Upstream Methane Accounting for 45V

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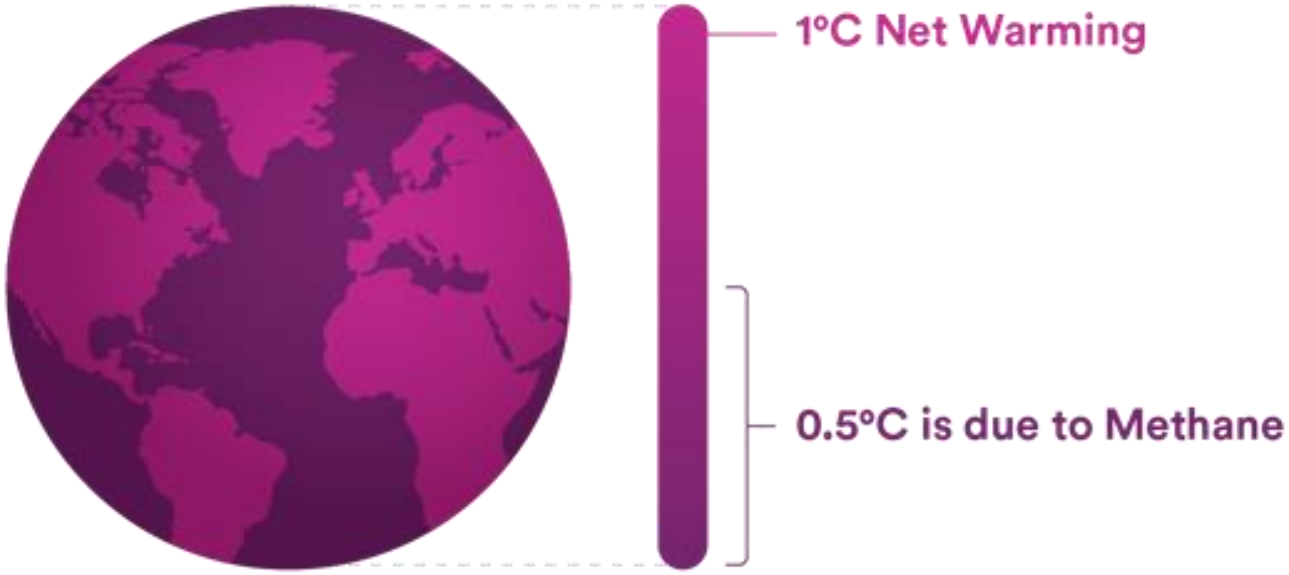
CLEAN AIR TASK FORCE

The upstream methane problem

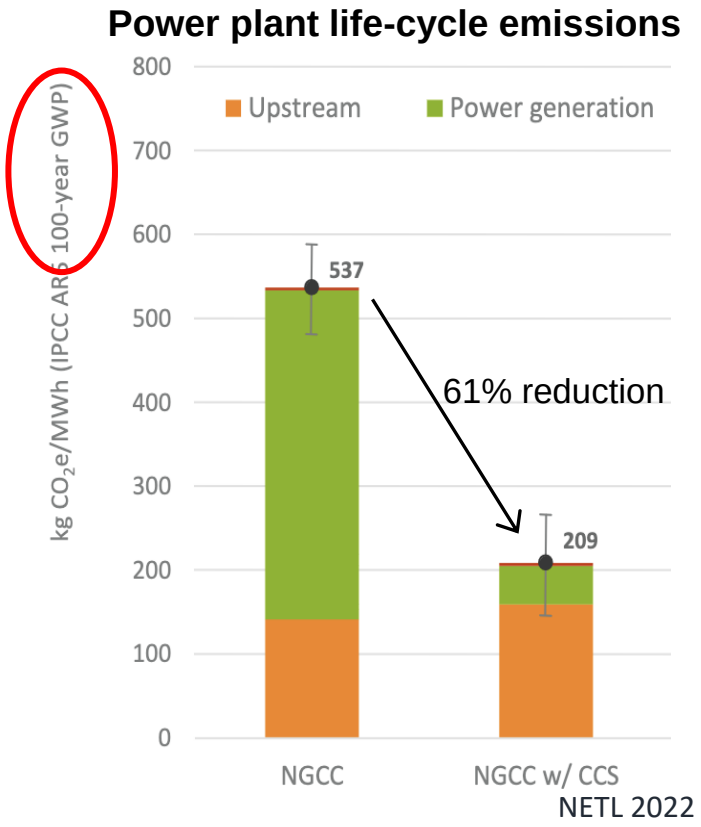
Methane is ~**80x more damaging to climate** than carbon dioxide, ton for ton, in the short term, and concentrations in the atmosphere are surging. It is responsible for at least 0.5°C of the warming have already experienced. Climate goals cannot be met without steep methane cuts.

Methane associated with oil and gas production, processing, and transport is one of the largest anthropogenic sources, both in the US and globally, and clearly one of the most feasible and cost-effective to mitigate.



The upstream methane problem for natural gas

Because of methane's potency and natural gas systems' leakiness, upstream methane emissions are a large portion of the climate impact of gas consumption – and if they aren't addressed, they limit the effectiveness of mitigation via CCS for systems such as blue hydrogen.

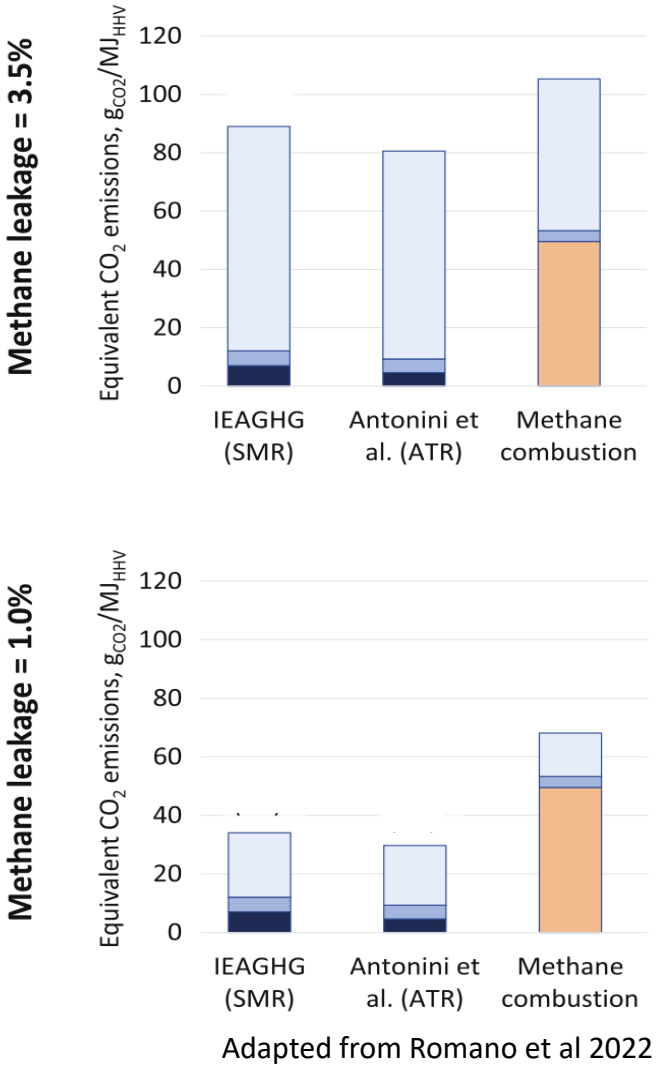


According to NETL, CCS on NGCC power plants only reduces total emissions 61% (left). *NETL's analysis substantially* ***underestimates*** *methane's impact for power generation.*

Because of the energy losses involved in converting methane to hydrogen, blue hydrogen production requires more gas than would be needed to generate the same heating directly with natural gas. **This further magnifies upstream emissions.**

Upstream abatement is necessary for energy systems utilizing CCS, such as blue hydrogen, to achieve their decarbonization potential.

The upstream methane problem for blue hydrogen



Adapted from Romano et al 2022

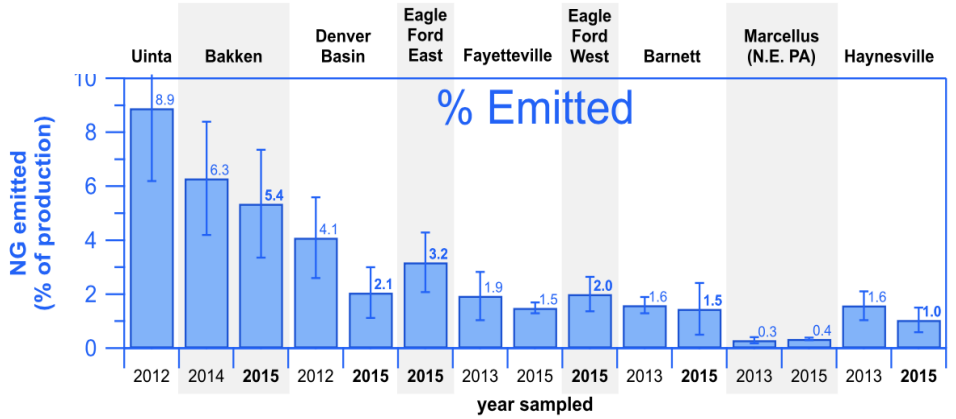
These figures for blue hydrogen are calculated using a 20-year GWP for methane. In that case, when methane emissions are high (top panel) there is little advantage for burning blue H_2 over burning natural gas (without CCS).

Even with optimistic assumptions about leak rate (bottom panel), blue H_2 emissions remain significant compared to uncontrolled natural gas.

Upstream Accounting for 45V

Upstream methane will be the largest source of lifecycle GHG emissions for blue hydrogen, so accurate accounting is essential.

- EPA Inventories (US GHG Inventory, GHGRP) *substantially* underestimate oil and gas methane emissions
  - A large body of “top-down” measurement studies have demonstrated equipment-based inventories (like EPA’s) significantly underestimate real emissions
  - “Top-down” & Equipment-based emissions estimates both show that emissions variation between regions and is very large



- Models such as GREET take into account national top-down estimates, but still appear to underestimate average upstream emissions.
  - GREET estimates 1.0% leakage, substantially lower than estimates based on top-down analysis
  - GREET also provides just a single national estimate. Top-down and bottom-up analyses both indicate large variability between producing regions and operators

Upstream Accounting for 45V – Best Practices

- EPA and GREET currently underestimate upstream emissions
    - Upstream emissions are most accurate when based on “top-down” assessments
    - Emissions estimates should be transparent for inputs and calculations / methodology
- Upstream assessments of emissions **based on specific operators, and for specific producing regions,** will improve accuracy and increase incentives to reduce emissions
    - Due to the large variability in emissions between operators and producing regions, upstream emissions cannot be estimated accurately simply by using national figures.
        - Example: Alvarez et al estimated 2015 national leak rate (oil + gas) = ~2.3%, but recent estimates from the Permian have ranged as high as 9%
    - If any default upstream emissions estimate for 45V is set conservatively high, hydrogen producers will be incentivized to require gas suppliers to provide information on gas origin and emissions associated with that gas. In turn this provides a market incentive for producers to reduce emissions and document those reductions
    - Leading jurisdictions and programs are **developing rigorous methodologies** for quantifying emissions that operators can apply to their assets, which can be applied for programs such as 45V

Thank you