PSE Healthy Energy
SCIENCE SUMMARY
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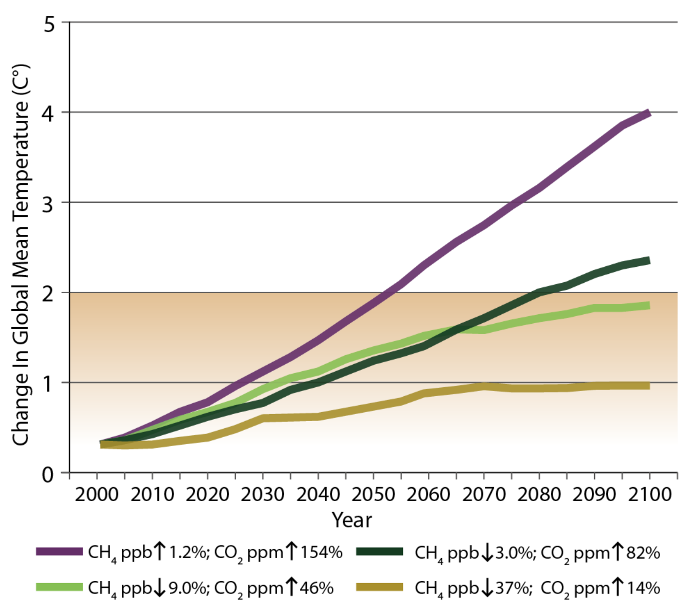
Climate Impacts of Methane Losses from Modern Natural Gas and Petroleum Systems

The climate implications of increased natural gas production and use, particularly substitution of coal by natural gas in the power sector has been hotly debated since 2011.Because natural gas combustion is associated with half the carbon dioxide (CO_2) emissions of coal in the electric power sector, it is often assumed that a switch to natural gas power will result in lowered greenhouse gas emissions. However, this assumption does not account for methane emissions associated with producing natural gas and bringing that natural gas to market. The past several years have seen major changes both in our understanding of the importance of reducing methane emissions as a climate mitigation measure, and the significance of natural gas and petroleum systems as a source of atmospheric methane. Here, we review the current literature to provide the most up-to-date calculations for the climate impact and magnitude of methane emissions from modern natural gas and oil development.

Calculated methane losses from the U.S. natural gas supply chain based on new atmospheric measurements = 3.8% **(see page 2)**

At this rate of loss, fuel conversion from coal to natural gas would not produce a climate benefit for another 40 years. (Adapted from ref.2 using AR5 radiative efficiency for methane and a 3.8% loss rate). Weighted average of methane losses from natural gas and petroleum systems relative to gross natural gas production from natural gas and oil wells (see page 2). Assumes default gas composition 88% methane. *Adapted from Alvarez et al. (2012)[2] using AR5 radiative efficiency for methane[3] and 3.8% loss rate.

Predicted Increase in Global Mean Temperature under Various Climate Mitigation Scenarios



CO_2 mitigation alone will not be enough to warming below the 1.8C threshold *(Adapted from IPCC 2013)*

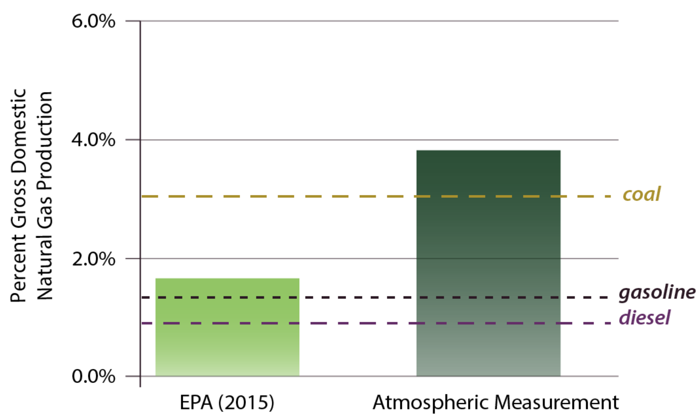
Rapid methane mitigation combined with CO2 mitigation is society's best chance for stabilizing the climate

Climate scientists estimate a warming threshold of 1.8 - 2 C° over pre-industrial levels. Additional warming beyond this threshold is associated with rapid onset of a climate never before experienced by humans, which we may not be able to adopt to fast enough.[3] **Immediate and ongoing methane mitigation combined with even conservative CO_2 mitigation is society's best chance for stabilizing the climate.**

Natural Gas is not a Bridge Fuel to a Lower Carbon Future

Updated Technology Warming Potentials (TWP)[2] using the most recent IPCC findings[3] indicate an emission limit of 2.8% of natural gas production for conversion from coal. **Loss rates above 2.8% negate any near-term climate benefits associated with lower carbon dioxide emissions during fuel combustion.**

EPA (2015) Estimated vs. Measurement-Based Methane Losses From U.S. Natural Gas & Petroleum Systems Compared to Maximum Emission Rates for Climate Benefit

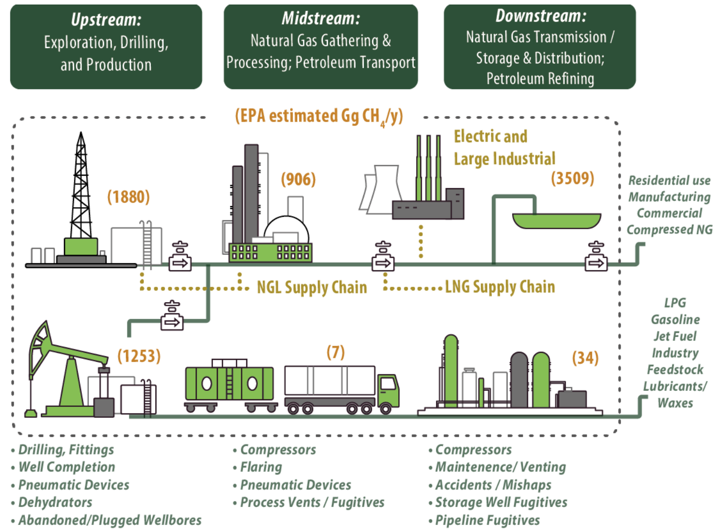


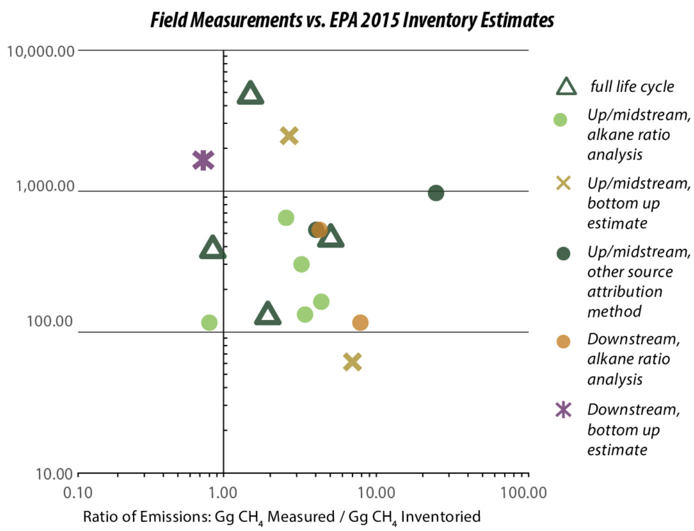
EPA (2015) Estimated vs. Measurement-Based Methane Losses From U.S. Natural Gas & Petroleum Systems Compared to Maximum Emission Rates for Climate Benefit. Dashed lines represent break-even loss rates for natural gas substitution for various fuels (coal, gasoline, diesel). Emission rates above these lines result in greater climate warming due to fuel switching. *(Adapted from Alvarez et al. 2012 assuming updated radiative efficiency for methane[3])*

- Methane emissions inferred from atmospheric concentrations reflect the weighted average emissions attributed to onshore natural gas and petroleum systems as reported in 13 atmospheric studies (see emissions discussion, page 2);
- Methane emissions inferred from atmospheric sampling exceed the emissions limit for substitution of coal by at least 40%;
- Conversion to natural gas in vehicles to replace gasoline and diesel have much lower TWPs and already exceed emission limits based on in EPA emission estimates.

Methane Emissions from Petroleum and Natural Gas Systems

- Methane, the primary component of natural gas, is produced from both natural gas (non-associated) and oil (associated) wells;
- Fugitive emissions (unintentional) and vented (intentional) emissions occur throughout both supply chains;
- U.S. EPA estimates methane emissions from oil and gas activity to be 7,589 Gg methane (10^9 g) per year, or roughly 27% of all 2013 methane emissions in the U.S.[1]





Atmospheric methane measurements indicate that actual emissions from these systems are at least a factor of 2 - 2.5 higher than what is reported in EPA inventory.

Our comparison of EPA inventory estimates and emissions inferred from atmospheric sampling focus solely on field measurement studies published since 2011[4-16] and emissions attributable specifically to natural gas and petroleum sectors.

Based on these measurements, weighted by the study region's percent of gross domestic production, **we estimate that real-world 2013 U.S. methane emissions from petroleum and natural gas systems were 16,141 to 18,952 Gg/y**, compared to EPA's estimate of 7,589 Gg/y. **This equates to 3.8% of the U.S. gross natural gas production.**

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