

Energy Analysis

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REDUCING GREENHOUSE GAS EMISSIONS WITH NATURAL GAS – HAVE THE BENEFITS LESSEned?

I. Introduction

The U. S. Environmental Protection Agency recently released their annual Greenhouse Gas Inventory. The new release includes a considerable increase in methane emissions resulting from the production of natural gas. The revision is primarily attributable to assumptions regarding drilling practices, particularly those related to the hydraulic fracturing of shale formations. Given the increases in the revised data, some have questioned whether natural gas can, or should, be pursued as a viable tool for reducing greenhouse gas (GHG) emissions.

The purpose of this analysis is to consider what impact, if any, the revised methane numbers have in terms of the attractiveness of natural gas in reducing GHG emissions. While AGA has not performed an independent analysis of the revisions performed by EPA, it recognizes that significant questions have arisen related to the revisions. These questions must be fully scrutinized and resolved. That, however, is not the purpose of this analysis which was performed assuming that the EPA revisions are entirely accurate.

II. Executive Summary

Even if the higher methane emission numbers as revised by EPA are correct, total GHG emissions per MMBtu of natural gas consumed (on a CO₂ equivalent basis) were slightly lower in 2009 than in 1990 – 136 pounds of GHG in 2009 versus 136.8 pounds in 1990. (See Exhibit 1.)

- While absolute emissions from gas production increased from 89 million tons in 1990 to 130 million tons in 2009 (46 percent) according to EPA, gas consumption increased by 19 percent over this same period and the production-related methane emissions were up far less on a per MMBtu of gas consumed basis – about 23 percent.
- Much of the increase in production-related methane emissions was offset by reductions in methane emissions in gas processing, transportation and storage and distribution – reductions in these segments ranged from 15 percent (gas processing) to 27 percent (gas distribution) per MMBtu of gas consumed.

- Methane accounts for only about 15 percent of natural gas related GHG emissions, assuming a global warming potential 21 times that of CO₂ (as per EPA and the Intergovernmental Panel on Climate Change or IPCC). Thus, even relatively large changes in methane may not have a significant impact on total GHG emissions which are dominated by CO₂ from combustion.

GHG emissions are significantly less for natural gas than for coal or oil on a Btu equivalent basis. This advantage is multiplied with the efficiency advantage offered by many gas applications. Greater efficiency means that less energy must be consumed to obtain the same product (such as heat, hot water, or electricity), therefore GHG emissions are reduced.

- Generating electricity with coal produces two to two-and-one-half times the GHG emissions from generating with natural gas. (AGA believes that a diversified generation portfolio, including clean coal generation, serves the nation best. It is important, however, to appreciate the advantages inherent in each mode of generation. Natural gas clearly has an advantage in terms of GHG emissions, even assuming EPA's recently revised production-related methane emission numbers).
- The direct use of natural gas – using natural gas directly in homes and businesses to provide heat, hot water, cooking, drying and other products rather than converting the gas to electricity to provide the same – is generally the most efficient and lowest emitting strategy from a GHG perspective. This analysis does not consider the direct use option. Instead, it is focused on the generation of electricity that has recently come into question.

It has become abundantly clear that the increasing availability of natural gas, particularly that developed from natural gas shale formations, offers the U.S. plentiful domestic, clean, affordable energy. It is plausible that methane emissions have increased as a result of a greater use of hydraulic fracturing to produce shale gas. This increase, if accurate, in no way diminishes the attractiveness of natural gas as a tool for environmental improvement and GHG reductions.

- While the recently revised estimates of EPA are assumed to be correct for the purposes of this analysis, questions regarding their accuracy are significant and they should be fully examined and scrutinized.
- Further, it is anticipated that over time methane control technologies and practices applicable to shale gas production will continue to improve and proliferate. We encourage the use of these technologies and practices by gas producers and we also encourage the recognition of their use by regulators and analysts.
- Natural gas industry participation in EPA's voluntary Star Program has been instrumental in identifying and controlling methane emissions. AGA fully supports and encourages involvement in this program.

III. Methodology and Results

The EPA produces an inventory of greenhouse gas emissions by source annually. The most recent inventory was released by EPA on April 18, 2011. This inventory includes data for 1990 through 2009, the most recent year for which data is available. Data are reported in terms of “CO₂ equivalence”. CO₂ is the dominant GHG, and other GHGs are converted to a CO₂ equivalence based on their potency or potential to contribute to climate change relative to CO₂. For example, methane is considered to be a more potent GHG than is CO₂, 21 times more potent according to the IPCC, therefore one pound of methane emitted is treated the same as 21 pounds of CO₂ emitted. EPA uses the global warming potential factors as established by the IPCC and a 100 year time horizon, recognizing that impacts in terms of climate change resulting from GHG emissions are not instantaneous but linger for many years.

Total U.S. GHG emissions in 2009 had a CO₂ equivalence of 6,633 million metric tons (MMT) according to EPA. Approximately 83 percent of the total is attributable to CO₂ and 10 percent to methane. The remainder is attributable to other GHGs. Of the 5,505 MMT of CO₂ emitted in 2009, 5,377 MMT is attributable to the delivery and use of energy. Of the total methane figure of 686 MMT, 337 MMT is attributable to the delivery and use of energy. For the energy sector as a whole, CO₂ has about 16 times the GHG contribution of methane in the U.S.

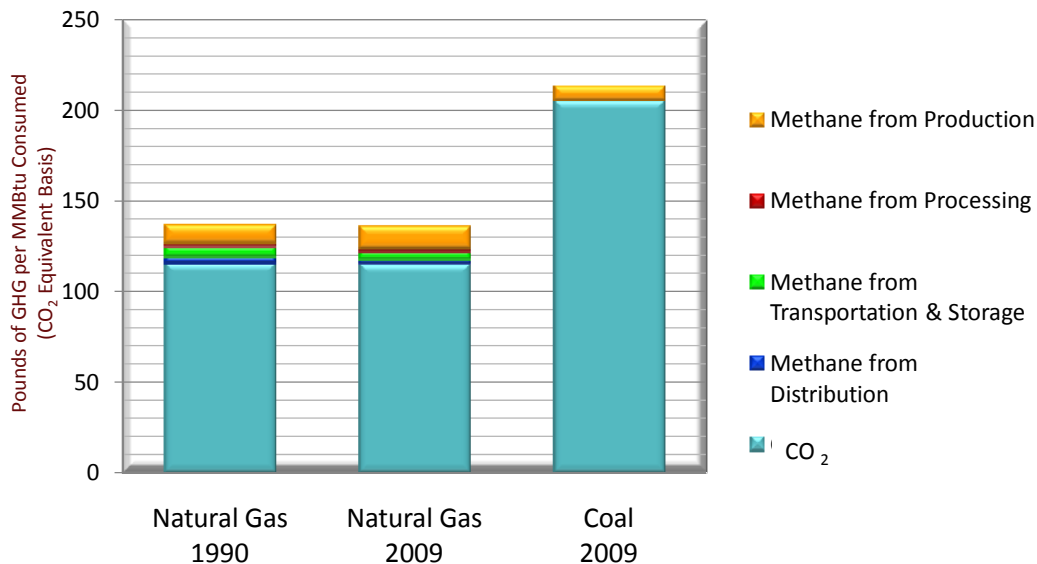
In 2009, natural gas production, delivery and use produced 1,233 MMT of CO₂ and 221 MMT of methane (all methane data in this analysis is presented in terms of its CO₂ equivalent). The methane total is divided among the various segments of the gas production and delivery system – production (130 MMT), processing (18 MMT), transmission and storage (44 MMT) and distribution (29 MMT). Some analysts have focused on the increase in the methane estimate in 2009 relative to 1990 – 130 MMT versus 89 MMT, an increase of 46 percent. The bulk of the increase is due to a change in the estimation methodology of EPA, particularly as it relates to hydraulic fracturing in the gas production process. The revised EPA methodology is quite recent and a number of parties have raised serious questions about it. AGA has not performed an independent analysis of the revised methodology and for the purposes of this analysis assumes the revised methodology is correct.

CO₂ and CO₂ equivalent methane emissions for coal and natural gas were obtained from the EPA inventory. These data were then divided by total natural gas and coal consumption, obtained from the U.S. Energy Information Administration website, in order to obtain total GHG emissions per unit of energy consumed by industry segment. The results of this calculation (see Exhibit 1) indicate that each million Btu's (MMBtu) of natural gas consumed produced 136 pounds of CO₂ equivalent in 2009, marginally lower than the 136.8 pounds per MMBtu produced in 1990. There are two principal reasons for this slight reduction in GHG emissions per unit of natural gas consumed in 2009 relative to 1990. First, although absolute emissions increased by 18 percent from 1990 through 2009, natural gas consumption increased by 19 percent. Therefore, emissions per unit of gas consumed went down. Second, CO₂ emissions accounted for 85 percent of the total natural gas industry-wide GHG emissions in 2009 and it is difficult for an increase in methane emissions which represent only 15 percent of the total GHG profile to offset the dominant CO₂ emissions. Finally, while methane emissions per unit of gas consumed in the production segment increased by 23 percent - again assuming the revised methodology is correct - emissions per unit of gas consumed declined in the processing (15 percent decline), transmission and storage (26 percent decline) and distribution (27 percent decline) segments. These declines more than offset the 23 percent increase in the production segment. Much of this decline is attributable to the voluntary participation of all natural gas industry segments in the EPA Star program. This program seeks to identify and implement strategies to reduce GHG emissions from industry operations.

Total GHG emissions in the coal sector were 214 pounds per MMBtu of coal consumed in 2009 based on the EPA and DOE data, 57 percent higher than the 136 pounds per MMBtu consumed in the natural gas sector. Coal sector GHG emissions are also dominated by CO₂ from combustion – about 96 percent of the GHG total. What this data indicates is that if 1 MMBtu of coal is consumed in place of 1 MMBtu of natural gas, GHG emissions will increase by 57 percent – including consideration of all CO₂ and methane emissions from all industry segments and final consumption.

GHG emissions per unit of fuel consumed is a good starting point for comparison. It is, however, incomplete from a policy perspective. From a GHG perspective there are two relevant questions. First, what are the emissions per unit of energy consumed? Secondly, and equally important, how much energy is actually consumed? GHG emissions per unit of natural gas consumed is the same whether the gas is consumed in a 65 percent efficient furnace or a 95 percent efficient furnace. Obviously, however, the 95 percent efficient furnace produces far less GHG emissions.

Exhibit 1 Greenhouse Gas Emissions per MMBtu of Fuel Consumed



NOTES: Data based on CO₂ equivalence using methane potency factor of 21 as per Intergovernmental Panel on Climate Change. Consumption data from U.S. Energy Information Administration website. Emissions data from U.S. Environmental Protection Agency, *Greenhouse Gas Inventory*, April 18, 2011.

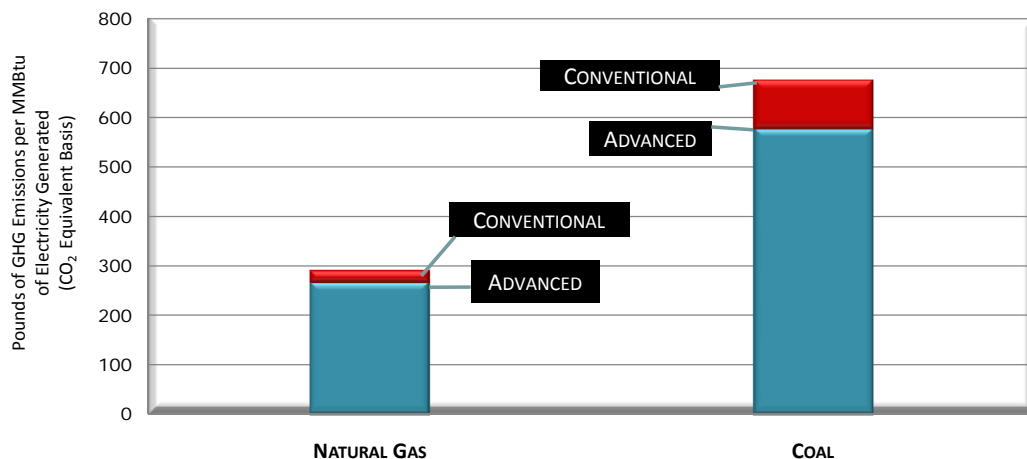


The same combustion efficiency consideration must be given when comparing different energy sources – for example, natural gas versus coal. The overwhelming majority of the coal consumed in the U.S. is for generating electricity – about 95 percent. Electricity generation is also the largest potential growth market for natural gas and it is also the largest single source of GHG emissions in this country. It

therefore seems prudent to compare GHG emissions from coal and natural gas including consideration of their relative efficiencies in generating electricity. The overwhelming natural gas technology choice for generating electricity over the past two decades has been combined cycle power plants due to their high efficiency – 47 percent efficient for conventional units and 51 percent efficient for advanced units according to the Energy Information Administration. Coal generating efficiencies range from 32 to 37 percent in conventional and advanced applications according to EIA.

Applying the above efficiency assumptions to the GHG emissions per unit of fuel consumed (Exhibit 1) illustrate the ranges in GHG emissions from natural gas and coal-fired power plants producing equal amounts of electricity (see Exhibit 2). Exhibit 2 shows that generating electricity with coal produces 2 to 2.5 time the GHGs of producing electricity with natural gas. The lower end of the range is based on an advanced coal plant compared to a conventional gas plant, while the upper end compares a conventional coal plant to an advanced gas plant.

Exhibit 2 Greenhouse Gas Emissions per Unit of Electricity Produced - - Conventional and Advanced Generating Units



NOTES:

Based on GHG emissions per MMBtu of fuel consumed (See Table 1) and electricity conversion factors for conventional and advanced equipment as employed by the U.S. Energy Information Administration.

Includes emissions of CO₂ and methane (methane GWP of 21 times CO₂ as per IPCC).

IV. A Comment on the Work of Dr. Howarth

A report by Dr. Robert Howarth released in April of 2011 claims that the GHG footprint of natural gas from shale formations is at least equal to, and may be as much as double the footprint of coal. The report has been widely questioned and criticized by a variety of audiences, from the natural gas industry to national environmental organizations. Although a detailed review of the study is not provided here, some of the major flaws include:

- Use of global warming potential factors for methane that are roughly 50 to 60 percent higher than those consistently used by EPA, the IPCC and other reputable and recognized parties;
- Focus on a 20 year time frame when EPA, the IPCC and other reputable and recognized parties consistently use a 100 year time horizon;
- Giving no consideration to the dramatically different combustion efficiencies of natural gas and coal, thereby eliminating any usefulness in terms of providing meaningful policy insight;
- Use of data that the authors note is limited and questionable;
- Failure to adequately consider industry control technologies; and,
- Misinterpretation of industry terms and data such as “lost and unaccounted for” gas.

V. Conclusion

It is certainly plausible that methane emissions from new formations produced with new technologies that are now being relied on to supply natural gas - like shale formations and hydraulic fracturing – are currently emitting more methane than more traditional drilling methods. However, due to a focus on methane emission reductions by all industry segments, and also due to the fact that the total climate change potential of natural gas is dominated by CO₂ from combustion, the overall greenhouse gas emissions related to natural gas production, delivery and use have been essentially unchanged. Further, as emission control technologies and strategies continue to be developed and implemented by all segments of the industry, including natural gas producers relying to a greater extent on hydraulic fracturing of shale formations, emissions will further decline. Despite the possibility of a temporary increase in one portion of the overall natural gas-related GHG emission profile, there is no question that natural gas can be substituted for other energy forms with very positive GHG effects. In terms of generating electricity, for example, using natural gas as a generating fuel can cut GHG emissions in half, or more, relative to coal.