METHANE MATTERS, part two **February, 2024**

Natural Gas is Methane

Methane makes up over 95% of processed natural gas. When burned, natural gas, oil, and coal fossil fuels release carbon dioxide, the main greenhouse gas overheating the planet. The United States is the world's largest producer of oil and largest producer of natural gas. And in less than a decade, the US has become the top exporter of liquefied natural gas (LNG), which is made when natural gas is cooled to a liquid state for shipping and storage.

In the news right now is a pause on approving new LNG export terminals, while the Department of Energy (DOE) updates how to determine whether a request is in the "public interest." The proposed Calcasieu Pass 2 (CP2) in Louisiana is pending approval. Points to consider:

- Communities along the Gulf Coast, a center of export LNG expansion, are harmed by air pollution and environmental damage.
- The LNG does not benefit Americans: export LNG cannot go to US ports (no US-built carriers as required by Jones Act) and higher LNG exports tend to push up natural gas prices at home.
- North American export capacity will likely double by 2027. There are eight existing US terminals. Seven are under construction and eleven more approved; US capacity will triple if all are built.
- Whether LNG is a "greener" choice depends on what the alternative is and whether methane is considered. Export LNG leaks methane from venting, flaring, and shipping, but actual leakage rates and how to weight methane's warming effects are still debated. Natural gas produces half as much carbon dioxide per unit electricity as coal, so substituting LNG for coal decreases CO2 emissions. Choosing renewable energy instead of either coal or LNG drops carbon emissions much more.
- If countries shift to zero-carbon fuels, for climate change or fuel security reasons, falling LNG demand could lead to stranded asset risk for LNG exporters.
- Building LNG infrastructure locks in LNG use and hinders the transition to renewable energy. Long term expansion of gas is not compatible with 1.5°C and 2°C pathways

If you were going to write a letter to the editor about export LNG terminals, what would you write?

What's up with methane?

Atmospheric methane (CH_4) arises from biogenic, fossil, and pyrogenic processes. Microbes make methane in low oxygen environments, such as wetlands, rice paddies, ruminant digestive tracts (cows, sheep), or landfills. Fossil methane, formed over geologic timespans, leaks from oil and gas and coal industry. Pyrogenic methane is from burning vegetation and wildfires. Carbon isotopes can distinguish microbial methane, which has less Carbon-13, from fossil and pyrogenic methane (more C13).

Methane concentrations rose during industrialization, leveled off around 1999-2006, and have since accelerated upward. What is driving this new rise? There has been an isotopic shift from more 13C-rich methane, consistent with fossil fuel use, to methane that is less 13C-rich, pointing to biogenic sources. Based on this and air sampling at different latitudes, tropical wetlands are thought to be responsible for most of the recent methane increases, with smaller contributions from ruminants, waste, and fossil fuels. (Wetlands are a major carbon dioxide sink, so their net climate effects are complicated.) It is hypothesized that heat and intense rainfall spur microbial activity and expand wetlands, increasing methane emissions. This leads to more warming, in a warming-wetland-methane feedback loop.

Methane matters and so does carbon dioxide

It remains important to reduce methane emissions where we can, such as from the oil and gas industry, especially since methane is rising from surprising sources. At the same time, carbon dioxide is the primary driver of rising temperatures. Is more oil and gas expansion in our best interests? I hope this pause in export LNG approvals turns the focus to how we can transition away from fossil fuels.

SELECTED REFERENCES (my comments in italics)

Liquefied Natural Gas

> *DOE pause* (https://www.energy.gov/articles/unpacking-misconceptions-surrounding-does-lng-update)
> Louisiana Bucket Brigade (https://labucketbrigade.org/wp-content/uploads/2023/12/LABB-Monitoring-Report-r7.pdf) -*local impact of export LNG, December 2023*
> US Energy Information Administration (EIA): Effects of LNG exports on the US natural gas market (https://www.eia.gov/outlooks/aeo/IIF_LNG/)
> EIA: LNG export capacity projection (https://www.eia.gov/todayinenergy/detail.php?id=60944)
> Federal Energy Regulatory Commission (FERC) (https://cms.ferc.gov/media/us-lng-export-terminals-existing-approved-not-yet-built-and-proposed) -*The liquefaction capacity from eight existing export terminals in the US is 14.43 Bcfd (billion cubic feet per day). Seven terminals under construction and eleven approved would triple capacity to 46.4 Bcfd. The proposed CP2 would add 3.96 Bcfd.*
> International Energy Agency (IEA), 2021. Net Zero by 2050: a roadmap for the global energy sector (https://www.iea.org/reports/net-zero-by-2050) "...beyond projects already committed as of 2021, there are no new oil and gas fields approved for development in our pathway" *(or coal mines)*

Natural gas vs coal

> Gordon D, et al, 2023. Evaluating net life-cycle greenhouse gas emissions intensities from gas and coal at varying methane leakage rates. Environ Res Lett (https://iopscience.iop.org/article/10.1088/1748-9326/ace3db)
> Yang S, et al, 2022. Global LNG expansion exceeds demand for coal-to-gas switching in paris compliant pathways. Environ Res Lett (https://iopscience.iop.org/article/10.1088/1748-9326/ac71ba)
> Howarth RW. The greenhouse gas footprint of LNG exported from the US (https://www.research.howarthlab.org/publications/Howarth_LNG_assessment_preprint_archived_2023-1103.pdf) -*total emissions from export LNG are larger than from coal. Unpublished.*

> *Methane metrics: Carbon dioxide equivalent (CO2e) units can be used when evaluating multiple greenhouse gases. The heating effect or global warming potential (GWP) of a gas is compared to that of the same mass of carbon dioxide over 100 years. This is useful for long term climate models or for mixed emissions from airplane flights, for example. Methane is powerful but short-lived; its GWP over 20 years (GWP20) is 84, but because it fades from the atmosphere, its GWP over 100 years (GWP100) is 28. There are newer metrics, some briefly discussed here:* (https://rmi.org/a-matter-of-time-three-ways-to-clarify-emissions-data/). *The most appropriate metric may depend on the policy goal and context.*
> *For more on GWP*:* Lynch J et al, 2020. (https://iopscience.iop.org/article/10.1088/1748-9326/ab6d7e) -*GWP* is useful; and* Meinshausen and Nicholls, 2022. (https://iopscience.iop.org/article/10.1088/1748-9326/ac5930) -*GWP* falls short*

Rising methane

> National Oceanic and Atmospheric Administration(NOAA), 2017 (https://www.climate.gov/news-features/understanding-climate/after-2000-era-plateau-global-methane-levels-hitting-new-highs)-*overview*
> Nisbet EG, et al, 2019. Very strong atmospheric methane growth in the 4 years 2014-2017: implications for the Paris Agreement. Global Biogeochem Cycles (https://doi.org/10.1029/2018GB006009); *also,* Nisbet EG, et al, 2023. Atmospheric methane: comparison between methane's record in 2006-20022 and during glacial terminations (https://doi.org/10.1029/2023GB007875). *Examples of tropical wetlands are the African Congo and Zambezi river basins and the Amazonia and Pantanal in South America. Methane from ruminants, waste, and fossil fuels is increasing but with no apparent acceleration. Is this ongoing rapid rise part of oscillating weather or a signal of a new scale of climate change? More study is needed.*
> Zhang Z, et al, 2023. Recent intensification of wetland methane feedback. Nat Clim Chang (https://doi.org/10.1038/s41558-023-01629-0)