Methane Management Report
2017, Revised May 3, 2018
Dominion Energy (NYSE:D) is one of the nation’s largest producers and transporters of energy, with a portfolio of electric generation, electric transmission and distribution lines, and natural gas transmission, gathering, storage and distribution pipelines. This report focuses on how we manage methane emissions from our natural gas operations.

Since 2008, Dominion Energy has reduced methane emissions by 5.4 billion cubic feet, according to EPA estimates. This results from years of taking increasingly stringent voluntary actions in our natural gas operations. We will continue a comprehensive methane strategy that will further reduce methane emissions over the next five years at an even more rapid pace. From our electric businesses, methane is released as a by-product of combustion in the process of generating electricity. We plan to further increase our reliance on cleaner generating technologies, and when combined with continued operation of our three nuclear power stations, should result in an additional reduction of our methane emissions.

More than five years ago, we joined the EPA’s Natural Gas STAR program, which emphasized best management practices (BMPs) to voluntarily reduce methane emissions and report those reductions. In 2016, we demonstrated industry leadership by becoming a founding member of the EPA’s Methane Challenge.

As part of the Methane Challenge, we committed to methane reduction targets through 2021, and we began disclosing results before the Methane Challenge deadline. Experience has taught us that one of the most effective ways to reduce methane emissions is to upgrade older pipelines. In Ohio—our largest gas distribution market—we have been actively replacing more than 5,000 miles of bare steel mains since 2008. As part of the Methane Challenge, we are planning to reduce methane emissions by investing $200 million or more annually over the next two decades to upgrade aged bare steel, cast iron, wrought iron and copper pipe in our Ohio pipeline system—expanding on the $1.2 billion investment we have already made to replace more than 1,300 miles of pipeline in the Buckeye State. In 2016, we began to grow a similar program we created in West Virginia, and plans call for an additional $58 million investment there over the next two years.

On the high pressure transmission side of our business, we are reducing emissions in the Methane Challenge by relieving pressure before conducting pipeline maintenance. The Dominion Energy Transmission team will reduce methane emissions from maintenance activities by at least 50 percent by 2021. New procedures include reducing pipeline pressure before blowing down (this is the procedure where maintenance is based on first relieving pressure in the pipeline by releasing methane into the atmosphere), routing gas to a compressor or other systems for beneficial use, and using “hot taps.” (This is the ability to safely tap into a pipeline while it remains under pressure. The technology is a procedure that can only be done on newer pipelines.)

In Utah—our newest gas distribution market—all cast iron pipe was replaced in the 1980s; all bare steel pipe was replaced in the 1990s. Since the 2000s, the company has been focused on replacing all reconditioned high-pressure pipe in high-consequence areas at an annual investment of $75 million. We plan to reduce methane emissions under the Methane Challenge through a new program to prevent excavation damage of pipelines.

Dominion Energy Wexpro anticipates installing new air compressors and air dryers to 31 devices at Canyon Creek and Church Buttes well sites in Wyoming, eliminating 46,000 thousand cubic feet (MCF) gas lost and related emissions. We also are proud that the Utah Clean Cities Coalition recognized Dominion Energy as one of the top idle-free businesses in 2017.
The new export facility at our Cove Point liquefied natural gas (LNG) facility in Calvert County, Maryland, has implemented the most aggressive and best-in-class leak detection and repair program in the state. In addition, an extensive flaring system has been installed to reduce methane emissions from the liquefaction process.

Recently, we challenged ourselves to find additional measures to augment our prior methane emissions reduction programs, and launched new voluntary initiatives to achieve additional reductions over the next five years.

We are also focused on continuing to be transparent about our methane emissions, and in fact, we are proud to have the most comprehensive public disclosures of methane emissions of any peer gas company. Dominion Energy plans to provide additional disclosures around greenhouse gases by participating in the CDP (formerly the Carbon Disclosure Project) reporting on greenhouse gases in 2018.

In 2015, we published our first methane report, building on more than a decade of voluntary reports on GHG emissions (Link). This report was updated again in 2016 (Link). In 2012, we began reporting methane emissions from our natural gas system under the EPA mandatory greenhouse gas reporting program (GHGRP). In 2008, we began developing a corporate GHG inventory for our natural gas businesses, and we have voluntarily reported our total carbon emissions on our website since 2005. Dominion Energy has been proactive about reporting methane emissions, and our program for estimating GHG emissions uses approaches that the EPA recommends.
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Introduction

In the United States, carbon dioxide (CO₂) emissions have fallen over the past decade, thanks in large part to the increased use of natural gas as a fuel to generate electricity. At the same time, this has led to an increased focus on natural gas as a contributor to GHG emissions, and methane (CH₄) in particular.

In the United States, methane emissions make up approximately 10% of all greenhouse gas emissions. Methane emitted from the natural gas sector accounts for approximately 25% of methane emissions, or about 2.5% of the national total, based on carbon dioxide equivalent (CO₂e). In addition to leakage from natural gas operations, methane is emitted from natural sources such as wetlands and also from human activities such as raising livestock and manure management.

Although natural gas is a clean-burning fuel, when it is released to the atmosphere as un-combusted methane, it has a higher global warming potential than carbon dioxide. The current EPA-specified global warming potential (GWP) for methane when converting it to CO₂e is 25. This means that a molecule of CH₄ is 25 times more potent than a molecule of CO₂ in terms of global warming impact over a 100-year period. Un-combusted methane is leaked or emitted from pipeline and equipment blowdowns during normal operations and maintenance activities. Efforts to reduce these emissions focus on reducing both the frequency and duration of unintentional leaks, and on implementing practices that result in fewer, less extensive releases of natural gas prior to planned maintenance activities.

MMT: Million metric tons
Dominion Energy’s Natural Gas Operations

Overview

Headquartered in Richmond, VA, Dominion Energy [NYSE: D] is one of the nation’s largest producers and transporters of energy, with a portfolio of approximately 26,000 megawatts of electric generation, 66,000 miles of natural gas transmission, gathering, storage and distribution pipeline and 64,500 miles of electric transmission and distribution lines. We operate one of the largest natural gas storage systems in the U.S. with approximately 1 trillion cubic feet of capacity, and serve nearly 6 million utility and retail energy accounts.

Dominion Energy’s natural gas operations span the entire value chain from production to local distribution. Dominion Energy operates production assets in Colorado, Ohio, Pennsylvania, Utah, West Virginia, and Wyoming. The company operates natural gas processing (extraction) facilities in Ohio and West Virginia and processes gas at facilities in Utah and Colorado.

Dominion Energy’s natural gas transmission, gathering, and storage pipelines operate in 11 states—Colorado, Georgia, Maryland, New York, Ohio, Pennsylvania, South Carolina, Utah, Virginia, West Virginia, and Wyoming.

Dominion Energy’s natural gas distribution systems operate in Idaho, Ohio, Utah, West Virginia, and Wyoming, and has an LNG facility in Calvert County, Maryland.

Dominion Energy is actively engaged in efforts to manage methane emissions from its natural gas operations. This report covers emissions from sources that Dominion Energy wholly owns and operates. It does not cover facilities or sources that are not operated by the company.
Dominion Energy’s Methane Emissions Management

Since 2011, the EPA has required through its GHGRP the reporting of emissions from individual facilities, such as compressor stations, and aggregated natural gas systems, such as local distribution companies or gathering and boosting (G&B) networks, which exceed GHG emission thresholds of 25,000 metric tons (MT) per year of CO$_2$e. It should be noted that CO$_2$e includes all regulated GHG pollutants (CO$_2$, CH$_4$, and nitrous oxides (N$_2$O)). As a general matter, Dominion Energy reports emissions under the GHGRP for our facilities/systems that exceed 25,000 metric tons of CO$_2$e per year.

The emissions reported are based on protocols established in EPA’s GHGRP and are measured, calculated, or estimated based on a combination of the following:

- Actual field measurements (such as annual leak rate surveys at compressor vents);
- Company average population counts and leak factors obtained through the GHGRP and then applied to unmeasured compressor operating modes and for non-GHGRP facilities;
- Annual fugitive leak surveys and population counts of equipment or components used in conjunction with EPA-specified emission factors;
- Activity data, such as number of well re-works (workovers) and completions, times emission factors;
- Engineering estimates of flare emissions and blowdown volumes based on gas flow, pipe diameter, pressure and time; and
- Modeling results for equipment such as glycol dehydrators and drip tanks as specified in the GHGRP.

Due to the size and number of potential fugitive emission sources within the natural gas value chain, real time emission monitors, such as CO$_2$ continuous emissions stack monitors on large fossil fuel electric generating units, are not practical.

In January 2016, the EPA expanded the GHGRP to include inputs and emissions associated with the natural gas G&B operations (the midstream segment taking gas from the wellhead to the processing facility and/or transmission pipelines), and transmission pipeline (TPL) blowdowns, for facilities that exceed 25,000 MT per year of CO$_2$e emissions. The sources within these operational segments were not previously covered under the federal rule and the first reports were submitted on March 31, 2017. Methane emissions data from Dominion Energy’s GHGRP reports are provided in this report. Additionally, the EPA makes reported GHGRP data publicly available on its website [Link](Link).
Understandable
Methane
Emissions

**Leak Rate Metric:** There is a great deal of interest in developing a method for determining and reporting natural gas leakage, from production through customer distribution, as a percentage of total natural gas produced in the United States, and, for individual companies, of natural gas leakage as a percentage of throughput. We believe that in order for any such disclosure to be meaningful, it must be derived through a consistently understood process and there is currently no industry or EPA standard for reporting leaks as a function of production, throughput and/or stored gas. Dominion Energy agrees that it is important to understand where leaks come from, how big they are, and to take measures to reduce them.

In the natural gas industry leaks are quantified using a combination of measurements, emissions factors, and estimates. The estimates can vary due to the nature of the business and the state of measurement technologies. The EPA’s Greenhouse Gas Inventory for the natural gas value chain is revised almost every year to account for changes in emissions estimation methods, equipment, and operational trends. More importantly, there is no one industry-wide accepted methodology for calculating a leak rate for individual companies with operations in one or more segment of the value chain. Natural gas molecules can flow into and out of equipment, in any combination of possible configurations, at any point in time, including between different owners and operators. As a result, it is difficult to establish an equitable leak rate methodology.

**Leak Rates Based on EPA-Reported Data under the GHGRP:**
Until an industry standard is developed, Dominion Energy has calculated methane leak rates based on federally reported emissions and throughput values (converted to thousand standard cubic feet of methane) and provides the results in the table below.

<table>
<thead>
<tr>
<th>Subpart W Segment</th>
<th>Subpart W Total CH4 Emissions (mcf CH4) (numerator)</th>
<th>Subpart W Total Gas Throughput (mcf CH4) (denominator)</th>
<th>Methane Leak Rate % (Column A divided by Column B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>762,788</td>
<td>48,657,430</td>
<td>1.57%</td>
</tr>
<tr>
<td>Gathering &amp; Boosting</td>
<td>144,188</td>
<td>345,183,263</td>
<td>0.04%</td>
</tr>
<tr>
<td>Processing</td>
<td>916</td>
<td>51,726,956</td>
<td>0.00%</td>
</tr>
<tr>
<td>Storage</td>
<td>53,748</td>
<td>685,982,435</td>
<td>0.01%</td>
</tr>
<tr>
<td>Transmission Compressor Stations</td>
<td>147,565</td>
<td>1,932,881,920</td>
<td>0.01%</td>
</tr>
<tr>
<td>Transmission Pipelines</td>
<td>396,720</td>
<td>3,413,159,570</td>
<td>0.01%</td>
</tr>
<tr>
<td>LNG Import/Export</td>
<td>6,444</td>
<td>5,692,582</td>
<td>0.11%</td>
</tr>
<tr>
<td>Distribution</td>
<td>1,668,183</td>
<td>485,999,179</td>
<td>0.34%</td>
</tr>
</tbody>
</table>

*Note:* Consistent with EPA regulations, the foregoing data includes only the facilities and emissions subject to Subpart W of the GHGRP. Methane emissions from facilities and emission sources subject to Subpart W of the GHGRP are totaled for each segment and converted to standard cubic feet of methane. The natural gas throughputs (reported in terms of standard cubic feet of methane) differ for each segment, but are based on volumes reported under Subpart W of the GHGRP.

For compressor stations along common transmission pipelines, and for gas into and out of underground storage fields and compressor stations, a certain amount of
double counting of gas throughput is necessary to develop facility-specific leak rates based on EPA-reported data. This is a known issue that the industry is in the process of working through in order to compare facility and company-level performance to a national one percent leak rate goal.

**Measuring Methane Emissions**

**Leak Rate Measurement:** Unlike with a power generating facility, there is no single point source along the natural gas value chain. This makes fugitive leak sources unrealistic to monitor individually in real time. At fossil fuel fired power stations, owners install continuous emission stack monitors, including CO₂, to monitor real time emissions in compliance with federal regulations. A stack is one point source through which thousands of tons of GHG emissions flow. The denominator normalizing the stack emissions based on throughput from power stations is the amount of energy produced in net megawatt hours (MWH). The intensity metric (pounds of pollutant per net megawatt hour) is a universally accepted standard. The search is on, however, for the establishment of a similar metric on the natural gas side.

**Leak Rate Variables:** For natural gas operations, emission sources are much smaller and more numerous, and spread across expansive geographies. There are hundreds of valves, connectors and other components at a compressor station that could potentially leak at any given point in time. Depending upon the quality of the natural gas, which differs across the nation, some natural gas requires processing before it is of sufficient quality to enter the interstate pipeline system. These processing facilities likewise have hundreds of components that could potentially leak.

Additionally, some companies store natural gas in underground pools to ensure there is sufficient gas to meet peak period customer demand. These facilities have flanges, valves and other pressurized equipment to move gas into and out of storage fields.

Developing a leak rate calculation to compare the performance of one company to another, and that adequately accounts for the movement of gas through ancillary equipment between receipt and eventual transmission to a distribution company, is therefore complicated. For example, natural gas may be produced (and reported) by one company, then stored by another, and then transported by still another. In this case, the “throughput” of the same molecule of natural gas could be reported three times by three different companies. On the other hand, gas (and the resulting leaks) that does not pass through a facility subject to reporting is not reported at all. Some facilities because of size are excluded from reporting requirements. There remains a great deal of opportunity to develop an industry standard to address these issues.

The above table represents methane leak rates and gas throughputs based on federally-reported data provided to EPA under the GHGRP.

**Disclosure**

Dominion Energy has the most comprehensive public methane disclosures of any peer gas company. Until a methane leak rate methodology is fully developed, Dominion Energy is disclosing leak rates based on the facilities and emissions reported to EPA under the GHGRP. Methane disclosures for emissions and reductions focus on a combination of source inventories and descriptions of activities to mitigate methane emissions through BMPs. Dominion Energy has disclosed estimates of its GHG emissions for more than a decade.
Dominion Energy’s Underground Storage Operations

In January 2017, the Pipeline and Hazardous Materials Safety Administration’s (PHMSA) Interim Final Rule on Underground Gas Storage was enacted and required storage operators to develop standards and procedures pertaining to storage well operations, maintenance, and emergency response. These procedures and standards were required to be in place by January 2018. Dominion Energy facilities complied with the Interim Final Rule on December 19, 2016.

Dominion Energy’s storage holdings include 21 underground depleted hydrocarbon reservoirs in Ohio, West Virginia, Pennsylvania, New York, and Utah, and three aquifer reservoirs in northern Utah and Wyoming (see maps of our storage assets in Appendix A). Aquifers are underground, porous and permeable rock formations that act as natural water reservoirs that, in some cases, may be used for natural gas storage.

The storage capacity of Dominion Energy’s reservoirs totals approximately 1 trillion cubic feet of natural gas. Over 2,300 injection and/or withdrawal wells are distributed within these storage pools. Compressor stations on or near the storage fields are used to assist the movement of gas into and out of the reservoirs through the wells, depending on customer demand.

Dominion Energy has successfully managed its natural gas storage facilities since it began storing natural gas for its customers in the 1930’s. Many of our storage wells are depleted production wells that are redesigned for gas storage by replacing the casing that contains the storage pressure, as well as often replacing other larger diameter casings in the wells. Many new storage wells have also been drilled in the intervening years since the storage fields were developed.

The storage wells are designed to withstand the high pressures associated with storage compression and withdrawal. Ongoing casing integrity inspection logging (described below) allows for monitoring the condition of the casing that contains the storage pressure in these wells. Our wells contain up to three concentric linings, on many, the innermost casing is cemented to provide additional leak prevention.

A small portion of our wells are monitored real time by differential pressure. The remaining are being proactively inspected and addressed through our storage integrity program described below.

Under normal operations, fugitive methane emissions from underground storage field wellheads owned by Dominion Energy constitutes less than one percent (closer to 0.2%) of Dominion Energy’s total inventoried methane emissions. This estimate is based on the methodology specified in EPA’s GHGRP for underground storage facilities, which utilizes wellhead component counts and emission factors.

The remaining emissions from underground storage facilities, including from the compressor station(s) associated with the storage field, are included in company-wide methane emission graphs under the “Methane Emissions Reported to EPA under GHGRP by Subsidiary” and the “EPA Reported vs. Corporate Inventory” sections of this report. A breakdown of emissions from Dominion Energy’s storage facilities is provided below.
Dominion Energy has a variety of programs and methods in place to assess the integrity of its natural gas wells and storage system on an ongoing basis. We have performed casing integrity inspection logging on the majority of our storage wells for over a decade and have an ongoing prioritized logging program to complete the remainder within the PHMSA specified period of 3-8 years.

We take into account a variety of parameters in deciding how often to perform casing inspection logging on our storage wells. This work is prioritized using a risk ranking, which takes into account factors such as depth, operating pressure, and location, as well as incorporating feedback from our experienced team based on many years of working with these wells and interpreting logs. Our integrity programs include:

- Periodic casing integrity inspections of well casings for internal and external corrosion;
- Regular inspections (typically monthly) to verify well status and pressure, and to look for signs of atmospheric corrosion, vent gas, or leaks;
- Remote monitoring by gas control and operations;
• Top-casing joint and wellhead replacements, re-plugging, and abandonment of formerly plugged wells;
• Cementing the innermost production casing to prevent corrosion and leakage; and
• Monitoring third-party drilling activities in and around storage pools.

Electronic logging is an example of how technology can help assure well integrity. Our subsidiary, Dominion Energy Transmission, Inc. has been using this technique since 2000, before it was required by PHMSA. Casing integrity inspection logging is a process by which a high resolution electronic tool is lowered into the well in order to take readings which indicate the condition of the casing in the well. The technology used measures the electromagnetic response from a transmitter on the logging tool at a receiver on the same logging tool. From these readings, taken over the entire depth of the well, important knowledge can be determined regarding the condition of the well casing. Then, remedial work is performed where needed.

Dominion Energy has a formally documented risk ranking program for its storage wells that continues to evolve as technology and methodology advances. We have also adjusted the documentation of these processes to fit the expectations of the recent PHMSA rules regarding underground storage. The formal risk management strategy includes an initial evaluation of risk, based on threats and consequences of potential events. Each storage well is ranked according to risk and Dominion Energy has a plan to manage risks through application of preventive and mitigation measures, some of which are described above. The strategy also includes feedback and validation measures for continual improvement over time. A capital improvement budget is set aside each year to make necessary repairs and improvements, such as replacing wellheads and casings, to address potential risk and keep the system operating efficiently.

Inspections and remedial work are prioritized using a risk ranking which takes into account factors such as depth, operating pressure, and location, as well as incorporating feedback from our experienced team based on many years of working with these wells and interpreting logs.

We have an annual budget for our well integrity programs that is used:

• To perform the casing integrity inspection logging of our storage wells,
• To perform downhole repairs if indicated as necessary by our logging, and
• To replace above ground portions of storage wells in response to atmospheric corrosion (typically the wellhead valve assembly and the top casing joint near or just below ground level).

In the event of a major leak, Dominion Energy has in place site-specific Emergency Plans for each storage field. These site specific Emergency Plans include provisions for addressing a storage well emergency for each storage field, including having a contractor on retainer to respond promptly in the event they are needed.

In summary, Dominion Energy’s underground storage system is operated and maintained in a manner that minimizes gas loss. Our risk management process is designed to identify conditions in well casings and wellhead equipment before a leak occurs.
Dominion Energy’s Methane Emissions and Reductions

Natural Gas STAR Cumulative Reductions: The EPA’s Natural Gas STAR program has provided a platform where proactive and progressive natural gas companies can voluntarily report methane emission reductions from their operations through implementation of BMPs. Several Dominion Energy subsidiaries began participating as early as 2010, submitting historical reductions back to 2008. Collectively, the EPA estimates that our cumulative methane reductions through the Natural Gas STAR program are 5,431,636 MCF, or 5.4 billion cubic feet, of natural gas reductions. Including reductions reported by Questar companies (prior to being acquired by Dominion Energy in late 2016), cumulative reductions exceed 5.8 billion cubic feet. Methane makes up approximately 95% of natural gas, which means that Dominion Energy has prevented the equivalent of over 100,000 MT of methane from being released to the environment (108,560 MT including Questar). The savings equates to more than 2.5 million MT of CO₂e (2.7 million MT including Questar).

Lost and Unaccounted for Gas: For years, Dominion Energy has focused on reducing its lost and unaccounted for gas (LAUFG) rate. LAUFG is an annual calculated quantity of gas consisting of the sum of reported losses and the unaccounted-for gas. It is an expense for the pipeline.

The gas exiting the pipeline system, along with the gas used as fuel in operations, and the known volumes of gas released during operations (from purges, emergency shut downs, and other activities) is subtracted from the amount of gas entering the pipeline system. The difference between those two volumes is the unaccounted-for gas. We do not know where or what this is. It can be caused by measurement uncertainty, theft, reporting errors, equipment malfunction, or unmeasured activities.

Dominion Energy Transmission monitors LAUFG to identify and remediate losses on the system. The system is segregated into zones and gas is measured in and out of each zone to monitor daily for losses. The process allows Dominion Energy Transmission to identify losses on the system faster and remediate in a timely manner to reduce any losses on the system. By addressing indications of gas loss, and putting systems in place to track releases of gas during operations, Dominion Energy has been able to reduce the LAUFG rate across its pipeline operations.

Methane Reductions and Gas Loss Avoided Terminology: A note about terminology is helpful here. Best management practices implemented by Natural Gas STAR program participants do not “reduce” methane emissions in the same way that air emission control technologies reduce emissions from a stack. For example, when a wet scrubber is installed on a coal-fired power station, the percent reduction in sulfur dioxide can be directly calculated and monitored before and after the installation of the control device. When referring to natural gas fugitive emissions, a best management practice results in “avoided” or “reduced” gas loss from leakage or blowdowns. Since the actual real time ongoing methane emissions are not directly measured in the natural gas industry, reductions are better described as estimated “gas savings” or “avoided gas loss.” These terms are often used interchangeably with “methane reductions” in that, for every million cubic feet of gas not lost to the atmosphere, approximately 18.74 MT of methane are not emitted.

Natural Gas STAR Methane Reductions by Business Unit: The chart below shows annual methane emissions reduction credits calculated under the Natural Gas STAR program. In the graphics, Dominion Energy is abbreviated as DE followed by a hyphen. The business units/subsidiaries have also been abbreviated. A list of acronyms is provided at the end of the report.
Some of the credits attributed to 2015 included historical reductions reported to the EPA by Dominion Energy West Virginia (DE-WV) and Dominion Energy Carolina Gas Transmission (DE-CGT) during their first year in the program. Also included are pre-2010 reductions reported by Dominion Energy Questar Pipeline and Dominion Energy Overthrust Pipeline (collectively, DE-QP) under previous ownership, and reductions reported to the EPA for a gas-driven high bleed pneumatic changeout effort conducted in 2014 by Dominion Energy Wexpro (Wexpro Company, dba DE-Wexpro) under previous ownership.

The EPA provides multi-year reduction credits for certain best management practices that result in avoided gas loss beyond the calendar year in which the BMP was implemented. The EPA describes each BMP and the expected annual and multi-year benefits at [https://www.epa.gov/natural-gas-star-program](https://www.epa.gov/natural-gas-star-program).
Dominion Energy Natural Gas STAR Best Management Practices: Dominion Energy achieved the above reductions by implementing a variety of BMPs relevant to our operations, summarized in the below table and subsequent paragraphs:
<table>
<thead>
<tr>
<th>Dominion Energy Natural Gas (NG) STAR and Methane Challenge BMP Commitments</th>
<th>DE-TI</th>
<th>DE-OH</th>
<th>DE-WV</th>
<th>DE-CGT</th>
<th>DE-UT/ID/WY and QP</th>
<th>DE-Wexpro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directed Inspection &amp; Maintenance (DI&amp;M)</td>
<td>NG STAR</td>
<td>NG STAR</td>
<td>NG STAR</td>
<td>NG STAR</td>
<td>NG STAR*</td>
<td></td>
</tr>
<tr>
<td>Use of Turbines at Compressor Stations</td>
<td></td>
<td></td>
<td></td>
<td>NG STAR</td>
<td>NG STAR</td>
<td></td>
</tr>
<tr>
<td>Replace Older Pipe/Services (PIR and PREP)</td>
<td></td>
<td>NG STAR, Methane Challenge**</td>
<td>NG STAR, Methane Challenge**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace High Bleed Pneumatic Devices or Install Air-driven Devices</td>
<td>NG STAR</td>
<td>NG STAR</td>
<td>NG STAR</td>
<td>NG STAR*</td>
<td>NG STAR*</td>
<td></td>
</tr>
<tr>
<td>Damage Prevention Program</td>
<td></td>
<td>NG STAR</td>
<td>NG STAR</td>
<td></td>
<td>Methane Challenge**</td>
<td></td>
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<tr>
<td>Engine Blowdown Recovery</td>
<td>NG STAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce Pressure before Maintenance</td>
<td>NG STAR, Methane Challenge**</td>
<td>NG STAR</td>
<td></td>
<td>NG STAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace orifice with ultrasonic meters</td>
<td>NG STAR</td>
<td></td>
<td></td>
<td>NG STAR</td>
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<tr>
<td>Additional DI&amp;M</td>
<td></td>
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<td></td>
<td>NG STAR</td>
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<td></td>
</tr>
<tr>
<td>Use of Hot Taps</td>
<td>NG STAR, Methane Challenge**</td>
<td></td>
<td></td>
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<td>NG STAR</td>
<td></td>
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<tr>
<td>Capped Emergency Shutdown Tests</td>
<td>NG STAR</td>
<td></td>
<td></td>
<td></td>
<td>NG STAR</td>
<td></td>
</tr>
</tbody>
</table>

*BMPs implemented by Questar under prior ownership
**Certain BMPs will transition to Methane Challenge in 2017 and be reported in 2018.
Best Management Practices

Dominion Energy is actively engaged in efforts to reduce methane emissions from its natural gas subsidiaries. We use a comprehensive approach to reduce methane emissions, starting with engineering design specifications for new projects, upgrades to existing facilities, and construction and subsequent operation of the facilities. Once a facility or project is in operation, appropriate work practice measures are implemented to minimize methane emissions. A number of approaches reduce methane emissions along the natural gas value chain. The EPA has a comprehensive list of these measures by sector on its Natural Gas STAR Program website at https://www.epa.gov/natural-gas-star-program.

New Projects

Dominion Energy uses best-in-class engineering design and operational measures for its new projects to minimize fugitive and episodic methane compressor turbine combustion emissions. Implemented together, these measures represent the most efficient design with the least environmental impact while providing reliable pipeline operation. Some of the measures include:

- Installing new centrifugal compressors with dry seals, which are inherently lower emitting than the wet seals on older compressors;
- Using pneumatic controllers that are air-activated when station air is available, as opposed to natural gas-activated or continuous bleed devices;
- Designing isolation valves as close to the compressor stations as possible to reduce emissions during blowdowns;
- Installing a large volume, lower pressure header to recover blowdown gas that can be used as fuel where sufficient fuel burning sources are installed;
- Pumping down the pressure of lines using in-line compression prior to blowdown for maintenance;
- Installing instrument air (as opposed to natural gas) compressor engine start systems; and
- Installing valve enclosures to reduce emissions during emergency shutdown testing.

Atlantic Coast Pipeline

For all new projects, Dominion Energy looks for opportunities to reduce methane and other emissions in a cost-effective and holistic manner. This is evident in the design of the approximately 600 mile Atlantic Coast Pipeline which incorporates state-of-the-art controls that are expected to reduce emissions of air pollutants. Some of the key design considerations for this project include the selection of high efficiency turbines with voluntary add-on controls, design measures to reduce methane emissions during blowdown from the compression stations and the implementation of leak monitoring and repair programs.

Pipeline Replacement

We are also upgrading existing infrastructure. Studies conducted by the Environmental Defense Fund show that such programs can significantly reduce the methane emissions from distribution systems. For example, our Dominion Energy Ohio subsidiary launched a 25-year Pipeline Infrastructure Replacement (PIR) Program to replace all cast iron and unprotected steel mains and services with plastic, which significantly reduces emissions. Approximately 15 miles of old cast iron pipes and 4,000 miles of bare steel pipes are scheduled to be replaced under
this program. In 2016, our Dominion Energy West Virginia subsidiary began a Pipeline Replacement and Enhancement Program (PREP), where approximately 1,000 miles of bare steel or unprotected pipes will be replaced. Methane reductions from pipeline main and service replacements, including from the two programs above, have been reported under the EPA Natural Gas STAR program and will be reported under the EPA Methane Challenge program annually going forward.

Additional Best Management Practices
Dominion Energy continues to evaluate the feasibility of additional methane reduction measures across the company, tailoring them to local needs. Here are some of the BMPs and reduction measures being implemented by Dominion Energy:

- Directed inspection and maintenance at compressor stations and metering and regulating stations;
- Installing centrifugal compressors with dry seals, rather than wet seals;
- Replacing high-bleed pneumatic devices with low or no-bleed devices;
- Reducing pipeline pressure before maintenance;
- Injecting compressor blowdown gas into low pressure mains or fuel gas system;
- Use of capped emergency shutdown testing;
- Replacing orifice meters with ultrasonic meters;
- Rehabilitating older, more leak prone distribution pipe;
- Damage prevention programs for distribution lines; and
- Green Completion technology on completed and recompleted wells.

Below is a description of the most successful BMPs implemented by Dominion Energy under Natural Gas STAR and the reductions achieved in 2016. Copies of the full reports, including all reductions, can be found in Appendix B. Copies of the EPA’s summary reports showing its calculation of methane reductions and cumulative credits attributed to Dominion Energy for each Natural Gas STAR report are provided in Appendix C.

Compressor Blowdown Recovery
In this technique, natural gas vented from compressor blow downs is captured and re-routed for use with other combustion sources, including engines and turbines at the facility. This technique reduced 129,290 MCF, or 2,423 MT of methane emissions in 2016. Several more stations are being considered for similar modifications. This technique works best when other design changes are being considered at the facility or during design of new facilities.

Directed Inspections and Maintenance (DI&M)
This technique is a cost-effective approach to identifying and fixing gross leakers, making it more cost effective than the traditional leak detection and repair program. The technique used at Dominion Energy Transmission is based on conducting semiannual surveys, called Atmospheric Gas Loss Surveys, of the sources most likely to leak and fixing them. This BMP resulted in 8,049 MCF of natural gas or 151 MT of methane emission reductions in our transmission business. At our local distribution companies, Dominion Energy West Virginia and Dominion Energy Ohio, the DI&M at gate stations and surface facilities BMP resulted in 1,064,903 MCF of natural gas avoided or 19,956 MT of methane reductions, and 10,505 MCF or 197 MT of methane emissions reductions, respectively.

Reducing Pipeline Pressure before Maintenance
Significant savings in natural gas is possible from reducing pipeline pressure before blowing down for maintenance and repair, as the Natural Gas STAR program recognizes. In this technique, the pipeline pressure is reduced using either inline
compressors or portable compressors. Typically, the pressure can be reduced up to 50% using inline compressors, and by up to 90% using additional portable compressors. We reduced 264,045 MCF of natural gas or 4,948 MT of methane in 2016 at Dominion Energy Transmission using this technique. Under the Methane Challenge, Dominion Energy Transmission has begun implementing measures to reduce methane emissions from planned pipeline blowdown systems by at least 50%. The emission reductions achieved by Dominion Energy Transmission will be reported annually to the EPA and published on their website. Our pilot report to EPA under Methane Challenge for this BMP is provided in Appendix D. Starting in 2018, this BMP will only be reported under Methane Challenge for Dominion Energy Transmission, Inc.

Another one of our gas transmission subsidiaries, Dominion Energy Carolina Gas Transmission, reduced 16,318 MCF of gas or 306 MT of methane in 2016 using pump down measures. Additionally, one of Dominion Energy’s gas distribution companies, Dominion Energy Ohio, reduced 3,345 MCF of natural gas or 63 MT of methane emissions using this measure.

**Capped Emergency Shutdown Testing**

Full compressor station blowdowns are required to be conducted periodically for regulatory safety evaluations. Dominion Energy Transmission staggers these shutdowns every five years in order to minimize annual emissions. During the other five years, stations do their annual safety test using enclosures to prevent gas loss. The enclosures function similar to a cap at the end of the pipe and prevent gas loss. Dominion Energy Transmission saved 22,047 MCF of natural gas or 413 MT of methane emissions in 2016 using this technique.

**Replacing High-Bleed Pneumatic Devices**

A continuous bleed pneumatic device is used to modulate process conditions for operational or safety purposes. A pneumatic device using natural gas with a bleed rate of greater than 6 standard cubic feet per hour is a high bleed device. Replacing high bleed pneumatic devices with either low bleed or no-bleed (using instrument air instead of natural gas to activate the device) results in reductions of methane emissions. All new projects undertaken by Dominion Energy typically involve installation of instrument air pneumatic devices only. Dominion Energy Transmission has implemented this technique and reduced 3,120 MCF of natural gas or 59 MT of methane in 2016. Dominion Energy Ohio reduced 13,769 MCF of gas or 258 MT of methane emissions in 2016.

**Pipeline Infrastructure Replacement Programs**

Since 2008, Dominion Energy Ohio has been actively replacing more than 5,000 miles of bare steel mains, and it has only 36 miles of old cast iron pipes left to replace. The pipeline infrastructure replacement program is a self-imposed program that has been approved by the Public Utilities Commission of Ohio. Bare steel and cast iron mains made up nearly 30% of the distribution pipeline system in Dominion Energy Ohio’s service territory in 2016. Dominion Energy Ohio schedules about 200 miles for replacement per year. In addition, Dominion Energy Ohio targets about 17,000 service line replacements per year as well. Starting in 2018, this BMP will be reported under the Methane Challenge program. Results from our pilot report are provided in Appendix D.

In 2016, Dominion Energy West Virginia began its pipeline replacement program where approximately 1,000 miles of unprotected steel and bare steel pipes will be replaced. Starting in 2018, this BMP will be reported under the Methane Challenge program. Results from our pilot report are provided in Appendix D.
Dominion Energy Utah, Dominion Energy Idaho, and Dominion Energy Wyoming (collectively, Questar Gas Company, also abbreviated in this report as DE-UT/ID/WY) replaced all cast iron and unprotected steel (3,400 miles) prior to 1996. The company now has a proactive program to replace portions of coated, but aging, high-pressure infrastructure on an annual basis.

In March 2016, the EPA finalized its Methane Challenge program, the next generation of the EPA’s Natural Gas STAR program, with more emphasis on transparency and increased reporting for both annual emissions and reductions achieved through implementation of reduction measures. The existing Natural Gas STAR program continues to be available with no changes. Eventually, the companies reporting under both programs have the option to transition solely to the Methane Challenge program or maintain both.

Dominion Energy joined the EPA’s Methane Challenge as a founding partner under the BMP option. Companies may select one or more BMPs from a short list of prescribed reduction measures relevant to their operations and make a commitment over a five year period.

Dominion Energy made three commitments under Methane Challenge. The commitments are summarized below, as well as reductions already achieved in 2016, a year ahead of the first reporting season under the Methane Challenge:

- **Commitment 1**: Dominion Energy Ohio and Dominion Energy West Virginia are implementing a pipeline replacement program for their mains and service lines and committed to replacing at least 1.5% of the unprotected steel and cast iron pipes every year by the end of 2021:
  - Accomplishment (2016): Together the local distribution companies replaced more than 3% of their cast iron and unprotected steel mains. Replacement of mains and service lines resulted in 957.14 MT of methane reductions (or 23,928.5 MT of CO₂e).

- **Commitment 2**: Dominion Energy Transmission is reducing methane emissions from planned pipeline blowdown events by at least 50% by the end of 2021. The team does this by reducing pipeline pressure before blowing down, utilizing hot taps for new pipelines and routing gas to a compressor or other systems for beneficial use:
  - Accomplishment (2016): Dominion Energy Transmission achieved a 55% reduction in methane emissions from planned maintenance event blowdowns along its pipelines, resulting in 4,787 MT of methane avoided (or 119,667 MT of CO₂e).

- **Commitment 3**: Questar Gas Company committed to implementing a pipeline excavation damage prevention program to reduce methane emissions:
  - Accomplishment (2016): The local gas distribution companies implemented the program, achieving a damage per thousand locate call rate of 3.

The Methane Challenge 2016 pilot reports are included in Appendix D.
State and Federal Programs to Reduce Methane

Federal and state regulatory requirements aimed at methane reduction from the natural gas industry have focused on key sources. For production, in which natural gas (sometimes mixed with crude oil) is extracted from geologic formations, regulations have been in place for a number of years to minimize gas loss during certain activities. Examples include:

- New well completions;
- Well workovers and maintenance;
- Liquids handling;
- Dehydration;
- Gas-driven pneumatic pumps and devices;
- Compression;
- Pressure regulation;
- Venting and flaring; and
- Piping components such as valves and flanges.

When natural gas is extracted, the concentration of methane is lower and the percentage of volatile organic compounds (VOC) is typically higher than commercial grade natural gas transported through transmission and distribution pipelines. VOCs are regulated air pollutants; thus, regulations to reduce VOCs result in commensurate methane reductions. Requirements involve completing extraction activities in a manner that reduces gas loss. Dominion Energy has programs in place to comply with these regulations.

After the gas is extracted from the ground, gathering and boosting facilities take that gas through a network of small pipes. Small compressor stations move the gas and hydrocarbon liquids are dropped out along the way, until the gas gets to a processing or transmission facility. The processing facility will further refine the gas and extract liquid products, such as propane, for sale or disposal. Sources of methane along the G&B system include liquids handling, dehydration, compressor vents, and pipeline components such as valves and flanges.

Federal regulations are in place, similar to those described above, for processing plants due to the high concentrations of VOCs in their operations. Sources of methane emissions beyond those already mentioned include extraction columns, liquid and gas handling equipment, transfer equipment, flares, piping, and tank storage. Comprehensive Lead Detection and Repair (LDAR) programs are required so that leaks are identified and mitigated promptly to minimize emissions. Dominion Energy has several processing plants with effective LDAR programs in place.

Natural gas can be liquefied for storage along the transportation system, or for import and export utilizing specialized ships. Dominion Energy’s LNG facility in Calvert County, Maryland, has been importing natural gas for a number of years. The facility began exporting natural gas in 2018. Sources of methane at LNG facilities beyond those mentioned above, include liquefaction and vapor recovery equipment. An extensive flaring system reduces methane emissions vented to the atmosphere. The annual GHGRP-required GHG surveys already in place at the import facility since 2011 have been enhanced with a state-of-the-art quarterly program for the expansion.

Along transmission pipelines and underground storage facilities, compressor stations are spaced strategically along the miles of pipelines to pressurize and move gas when and where it is needed by the customer. Sources of methane occur mainly from compressor vents and piping components. Some compressor stations are large enough point sources individually to require state air permits. These permits contain
regulatory requirements to minimize emissions. Approximately a quarter of Dominion Energy’s compressor stations are subject to the GHGRP and conduct annual leak surveys.

The distribution system delivers natural gas to customers. Sources of methane along this vast network of small pipes and service lines focus mainly on metering and regulating stations and other piping components. The GHGRP requires annual leak surveys at above grade metering and regulating stations.

A recent and growing regulatory focus has been on LDAR. General operational knowledge, backed up by recent studies conducted by the Environmental Defense Fund, universities, and energy companies (including Dominion Energy), have concluded that a relatively small number of fugitive leaks across the country result in the majority of methane emissions from compressor stations. Having a program that frequently evaluates equipment and processes to identify leaks, and that has a prompt repair schedule is the most effective way for companies to minimize the magnitude and duration of gas loss.

Dominion Energy implements both regulatory and voluntary programs to periodically scan for, locate, evaluate, and fix fugitive leaks. These programs have a variety of names, but can all be categorized as a form of LDAR. Programs that rely on inspections to detect leaks based on sight, sound, and smell are called AVOs (audio, visual, and olfactory). The AVOs are typically required monthly, although some states require weekly inspections. A growing number of Dominion Energy facilities are subject to these requirements. The table below identifies the mandatory leak programs required by federal or state regulations, as well as voluntary leak detection and repair programs conducted in 2016 under the Natural Gas STAR program.

<table>
<thead>
<tr>
<th>LDAR Program</th>
<th>Driver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual GHG Leak Surveys</td>
<td>Federal Regulation</td>
</tr>
<tr>
<td>Quarterly LDAR Surveys</td>
<td>Federal Regulation</td>
</tr>
<tr>
<td>Monthly AVO Facility-Wide Inspection</td>
<td>State Requirement</td>
</tr>
<tr>
<td>Monthly Gas Leak Inspection</td>
<td>State Requirement</td>
</tr>
<tr>
<td>Weekly AVO Facility-Wide Inspections</td>
<td>State Requirement</td>
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<td>Atmospheric Gas Loss Survey at DE-TI</td>
<td>Voluntary BMP under NG STAR</td>
</tr>
<tr>
<td>Directed Inspection and Maintenance at Gate Stations and Surface Facilities at DE-WV</td>
<td>Voluntary BMP under NG STAR</td>
</tr>
<tr>
<td>Directed Inspection and Maintenance at Gate Stations and Surface Facilities at DE-OH</td>
<td>Voluntary BMP under NG STAR</td>
</tr>
</tbody>
</table>
Regulatory Reporting and Corporate Inventory

Dominion Energy is required to report methane emissions, along with other GHGs, from our natural gas and electric generation facilities subject to the EPA’s GHGRP. Below is a summary of Dominion Energy’s methane emissions from our natural gas businesses for calendar year 2016 compared to previous years. Subsidiaries with an asterisk (*) indicate a new reporting requirement in 2016. Historical emissions from Questar under previous ownership are also provided. Additional information on the emissions reported to the EPA under the GHGRP, including station by station information, can be found at [https://ghgdata.epa.gov/ghgp/main.do](https://ghgdata.epa.gov/ghgp/main.do).

Methane Emissions Reported to EPA under the GHGRP by Subsidiary

<table>
<thead>
<tr>
<th>Year</th>
<th>DE-TI (Pipeline Blowdowns)*</th>
<th>DE-Midstream GP (G&amp;B)*</th>
<th>DE-OH (G&amp;B)*</th>
<th>Questar (Acquired in 2016)</th>
<th>DE-OH</th>
<th>DE-WV</th>
<th>DE-CP</th>
<th>DE-CGT</th>
<th>DE-TI</th>
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</tbody>
</table>

**Methane from our Electric Generating Businesses**

In addition to methane emissions from our natural gas businesses, combustion methane emissions from Dominion Energy’s electric power generation businesses emitted 3,231 MT of methane in 2016.
Because the EPA’s GHGRP sets *de minimis* exemptions, Dominion Energy acknowledges that a number of its smaller compressor stations, sources and facilities are not required to report. Dominion Energy, however, includes emission estimates from these *de minimis* sources in our corporate GHG inventory in an attempt to be as transparent and comprehensive as possible for our stakeholders. Emission estimates are based on the EPA methodologies described above. We conduct equipment population counts and track blowdown emissions as specified. Corporate-developed average leak rates and factors are substituted where measured/survey data is absent.

Below is a graph comparing methane reported under the GHGRP to our more comprehensive corporate inventory. For some segments of the natural gas value chain, such as distribution, there is little difference between reported and corporate emission totals. EPA’s GHGRP is quite comprehensive for these segments. For other segments, such as transmission, there is a greater discrepancy. This is because Dominion Energy has a number of small compressor stations that are below *de minimis* reporting levels. The difference in 2016 between the two inventories in total is 8%.

The charts below shows Dominion Energy’s corporate inventory compared to what is reported to the EPA under the GHGRP since 2011 when the mandatory reporting program began. Our overall methane emissions trend continues to decline when comparing previously inventoried sources and owned assets. The orange section of the 2016 bars represent emissions associated with transmission pipeline
blowdowns, a new EPA reporting requirement not previously part of Dominion Energy’s corporate inventory.

DE Methane
EPA-Reported v. Corporate Inventory
(Excluding DE-QP/UT/Wexpro prior to DE ownership in 2016)

The additional 2016 increase in methane emissions seen in the above graph under the Dominion Energy Transmission (Pipeline Blowdown) category (designated in orange), stems from a change in the EPA’s reporting rule.
Pipeline blowdown emissions had not been comprehensively tracked and reported by Dominion Energy prior to 2016.

As Dominion Energy prepared for the new EPA reporting requirement and began tracking the volume of gas released during planned maintenance events and unplanned safety releases, the Company realized an opportunity to implement additional best management practices to reduce gas loss from blowdowns going forward. In 2016, Dominion Energy Transmission made a commitment to reduce pipeline blowdown volumes by a minimum of 50% by the end of 2021 under EPA’s voluntary Methane Challenge program, as described above. Dominion Energy Transmission achieved that goal in 2016 and is continuing to implement BMPs for even greater savings.
Conclusion

Dominion Energy is committed to operating its natural gas businesses to minimize gas loss and methane emissions. While the industry grapples with finding even better ways to measure and estimate methane leakage along the natural gas value chain, Dominion Energy is proactively implementing mitigation measures and reporting beyond federal requirements. We have made voluntary commitments under the EPA’s Natural Gas STAR and Methane Challenge programs, which have successfully resulted in substantial methane emissions reductions from Dominion Energy operations.

We will continue to work with our industry peers, regulators, and stakeholders to improve the efficiency of our operations and to push new leak detection and measurement technologies. Establishing a meaningful methane leak rate metric is a high priority for the industry, which Dominion Energy highly supports. Future Dominion Energy methane reports will incorporate advances in characterizing fugitive emissions from the natural gas value chain.
Glossary of Terms

DE Dominion Energy, Inc.
DE-CGT Dominion Energy Carolina Gas Transmission, LLC
DE-CP Dominion Energy Cove Point LNG, LP
DE-GP Dominion Gathering & Processing, Inc.
DE-OH The East Ohio Gas Company, dba Dominion Energy Ohio
DE-QP Dominion Energy Questar Pipeline, LLC (including Dominion Energy Overthrust Pipeline, LLC)
DE-TI Dominion Energy Transmission, Inc.
DE-UT Questar Gas, dba Dominion Energy Utah
DE-UT/ID/WY Questar Gas, dba Dominion Energy Utah, Dominion Energy Idaho, Dominion Energy Wyoming
DE-WV Hope Gas, Inc., dba Dominion Energy West Virginia
BMP Best Management Process
CH₄ Methane
CO₂e Carbon Dioxide Equivalent
DI&M Directed Inspection and Maintenance
EPA Environmental Protection Agency
ESD Emergency Shut Down
G&B Gathering and Boosting
GHGRP Greenhouse Gas Reporting Program
GWP Global Warming Potential
LAUFG Lost and Unaccounted For Gas
LDAR Leak Detection and Repair
LNG Liquefied Natural Gas
MCF Thousand cubic feet
MT Metric tons
PHMSA Pipeline and Hazardous Materials Safety Administration
T&S Transmission and Storage
TPL Transmission Pipeline
VOC Volatile Organic Compounds

Appendices

Appendix A: Maps of Dominion Energy Underground Storage Assets
Appendix B: Dominion Energy Natural Gas STAR Reports for 2016
Appendix C: EPA Natural Gas STAR Summary Reports for 2016
Appendix D: Dominion Energy Methane Challenge Pilot Reports for 2016
Appendix A: Maps of Dominion Energy Underground Storage Assets

Dominion Energy Storage Assets in the East

Dominion Energy Storage Assets in the West
Appendix C: EPA Natural Gas STAR Summary Reports for 2016
Appendix D: Dominion Energy Methane Challenge Pilot Reports for 2016