METHANE MATTERS, part one January, 2024

Whether you call it "meh-thane" or "ME-thane," please don't say meh to methane! After carbon dioxide (CO_2), methane is the second most important of the greenhouse gases that overheat the Earth. Methane traps 80 to 100 times more heat than CO_2, but lasts only one or two decades, while CO_2 stays in the atmosphere for hundreds of years. For a hypothetical single year's worth of current emissions, methane and carbon dioxide have nearly equivalent impacts on temperature, over time scales of 10 to 20 years. Then as methane fades, CO_2 dominates long-term heating. It turns out that emissions of both methane and carbon dioxide need to fall to keep the planet in a safe zone. I'm keen on lessening methane emissions because it's a chance to slow warming during my lifetime.

Choosing a target for methane reduction

About 40% of atmospheric methane is from natural sources, primarily wetlands, and 60% from human activity. Agriculture makes up 40% of this, from ruminants mostly (cattle, buffalo, sheep, goats) and rice cultivation. Nearly as much (~35%) comes from energy systems, including oil and gas extraction, processing, and distribution, and coal mining. Another 20% is from waste (landfills, wastewater). Of these sectors, fossil energy has the largest potential for rapid and low-cost reductions. Methane, the main component of natural gas, can be captured rather than wasted and used or marketed to offset costs. More than 155 countries have joined the Global Methane Pledge to reduce human-caused methane emissions at least 30% from 2020 levels by 2030, and more than half of this decrease expected to come from the fossil fuel sector. Fifty companies have signed the Oil and Gas Decarbonization Charter to eliminate routine flaring and zero-out methane emissions by 2030.

Measuring methane in the oil and gas industry

In the oil and gas industry, methane comes from venting (for safety or operational purposes), leaks ("fugitive emissions" from accidents or malfunctions), and flaring (burning natural gas that is not captured, releasing CO_2). New aerial and ground-based sensors and satellites are providing more complete methane information. Small numbers of super emitters account for significant but variable proportions of emissions. Methane emissions are underestimated in government reports, likely because very large releases are not included. Lower-producing wells in aggregate tend to be leakier than higher producing wells and may make up half or more of methane emissions. Some 8-10% of flares may be malfunctioning or unlit, releasing methane directly into the atmosphere. Improved measurements of methane pollution help operators decrease waste and also provide a framework for policy.

Leak Detection and Repair (LDAR) in the United States

The Environmental Protection Agency (EPA) regulation on methane emissions from the oil and gas industry was announced in December 2023. LDAR standards apply to new and existing well sites, not exempting low-production wells. Routine flaring is phased out. Third parties help detect super emitters. The EPA estimates the rule will cut methane emissions by nearly 80% from 2024 to 2035 and harmful smog-forming pollutants and toxics will be decreased. There were close to a million public comments – including one from me! A separate policy imposes a fee for excessive methane waste. The oil and gas industry also has a Methane Action Plan to limit emissions.

Methane matters

Powerful but short-lived methane matters a lot, for warming effects in the next decades. I've chosen to focus on US oil and gas, where I think the outlook is pretty good for reducing methane emissions. Policy, aligned industry incentives, and satellites will all play a part. However, I've ignored agriculture, the biggest source of human-caused methane emissions, and waste. Very briefly, here are opportunities for individual action: Eat less meat! Compost!

SELECTED REFERENCES (my comments in italics)

Methane emissions and sources, including fossil energy

> IPCC (Intergovernmental Panel on Climate Change) Technical Summary, 2023. pp.101-102 (https://doi.org/10.1017/9781009157896.002)

> From the IEA (International Energy Agency): Global Methane Trackers 2021, 2022, 2023 (https://www.iea.org/reports/global-methane-tracker-2023); Global Methane Assessment 2021 (https://www.unep.org/resources/report/global-methane-assessment-benefits-and-costs-mitigating-methane-emissions); Methane Tracker (https://www.iea.org/data-and-statistics/data-tools/methane-tracker-data-explorer). *How much methane are we talking about? Annual **globa**l methane emissions were 580 million tonnes (Mt) in 2022; 80219 kilotons (kt) from the oil and gas sector; with 38647 kt to be avoided by tried and tested measures. Zero non-emergency flaring and venting is the most impactful abatement measure globally. **US** methane emissions were 31835 kt in 2022; 13982 kt from oil and gas; 6140 kt avoidable. LDAR is the most impactful abatement measure for the US.*

> Global Methane Pledge (https://www.globalmethanepledge.org)

> Oil and Gas Decarbonization Charter (https://www.cop28.com/en/news/2023/12/Oil-Gas-Decarbonization-Charter-launched-to--accelerate-climate-action)

Better methane measurements

> *Multiple reports, such as:* Alvarez RA, 2018 (https://doi.org/10.1126/science.aar7204) *on bottom-up and top-down measurements*; Omara M, 2018 (https://doi.org/10.1021/acs.est.8b03535) *on low-producing wells in the US;* Lauvaux T, 2022 (https://doi.org/10.1126/science.abj4351) *on ultra-emitters identified by satellite;* Zhang Y, 2020 (DOI: 10.1126/sciadv.aaz5120) *on the Permian basin. For nice visuals, try the* PermianMAP Final Report (https://blogs.edf.org/energyexchange/wp-content/blogs.dir/38/files/2022/11/PermianMAPFinalReport.pdf)

> *Satellites:* Methane Alert and Response System (MARS) (https://www.unep.org/explore-topics/energy/what-we-do/methane/imeo-action/methane-alert-and-response-system-mars) *and* EMIT (https://earth.jpl.nasa.gov/emit/data/data-portal/Greenhouse-Gases/) *zoom in closer to see methane plumes*

United States: policy and industry

> Environmental Protection Agency (EPA) Final Rule for Oil and Natural Gas Operations (https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-operations/epas-final-rule-oil-and-natural-gas). (*During the public comment period, I wrote to include smaller wells in the program.) How much methane is this? The EPA estimates the rule will avoid 58 million tons of methane from 2024 to 2035, or about 5800 kt per year after a phase-in period.*

> Waste Emissions Charge (WEC) (https://www.epa.gov/system/files/documents/2024-01/wec_factsheet.pdf). *Public comment open to March 11, 2024.*

> American Petroleum Institute Methane Action Plan, September 2023 (https://www.api.org/~/media/files/news/2023/09/13/api-methane-action-plan-2023) *and comment on methane waste emissions charge* (https://www.api.org/news-policy-and-issues/news/2024/01/12/api-calls-on-congress-to-repeal-ira-methane-fee)

Miscellaneous

> TILclimate (Today I Learned:Climate): "How tackling methane cools the planet fast" (https://climate.mit.edu/podcasts/e2-how-tackling-methane-cools-planet-fast) *MIT podcast with transcript*

> *Methane also come from orphaned or abandoned oil and gas wells with no solvent owner. These number around 3.4 million in the US with limited Federal and state funds to plug them. This non-profit, the Well Done Foundation, locates and plugs leaking wells* (https://welldonefoundation.org)