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Top-down methane emissions from Harvard studies

Additional submitted attachment is included below.

May 25, 2021

To: California Energy Commission
Attn: Docket number 19-ERDD-01
Re: Research to Improve Characterization of Methane Emissions from California's Residential Sector

These comments are submitted by Maryann Sargent and Steven Wofsy from Harvard University and Joe Rudek from the Environmental Defense Fund.

What is the best estimate of methane emissions from Natural Gas infrastructure and buildings?

Methane emissions from natural gas infrastructure can be estimated by either "bottom-up" or "top-down" methods, which are complementary to each other. In bottom-up methods used in many inventories, leaks are measured for a sample of pipeline types, meters, appliances, etc., and multiplied by the total miles of pipeline, number of meters, or household appliances to determine total emissions. One challenge in using bottom-up inventories is the presence of "super-emitters"; typically, a large portion of the methane emitted is from a small number of pipes/meters/appliances that have much larger emissions than the average. If the sample tested for leaks does not contain a representative number of strong emitters, the total emissions can be biased low. Another potential problem is sources or sectors missing from the inventory.

Top-down methods quantify emissions based on the methane concentration measured in the atmosphere along with wind data and meteorological models to provide an integrated assessment of emissions from a region. Unlike bottom-up methods, they have quantifiable uncertainties and the ability to apply a consistent methodology over time for the detection of trends.

Top-down studies of urban natural gas emissions across 6 U.S. cities have all shown significantly higher NG emissions (2-6 fold higher) than bottom-up inventories[1] [2] [3]. The top-down measurements capture all emissions in the city, including losses of gas from buildings which are not included in all inventories. This consistency across cities with different topography, wind patterns, and model frameworks carried out by different research groups provides confidence that there are very likely large missing sources of emissions in bottom-up methane inventories. In Los Angeles, 5 distinct top-down studies using different methodologies have found NG emissions to be ~2x higher than the latest bottom-up inventory[4] [5] [6] [7] [8].

Our group maintains a network of 5 spectrometers located on tall buildings in Boston and towers outside the city which have continuously measured atmospheric methane since 2012. We used a model-measurement framework to assess top-down natural gas emissions from the Boston area from 2012-2020 and found emissions to be ~3 times higher[9] [10] [11] than the bottom-up inventory we compiled using building losses from several recent studies[12] [13] [14] [15] and pipeline losses from Weller et al.[16] We calculated a loss rate of 2.5 ± 0.6% from natural gas infrastructure and all other sources, with no significant trend in loss rate over 8 years.

Natural gas emissions from appliances/buildings

Determining the sources of NG emissions that are observed from top-down methods but unaccounted for in bottom-up inventories remains a significant challenge. A clue as to possible missing sources is found in the strong correlation between NG emissions and consumption observed in Boston[11], Washington D.C.[17], and Los Angeles[5 8]. This correlation is somewhat surprising because distribution pipelines, thought to be a dominant source of NG losses, are at fairly constant pressure year-round and thus their emissions are not expected to vary with consumption. Therefore, it is likely that a large fraction of urban emissions is from non-pipeline sources where emissions are directly linked to consumption, such as appliances/buildings, transmission stations, or industrial use.

Methane losses from appliances in residential and commercial buildings should follow consumption, making them good candidate for study in the search for emissions missing from bottom-up inventories. Further, targeted studies are required from both bottom-up and top-down perspectives to see if there are additional building emissions that have not been captured in previous bottom-up studies and to assess the impact of super-emitter appliances. Commercial and industrial building emissions also warrant further study. In Boston, the emissions from residential and commercial buildings accounts for 18% of our bottom-up inventory, and 6% of our estimated top-down emissions; 67% of top-down emissions are unaccounted for in the bottom-up inventory. Therefore, estimates of building emissions would need to be increased by 4-fold or more compared to current bottom-up estimates to account for a significant fraction of missing emissions.

Current efforts to reduce NG emissions often target pipeline leaks; however, if a significant portion of NG emissions are not from pipelines, but from consumption-driven processes, it could require changing the scope of future policy. The results of our study also imply that policies aimed at reducing NG consumption such as prohibiting NG lines to new buildings could substantially reduce GHG emissions if NG is replaced with green alternatives.

Thank you for this opportunity to speak on these important topics to reduce methane emissions as part of our goal to reduce greenhouse gas emissions in the U.S.

Respectfully submitted,

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