3-8 or a company-specific factor.

3. Calculate the gas ratio (*GR*) as the energy equivalent of received natural gas divided by the total energy equivalent of received natural gas and liquids, or $\frac{E_{ng}}{E_{ng}+E_{liq}}$

4. Calculate share of emissions allocated to the natural gas supply chain as *GR* multiplied by the estimated segment methane emissions.

Processing Segment Throughput

For companies with processing operations, segment throughput equates to the quantity of natural gas received at the gas processing plant in thousand standard cubic feet consistent with 98.236(aa)(3)(i) as reported to the GHGRP.

Processing Segment Methane Emissions Intensity

To convert processing segment throughput to methane, the reporting company will have to make an assumption about the methane content of processed natural gas. The reporting company can use and disclose its own estimate of the methane content of natural gas or can use a default factor of 87 percent.

To calculate processing segment intensity, the emissions and throughput estimates must be converted to like units of methane. This can be on a mass basis or a volumetric basis. Companies reporting methane emissions intensity should use a methane density of 0.0192 metric tons per thousand cubic feet, consistent with the methane density used by EPA in the GHGRP (40 CFR 98.233(u)(2)(v)).

For example, a company could calculate its methane emissions intensity as:

$$Methane\ Emissions\ Intensity = \frac{Methane\ Emissions * Gas\ Ratio}{Natural\ Gas\ Throughput * Methane\ Content * \frac{0.0192\ metric\ tons}{thousand\ cubic\ feet}}$$

Alternatively, a company could calculate its methane emissions intensity as:

$$Methane\ Emissions\ Intensity = \frac{Methane\ Emissions * Gas\ Ratio * \frac{thousand\ cubic\ feet}{0.0192\ metric\ tons}}{Natural\ Gas\ Throughput * Methane\ Content}$$

Processing Segment Reported Data

Companies with natural gas processing operations following the NGSI protocol should publicly report the information described in Table 10. Information should be reported at the company level.

Table 10. NGSI Disclosure Elements for a Company with Natural Gas Processing Operations

Disclosure Element	Description
Total Methane Emissions	Methane emissions (metric tons) associated with natural gas processing, sum of emissions from the sources listed in Tables 7 and 8
Received Natural Gas	Volume of received gas (thousand standard cubic feet)
Energy Content of Received Natural Gas	Raw gas higher heating value (MMBtu per thousand standard cubic feet)
Methane Content of Received Natural Gas	Methane content of produced natural gas (percent)
Received Natural Gas Liquids	Volume of natural gas liquids received (barrels)
Energy Content of Received Natural Gas Liquids	Received natural gas liquids heating value (MMBtu per barrel)
Gas Ratio	Share of natural gas processed on an energy equivalent basis (percent)
NGSI Methane Emissions Intensity	Methane emissions intensity associated with natural gas processing (percent)

6. Protocol for the Transmission & Storage Segment

For NGSI reporting purposes, the transmission & storage segment definition includes natural gas transmission compression & underground natural gas storage, LNG storage, and natural gas transmission pipelines consistent with the definitions EPA established for the Methane Challenge Program:

- **Onshore natural gas transmission compression** means any stationary combination of compressors that move natural gas from production fields, natural gas processing plants, or other transmission compressors through transmission pipelines to natural gas distribution pipelines, LNG storage facilities, or into underground storage. A transmission compressor station includes equipment for liquids separation, and tanks for the storage of water and hydrocarbon liquids. Residue (sales) gas compression that is part of onshore natural gas processing plants are included in the onshore natural gas processing segment and are excluded from this segment.

- **Underground natural gas storage** means subsurface storage, including depleted gas or oil reservoirs and salt dome caverns that store natural gas that has been transferred from its original location for the primary purpose of load balancing (the process of equalizing the receipt and delivery of natural gas); natural gas underground storage processes and operations (including compression, dehydration and flow measurement, and excluding transmission pipelines); and all the wellheads connected to the compression units located at the facility that inject and recover natural gas into and from the underground reservoirs.

  A natural gas transmission compression facility or underground natural gas storage facility for the purposes of reporting is any physical property, plant, building, structure, source, or stationary equipment in the natural gas transmission compression industry segment or underground natural gas storage industry segment located on one or more contiguous or adjacent properties in actual physical contact or separated solely by a public roadway or other public right-of-way and under common ownership or common control, that emits or may emit any greenhouse gas. Operators of military installations may classify such installations as more than a single facility based on distinct and independent functional groupings within contiguous military properties.

- **Onshore natural gas transmission pipeline** means all natural gas pipelines that are a Federal Energy Regulatory Commission rate-regulated Interstate pipeline, a state rate-regulated Intrastate pipeline, or a pipeline that falls under the “Hinshaw Exemption” as referenced in section 1(c) of the Natural Gas Act, 15 I.S.C. 717-717(w)(1994).

  An onshore natural gas transmission pipeline facility for the purpose of reporting is the total U.S. mileage of natural gas transmission pipelines owned or operated by an onshore natural gas transmission pipeline owner or operator. If an owner or operator has multiple pipelines in the United States, the facility is considered the aggregate of those pipelines, even if they are not interconnected.

- **LNG storage** means onshore LNG storage vessels located above ground, equipment for liquefying natural gas, compressors to capture and re-liquefy boil-off-gas, re-condensers, and vaporization units for re-gasification of the liquefied natural gas. An LNG storage facility for the purposes of reporting is any physical property, plant, building, structure, source, or stationary equipment in the LNG storage industry segment located on one or more contiguous or adjacent properties in actual physical contact

or separated solely by a public roadway or other public right-of-way and under common ownership or common control, that emits or may emit any greenhouse gas.

For facilities that do not report to Subpart W (only), a natural gas transmission compression facility or underground natural gas storage facility for the purposes of reporting consists of an aggregation at the "Transmission Pipeline Company" level of the facilities described in the previous paragraph.

Transmission & Storage Segment Emissions

Under NGSI, companies will aggregate emissions from all facilities within the segment to estimate total company-level emissions from sources in the segment. Emission sources included in the calculation are listed in Table 11 and Table 12. Table 11 lists sources that are estimated using the GHGRP quantification method. Table 12 lists sources that are estimated using emission factors utilized by EPA in the GHG Inventory.

Table 11. Transmission & Storage Segment Emissions Calculated Using GHGRP Methodology

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Blowdowns, Transmission Pipeline (Between Compressor Stations)	40 CFR 98.233(i)(2)	Subpart W – Calculation method using the volume of transmission pipeline segment between isolation valves and the pressure and temperature of the gas within the transmission pipeline
	40 CFR 98.233(i)(3)	Subpart W – Calculation method using direct measurement of emissions using a flow meter Alternate calculation method using actual event counts multiplied by the average emission factor as calculated from all company-specific Subpart W facility events (for facilities not reporting to Subpart W only)
Blowdown Vent Stacks	40 CFR 98.233(i)(2)	Subpart W – Calculation method using engineering calculation method by equipment or event type
	40 CFR 98.233(i)(3)	Subpart W – Calculation method using direct measurement of emissions using a flow meter Alternate calculation method using actual event counts multiplied by the average unique physical volumes as calculated from all company-specific Subpart W facility events (for facilities not reporting to Subpart W only)
Combustion Units	40 CFR 98.33(c)	Subpart C methods, as applicable based on fuel type – Calculation using fuel usage as recorded or measured, fuel high heating value (HHV) default value or as calculated from measurements, and fuel-specific emission factors Alternate calculation method using total volume of fuel consumed and the fuel-specific emission factors for methane (for facilities not reporting to Subpart C only)

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Compressors, Centrifugal	40 CFR 98.233(o)(1)(i)	Subpart W – Individual compressor source "as found" measurements • Operating mode: blowdown valve leakage • Operating mode: wet seal oil degassing vent • Not-operating-depressurized mode: isolation valve leakage
	40 CFR 98.233(o)(6)	Subpart W – Reporter-specific emission factor for mode-source combinations not measured in the reporting year
	40 CFR 98.233(o)(1)(ii)	Subpart W – Continuous monitoring
	40 CFR 98.233(o)(1)(iii)	Subpart W – Manifolded "as found" measurements Alternate calculation method using average company emission factor based on all company-specific Subpart W centrifugal compressor measurements (for facilities not reporting to Subpart W only)
Compressors, Reciprocating	40 CFR 98.233(p)(1)(i)	Subpart W – Individual compressor source "as found" measurements • Operating mode: blowdown valve leakage and rod packing emissions • Standby-pressurized mode: blowdown valve leakage • Not-operating-depressurized mode: isolation valve leakage
	40 CFR 98.233(p)(6)	Subpart W – Reporter-specific emission factor for mode-source combinations not measured in the reporting year
	40 CFR 98.233(p)(1)(ii)	Subpart W – Continuous monitoring
	40 CFR 98.233(p)(1)(iii)	Subpart W – Manifolded "as found" measurements Alternate calculation method using average company emission factor based on all company-specific Subpart W centrifugal compressor measurements (for facilities not reporting to Subpart W only)
Equipment Leaks	Per Greenhouse Gas Reporting Rule Leak Detection Methodology Revisions	Subpart W – Leak survey and default leaker emission factors for compressor and non-compressor components in gas service Subpart W Methodology for Storage – Leak survey and default leaker emission factors for storage station components in gas service and storage wellhead components in gas service, and population counts and default population emission factors Subpart W Methodology for LNG Storage – Leak survey and default leaker emission factors for LNG storage components in LNG service and gas service, and population counts and default population emission factors for vapor recovery compressors in gas service Alternate calculation method using average company emission factor based on all company-specific Subpart W leak surveys (for facilities not reporting to Subpart W only)

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Flare Stacks	40 CFR 98.233(n)(5); 40 CFR 98.233(n)(6)	Subpart W – Calculation using measured or estimated flow and gas composition, and flare combustion efficiency; accounting for feed gas sent to an un-lit flare as applicable
Pneumatic Device (Controller) Vents), Natural gas	40 CFR 98.233(a)	Subpart W – Calculation using count of devices and default emission factors.
Storage Tank Vents, Transmission Compression	40 CFR 98.233(k)	Subpart W – Calculation using measured flow data for leakage due to scrubber dump valve malfunction, gas composition, and estimated leakage duration; accounting for flare control as applicable Alternate calculation method using actual tank counts multiplied by an emission factor calculated from company-specific transmission storage tank vent data reported to Subpart W (for facilities not reporting to Subpart W only)

Table 12. Transmission & Storage Segment Emissions Calculated Using GHG Inventory Emission Factors

Emission Source	Description of Quantification Method	GHG Inventory Emission Factor
Compressors, Centrifugal with dry seals	GHG Inventory emission factor multiplied by number of centrifugal compressors with dry seals	44,000 kg/compressor
	Number of centrifugal compressors multiplied by average company emission factor based on measurements from dry seals (measurements are to be taken using Subpart W measurement methods for wet seals)	NA
Dehydrator Vents	GHG Inventory emission factor multiplied by volume of gas dehydrated	1.8 kg/MMscf (Transmission) 2.3 kg/MMscf (Storage)
	Alternate calculation method using Subpart W Calculation Method 1 for Transmission Compression and Storage facilities that elect to use computer modeling	NA
Equipment Leaks, transmission pipelines	GHG Inventory emission factor multiplied by miles of pipeline	10.9 kg/mile
Station Venting, Natural Gas Storage and LNG Storage	GHG Inventory emission factor multiplied by number of stations	83,954.3 kg/station

For all sources, EPA published the GHG Inventory emission factors in Appendix A of the *Natural Gas STAR Methane Challenge Program: ONE Future Commitment Option Technical Document*. Available at: https://www.epa.gov/natural-gas-star-program/methane-challenge-program-one-future-commitment-option-technical-document

Transmission & Storage Segment Throughput

For companies with transmission and storage operations, segment throughput equates to the volume of natural gas transported by the pipeline company on a total throughput basis as reported to EIA for Form 176.[4]

Transmission & Storage Segment Methane Emissions Intensity

To convert transmission and storage segment throughput to methane, the reporting company will have to make an assumption about the methane content of transported natural gas. The reporting company can use and disclose its own estimate of the methane content of natural gas or can use a default factor of 93.4 percent.

To calculate transmission and storage segment intensity, the emissions and throughput estimates must be converted to like units of methane. This can be on a mass basis or a volumetric basis. Companies reporting methane emissions intensity should use a methane density of 0.0192 metric tons per thousand cubic feet, consistent with the methane density used by EPA in the GHGRP (40 CFR 98.233(u)(2)(v)).

For example, a company could calculate its methane emissions intensity as:

$$Methane\ Emissions\ Intensity = \frac{Methane\ Emissions}{Natural\ Gas\ Throughput * Methane\ Content * \frac{0.0192\ metric\ tons}{thousand\ cubic\ feet}}$$

Alternatively, a company could calculate its methane emissions intensity as:

$$Methane\ Emissions\ Intensity = \frac{Methane\ Emissions * \frac{thousand\ cubic\ feet}{0.0192\ metric\ tons}}{Natural\ Gas\ Throughput * Methane\ Content}$$

Transmission & Storage Segment Reported Data

Companies with natural gas transmission & storage operations following the NGSI protocol should publicly report the information described in Table 13. Information should be reported at the company level.

Table 13. NGSI Disclosure Elements for a Company with Natural Gas Transmission & Storage Operations

Disclosure Element	Description
Total Methane Emissions	Methane emissions (metric tons) associated with transmission and storage, sum of emissions from the sources listed in Tables 10 and 11
Natural Gas Transported	Volume of natural gas transported (thousand standard cubic feet)
Methane Content of Transported Natural Gas	Methane content of transported natural gas (percent)
NGSI Methane Emissions Intensity	Methane emissions intensity associated with transmission and storage (percent)

[4] NGSI recognizes that companies in the transmission & storage segment continue to work to improve the approach to estimating transmission throughput at the company level, NGSI will work with stakeholders to incorporate advancements in this area in future versions of the protocol.

7. Protocol for the Distribution Segment

For NGSI reporting purposes, the distribution segment definition is consistent with the definitions EPA established for the Methane Challenge Program:

> **Natural gas distribution** means the distribution pipelines and metering and regulating equipment at metering-regulating stations that are operated by a Local Distribution Company (LDC) within a single state that is regulated as a separate operating company by a public utility commission or that is operated as an independent municipally-owned distribution system. This segment also excludes customer meters and regulators, infrastructure, and pipelines (both interstate and intrastate) delivering natural gas directly to major industrial users and farm taps upstream of the local distribution company inlet.
>
> A natural gas distribution facility for the purposes of reporting under [NGSI] is the collection of all distribution pipelines and metering-regulating stations that are operated by an LDC within a single state that is regulated as a separate operating company by a public utility commission or that are operated as an independent municipally-owned distribution system.

Distribution Segment Emissions

Under NGSI, companies will aggregate emissions from all facilities within the segment to estimate total company-level emissions from sources in the segment. Emission sources included in the calculation are listed in Table 14 and Table 15. Table 14 lists sources that are estimated using the GHGRP quantification method. Table 15 lists sources that are estimated using emission factors utilized by EPA in the GHG Inventory.

Table 14. Distribution Segment Emissions Calculated Using GHGRP Methodology

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Blowdown Vent Stacks	40 CFR 98.233(i)(2)	Subpart W – Calculation method using engineering calculation method by equipment or event type
	40 CFR 98.233(i)(3)	Subpart W – Calculation method using direct measurement of emissions using a flow meter Alternate calculation method using actual event counts multiplied by the average unique physical volumes as calculated from all company-specific Subpart W facility events (for facilities not reporting to Subpart W only)
Combustion Units	40 CFR 98.233(z)(1); 40 CFR 98.233(z)(2)	Subpart W, as applicable based on fuel type – Calculation using fuel usage records and measured or estimated composition
Distribution Mains	40 CFR 98.233(r)	Subpart W – Equipment leaks calculated using population counts and emission factors • Cast Iron Mains • Plastic Mains • Protected Steel Mains • Unprotected Steel Mains

Emission Source	GHGRP Reference(s)	Description of Quantification Method(s)
Distribution Services	40 CFR 98.233(r)	Subpart W – Equipment leaks calculated using population counts and emission factors • Copper services • Plastic services • Protected steel services • Unprotected steel services
Equipment Leaks, Above grade transmission-distribution transfer stations	40 CFR 98.233(q)(8)(ii); 40 CFR 98.233(r)(2)(ii); 40 CFR 98.236(q)(3)	Subpart W – Develop an emission factor based on equipment leak surveys; calculate emissions using population counts and emission factors
Equipment Leaks, Below grade transmission-distribution transfer stations	40 CFR 98.233(r)(6)(i); 40 CFR 98.232(i)(2)	Subpart W – Calculation of emissions using population counts and emission factors
Equipment Leaks, Above grade metering-regulating stations	40 CFR 98.233(r)(6)(ii); 40 CFR 98.232(i)(3)	Subpart W – Calculation of emissions using population counts and emission factors
Equipment Leaks, Below grade metering-regulating stations	40 CFR 98.233(r)(6)(i); 40 CFR 98.232(i)(4)	Subpart W – Calculation of emissions using population counts and emission factors

Table 15. Distribution Segment Emissions Calculated Using GHG Inventory Emission Factors

Emission Source	Description of Quantification Method	GHG Inventory Emission Factor
Blowdowns, Distribution pipeline	GHG Inventory emission factor multiplied by miles of pipeline (mains and service) Companies should use the average service length reported annually to PHMSA to convert services counts to services mileage. If an average service length is not available, companies should use PHMSA's default length of 90 feet/service.	1.965 kg/mile
Damages (Distribution Upsets: Mishaps)	GHG Inventory emission factor multiplied by miles of pipeline (mains and service) Companies should use the average service length reported annually to PHMSA to convert services counts to services mileage. If an average service length is not available, companies should use PHMSA's default length of 90 feet/service.	30.6 kg/mile

Emission Source	Description of Quantification Method	GHG Inventory Emission Factor
Distribution Mains, Mains with plastic liners or inserts	Subpart W plastic mains emission factor multiplied by miles of cast iron or unprotected steel distribution mains with plastic liners or inserts	1.13 scf/hour/mile (from Subpart W)
Distribution Services, Cast iron services	Subpart W steel services emission factor multiplied by number of cast iron services	0.19 scf/hour/number of services (from Subpart W)
Distribution Services, Cast iron or unprotected steel services with plastic liners or inserts	Subpart W plastic services emission factor multiplied by number of cast iron or unprotected steel services with plastic liners or inserts	0.001 scf/hour/number of services (from Subpart W)
Meters, Residential	GHG Inventory emission factor multiplied by number of meters	1.5 kg/outdoor meter
Meters, Commercial and industrial	GHG Inventory emission factor multiplied by number of meters	9.7 kg/meter
Pressure Relief Valves, Routine maintenance	GHG Inventory emission factor multiplied by number of valves	0.963kg/mile

For all sources, EPA published the GHG Inventory emission factors in Appendix A of the *Natural Gas STAR Methane Challenge Program: ONE Future Commitment Option Technical Document*. Available at: https://www.epa.gov/natural-gas-star-program/methane-challenge-program-one-future-commitment-option-technical-document

Distribution Segment Throughput

For companies with distribution operations, segment throughput equates to the volume of natural gas delivered to end users by the distribution company on a total throughput basis as reported to EIA for Form 176. As part of its approach to calculating throughput for companies in the distribution segment, ONE Future normalizes the volumes of gas delivered to residential and commercial customers. Companies may want to calculate methane emissions intensity using normalized throughput in addition to calculating methane emissions intensity using reported throughput. Appendix B describes an NGSI approach to calculating normalized throughput for interested companies.

Distribution Segment Methane Emissions Intensity

To convert distribution segment throughput to methane, the reporting company will have to make an assumption about the methane content of distributed natural gas. The reporting company can use and disclose its own estimate of the methane content of natural gas or can use a default factor of 93.4 percent.

To calculate distribution segment intensity, the emissions and throughput estimates must be converted to like units of methane. This can be on a mass basis or a volumetric basis. Companies reporting methane emissions intensity should use a methane density of 0.0192 metric tons per thousand cubic feet, consistent with the methane density used by EPA in the GHGRP (40 CFR 98.233(u)(2)(v)).

For example, a company could calculate its methane emissions intensity as:

$$Methane\ Emissions\ Intensity = \frac{Methane\ Emissions}{Natural\ Gas\ Throughput * Methane\ Content * \frac{0.0192\ metric\ tons}{thousand\ cubic\ feet}}$$

Alternatively, a company could calculate its methane emissions intensity as:

$$Methane\ Emissions\ Intensity = \frac{Methane\ Emissions * \frac{thousand\ cubic\ feet}{0.0192\ metric\ tons}}{Natural\ Gas\ Throughput * Methane\ Content}$$

Distribution Segment Reported Data

Companies with natural gas distribution operations following the NGSI protocol should publicly report the information described in Table 16. Information should be reported at the company level.

Table 16. NGSI Disclosure Elements for a Company with Natural Gas Distribution Operations

Disclosure Element	Description
Total Methane Emissions	Methane emissions (metric tons) associated with natural gas distribution, sum of emissions from the sources listed in Tables 13 and 14
Natural Gas Delivered to End Users*	Volume of natural gas delivered to end users (thousand standard cubic feet)
Methane Content of Delivered Natural Gas	Methane content of delivered natural gas (percent)
NGSI Methane Emissions Intensity*	Methane emissions intensity associated with natural gas distribution (percent)

*Companies may want to report throughput and methane emissions intensity on a normalized basis in addition to a non-normalized basis. Appendix B describes NGSI's approach to normalizing throughput.

Appendix A: Resources

In the course of developing these recommendations, NGSI has worked to leverage a wide range of existing sources, including those listed here.

Alvarez, Ramon et. al. “Assessment of methane emissions from the U.S. oil and gas supply chain.” Science Magazine, Vol. 361, Issue 6398, pp. 186-188. July 13, 2018. Available at: http://science.sciencemag.org/content/361/6398/186.full?ijkey=42lcrJ/vdyyZA&keytype=ref&siteid=sci

BP. “Tackling Methane.” Available at https://www.bp.com/en/global/corporate/sustainability/climate-change/tackling-methane.html

CDP. “CDP Climate Change 2019 Reporting Guidance.” Available at https://guidance.cdp.net/en/guidance?cid=8&ctype=theme&idtype=ThemeID&incchild=1&microsite=0&otype=Guidance&tags=TAG-585,TAG-605,TAG-599

ConocoPhillips. “Greenhouse Gas Emissions Intensity Target.” Available at: http://www.conocophillips.com/environment/climate-change/climate-change-strategy/greenhouse-gas-emissions-intensity-target/

ConocoPhillips. “Sustainability Report 2017.” Available at: http://static.conocophillips.com/files/resources/17sr.htm#1

Disclosing the Facts. “Disclosing the Facts: Transparency and Risk in Methane Emissions.” 2017. Available at: http://go.asyousow.org/DisclosingTheFacts_2017. Scorecard available at http://disclosingthefacts.org/2017/

Dominion Energy. “Sustainability Metrics.” Available at: https://sustainability.dominionenergy.com/metrics/

Dominion Energy. “Methane Management Report 2017.” Revised May 3, 2018. Available at: https://www.dominionenergy.com/library/domcom/media/community/environment/reports-performance/methane-management-report-2017.pdf?la=en

DTE Energy. “2018 DTE Methane Report.” Available at: https://empoweringmichigan.com/dte-impact/performance/

Edison Electric Institute. “AGA Voluntary Sustainability Metrics: Quantitative Information - October 2018 Version.” Available at https://www.aga.org/globalassets/policy/aga-esg-gas-quantitative-metrics-template-oct-2018-version.xlsx and on the EEI ESG/Sustainability webpage at http://www.eei.org/issuesandpolicy/finance/Pages/ESG-Sustainability.aspx

Environmental Defense Fund. “Taking Aim: Hitting the mark on oil and gas methane targets.” April 2018. Available at: https://www.edf.org/sites/default/files/documents/EDF_TakingAim.pdf

Environmental Defense Fund. “Setting the Bar on Methane Disclosure.” October 2018. Available at: https://www.edf.org/energy/setting-bar-methane-disclosure

Environmental Defense Fund. “The Disclosure Divide.” February 2018. Available at: https://www.edf.org/energy/methane-companies-split-methane-disclosure

ExxonMobil. “Performance Data Table.” Available at: https://corporate.exxonmobil.com/en/community-engagement/sustainability-report/performance-data-table

IPIECA. “Oil and gas industry guidance on voluntary sustainability reporting (3rd edition).” Available at: http://www.ipieca.org/resources/good-practice/oil-and-gas-industry-guidance-on-voluntary-sustainability-reporting-3rd-edition/

Oil & Gas Climate Initiative. “At Work: Committed to Climate Action.” September 2018. Available at: https://oilandgasclimateinitiative.com/wp-content/uploads/2018/09/OGCI_Report_2018.pdf

ONE Future. “Methane Emissions Estimation Protocol.” August 27, 2018. Available at: http://onefuture.us/wp-content/uploads/2018/11/ONE-Future-Methane-Intensity-Protocol_V2.3_27Aug18.docx

Royal Dutch Shell. “Shell announces methane emissions intensity target for oil and gas assets.” September 17, 2018. Available at: https://www.shell.com/media/news-and-media-releases/2018/shell-announces-methane-emissions-intensity-target.html

U.S. Environmental Protection Agency. “Greenhouse Gas Reporting Program Subpart W – Petroleum and Natural Gas Systems.” Available at: https://www.epa.gov/ghgreporting/subpart-w-petroleum-and-natural-gas-systems

U.S. Environmental Protection Agency, “Natural Gas STAR Methane Challenge Program: ONE Future Commitment Option Technical Document.” March 15, 2019. Available at: https://www.epa.gov/sites/production/files/2016-08/documents/methanechallenge_one_future_supp_tech_info.pdf

U.S. Environmental Protection Agency. “Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017.” April 12, 2019. Available at: https://www.epa.gov/sites/production/files/2019-02/documents/us-ghg-inventory-2019-main-text.pdf

Waters, Saphina. “Methodological note for OGCI methane intensity target and ambition.” September 24, 2018. Available at: https://info.oilandgasclimateinitiative.com/blog/methodological-note-for-ogci-methane-intensity-target-and-ambition

Appendix B: Protocol to Calculate Normalized Throughput

Companies with operations in the distribution segment may want to calculate methane emissions intensity using normalized throughput in addition to calculating methane emissions intensity using reported throughput. This Appendix describes NGSI's approach to normalizing throughput for these calculations.

As part of its approach to calculating throughput for companies in the distribution segment, ONE Future uses state-specific Heating Degree Day (HDD) values to normalize the volumes of gas delivered to residential and commercial customers. ONE Future uses HDD values that are population-weighted by state and are published by the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center (CPC). Companies can download HDD for states in which they operate from NOAA. NOAA reports cumulative annual data from July 1 to June 30, not January 1 to December 31. To identify the appropriate HDD data, companies will download the monthly data for June of the year of interest.[5] For example, for reporting year 2019, companies would download the HDD data for June 2019, representing cumulative data from July 1, 2018 to June 30, 2019.

Under NGSI, companies that opt to report throughput and methane emissions intensity on a normalized basis, in addition to calculating methane emissions intensity using reported throughput, will use the following methodology:

1. Identify the average HDD value for the states in which the company operates (*State HDD*) and the average HDD value for the United States (*US HDD*) for the reporting year.
2. Calculate the normalization factor for each state as the *US HDD* value divided by the *State HDD* value, or $\frac{US\ HDD}{State\ HDD}$.
3. For each state in which the company operates, calculate an adjusted throughput for natural gas delivered to residential and commercial customers, as reported to EIA in Form 176, as the normalization factor multiplied by the volume of natural gas delivered to residential customers (V_{Res}) plus the volume of natural gas delivered to commercial customers (V_{Comm}).
4. For each state in which the company operates, add the volume of natural gas delivered to other customers to the normalized volume for residential and commercial customers. This can be calculated as the total volume (V_{Total}) minus the residential and commercial volumes.

This methodology can be written as:

$$Normalized\ V_{State} = (V_{Res} + V_{Comm}) \times \frac{US\ HDD}{State\ HDD} + V_{Total} - (V_{Res} + V_{Comm})$$

After calculating the normalized volume for each state, the normalized natural gas throughput for the purposes of calculating a company's methane emissions intensity is calculated as the sum of the normalized throughput for each state.

[5] Population-weighted state HDD data are available for download from NOAA CPC at: ftp://ftp.cpc.ncep.noaa.gov/htdocs/products/analysis_monitoring/cdus/degree_days/archives/Heating%20degree%20Days/monthly%20states/