

Climate Impacts of Natural Gas Production and LNG Export

A Synopsis of Current Science

August 2014

The climate impacts of producing natural gas and exporting liquefied natural gas (LNG) have been analyzed in peer-reviewed studies over the last three years. We now have a clear outcome:

- Natural gas consumption – at home or abroad – exacerbates greenhouse gas pollution; and
- Natural gas production and LNG exports offer no substantive reduction of carbon pollution over other fossil fuels.

Therefore, natural gas cannot be a “bridge to the future.” This synopsis explains why.

Methane Leakage is Pervasive in the Supply Chain

The studies detailed here identified methane leakage as a key factor determining the overall greenhouse-gas impact of natural gas. Natural gas is predominantly methane at the well, and essentially 100% methane post-refinery.

Leakage occurs in drilling and production, transmission, processing and refining, and distribution (including liquefaction into LNG, its transport, regasification and redistribution). These fugitive methane emissions are critical factors in the overall life-cycle pollution of natural gas.¹

Methane is More Dangerous Than Carbon Dioxide

The characterization of natural gas as the ideal long-term transition fuel to a distant renewable-energy economy (“the bridge to the future”) comes from the perception that it is the least-polluting fossil fuel. (It also embodies the false claim that renewable energy is not ready for prime time.²) Industry constantly claims that natural gas is actually “clean.”³

It is true that direct methane combustion, viewed in isolation from the rest of the natural gas supply chain and the methane atmospheric life cycle, releases significantly less carbon dioxide than burning other fossil fuels. Unburned, however, methane is a much more potent heat-trapping greenhouse gas than carbon dioxide.

Specifically, the Intergovernmental Panel on Climate Change (IPCC) assesses methane impact over a twenty-year period as having a global warming potential **86 times greater than carbon dioxide**. Over a 100-year period, methane presents a global-warming effect 34 times that of carbon dioxide – still a massive imbalance, with dangerous ramifications.⁴

¹ For bullet points listing other forms of environmental, economic, and personal damage not addressed in this synopsis, please see “Note: Other Damages from Natural Gas Production and LNG Export” on page 6.

² See the counter-argument by Al Gore, *The Turning Point: New Hope for the Climate*, Rolling Stone, June 18 2014.

³ See, for example, *Energy Tomorrow*, www.energytomorrow.com; America’s Natural Gas Alliance, anga.us.

⁴ Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2013: Physical Science Basis, Anthropogenic and Natural Radiative Forcing*, p. 714

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Time is of the Essence

Tragically, we do not have a century to make changes. The next two decades are critical and methane emissions factor heavily into addressing greenhouse gas pollution in this near term. The IPCC projects that warming increases may reach 3.6° F (2° C) within decades.⁵ The dramatic climate impacts witnessed to date come from an increase of only a bit more than 1.5° F.⁶

This 3.6° F heat increase is the level that scientists agree is about the maximum that the Earth can stand without suffering the most devastating consequences of climate change. Furthermore, the growth in heat-trapping gases will continue for decades, regardless, and the impacts will build for centuries.⁷

Because methane is such a devastating greenhouse gas, even a tiny percentage of leakage at the well, in the pipeline distribution system, at refineries, and in the consumer distribution system creates an enormous impact. Variations that superficially may appear small – say, from a rate of 1.5% to 3% – drastically increase overall pollution in the natural gas supply chain.

Scientists Sound the Alarm on Methane Leakage

On July 29, 2014, a panel of leading scientists called on the Obama administration to accurately account for the contribution of methane emissions to potential global warming: “As evidence continues to mount that serious climate change impacts are already upon us, research indicates that mitigation of short-lived pollutants such as methane can play a significant role in slowing the rate of climate change....”⁸ The scientists’ letter directly urges the U.S. Environmental Protection Agency (EPA), DOE, and other agencies to use a 20-year timeframe to evaluate the greenhouse gas impact of methane because of the urgency of the climate crisis.

Governmental Analyses are Deficient

An important review of the key literature on natural gas impacts was provided in two sets of comments submitted by Sierra Club, Food & Water Watch, Cascadia Wildlands, Columbia Riverkeeper, and others (*Sierra Club et al.*)⁹ to the United States Department of Energy (DOE) on July 21, 2014. *Sierra Club et al.* makes it clear that DOE’s life-cycle analyses of natural gas destined for export (*DOE LNG Life-Cycle*)¹⁰ contains significant gaps and flaws, highlighted throughout this synopsis.

⁵ IPCC, Climate Change 2013: Physical Science Basis, Summary for Policymakers, pp. 27-28.

⁶ IPCC, Climate Change 2013: Physical Science Basis, Summary for Policymakers, p. 3.

⁷ IPCC, Climate Change 2013: Physical Science Basis, Summary for Policymakers, pp. 27-29. Regarding the Oregon coast, see especially the analysis paragraphs on the melting of the Greenland ice sheet and on global sea-level rise, pp. 28-29.

⁸ Chapin, Davidson, Hong, Howarth, et al., Letter to the U.S. EPA, U.S. DOE, CEQ, and White House Domestic Policy Council, July 29, 2014. “Recommendation to accurately account for warming effects of methane.” See

<http://tinyurl.com/mjg79hg>

⁹ Sierra Club et al., Comments re DOE, “Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States,” addressed “Attn: LCA GHG Report Comments,” July 21, 2014. See

<http://tinyurl.com/lh9phuj>. In addition to this comment set on LNG and methane, please see the related comment set focused on fracking: Comments re DOE, “Environmental Impacts of Unconventional Natural Gas Development and Production” and other DOE documents, addressed, “Attn: Addendum Comments,” July 21, 2014. See

<http://tinyurl.com/qc94dph>. These comment sets interact.

¹⁰ U.S. Department of Energy, Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States, May 29, 2014. See <http://tinyurl.com/orc3ytz>.

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The Industry Has Failed to Monitor and Stop Methane Leakage

In this vein, *Sierra Club et al.* addresses how *DOE LNG Life-Cycle*, in its attempt to evaluate the relative impacts of natural gas production and plans for LNG export, consistently underestimates the methane leakage rate of domestic gas production.¹¹

For example, a 2013 study by a team led by University of Texas professor David Allen¹² (*Texas*) directly measured methane leaks from wells chosen by the industry. These specimens are likely to have some of the best controls and lowest emissions. EPA and DOE estimate the industry average leak rates to be about the same as the *Texas* best-case examples – a severe underestimate of realistic leakage methane leakage rates.

Significantly, two other seminal studies – one at Argonne National Laboratory in 2011, led by Andrew Burnham,¹³ and another at the federally-chartered Institute for Defense Analyses in 2012, by Christopher Weber and Christopher Clavin¹⁴ – found markedly higher leakage estimates than those cited by DOE.

Top-Down versus Bottom-Up Makes a Difference

Sierra Club et al. also notes that, in the last two years, peer-reviewed studies looking at methane levels in the atmosphere (“top-down” studies) have provided compelling evidence that the aggregate methane leakage estimates based on examinations of wells, pipelines, refineries, and other gas facilities (“bottom-up” reviews, like *Texas*) have dramatically underestimated gas-sector methane leaks.¹⁵

Two other recent studies addressed natural gas’s life-cycle methane emissions nationwide and found that emissions levels are much higher than current EPA estimates.

The first, from a team led by Harvard University’s Scot M. Miller¹⁶ (*Harvard*), reviewed atmospheric measurements of methane and concluded that the “EPA recently [in the 2013 Greenhouse Gas Inventory] decreased its [methane] emission factors for fossil fuel extraction and processing by 25–30% (for 1990–2011), but we find that [methane] data from across North America instead indicate the need for a larger adjustment of the opposite sign.”¹⁷

Harvard concluded that atmospheric measurements of methane emissions from all sources were 50% higher than the EPA 2013 Greenhouse Gas Inventory’s bottom-up estimate. *Harvard* emphasizes that gas emissions are a significant portion of the observed emissions that the EPA missed in their Inventory amendments, and suggests that the actual leak rate is likely to be 3% or more. This is a stunning figure, which establishes natural gas production and LNG exports as significant contributors to climate-changing pollution, even as destructive as coal or oil.

¹¹ Sierra Club et al., pp 5-10.

¹² Allen, D. T., Torres, V. M., Thomas, J., Sullivan, D. W., Harrison, M., Hendler, A., Herndon, S.C., Kolb, C.E., Fraser, M.P., Hill, A.D., Lamb, B.K., Miskimins, J., Sawyer, R.F., Seinfeld, J. H. (2013). Measurements of methane emissions at natural gas production sites in the United States. Proceedings of the National Academy of Sciences.

¹³ Burnham, A., Han, J., Clark, C.E., Wang, M., Dunn, J.B., and Palou-Rivera, I. (2011). Lifecycle Greenhouse Gas Emissions of Shale Gas, Natural Gas, Coal, and Petroleum. Environmental Science & Technology.

¹⁴ Weber, C. L., and Clavin, C. (2012). Life Cycle Carbon Footprint of Shale Gas: Review of Evidence and Implications. Environmental Science & Technology, DOI: 10.1021/es300375n

¹⁵ Sierra Club et al., p. 9.

¹⁶ Miller, S., et al., Anthropogenic emissions of methane in the United States, Proceedings of the National Academy of Sciences (Dec. 10, 2013) (“PNAS Study”), available at <http://calgem.lbl.gov/Miller-2013-PNAS-US-CH4-Emissions-9J5D3GH72.pdf>

¹⁷ Miller et al., p. 5.

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The second study, by a team led by Stanford University's Adam Brandt¹⁸ (*Stanford*) also concluded that EPA's Inventory and other bottom-up estimates, which generally use values similar to those assumed by DOE, significantly underestimate methane emissions from oil and gas production. (See *The Stanford Report* article referenced below for a good summary of *Stanford*.)

Harvard and *Stanford*, as nationwide studies, parallel with atmospheric studies examining individual regions, which have found even higher local fugitive methane emissions.

In Colorado's Front Range fracking region (the Denver-Julesburg Basin), two studies by a National Oceanic & Atmospheric Administration (NOAA) team led by Gabrielle Petron concluded that during gas production alone, the gas leak rate was about 4%.¹⁹

Alarming, the same NOAA research team, led by Anna Karion, found dramatically higher methane leak rates from wells in Utah's Uinta Basin, estimating escaped methane at 9% ± 3% of total production.²⁰ Notably, these valuable research projects did not include additional leaks from downstream segments of the industry, such as transmission and distribution pipelines and processing facilities.

Federal Perspectives Must Change

This evidence makes it clear that, to fully assess the life-cycle impacts of natural gas production and export, we must also look at the markets that would import LNG and consider transportation leaks and other fugitive emissions in those locations. Unfortunately, DOE has ignored this.²¹

Moreover, DOE also cannot assume that U.S. LNG exports will offer one-for-one displacement of other fossil fuel use overseas. The International Energy Agency (IEA) predicts that U.S. LNG exports would cause reductions in renewable energy development in other countries – leading directly to increased greenhouse gas emissions. Similarly, U.S. LNG exports may also increase U.S. greenhouse gas emissions.²²

Sierra Club et al. also addresses why DOE must do more than simply compare the life-cycle emissions of domestic LNG with other fossil fuels to fully analyze production and export impacts. One assessment in *DOE LNG Life-Cycle* shows the complexity and problematic nature of these impact analyses: DOE concluded that U.S. LNG used for electricity generation in China would have higher life-cycle greenhouse gas emissions than Chinese coal-based electrical generation during a 20-year timeframe!²³

¹⁸ Brandt, A.R., et al., Methane Leaks from North American Natural Gas Systems, *Science*, Vol. 343, no. 6172, pp.733-735 (Feb. 14, 2014).

¹⁹ Petron, et al., A new look at methane and non-methane hydrocarbon emissions from oil and natural gas operations in the Colorado Denver-Julesburg Basin, 119:9 *J. Geophys. Res. Atmospheres* (June 3, 2014), abstract available at <http://onlinelibrary.wiley.com/doi/10.1002/2013JD021272/abstract>. The second Colorado study is Petron, et al., Hydrocarbon emissions characterization in the Colorado Front Range: A pilot study, 117:D4 *J. Geophys. Res. Atmospheres* 4304 (Feb. 21, 2012).

²⁰ Karion, et al., Methane emissions estimate from airborne measurements over a western United States natural gas field, 40:16 *Geophysical Research Letters* 4393 (Aug. 27, 2013), abstract available at <http://onlinelibrary.wiley.com/doi/10.1002/grl.50811/abstract>.

²¹ *Sierra Club et al.*, pp. 10-11.

²² *Sierra Club et al.*, pp. 2-5.

²³ DOE, *Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas...*, pp. 14-15. See footnote 10.

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It's clear from these studies that *DOE LNG Life-Cycle* estimates of natural gas life-cycle leak rates are far too low, and that EPA also currently underestimates the scope of the problem.

LNG Exports Require More Fracking

LNG export terminals and pipelines proposed for Oregon are targeting Asian markets, working to lock themselves into 20-year export contracts.²⁴ One agonizing result of West Coast LNG exports to the Pacific Rim would be opening up most of Western North America to much more fracking.

In fact, the Jordan Cove Energy Project proposed in Oregon even highlights that as a major plus, to “balance supply and demand...in the current market environment of oversupply and low prices.” A Jordan Cove consultant states, “LNG exports... should be seen as instrumental in providing the increased demand to spur exploration and development of gas shale assets in North America.”²⁵ Gulf and Atlantic coast projects will similarly induce much more regional fracking.

Climate-Change Mitigation Efforts Would be Undone by LNG Exports

Taken as a whole, the current science makes a compelling case: LNG exports are not a climate solution. Oregon should reject proposals to make the Pacific Northwest a throughway for fracked-gas exports. Pipeline and terminal proposals on the U.S. Atlantic and Gulf Coasts claiming climate benefits are equally misguided.

The bottom line: Urgent near-term action against methane and other high-intensity greenhouse gases **must** parallel the necessary major reductions in direct carbon-dioxide output.²⁶

We will negate efforts to curb climate disruption if we permit LNG exports.

Other relevant information:

► *The Stanford Report* published a briefing paper summarizing the Brandt/Stanford study: *America's natural gas system is leaky and in need of a fix, new study finds.* (February 13, 2014). news.stanford.edu/news/2014/february/methane-leaky-gas-021314.html

► *The Washington Post* analyzed *DOE LNG Life-Cycle*: *Exporting U.S. Natural Gas isn't as "Clean" as You Think.* (June 9, 2014). washingtonpost.com/blogs/wonkblog/wp/2014/06/09/exporting-u-s-natural-gas-isnt-as-clean-as-you-think/.

► A *Chesapeake Climate Action Network* factsheet raises good points about *DOE LNG Life-Cycle*: *DOE: US LNG Exports to Asia are Likely Worse Than Coal for the Climate.* (June 9, 2014). chesapeakeclimate.org/press-releases/doe-u-s-lng-exports-to-asia-are-likely-worse-than-coal-for-the-climate/.

► *Scientific American* discusses a new NOAA study, from a team led by Stefan Schweitzke of Carnegie Mellon University, showing leakage rates double or triple the DOE estimates and *Texas* findings. The article notes, “[n]atural gas fields globally may be leaking enough methane, a potent greenhouse gas, to make the fuel as polluting as coal for the climate over the next few decades...” *Leaky Methane Makes Natural Gas Bad for Global Warming.* (June 26, 2014). scientificamerican.com/article/leaky-methane-makes-natural-gas-bad-for-global-warming/.

²⁴ Snow, N., DOE approves LNG exports to non-FTA countries from Oregon project, *Oil & Gas Journal*, March 24, 2014. This details 20-year export approval for the Jordan Cove Energy Project proposed for Coos Bay, Oregon, granted conditionally to Veresen, Inc., the Canadian corporation that owns Jordan Cove.

²⁵ Jordan Cove Resource Report 1, March 2012, p. 1-4.

²⁶ Sierra Club et al., pp. 10-12.

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Note: Other Damages from Natural Gas Production and LNG Export

The natural gas supply chain and LNG export development cause many other forms of environmental, economic, and personal damage not addressed in this synopsis.

These include but are not limited to:

- Surface water, ground water, and aquifer pollution from toxic fracking fluids;
- Massive consumptive water use for drilling and fracking, permanently removed from the hydrologic cycle;
- Toxic air pollution beyond fugitive methane emissions;
- Gas pipeline and LNG terminal construction impacts to forests, rivers, and farms and the people and species that depend on them;
- Corporate eminent domain use against landowners in pipeline routing, causing permanent deprivation for private-sector profit;
- Residential, commercial, and manufacturer consumer cost increases from LNG export;
- Massive loss of manufacturing jobs in the United States;
- Fracking-induced earthquakes;
- Health and safety risks of explosive facilities; and
- The planned siting of LNG facilities and pipelines in areas in Oregon guaranteed to suffer the most destructive seismic event and tsunami in U.S. history – and at very high risk of experiencing that earthquake and flood during the lifetime of the proposed LNG facilities.

Acknowledgements: Compiled by Oregonians

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Edition 1.1, August 30, 2014

Errata b.



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