National Methane Emission Intensity Currently Over 50% Lower than 1990 Levels

Background

The amount of methane emitted from the natural gas value chain has been a focal point for researchers, regulators, and the general public in recent years[1-7]. Of particular interest is the percentage of methane that gets emitted (emission intensity) as a function of natural gas production or consumption. In this white paper, we will discuss the methane emission intensity decrease over time to 1.0% presently (through 2018) for the natural gas value chain through delivery, a point over 50% lower than in 1990.

Several studies have conducted "snap-shot" looks to determine the national percentage of methane that gets emitted as a function of consumption or production in a given year. However, to effectively exam national-level methane emission percentages over decades involves the use of the only long-term data available. Each year information is released by the U.S. Environmental Protection Agency (EPA) and U.S. Energy Information Administration (EIA) that can be used for a historical look at methane emissions from natural gas systems. In particular, the U.S. EPA releases an annual Greenhouse Gas Inventory (GHGI)[8] which estimates the national methane emissions from natural gas systems and other sources. EIA releases values for annual natural gas consumption and production. In this white paper, we will focus on natural gas consumption because this takes into account all natural gas that enters the natural gas value chain, including any gas imported then used. Using total production does not factor in this additional gas, which is important because until recently the U.S. has used more gas than it produced (net importer)[9].

Emission Intensity Calculation

The data provided by EPA and EIA can be used to develop an annual snapshot of natural gas movement through the natural gas value chain each year. In particular, the volume of gas consumed for individual segments can be obtained from the EIA database of natural gas consumption by end use. This data includes consumption in upstream segments (Lease and Plant Fuel), segments with limited transmission and distribution infrastructure (Electric Power Consumers), consumers in the distribution system (Distribution Pipe Use), and consumers after the distribution system (Residential, Commercial, Industrial, and Vehicle

Fuel Consumption). The methane losses for each stage of the natural gas system are obtained from the EPA GHGI as a mass of methane. The reported mass methane emissions can be converted into a volume of natural gas using the density of methane at standard conditions[A] and the average volumetric methane content of natural gas[B]. For this analysis, leaks are assumed to occur prior to metering devices used to determine total consumption reported by the EIA, therefore the total natural gas in the value chain is the sum of the EIA consumption and EPA loss values.

Overall, we can represent the volumes of gas and the movement of that gas through the value chain with a Sankey diagram as shown in Figure 1. For the Sankey Diagram, the individual segments are represented by narrow boxes that are connected by flows of natural gas. The width of the flows is proportional to values of the destination segment for the flow. For 2018, there was 30,380 billion cubic feet (BCF) of natural gas in the system, 28,490 BCF flowed into the transmission pipeline system with 1,680 BCF going to Lease and Plant Fuel (natural gas used in well, field, and lease operations and as fuel in natural gas processing plants)[10]. Of the 28,490 BCF that went into the transmission system 10,590 BCF went to power/electricity generation and 16,320 BCF went to the distribution system. The data shown in Figure 1 is for 2018. For 2018, the largest consumers of natural gas are the electric power segments (10,590 Bcf) followed closely by industrial customers (8,380 Bcf). All natural gas in the system was treated as either consumed or emitted to determine the total amount of natural gas on the left side of Figure 1.

A. Standard conditions used are 60°F and 14.73 psia.

B. From a 2013 GTI survey of over 4500 natural gas samples, the assumed methane content of natural gas used is 95.27%.

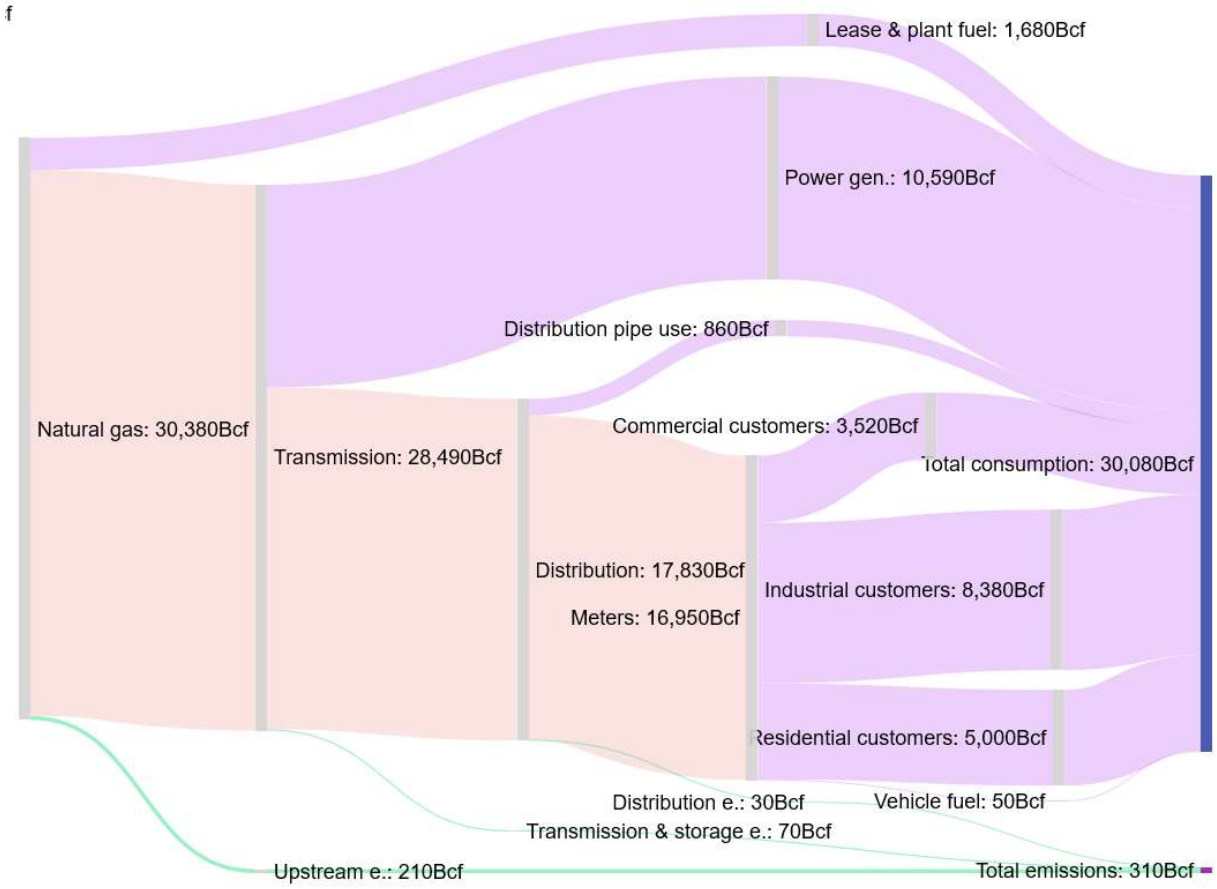

Figure 1. Total Natural Gas Amounts in Individual Segments of the Natural Gas Value Chain for 2018 Based on EPA and EIA data. The total for natural gas on the left side of the diagram consists of all natural gas emitted and consumed. Purple flows indicate consumption, pink flows indicate movement of natural gas within the supply chain and green flows indicate emissions. Due to rounding, nodes may not sum exactly.

Annual Emission Intensity

The amount of natural gas consumed varies from year to year. Therefore, to truly compare the performance of the natural gas value chain on an annual basis, the amounts of natural gas in the various segments need to be converted to percentages of the total volume as shown in Figure 2. Figure 2 shows that for 2018 0.7% of the natural gas consumed was emitted from upstream operations, 0.2% was emitted from the transmission and storage segment, and 0.1% from the distribution segment for a total emission intensity of 1.0% nationwide in 2018. This analysis can be performed over time to determine how the emission intensity has changed since 1990.

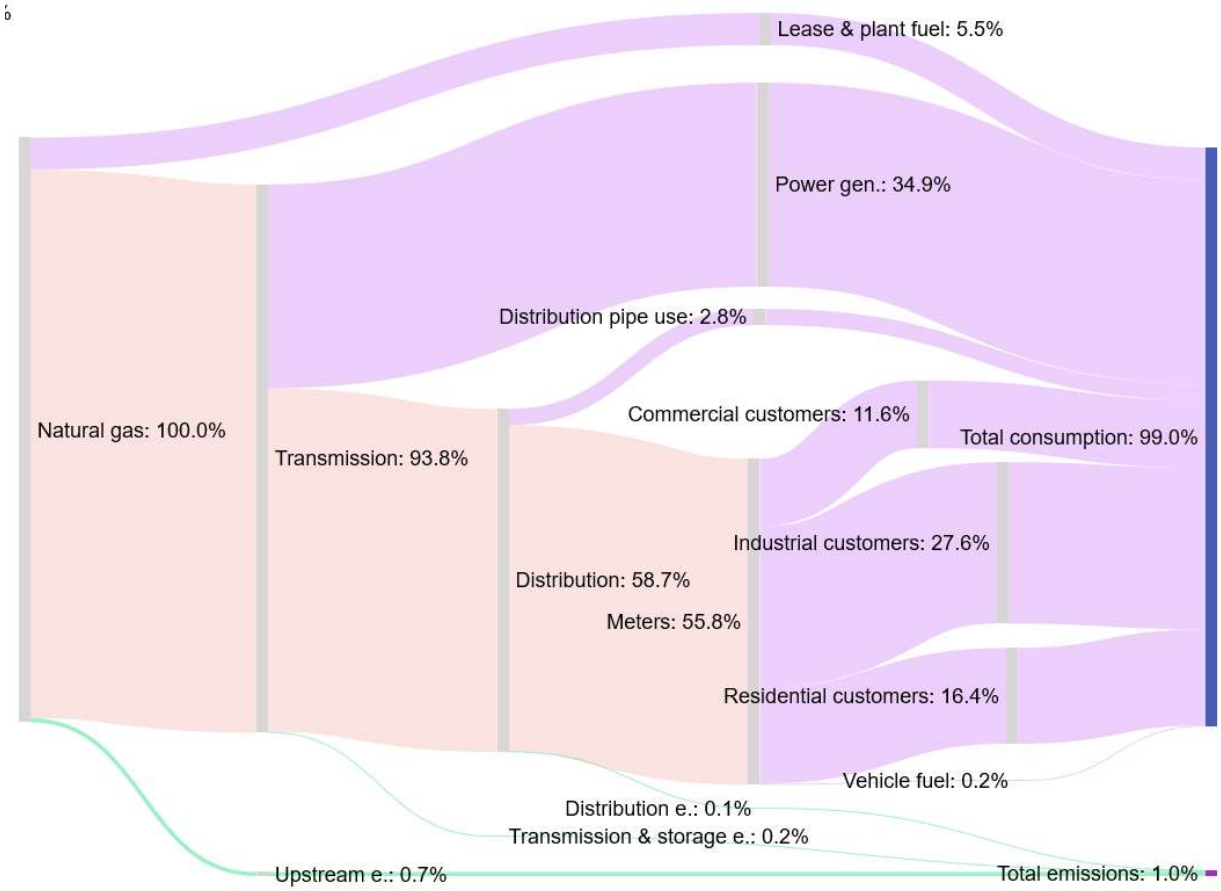

Figure 2. Sankey Diagram of the National Percentages of Methane in All Segments of the Natural Gas Value Chain for the year 2018. Purple flows indicate consumption, pink flows indicate movement of natural gas within the supply chain and green flows indicate emissions. Due to rounding, nodes may not sum exactly.

Emission Intensity Over Time

When methane emissions are normalized to natural gas consumption over time, there is a significant decrease in methane emission intensity on a national scale as shown in Figure 3. Based on the data collected by EPA and EIA, in 1990 the intensity was 2.2% of consumption. In 2018 it had dropped to 1.0%, a 51% reduction since 1990. At an emission intensity of 5% in the U.S., natural gas is equal to coal in terms of contributions to overall greenhouse gas emissions.[11] This is due to methane, the primary component in natural gas, having a higher global warming potential than CO_2. The further below 5% the emission intensity is, the greater the benefit of using natural gas for energy production.

There are several nationwide factors that contribute to this decrease, including significant investment in infrastructure to replacing aging pipeline systems, updates to equipment, evolving methodologies for limiting the loss of methane from the natural gas value chain, and higher levels of total natural gas use.

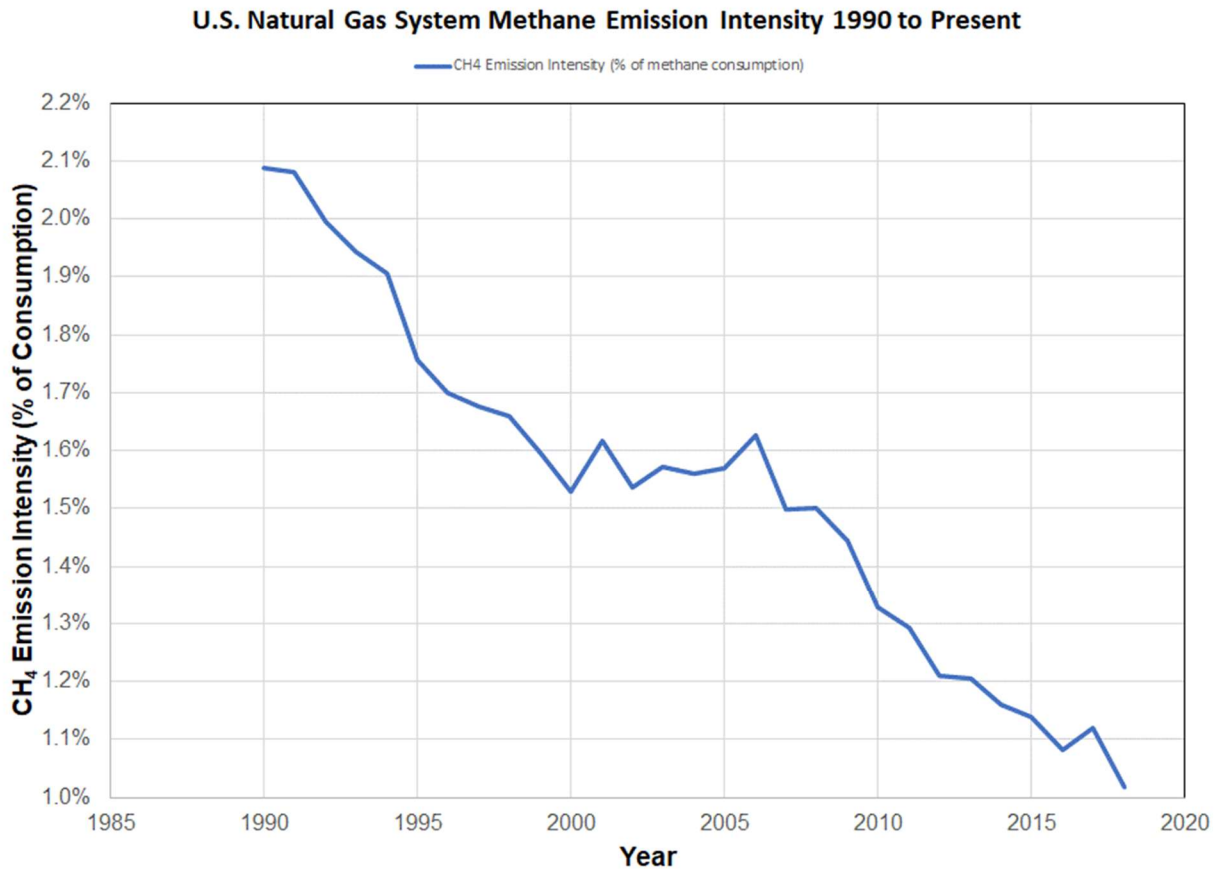

Figure 3. Annual Methane Emission Intensity Based on Annual Consumption per US EIA including the most recent EPA data through 2018.

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