White Paper

Lifecycle GHG Emissions from LNG Exports

Prepared by ICF International for Dominion *February 2014*

Executive Summary

Several articles have recently raised concerns over the potential lifecycle greenhouse gas (GHG) emissions from U.S. LNG exports. The Chesapeake Climate Action Network (CCAN) has released an analysis of lifecycle emissions from U.S. LNG exports that states that the GHG emissions from exported natural gas *could* have higher life-cycle emissions than those from coal due to methane emissions from gas production and transmission. This paper reviews the CCAN paper and corrects some omissions and errors in the analysis. The summary of our conclusions is:

- While the CCAN paper states that exported LNG would have GHG emissions 20% lower than coal based on the most recent official U.S. estimates of methane emissions, the LNG emissions would actually be 43 to 52% lower based on more standard assumptions and a more complete analysis.
- The paper suggests that methane emissions from natural gas might be 4 to 8 times higher than the official EPA estimate, but the cited references do not support that suggestion. In contrast, other recent studies suggest that emissions could be lower and that recent new regulations will result in lower emissions in the future.
- Based on the best available data and using standard assumptions, exported LNG would have GHG emissions 43% to 52% lower than coal.

These points are addressed in more detail below.

Baseline Emission Calculation

CCAN correctly cites the methane emissions estimates from the U.S. EPA "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011"[1]. The EPA Inventory is the official U.S. inventory of GHG emissions and is submitted to the United Nations Framework Convention on Climate Change as the official accounting of U.S. GHG emissions. As cited by CCAN, the EPA inventory estimates that methane emissions from the natural gas industry are about 1.4% of U.S. production. CCAN's estimate that this equates to LNG emissions 20% lower than coal understates the benefits of gas in several ways:

- The CCAN analysis only calculates the potential emissions from the fuel but does not account for end-use efficiency. Most LNG exports from the U.S. will be used to displace coal for electricity generation. New gas-fired power plants are typically more than 40% more efficient than conventional coal-fired power plants. This greater efficiency means that the actual emission reductions for delivered energy will be greater than the differential in the fuel.
- CCAN uses a higher emission factor for methane. Different greenhouse gases persist in the atmosphere for different lengths of time and have different warming effects, and thus have different effects on climate change. In order to compare them, we use a factor called the global warming potential (GWP), which relates each GHG's effect to that of CO_2, which is assigned a GWP of 1. Scientists and policy makers have historically relied on assessments by the Intergovernmental Panel on Climate Change (IPCC) to establish the GWPs. The currently accepted values in the U.S. are from the IPCC Fourth Assessment report[2] (AR-4).

[1] U.S. EPA, "Inventory of U.S. Greenhouse Gas Emissions And Sinks: 1990-2011", http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

[2] IPCC. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (Cambridge University Press and New York, NY, Cambridge, United Kingdom, 2007).

CO_2 has a long life in the atmosphere and climate change is a long-term process. For these reasons, the primary GWPs are established on a 100-year basis. The 100 year GWP is the standard value used by the EPA and other federal, state, and international agencies to measure GHG emissions. On a 100-year basis, methane is assigned a GWP of 25 by the AR-4. This means that one ton of methane has the same effect as 25 tons of CO_2 over 100 years. Methane has a stronger climate-forcing effect than CO_2 but has a shorter lifetime in the atmosphere (12 years). On a 20 year basis, the AR-4 assigns methane a GWP of 72.

The IPCC is currently preparing a Fifth Assessment Report (AR-5)[3], which has developed higher GWP values. The AR-5 sets a 100 year GWP of 28 and a 20 year GWP of 84 for methane. The CCAN analysis uses the 20 year AR-5 GWP in its analysis, which magnifies the effect of methane emissions. While there are good reasons to evaluate the effects of shorter term climate forcing, the 100 year value should also be presented since it is the standard for comparison to official estimates.

- Combining these factors, LNG would have GHG emissions 43% lower than coal at the 20 year GWP and 52% lower than coal at the 100 year GWP for the methane emissions currently estimated by the EPA.

GHG Emissions Comparison for LNG – 1.4% Leakage

	Gas				Coal		Electricity		
	lb CO_2e/MMBtu						lb CO_2e/MWh		
GWP	Combustion	Leakage	LNG	Total	Total	Reduction	Gas	Coal	Reduction
20 Yr=84	117.1	43.5	30.8	191.4	236.9	19.2%	1,340	2,369	43.4%
100 Yr=28	117.1	14.5	20.4	152.0	219.8	30.8%	1,064	2,198	51.6%

Alternative Estimates of Methane Emissions

CCAN says that LNG would have lower emissions than coal if the leakage remains less than 3%, more than twice the current EPA estimate. CCAN then suggests that other studies have found that U.S. methane emissions from natural gas operations are anywhere from 4 to almost 8 times higher the EPA Inventory. However, the cited studies do not support that claim.

First, the cited studies are not "leak measurement studies" as described in the CCAN paper. Rather they are studies of methane in the atmosphere sampled from planes or high towers. The authors then use various statistical and analytical techniques to estimate where the methane is coming from. This involves many different assumptions and calculations that affect the accuracy of the estimate. Specifically:

- The first study cited[4] is a study of methane measured from airplanes in one area in Utah on two days in 2012. While the authors estimate that emissions from gas and oil production in that area on those days might be equal to 6% to 11% of production, they specifically state that the emissions from this region are believed to be higher than in other regions due to specific characteristics of production in the region. Thus they cannot be extended to a national average. In addition, the Utah Division of Air Quality is quoted as stating that new emission regulations are expected to reduce emissions in the near future.

[3] IPCC. "Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change". (Cambridge University Press and New York, NY, Cambridge, United Kingdom, 2013).

[4] Karion, Anna et. al., "Methane emissions estimate from airborne measurements over a western United States natural gas field". Geophysical Research Letters, Volume 40, Issue 16, pages 4393–4397, 28 August 2013.

- The second study[5] is a compilation of ambient methane measurement studies from towers and airplanes in 2007 and 2008. It concludes that national methane emissions from all sources may be 1.5 times higher than the EPA estimate. This is not enough by CCAN's own estimate to make gas higher emitting than coal. The authors state that the data is not sufficient to develop an estimate of national emissions from oil and gas operations.
- Finally a new study[6] just released has received a lot of attention in the press. The study compares a number of top-down and bottom-up studies focusing on methane emissions from natural gas operations. It concludes that emissions may be 1.5 times higher than estimated by the EPA Inventory but points out that there are many sources of uncertainty in the top-down studies that could affect this estimate. Nevertheless, the 1.5 factor would not be enough to make LNG emissions higher than those from coal. The study also points out that there are many cost-effective methods of reducing methane emissions.

In contrast to these studies, a recent study[7] that does include direct measurement of emissions from gas production facilities found that in aggregate, emissions from many gas production sources are actually lower than estimated by the EPA. Moreover, the U.S. EPA has promulgated new regulations to reduce methane emissions from several segments of the gas industry. The World Resources Institute has estimated[8] that these regulations will result in a 13% reduction in methane emissions from gas operations over the next few years. This will result in an even greater environmental benefit for gas compared to coal.

Other Factors

There are other factors that contribute to the environmental benefits of LNG that are not included in the CCAN analysis.

- The U.S. is exporting record amounts of coal to other countries. The analysis does not account for the GHG emissions from transporting U.S. coal, which would make the LNG comparison more favorable.
- In addition to GHG benefits, natural gas has substantially lower emissions of conventional pollutants compared to coal. This creates enormous public health benefits in countries such as China, which are suffering from conventional pollution from coal-fired power generation.

Summary

Recent studies of ambient methane do not support the range of methane emissions suggested by the CCAN analysis. A more complete analysis using the most recent data shows that exported LNG has a significant GHG benefit compared to coal. Based on current information, LNG exports would have GHG emissions 43 to 52% lower than coal.

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[5] Miller, Scott et. al., "Anthropogenic Emissions of Methane in the United States". Proceedings of the National Academy of Sciences 18 Oct. 2013.

[6] Brandt, A. et. al., "Methane Leaks from North American Natural Gas Systems". Science Vol 343 14 February 2014

[7] Allen, David, et. al., "Measurements of Methane Emissions at Natural Gas Production Sites in the United States". 10.1073/pnas.1304880110

[8] Bradbury, James, et al., "Clearing The Air: Reducing Upstream Greenhouse Gas Emissions From U.S. Natural Gas Systems". World Resources Institute, April 2013.