ONE Future 2018 Methane Emission Intensities: Initial Progress Report

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REPORT HIGHLIGHTS

- **ONE Future surpasses goal; 2017 methane intensity recorded at 0.552%, versus 2025 goal of 1.0%**
- **Coalition results compare favorably to the estimated results in National Energy Technology Laboratory's May 2018 report**
- **Each sector of the natural gas value chain achieved significant reductions**

EXECUTIVE SUMMARY

Our Nation's Energy Future (ONE Future) is a coalition of 16 natural gas companies representing the entire natural gas value chain focused on implementing an innovative, performance-based approach to the management of methane emissions directed toward a concrete goal of one percent (or less) of total produced natural gas by 2025. ONE Future's first annual report based on 2017 emissions shows that the ONE Future methane intensity level was 0.552%. Methane intensity is calculated by dividing methane emissions from natural gas production, gathering and boosting, processing, transmission and storage or distribution by the mass of methane produced, gathered and boosted, processed, transmitted and stored, and distributed respectively (for more details see ONE Future Protocol). For the purposes of the ONE Future calculation natural gas from Alaskan production is not included as gas production because currently it does not enter the natural gas value chain.

The original goal of 1% established by the founding members of the ONE Future Coalition in 2014 was based on the best available data at that time (i.e., EPA's national greenhouse gas inventory for 2012) [1] which resulted in a national methane emission intensity rate of 1.44%. ONE Future's goal was developed to achieve an ambitious average rate of methane emissions across the entire natural gas value chain of one percent or less of the methane portion of gross natural gas produced (methane intensity) by 2025. Stated differently, we aspire to demonstrate that through existing regulatory compliance and through additional voluntary actions, if all natural gas companies operated as ONE Future companies do, an industry-wide average emissions intensity of one percent would be achieved by 2025.

We strive for continuous improvement to ensure that natural gas remains the fuel of choice for any end-use sector at all times: power – including natural gas delivered by local distribution companies for power generation; residential, commercial and industrial demand; and critical emerging markets like transportation and LNG exports.

We believe that ONE Future's results demonstrate that industry can cost-effectively achieve an average emissions intensity rate of one percent or less. ONE Future believes that targeted investment in abatement technologies today can both yield significant improvements in environmental performance and supply chain efficiency.

Natural gas is primarily composed of methane, a clean fuel that emits few air pollutants when burned in stove tops, in power plants to generate electricity, or to power vehicle engines. However,

[1] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2012

when methane is emitted directly into the atmosphere (and not burned), it is a potent greenhouse gas. By reducing methane emissions across the natural gas supply chain, ONE Future members will deliver more value to our customers and shareholders, and increase safety while meaningfully reducing our greenhouse gas emissions.

The organization was formed in 2014, however all ONE Future companies have invested in methane mitigation technologies and work-practices for several decades. This report explains ONE Future's approach for quantifying the methane emissions intensity for the Coalition and for each industry sector and presents the resulting methane emission intensity values based on 2017 data.

INTRODUCTION TO ONE FUTURE

ONE Future is a unique group of leading companies with operations spanning every sector of the natural gas value chain: (1) oil and natural gas production; (2) natural gas gathering and boosting (G&B); (3) natural gas processing; (4) natural gas transmission and storage (T&S); and (5) natural gas distribution. Since our formation in 2014, we have grown to 16 companies accounting for some of the largest natural gas producers, transmission and distribution companies in the United States (U.S.). ONE Future members operate in 11 out of the 19 production basins, and other segments of the value chain operate in multiple regions of the country, hence ONE Future's data represents a geographically diverse and material share of the U.S. natural gas supply chain. Its members include:

- Antero Resources,
- Apache,
- Berkshire Hathaway Energy Pipeline Group[2],
- BHP,
- Dominion Energy,
- Equinor (formerly StatOil),
- EQT,
- Hess Corporation,
- Jonah Energy LLC,
- Kinder Morgan,
- National Grid,
- Noble Energy[2],
- Southern Company Gas,
- Southwestern Energy,
- Summit Utilities,
- TransCanada U.S. Gas Operations.

Established as a non-profit 501(c)(6) trade group, ONE Future's mission is to reduce methane (CH_4) emissions across all segments of the natural gas value chain by means of innovative, cost-effective, and performance-based actions.

ONE Future's approach is goal-oriented but flexible in that member companies can choose how they can cost-effectively and efficiently achieve their CH_4 emissions intensity goal – whether that is by deploying an innovative technology, modifying a work practice, or in some cases replacing or retrofitting high emitting equipment. What is important is that each company demonstrates

[2] Berkshire Hathaway Energy Pipeline Group and Noble Energy joined ONE Future in the 4th quarter of 2018. Their emissions data are not reflected in this current report but will be included in future years.

progress toward its target, which in turn will achieve ONE Future's overall emission intensity target (total CH_4 emissions divided by gross production) of one percent or less by 2025[3].

Based on 2012 national methane emissions and production data, cumulative emissions from the natural gas sector were 1.44% of gross gas production. These emissions can be broken down by industry sector as shown in Figure 1. ONE Future's targets by industry segment to achieve the one percent methane emission intensity goal are also shown.

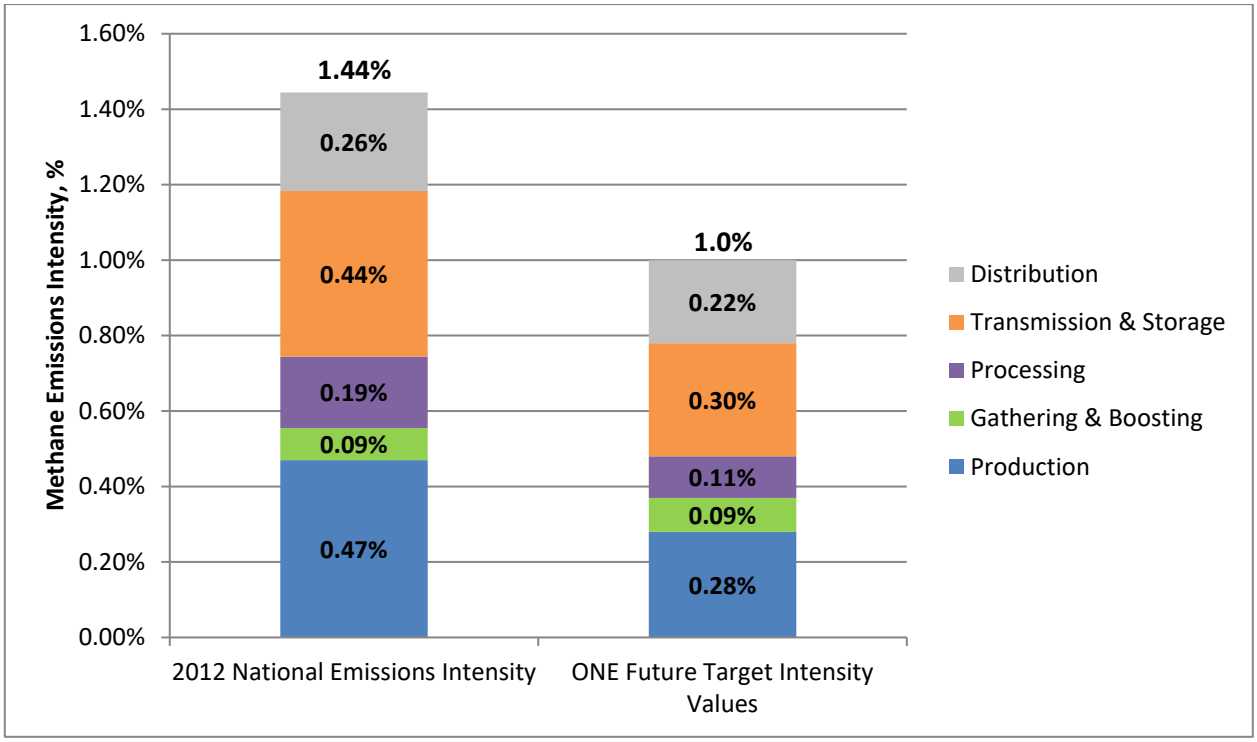

Figure 1. Illustration of 2012 Emissions and ONE Future 2025 Target

ONE FUTURE EMISSIONS INTENSITY APPROACH

ONE Future tracks company and program progress by calculating emission intensities at the national, segment, and participant levels. Segment and participant emission intensities are based on total methane emissions for the particular participant or for all ONE Future companies with operations in a particular segment divided by a segment-based throughput. The segment intensity values are not additive across different segments because they are referenced to different throughput quantities in the denominator; however, they are developed in such a way that meeting these targets

[3] The natural gas supply chain does not actually receive the "gross gas production", as some of the gas is re-injected for re-pressuring before leaving the production site. A "net gas production" value can be calculated that more accurately reflects the gas that flows into the supply chain. This net gas value subtracts the DOE EIA "repressuring" gas from the gross gas production.

within each segment corresponds to meeting the overall ONE Future one percent National Intensity Target.

To enable multiple companies involved in different sectors of the natural gas supply chain to report CH_4 emissions in a manner that is both consistent and transparent, ONE Future has developed a Methane Emissions Estimation Protocol (ONE Future Protocol).[4] The ONE Future Protocol defines both the annual emissions intensity calculation techniques, as well as the method by which annual results will be compared to the ONE Future sector and overall goals. By using a written protocol, ONE Future participants aim to benchmark performance according to a common and uniform set of emission calculations and measurements so that the results are transparent and verifiable.

The ONE Future Protocol also provides the procedures that member companies will use to quantify and report their emissions, in addition to tracking their progress. The detailed procedures that companies use to compute their emissions largely follows the EPA's Greenhouse Gas Reporting Rule (GHGRP)[5] or the national GHG inventory prepared annually by EPA (referred to as the GHGI) [6]. One Future members have included additional emission sources not required for reporting under the GHGRP and use the latest EPA approved emission factors in their reports.

Recognizing that each member company has unique objectives in addition to the overarching goal of the organization, ONE Future has identified sector-specific targets to benchmark company progress toward their methane reduction goals, as well as facilitate comparisons among the ONE Future participant companies. The segment intensity values are based on segment emissions divided by segment throughput. Segment intensity targets will be used to track the progress of the participant companies and will also be used to scale participant emissions to the national level to track progress toward ONE Future's overall emission intensity goal.

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[4].http://onefuture.us/wp-content/uploads/2018/11/ONE-Future-Methane-Intensity-Protocol_V2.3_27Aug18.docx ONE Future reserves the right to update the contents of the ONE Future Protocol at any time to maintain alignment with EPA definitions and methodologies and reflect EPA's most current GHG emissions data.

[5] https://www.epa.gov/ghgreporting

[6] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2016

SECTION SUMMARIES

Production

(Antero Resources, Apache, BHP, Dominion Energy, Equinor, EQT, Hess, Jonah Energy LLC, SWN)

The Production sector consists of the exploration of natural gas, wells producing natural gas (including oil wells producing gas) and equipment located at the well site associated with natural gas production. Because wells often co-produce natural gas and crude/condensate, the ONE Future Protocol describes an emission allocation approach using the energy content of the various streams to allocate total emissions to those represented by natural gas production only. This allocation is necessary because the ONE Future emission intensity value is based on the gross production of natural gas (co-produced crude or condensate volumes are not included in the natural gas value chain).

ONE Future member companies represent approximately 11% of the total U.S. natural gas production in 2017. The current (2017) ONE Future methane emission intensity value for the production sector is 0.205%. Figure 2 shows ONE Future's emissions by source type for the Production segment.

ONE Future's methane intensity value for Production reflects the implementation of some of the following types of methane reduction activities by the ONE Future companies with production operations[7]:

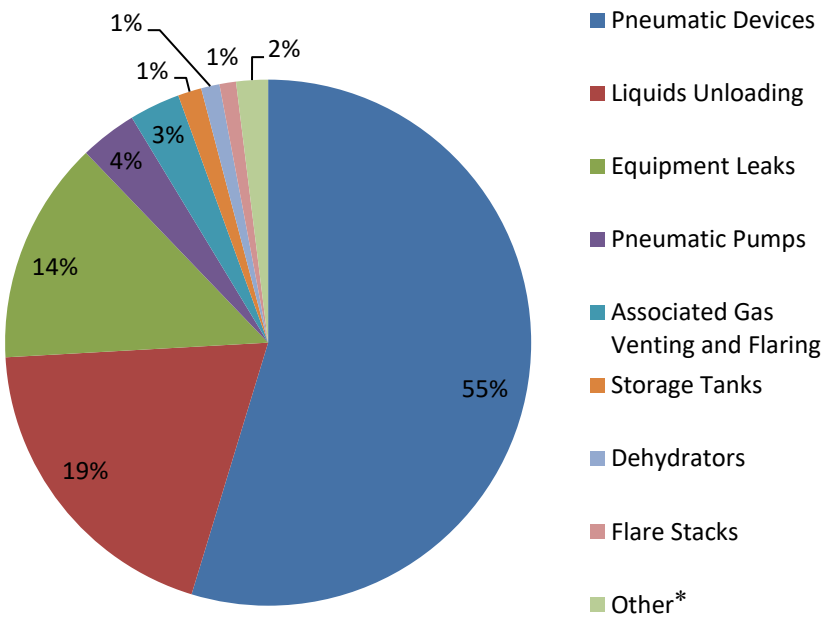

Figure 2. ONE Future's methane emissions for Production

*Note, Other includes Completions and Workovers, Combustion, and Reciprocating Compressors

[7] These listed methane reduction activities are intended to represent some examples of activities that the ONE Future companies may have implemented in 2017, but each company has the flexibility to decide on the activities to implement based on what is most appropriate and feasible for their company.

- Where possible, replace or repair high emitting pneumatic devices with low or no-bleed devices[8],
- Voluntary leak surveys and repair programs to identify and fix equipment leaks at aboveground production sites,
- Upgrade storage tank ventilation systems, and
- Control emissions from liquids unloading operations through the use of foaming agents, velocity strings, wellhead compression and vent less restoration.

Although not part of the natural gas value chain, the co-production of crude and/or condensate with natural gas represents additional opportunities for methane emission reductions. For transparency, if crude/condensate methane emissions from production operations were included in the ONE Future methane emission intensity calculation, the resulting production sector methane emissions intensity would be 0.219%, which is approximately 7% higher than the emission intensity value (0.205%) that is based on natural gas production operations only. The result of including emissions from crude/condensate production when calculating the overall emissions intensity across all sectors would be approximately (0.569%), or (3%) higher than the One Future value which is based on natural gas production operations only (0.552%).

[8] Given that pneumatic emissions reported here are driven solely by EPA GHGRP emission factors and not by direct field measurements, this device replacement approach is the only way to affect the large emissions reported here. In the future, actual field measurements of pneumatics may be used which could reflect reductions from voluntary pneumatic device monitoring and repair programs.

Gathering and Boosting

(Antero Resources, Apache, BHP, Dominion Energy, Equinor, EQT, Hess, SWN)

The Gathering and Boosting sector (G&B) includes pipelines and other equipment used to collect natural gas from production facilities, treat the gas as needed through dehydration or acid gas removal, and compress the gas to transport it to a natural gas processing facility, a natural gas transmission pipeline, or to a natural gas distribution pipeline. Methane emissions from equipment leaks, natural gas-operated pneumatic controllers and centrifugal compressors are the three largest sources of emissions for this sector.

Based on 2017 emissions data from ONE Future participant companies, the CH_4 emission intensity for the G&B sector is 0.093%. Figure 3 shows ONE Future's emissions by source type for the Gathering and Boosting segment.

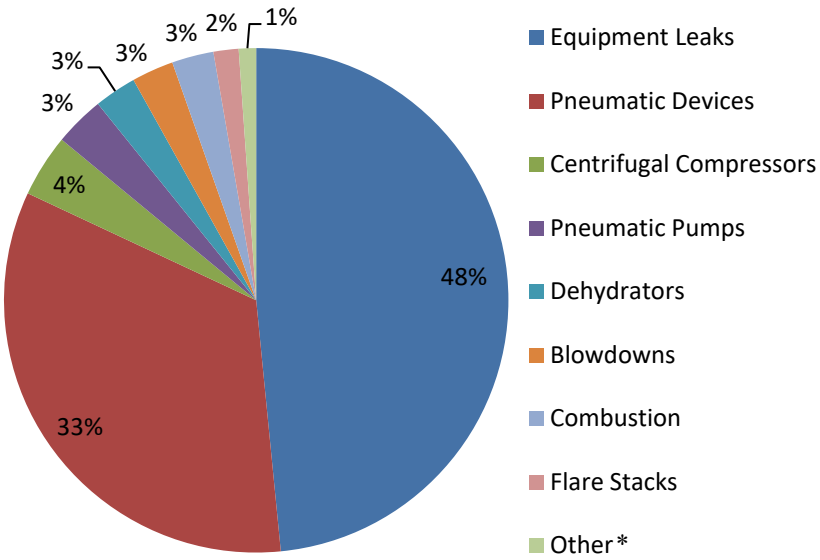

Figure 3. ONE Future's methane emissions for Gathering and Boosting

*Note, Other includes Reciprocating Compressors and Storage Tanks

ONE Future's methane intensity value for G&B reflects the implementation of some of the following types of methane reduction activities by the ONE Future companies with G&B operations[9]:

- Voluntary leak surveys and repair programs to identify and fix equipment leaks at aboveground G&B sites.
- Where possible, replace or repair high emitting pneumatic devices with low or no-bleed devices.
- Install electrically operated glycol pumps to replace natural gas operated pumps.
- Program compressor unit controls to reduce pressure prior to venting.
- Maximize the utilization of compressors to optimize combustion performance and fuel efficiency.
- Condition-based maintenance program to determine the need for compressor rod packing replacement. A condition-based program uses the measured leak rate of the rod packing to objectively evaluate whether rod packing needs replacement.

[9] These listed methane reduction activities are intended to represent some examples of activities that the ONE Future companies may have implemented in 2017, but each company has the flexibility to decide on the activities to implement based on what is most appropriate and feasible for their company.

- Continuously monitor operational parameters to quickly notify operators of performance issues and operating conditions.

Like the Production sector, the Gathering and Boosting sector also handles both gas and liquid streams. Therefore, GHG emissions from gathering and boosting operations are allocated between gas streams and crude/condensate using the energy content of the natural gas relative to the total energy content of all streams. For transparency, if all methane emissions from gathering and boosting operations were included in the ONE Future methane emission intensity calculation, the resulting methane emissions intensity would be only slightly higher at a rate of 0.095%.

National data for the G&B sector are limited and GHGRP reporting for this sector only began in 2016. As a result, the methane emission intensity value for this sector is scaled nationally by gross gas production, just as for the Production sector. This is the same as combining the emissions from Production and G&B operations together.

Processing

(Apache, BHP, Dominion Energy, Hess)

The Processing sector is made up of gas processing plants where hydrocarbons and fluids in produced natural gas are separated to result in natural gas that meets pipeline specifications. Equipment associated with the gas processing segment includes all equipment inside a gas processing plant, such as: absorption units or cryogenic expanders, fractionators, dehydrators, acid gas removal units, and compressors. Based on the EPA's national greenhouse gas inventory (GHGI)[10], equipment leaks and engine exhaust from un-combusted natural gas are the largest sources of CH_4 emissions for the processing sector.

ONE Future companies reporting emissions for the Gas Processing segment make up approximately 1.2% of the total national volume of gas processed. The CH_4 emission intensity for the processing sector is 0.024% on a net gas produced basis. Figure 4 shows ONE Future's emissions by source type for the Processing segment.

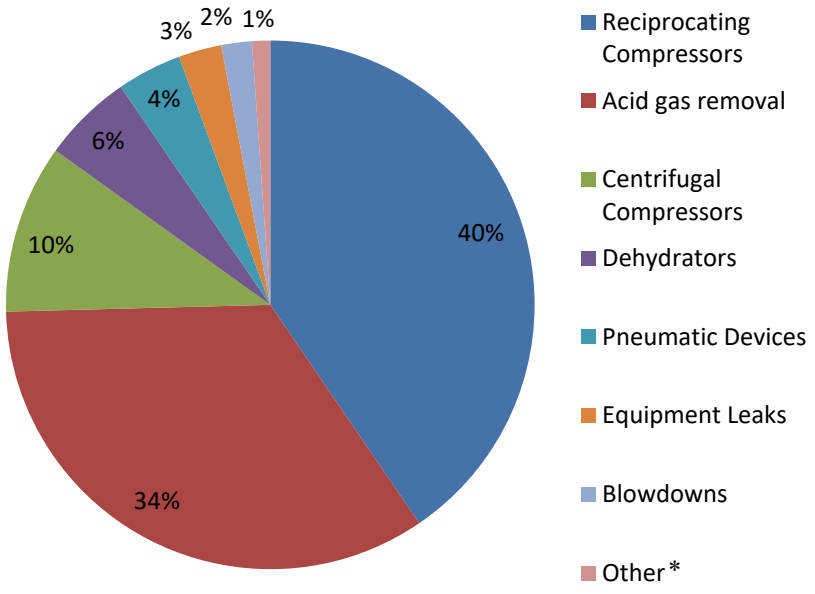

Figure 4. ONE Future's methane emissions for Processing

*Note, Other includes Combustion and Flare Stacks

ONE Future's methane intensity value for Processing reflects the implementation of some of the following types of methane reduction activities by the ONE Future companies with processing operations[11]:

- Where possible, replace or repair high emitting pneumatic devices with low or no-bleed devices.

Although, the Gas Processing sector also handles both gas and liquid streams, the volume of natural gas plant liquids (NGPL) and the corresponding energy content is small compared to natural gas. Allocating methane emissions between natural gas and NGPL on an energy basis has a small impact on the Gas Processing sector methane emissions intensity, changing the intensity value from 0.0241% to 0.0247%, or an increase of about 2.3%.

[10] U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016*, EPA 430-R-18-003, April 2018.
[11] These listed methane reduction activities are intended to represent some examples of activities that the ONE Future companies may have implemented in 2017, but each company has the flexibility to decide on the activities to implement based on what is most appropriate and feasible for their company.

Transmission and Storage

(Apache, Dominion Energy, EQT, Kinder Morgan, TransCanada)

The Transmission and Storage (T&S) sector comprises high pressure, large diameter pipelines that transport natural gas from production and processing to natural gas distribution systems or large-volume consumers such as power plants or chemical plants. This includes interstate and intrastate facilities. Storage facilities, such as underground storage in expended gas reservoirs are used by transmission companies to hold gas and allow for seasonal demand differences. EPA combines T&S into one segment since many of the storage facilities are owned and operated by transmission companies, and since, in some cases the surface facilities (compression at underground storage, for example) are similar to other transmission facilities. Compression of natural gas is a significant operation for the T&S sector, and therefore emissions from compressors, including fugitive components, components designed to vent gas, and compressor exhaust are significant contributors to CH_4 emissions.

Based on 2017 emissions data from ONE Future T&S companies, the CH_4 emission intensity for the T&S sector is 0.122%. Figure 5 shows ONE Future's emissions by source type for the Transmission and Storage segment.

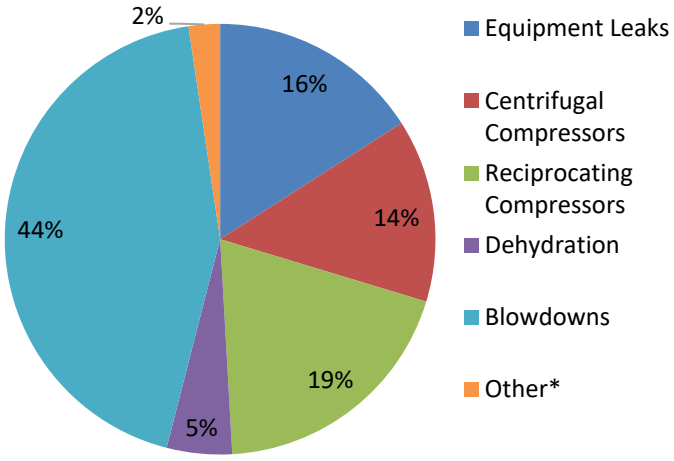

Figure 5. ONE Future's methane emissions for Transmission and Storage

*Note, Other includes Combustion, Tanks, Pneumatic Controllers and Flare Stacks

ONE Future's methane intensity value for T&S reflects the implementation of some of the following types of methane reduction activities by the ONE Future companies with T&S operations[12]:

- Using sleeves and composite wraps to repair pipelines, eliminating the need to blowdown the pipeline;
- Implementing pipeline pump-down techniques to lower the pipeline pressure prior to transmission pipeline blowdowns;
- Voluntary leak surveys and repair programs to identify and fix equipment leaks at aboveground T&S sites.
- Increasing the length of pressurized hold times on compressors to reduce number of compressor unit blowdowns to atmosphere.

[12] These listed methane reduction activities are intended to represent some examples of activities that the ONE Future companies may have implemented in 2017, but each company has the flexibility to decide on the activities to implement based on what is most appropriate and feasible for their company.

ONE Future member companies represent approximately 31% of the total U.S. natural gas transmission pipeline miles. Since the same natural gas can pass through multiple transmission pipelines before being delivered to downstream users, the total overall throughput volume reported to EIA for this sector exceeds the total volume of natural gas produced. Because the same gas can be recorded as throughput multiple times within this sector, ONE Future made an additional adjustment to total throughput in addition to being scaled to gross gas production as outlined in the ONE Future Protocol. This adjustment was intended to more closely represent the throughput solely within the ONE Future T&S companies by scaling nationally based on average gas volume per pipeline mile using data collected from the EIA.

Distribution

(Dominion Energy, National Grid, Southern Company Gas, Summit)

The Distribution sector covers natural gas pipelines that take high-pressure gas from the transmission system, reduce the pressure, and distributes the gas through primarily underground mains and service lines to individual end users. This segment includes natural gas mains and services, metering and pressure regulating stations, and customer meters. The ONE Future member companies represent 14% of the total U.S. natural gas delivered by local distribution companies and 12% of the total national miles of distribution mains.

Figure 6 shows ONE Future's emissions by source type for the Distribution segment. Fugitive emissions from distribution mains and services are the most significant source of CH_4 emissions for the distribution sector and are a function of system age and pipeline materials. ONE Future members include companies with large inventories of aged infrastructure, including cast iron pipe and unprotected steel pipe. This is reflected in the 2017 CH_4 emission intensity value of 0.108% (based on gross gas production) for the distribution sector.

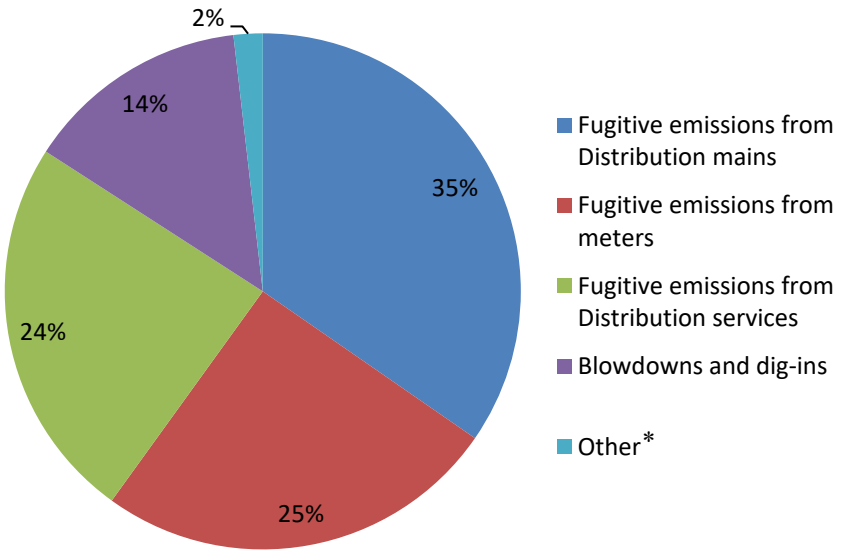

Figure 6. ONE Future's methane emissions for Distribution

*Note, Other includes Fugitive Emissions from Distribution Stations and PRV Releases

ONE Future's methane intensity value for Distribution reflects the implementation of some of the following types of methane reduction activities by the ONE Future companies with distribution operations[13]:

- Making significant progress in replacing leak-prone pipe and having ongoing initiatives that are replacing pipelines to reduce CH_4 emissions, and
- Voluntary leak surveys and repair programs to identify and fix equipment leaks at aboveground surface facilities.

[13] These listed methane reduction activities are intended to represent some examples of activities that the ONE Future companies may have implemented in 2017, but each company has the flexibility to decide on the activities to implement based on what is most appropriate and feasible for their company.

CONCLUSIONS

ONE Future is pleased to present the current consolidated progress of our participant companies toward achieving our collective goal achieving an average rate of methane emissions across the entire natural gas value chain of one percent or less of the methane portion of gross natural gas produced.

Figure 7 shows ONE Future's 2017 cumulative methane emission intensity by sector of 0.552% versus the ONE Future's 2025 cumulative target of 1%. Also Figure 7 compares ONE Future's 2017 value of 0.552% to the 2012 national emission intensity value of 1.44%[14].

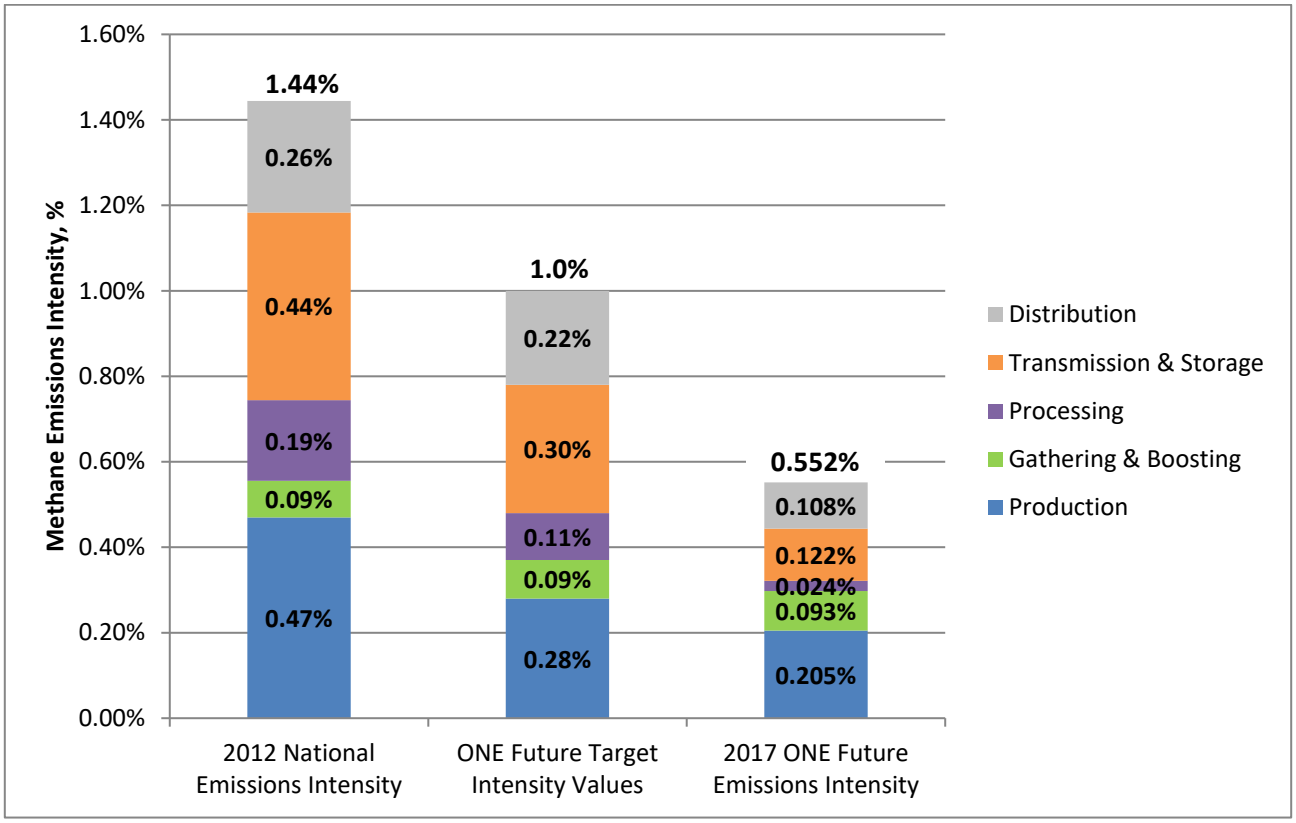

Figure 7. ONE Future 2017 Emission Intensity Results Compared to the ONE Future Target and 2012 National Emission Intensity

ONE Future's emission intensity value of 0.552% is in line with 2018 NETL report[15] that showed ONE Future's average life-cycle emission rate to be 0.67% based on the volume of natural gas delivered to consumers.

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[14] U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012, EPA 430-R-14-003, April 2014.

[15] National Energy Technology Laboratory (NETL), *Industry Partnerships and Their Role in Reducing Natural Gas Supply Chain Greenhouse Gas Emissions*, May 1, 2018.

Although ONE Future's 2017 data resulted in a methane emission intensity value well below the 1% target, ONE Future members are committed to continual improvements and ongoing methane emission reduction activities as well as openly and transparently sharing their best practices through technical reports and workshops to enable others across the industry to capture the key learnings from One Future's successful initial results.

ONE Future's overarching goal is to ensure the future of natural gas as a long-term sustainable fuel and that objective will be assured if additional players in the natural gas value chain step up and embrace the benefits of reducing methane emissions. We understand that methane emission reduction is not just good for the environment, but is also good for the natural gas industry, its employees, customers, communities, and investors.