United States Environmental Protection Agency

Summary of Public Review Comments and Responses:
Draft *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020*

June 2022
U.S. Environmental Protection Agency
Office of Atmospheric Programs
Washington, D.C.

Responses to Comments Received during the Public Review Period on the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020*

Preface

EPA thanks all commenters for their interest and feedback on the annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. Per Federal Register Notice 2022-02694 published on February 15, 2022, EPA announced document availability and request for comments on the draft "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020" report. The EPA requested recommendations for improving the overall quality of the inventory report to be finalized in April 2022 and submitted to the United Nations Framework Convention on Climate Change (UNFCCC), as well as subsequent inventory reports.

During the 30-day public comment period which ended March 25, 2022, EPA received 21 sets of comments, including 58 unique comments in response to the notice. This document provides EPA's responses to technical comments on methods and data used in developing the annual greenhouse gas inventory. One private citizen submitted 3 different sets of comments, all of which have been reflected in this document. The verbatim text of each comment extracted from the original comment letters is included in this document, organized by commenter. Full comments can be found in the public docket here: https://www.regulations.gov/docket/EPA-HQ-OAR-2022-0001. EPA's responses to comments are provided immediately following each comment excerpt.

Commenter: GHGSat Inc.

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0010

Ángel E. Esparza

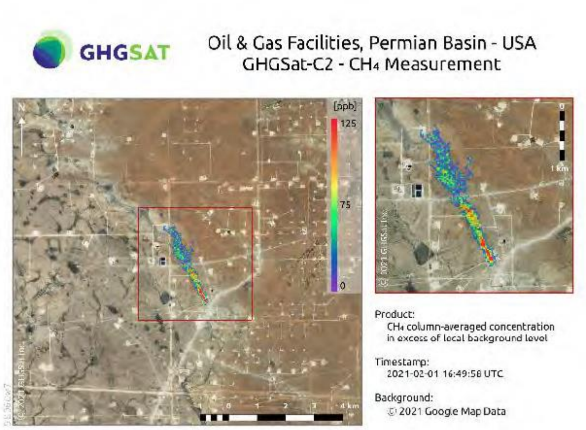
Comment 1: Methane Emissions

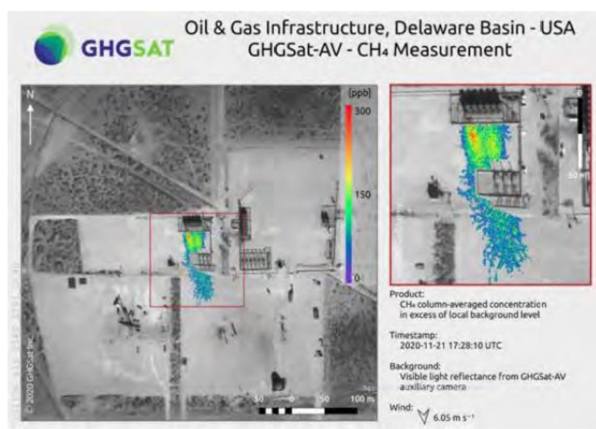
To Whom It May Concern:

GHGSat appreciates the opportunity to provide comments on the Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2020 (Docket ID No. EPA-HQ-OAR-2022-0001).

Established in 2011, GHGSat operates its own satellites and aircraft that have been detecting and quantifying greenhouse gas emissions from facilities across the United States and around the world, providing the timely and objective data needed to empower better environmental decisions by federal agencies, state and local governments, communities, companies, and individuals. GHGSat currently has three satellites in orbit, with the next three satellites scheduled for launch this summer towards the goal of a ten satellite constellation by the end of 2023. These satellites can measure greenhouse gas emissions with a spatial resolution as low as 30 meters, representing a unique capability to quantify point sources like individual oil and gas wells – a crucial capability for facility-level attribution. A complementary aircraft-based sensor has been performing operational flights since 2020 across North America.

The image below on the left was taken by a GHGSat satellite and shows a methane super-emitter in the Permian Basin in western Texas, while the image on the right shows an observation of a methane leak at a compressor station also in the Permian taken by the airborne instrument that complements the satellite constellation – an existing and operational system-of-systems for greenhouse gas measurement.





The Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2020 states that "EPA continues to examine the uses of facility-level…data to improve the national estimates" [Energy, Page 3-6], that "additional efforts will be made for future Inventory reports to improve the mapping of fuel types and examine ways to reconcile and coordinate any differences between facility-level data and national statistics" [Energy, Page 3-22], and that "EPA also continues to seek new data that could be used to assess or update the estimates in the Inventory." [Energy, Page 3-86] A tiered system-of-systems approach that leverages the remote sensing capabilities of satellites and aircraft-based instruments could dramatically improve the Inventory and help reconcile differences between facility-level data and national estimates without the need to deploy an impracticably large number of ground-based sensors. Federal and state regulators are currently reliant on limited field measurements, estimates, and self-reporting that are likely to underestimate emissions, particularly in areas with intense industrial activity.

Numerous scientific studies [Brandt, et al., 2016; Zavala-Araiza, et al., 2017; Duren, et al., 2019] have reported that methane emissions show a skewed distributions in which a small number of "super emitters" are responsible for the majority of emissions. Given the nature of this distribution, a practical strategy that could yield dramatic improvements in the Inventory would combine satellites, aircraft-based instruments, and ground-based sensors in a tiered system-of-systems approach. Satellites would monitor on a frequent basis with an emphasis on high-risk areas, quantifying very big emissions, about 50% of methane leaked by volume. Airborne instruments would be dispatched periodically to survey areas of interest, with emphasis on the high-risk areas identified by satellites. The objective of airborne monitoring would be to quantify large leaks that contribute the next 40% of methane emissions by volume. Finally, ground-based sensors would be employed to quantify the remaining 10% of methane emissions by volume.

GHGSat appreciates this opportunity to provide comments on the Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2020. For your interest, GHGSat also provided comments earlier this year on Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review (Docket ID No: EPA-HQ-OAR-2021-0317). GHGSat would welcome further opportunities to discuss with EPA the role of satellites and aircraft-based remote sensing capabilities towards improving the Inventory.

Response: In the text of the GHG Inventory (pp. 3-96 to 3-97 of Chapter 3, Section 3.7 Natural Gas Systems), we note that: "In general, there are two major types of studies related to oil and gas greenhouse gas data: studies that focus on measurement or quantification of emissions from specific activities, processes and equipment, and studies that use tools such as inverse modeling to estimate the level of overall emissions needed to account for measured atmospheric concentrations of greenhouse gases at various scales. The first type of study can lead to direct improvements to or verification of Inventory estimates. In the past few years, EPA has reviewed and in many cases, incorporated data from these data sources. The second type of study can provide general indications of potential over- and under-estimates. In addition, in recent years information from top-down studies has been directly incorporated to quantify emissions from well blowouts."

EPA continues to track technologies and programs that monitor methane and consider how information from such approaches can be used to update the GHG Inventory. The 2019 Refinement to the 2006 IPCC Guidelines discusses atmospheric observations under "Quality Assurance, Quality Control, and Verification." The Refinement provides a discussion on available technologies and provides examples and approaches for use of satellite data to improve GHG inventories. It describes components needed to compare inventories with atmospheric measurement, which include measurements of atmospheric gas concentrations, inverse modeling tools, gridded inventory, and collaboration. It also describes procedures for using comparisons to inform GHG Inventories, including steps to take when there are discrepancies.

Commenter: Friends of the Earth U.S.

EPA Docket ID No.: EPA-HQ-OAR-2021-0001-0009

Carrie Apfel, Peter Lehner, Ranjani Prabhakar, Mustafa Saifuddin

Comment 2: Prioritize efforts to validate and refine models for estimating methane and nitrous oxide from agriculture

Agriculture is the largest source of anthropogenic methane and nitrous oxide emissions in the U.S. Agricultural soil management emissions rose from 316.0 MMT CO2eq to 345.3 MMT CO2eq between 1990 and 2019, although these values fell during 2020.3 Despite some sectors' progress in curbing or slowing the growth of methane emissions, enteric fermentation emissions have risen from 163.5 to 175.2 MMT CO2eq between 1990 and 2020, and manure emissions have nearly doubled from 34.8 to 59.6 MMT CO2eq during this same period (See Figure 1)[1]. Thus, these non-CO2 greenhouse gas emissions are of growing importance and will continue to pose a threat to meeting climate targets in the absence of aggressive mitigation measures. An accurate and precise estimate of these emission sources is necessary to shape such efforts.

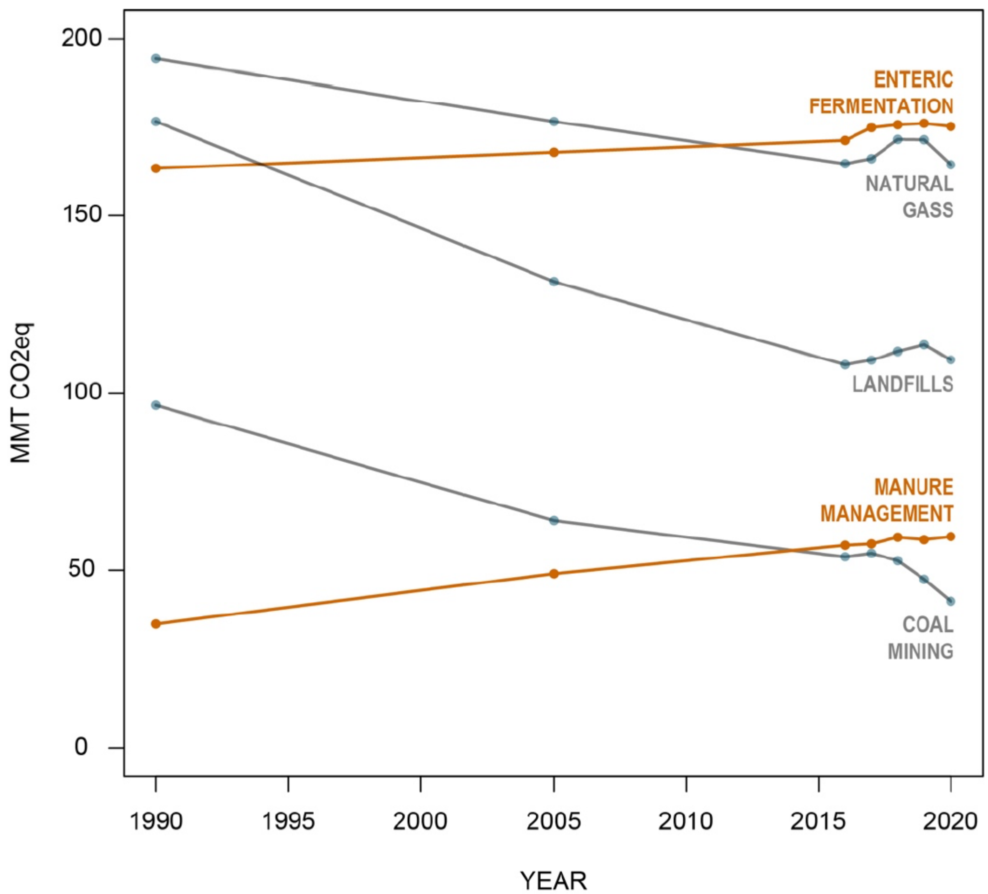


Figure 1. *Trends in U.S. anthropogenic methane emissions 1990-2020 showing increases methane emissions from animal agriculture over time. Data from draft Inventory.*

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[1] EPA, 430-P-22-001, DRAFT Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990–2020 92–94 tbl.2-1 (2022), https://www.epa.gov/system/files/documents/2022-02/us-ghg-inventory-2022-main-text.pdf. This carbon dioxide equivalence is based on the 100 year global warming potential.

As noted in the Inventory, there are a number of challenges associated with estimating agricultural emissions, leading to wide uncertainty ranges for these major emission sources.

These uncertainties are among the largest in the Inventory. For example, the 95% confidence interval[2] surrounding estimates of methane emissions from enteric fermentation and manure management range from nearly 20% below to 20% above the given values,[3] reflecting a critical need for model improvement (See Figure 2). Even more concerning, estimates of direct soil nitrous oxide emissions are only constrained to ± 33% of the given values, and the 95% confidence interval for indirect soil emissions ranges up to 145% above the given values.[4] These broad ranges of uncertainty have not improved substantially across successive annual inventories, reflecting slow progress on improving the precision of these critical estimates. EPA should accelerate efforts to improve underlying models, including the steps it outlines in the planned improvements sections of the Inventory.

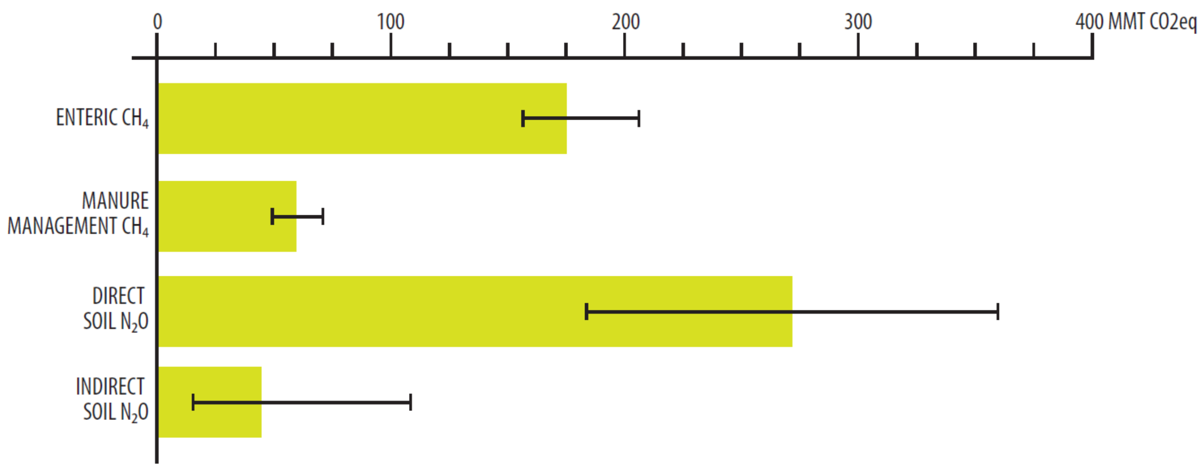

Figure 2. *U.S. 2020 agricultural greenhouse gas emissions with 95% confidence intervals showing large uncertainties in model estimates. Data from draft Inventory.*

Response: As described in the final Inventory, EPA in collaboration with USDA survey and census programs has undertaken a number of improvements within the 1990-2020 Inventory, including updates to the Cattle Enteric Fermentation Model (CEFM), and continues to identify and plan improvements for future Inventories, including a number of updates to the models and data used to calculate emissions within the agriculture and LULUCF sectors. As noted in the Planned Improvement sections of the Agriculture and LULUCF chapter, some improvements will take longer to implement due to the complexity of the analysis.

Comment 3: Validate existing models with a growing body of evidence from direct measurements indicating actual methane emissions are significantly higher than model predictions

Several national-scale studies (See attached) collecting direct top-down emission measurements suggest that annual animal methane emissions are 39-90% greater than bottom-up model predictions upon which EPA relies:

- Scot M. Miller et al., Anthropogenic emissions of methane in the United States, 110 Proceedings

[2] The range of values surrounding the estimate for which there is a 95% likelihood that the true value lies between.

[3] EPA, *supra* note 1, at 423–431 tbls.5-5 & 5-8.

[4] *Id.* at 458 tbl.5-19.

Nat’l Acad. Sci. 20018–22 (2013).

A combination of comprehensive atmospheric methane observations, extensive spatial datasets, and high-resolution atmospheric transport modelling suggests that EPA’s inventory underestimated methane emissions nationally by a factor of ∼1.5, and that emissions due to ruminants and manure are up to twice the magnitude of existing inventories.

- Kevin J. Wecht *et al*., *Mapping of North American methane emissions with high spatial resolution by inversion of SCIAMACHY satellite data*, 119 J. Geophysical Rsch. 7741–56 (2014).

  Satellite observations paired with chemical transport modeling suggest that U.S. livestock emissions are 40% greater than estimated according to EPA’s inventory, and that U.S. livestock emissions are 70% greater than the oil and gas emissions, in contrast to comparable values in EPA’s inventory.

- Alexander J. Turner *et al*., *Estimating global and North American methane emissions with high spatial resolution using GOSAT satellite data*, 15 Atmospheric Chemistry & Physics 7049–69 (2015).
  Space-borne methane observations indicate that anthropogenic U.S. methane emissions are approximately 1.5 times greater than as reported in EPA’s inventory, with 29–44 % of emissions attributed to livestock.

Similarly, several regional-level studies within the U.S. (See attached) find similar patterns in which direct measurements surrounding areas of confined animal production suggest significantly higher emissions than values predicted from bottom-up models used by EPA:

- Seongeun Jeong et al., Estimating methane emissions in California’s urban and rural regions using multitower observations, 121 J. Geophysical Rsch. 13,031–049 (2016).

  Atmospheric observations of methane emissions in California suggest values 1.2-1.8 times greater than those reported by the California Air Resources Board.

- Zichong Chen et al., Source partitioning of methane emissions and its seasonality in the U.S. Midwest, 123 J. Geophysical Rsch. 646–59 (2018).

  Anthropogenic methane emissions in the midwestern U.S. were observed to be 1.5 times greater than the bottom-up estimates from EPA’s inventory, and livestock sources were underestimated by 1.8-fold in the inventory.

- Xueying Yu et al., Aircraft-based inversions quantify the importance of wetlands and livestock for Upper Midwest methane emissions, 21 Atmospheric Chemistry & Physics 951–71 (2021).

  Airborne measurements across seasons in the U.S. corn belt and upper midwest indicate that livestock emissions in the summer and winter are 25% higher than predicted in EPA’s inventory, with particularly large discrepancies of 30-40% for dairies and hog farm estimates.

- Recent datasets relying on novel methods for direct measurement: Levi M. Golston et al., Variability of Ammonia and Methane Emissions from Animal Feeding Operations in Northeastern Colorado, 54 Env'tl Sci. & Tech. 11015–11024 (2020).

Observations at mobile laboratories in Colorado show large discrepancies between measured methane and ammonia plumes downwind of confined animal feeding operations and model predictions.

Taken together, these and other studies suggest that EPA's bottom-up models are likely to underestimate U.S. animal methane emissions.[5] EPA should integrate these existing direct measurements and explore opportunities for improving direct measurements, including through the use of novel remote sensing technologies, to refine and validate its models to correct for underestimation.

Response: Please see the response to Comment #1, above. EPA continues to track technologies and programs that monitor methane and consider how information from such approaches can be used to inform the GHG Inventory. We also note that many of the studies provided compare with earlier versions of the Inventory, and at different spatial scales, and may not reflect improvements already made. EPA is planning to update the gridded version of the national methane inventory in 2022, which will allow for better comparisons with outside studies.

Comment 4: EPA should include, in parallel with its current reporting, greenhouse gas emissions calculated according to 20-year global warming potentials.

As noted in the Inventory, there exist a range of possible global warming potentials associated with greenhouse gas emissions depending on the choice of timescale and climate feedback effects considered.[6] These choices have a significant impact on calculations of methane emissions, as the global warming potential of methane is 25 at 100-year timescales (GWP100) and 86 at 20-year timescales (GWP20). Thus, shifting to evaluating emissions under policyrelevant timescales results in weighting methane emissions nearly three times more than as suggested under 100-year timeframes.

The use of a 20-year global warming potential is more relevant for policymakers, as climate action is urgent and policy planning often occurs on the scale of years or decades rather than centuries.[7] While EPA's choice to use the 100-year timescale to report values in the Inventory aligns with the IPCC Fourth Assessment Report values, this makes it challenging for policymakers to easily recognize the significant need to mitigate methane emissions on policyrelevant timescales. The IPCC has consistently noted the need to appropriately tailor GWP choices to their appropriate policy contexts.[8] Thus, the Inventory should report, in parallel, values computed according to GWP20. This shift has been adopted in policy

[5] Matthew N. Hayek & Scot M. Miller, *Underestimates of methane from intensively raised animals could undermine goals of sustainable development*, 16 Env't Rsch. Letters 63006 (2021), https://doi.org/10.1088/1748-9326/ac02ef.

[6] *See supra* note 1 at 68–69 Box 1-2.

[7] See, for example, Robert W. Howarth, *A Bridge to Nowhere: Methane Emissions and the Greenhouse Gas Footprint of Natural Gas*, 2 Energy Sci. & Engineering 47, 53-55 (2014).

[8] Priyadarshi R. Shukla et al., Intergovernmental Panel on Climate Change, Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems.

contexts at the state level, such as in New York state's greenhouse gas inventory and in its climate planning.[9] Providing parallel information at the national scale will help align such efforts.

Response: EPA uses 100-year Global Warming Potentials (GWP) from IPCC's Fourth Assessment Report as required in reporting annual inventories to the UNFCCC. This is required to ensure that national GHG Inventories reported by all nations are comparable. Per updated reporting guidelines under the new Paris Agreement which take effect in 2024, the U.S. and other countries will shift to use of 100-year GWPs from IPCC's 5th Assessment report in their reported national GHG inventories. Until then EPA will continue to use GWPs from the IPCC's Fourth Assessment Report.

The U.S. Inventory also includes unweighted estimates in kilotons (see Table 2-2 of the Trends chapter) and stakeholder/researchers can and have used these values to apply other metrics. Further, Annex 6 of the Inventory includes information on effects to inventory estimates in shifting to AR5 and AR6 100-year GWPs. The U.S. Inventory report website is available at https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.

More information on GWPs is available on the IPCC's Working Group 1 website for AR5 (Chapter 8) and for AR6 (Chapter 7): https://www.ipcc.ch/working-group/wg1/

Comment 5: EPA should expand its agricultural economic sector emissions estimates in Chapter 2.2 to include a more complete accounting of emissions related to agriculture, including emissions from the manufacture of fertilizer and other agricultural inputs, land use and the carbon opportunity cost of agricultural land use.

In addition to estimates based on IPCC sectors, the Inventory includes emission estimates by economic sector. These expanded classifications are highly valuable for policymakers seeking a more complete accounting of emissions related to agriculture, as they include emissions from onfarm combustion and electricity use. However, while these expanded estimates provide a more accurate estimate, they should be further refined to include additional emissions closely associated with agriculture. EPA should include within the agricultural economic sector emission estimate an accounting of emissions from fertilizer manufacturing and the manufacturing of other inputs used almost exclusively for agricultural purposes. Additionally, EPA should include in this estimate emissions related to agricultural land use, including losses of soil carbon and carbon in vegetation due to land conversion and ongoing land use. Finally, EPA should expand this estimate to also include the carbon opportunity cost of ongoing agricultural land use, which quantifies the amount of carbon sequestration precluded through the use of land for agricultural purposes at the expense of sequestration that would have occurred in undisturbed vegetation.[10] These changes would allow for a more complete and accurate reflection of agriculture's broad climate impact.

Response: As described in Chapter 5, page 5-1, CO_2, CH_4 and N_2O fluxes from agriculture-related land-use and land-use conversion activities, such as cultivation of cropland, management on grasslands, grassland fires, aquaculture, and conversion of forest land to cropland, are presented in the Land Use,

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[9] N.Y.S. Dep't Env't Conservation, *2021 Statewide Greenhouse Gas Emissions Report* (2021), https://www.dec.ny.gov/docs/administration_pdf/ghgsumrpt21.pdf. *See also*, Robert W. Howarth *Methane emissions from fossil fuels: exploring recent changes in greenhouse-gas reporting requirements for the State of New York*, 17 J. Integrative Env't Sci. 69–81 (2020), https://doi.org/10.1080/1943815X.2020.1789666.

[10] Hayek et al., The Carbon Opportunity Cost of Animal-Sourced Food Production On Land, 4 Nature Sustainability 21 (2021); see also Timothy Searchinger, et al., Assessing the Efficiency of Changes in Land Use for Mitigating Climate Change, 564 Nature 249, 249 (2018).

Land-Use Change, and Forestry (LULUCF) chapter. Carbon dioxide emissions from stationary and mobile on-farm energy use and CH_4 and N_2O emissions from stationary on-farm energy use are reported in the Energy chapter under the Industrial sector emissions. Methane and N_2O emissions from mobile on-farm energy use are reported in the Energy chapter under mobile fossil fuel combustion emissions. The estimates for the Agriculture economic sector do include emissions from the Energy chapter, as noted above. EPA will assess potential to reflect greenhouse gas fluxes from the agriculture-related land sector and the emissions from fertilizer production attributable to agriculture in the discussion of Economic Sectors found in Section 2.2 of Chapter 2.

Commenter: Waterspirit

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0014

Rachel Dawn Davis

Comment 6: Be explicit about the potency of methane as a greenhouse gas, including accounting of cradle to grave emissions measurement; This is necessary to understanding the potency of methane, thus the increased risk to public health when methane is mixed with hydrogen.

Natural gas is not a viable option toward the reduction of carbon; natural[11] gas is more toxic through methane emissions, which contribute far more significantly to greenhouse gas emissions and related physical and mental illness incidence. Additionally, proponents of blue hydrogen and carbon capture and sequestration are the same establishments which continue to deceive and ravage communities without any sign of slowing. This remains the situation, even in New Jersey, the one state with landmark legislation to consider cumulative impacts. Presently there is national consideration through the Environmental Justice for All Act.[12] Fines for polluters will not shift our energy economy to just, stable and reliable renewable energy resources; only prioritization through funding will help along the overdue modifications of future planning.

Response: These comments to impacts of GHG mitigation policy options and life-cycle accounting are noted but are out of scope of this technical review of the national GHG Inventory. The national GHG Inventory reports emissions in line with international conventions on country level reporting which lists emissions by source or category and not by product or fuel type. Information on global warming potentials for all gases, including methane, is included in Chapter 1 (starting p. 1-8) of the report. Note that President Biden's Executive Order on Tackling the Climate Crisis at Home and Abroad notes the importance environmental justice in all communities across America, and curbing methane emissions.[13]

Comment 7: Increase transparency with respect to greenhouse gas emissions inventory relative to the historical deficiency of recording or reporting of emissions at every stage of a gas infrastructure project.

The inventory is unfortunately not comprehensive; gas emissions are grossly underreported due to failure to include many gaps in the release of emissions and related responsibility ownership, including

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[11] https://www.vox.com/22912760/natural-gas-methane-rename
[12] https://thehill.com/opinion/energy-environment/594175-its-time-for-congress-to-take-environmental-justice-seriously/
[13] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/

but not limited to fugitive emissions from electric powered compressor stations, referenced herein. It is impossible to allow an industry to honestly regulate itself.

It is important to understand that greenhouse gas emissions in 2020 include the variable of pandemic, causing a significant drop in cars on the road.[14] A United Nations Environmental Programme Report shares, "Concentrations of the major greenhouse gases – carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2 O) continued to increase in 2020 and the first half of 2021." It is intriguing that the EPA has not since considered-across history-the significance of unregulated toxic emissions, beginning with monitoring and measurement. Both activities, as Waterspirit has commented before across agencies, must be independently controlled and maintained.

Fugitive Emissions:

Indirectly, directly and cumulatively emissions must be considered. Dr. Sandra Steingraber pointed out recently in response to the new Methane Rules,[15] said they "*will not regulate methane emissions from abandoned wells, which is huge and may exceed leaks from productive wells in basins like the Marcellus, nor does it cover 'malfunctions' in gas flaring which are a big source of extreme methane plumes in the Permian*."

Response: See Chapter 2 of the Inventory for more information on impacts from the COVID-19 pandemic on emissions levels in 2020 (e.g. see pages 2-1, 2-13). Notable trends due to impacts from the COVID-19 pandemic are discussed throughout the report. Comments on EPA regulations are out of scope of this technical review of the national GHG Inventory.

Comment 8: Independent Measurement/Monitoring/Reporting of Air Quality: Project Sponsors as beneficiaries of perpetuated carbon industries:

Carbon Capture and Sequestration (CCS) and other technologies *not* possible of being proven to function without great health harm done to communities in proximity to operations. Additionally, CCS has not been proven to be economically where it exists, leave workers lost.[16] We must protect workers and their future and their families. Contaminating fresh water is ecological sin, even without doing so for financial profit. These carbon schemes are false solutions and we should be doing better for our children by preventing emissions as quickly as possible and investing in job training programs for transitioning workers into a green economy. For more on false solutions, Waterspirit is sharing the Hoodwinked in the Hothouse report.[17]

The Food & Water Watch Report, The Case Against Carbon Capture: False Claims and New Pollution[18] states: "If all power plants used CCS, they would burn 39 percent more natural gas and 43 percent more coal, thereby exacerbating air and water pollution impacts, which fall disproportionately on lower income people and communities of color." The same report also explains research finding, "In addition to (fresh) water use, CCS would produce a new stream of untreated wastewater. Scrubbing chemicals

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[14] https://www.nature.com/articles/d41586-021-00090-3
[15] https://www.epa.gov/newsreleases/us-sharply-cut-methane-pollution-threatens-climate-and-public-health
[16] https://www.cbsnews.com/news/clean-coal-projects-carbon-capture-government-accountability-office/
[17] https://climatefalsesolutions.org/wp-content/uploads/HOODWINKED_ThirdEdition_On-Screen_version.pdf
[18] https://foodandwaterwatch.org/wp-content/uploads/2021/04/ib_2003_carboncapture-web.pdf

emitted in low quantities from carbon capture devices could contaminate water supplies with probable carcinogens."[19]

Response: These comments impacts of greenhouse gas mitigation technologies are noted but are out of scope of this technical review of the national GHG Inventory. EPA also notes that underground injection of CO_2 is regulated under the Safe Drinking Water Act as Class VI wells. Nore information can be found here: https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxide

Comment 9: Recommends independent measurement, monitoring, reporting and ongoing community control over emissions and air quality data.

Communities are their own best experts given their lived experiences; solutions exist only with their assistance, which requires trust. A community driven and run program is best suited to accurately account for toxic emissions due to the need for public trust. Reliable data will help the EPA to wholly and accurately report on greenhouse emissions and sinks. The lived experiences, across generations, cumulatively impact directly and indirectly the human communities in proximity to oil and gas emissions infrastructure. Previously referred to as "Cancer Alley",[20] dubbed more recently "Death Alley"[21] is a sad and ghastly development to which EPA must turn its hearts.

We are all interconnected as are the needs for energy and the ways in which we fulfill said need. Infrastructure supporting the industry of transporting dirty energy is inherently intermingled with those making laws regulating the same. Renewable energy technology's economic prowess cannot equally be compared to the publicly assisted oil and gas markets which have benefited from subsidies for decades. The United States government's failure to study and prevent emissions has caused undue, preventable harm of mass proportions. 10 years ago, a talking point from industry workers was that horizontal gas drilling has been going on for many decades, since the 1950's. This is a decades old talking point from polluting gas industry proponents. The natural gas drilling done today is unconventional, horizontal gas drilling and uses not only copious amounts of fresh water – the most sacred dwindling resource on Earth- but also undisclosed toxic chemicals which have never been subject to the Clean Water Act or Safe Drinking Water Act, per the Halliburton loophole.[22] There is a direct link between failed accounting for emissions from these specific entanglements and resulting water contamination, wastewater issues, and toxic burn pits.[23] May we focus on trust and honesty that meets the urgency of our climate emergency.

Maarten van Aalst, director of the Red Cross Red Crescent Climate Center, and coordinating lead author of the most recent IPCC report remarked: "This is report is a flashing red light, a big alarm for where we are today. We are confronted with rising risks of disasters in so many places. But the report also shows that we can do something about it. We just need to raise our ambition dramatically in light of what this report is showing is coming our way."[24]

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[19] Ibid.
[20] https://www.propublica.org/article/welcome-to-cancer-alley-where-toxic-air-is-about-to-get-worse
[21] https://forensic-architecture.org/investigation/environmental-racism-in-death-alley-louisiana#:~:text=Residents%20of%20the%20majority-Black,their%20homeland%20'Death%20Alley
[22] https://www.statnews.com/2021/04/26/end-fracking-exemptions-a-threat-to-maternal-and-public-health/
[23] https://www.kcra.com/article/dangers-symptoms-veterans-exposure-toxic-burn-pits/39289768
[24] https://www.reuters.com/markets/commodities/expert-views-ipcc-climate-report-adapt-now-liveable-future-hotter-planet-2022-02-28/

Response: Development of greenhouse gas monitoring systems are noted but they are out scope for this technical review of the national greenhouse gas inventory, as is the assessment of toxic emissions[25]. See also response to Comment #1.

Comment 10: Recommends that EPA require all facilities in the gas systems to report annual methane emissions via independent reporting and verification

In previous comments, Waterspirit has amplified the need for independent verification of baseline measurement, monitoring, reporting and ownership as well as enforcement. At each stage of this process, community members are the best equipped to maintain the goal of superior air quality.

For instance, New Jersey resident, Kirk Frost's lived experience is captured when he shares:

> "There are many natural gas transmission facilities that do not report emissions, whether because they claim low emissions or that the facility is an electric compressor station. I have a small electric compressor station 2,000 feet away from the local high school driveway where I live. If you go to that high school driveway on any cold morning at 7am, it smells like a raging gas leak. Yet, the NJDEP and EPA pretend that compressor station doesn't even exist. It does, and it is dangerous. (Compressor station 2,000 feet from high school is Texas Eastern Transmission Corp.'s Freehold Compressor station located at 110 Weston Rd, Somerset, NJ 08873 and is stated to be 5,000hp electric compressor station.)
> Another example on a slightly theme is the Tennessee Gas Pipeline Compressor station CS-325. While CS-325 is in the GHG inventory database, the facility has reported less than 1.290 tons of methane emissions per year for the past 10 years despite upgrading the facility in 2009 with two Solar Taurus 70 turbines which identify in the specs, the turbine emits 5 tons of methane in the exhaust per year. This also means that those turbines have never vented or flared since their installation in 2009… (which would be) impossible.

He implores the EPA to "consider that all compressor station facilities must require methane emissions and start employing audits during peak operation using the OGI (optical gas imaging) measurements," and we echo his requests.

Response: Comments on EPA regulations and monitoring of facility-level emissions are out of scope of this technical review of the national GHG Inventory. Please check rulemaking notices for the Greenhouse Gas Reporting Program for opportunities to comment on proposed changes to EPA's facility level reporting requirements.[26]

Comment 11: Recommends that EPA consider existing technologies and programs being utilized and maintained by community, given the urgency of our climate emergencies.[27]

Time & Existing Technologies: Air and water know no bounds- their contamination is irreversible and public knowledge and outcry have demonstrated a need for a climate emergency declaration. FLIR cameras and GIS technologies exist to capture the data and there are some key studies out about PA,

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[25] See https://www.epa.gov/toxics-release-inventory-tri-program for information on toxic chemical releases and pollution prevention activities reported by industrial and federal facilities.
[26] https://www.epa.gov/ghgreporting/rulemaking-notices-ghg-reporting
[27] https://airquality.ucdavis.edu/

connected to the Delaware River Basin with respect to methane emissions reports. CO- also hosts an example.

Independent ownership of all emissions monitoring technology and emissions data collection is necessary. For example, UC Davis Air Quality Monitoring Research Center[28] is a good example as it operates in real time and the community contributes to the data, demonstrating trust.

Response: See response to Comment #1."

Comment 12: Recommends and encourages EPA to keep open comments and persistent dialogue with members of the public and experts alike who are proposing alternative energy options. Reliable technology that is proving helpful should be further invested in as we contend with in-effect greenhouse gas emissions accounting.

New rules could give EPA tools to audit and gather a more-closer to real methane emissions story. This would be a counter to the industry engaging in self-reporting at present, which should not have ever been allowed. Had subsidies gone to renewable energy technologies, we may not have ever had to rely on fossil fuel such that we would not be entangled in war. We have recommended in previously submitted comments that independent monitoring, reporting and recording and community control of emissions is key and vital to the longevity of a community. Climate extremes are exacerbated by greenhouse gas emissions. Shielding certain industries and government agencies from greenhouse gas emissions recording and reporting does not inform a livable future for children alive today.

Response: These comments on facility-level greenhouse gas monitoring are noted but are out of scope of this technical review of the national GHG Inventory. Please check rulemaking notices for the Greenhouse Gas Reporting Program for opportunities to comment on proposed changes to EPA's facility level reporting requirements.[29]

Commenter: Earthjustice Sustainable Food et al.

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0011

Carrie Apfel, Peter Lehner, Ranjani Prabhakar, Mustafa Saifuddin, Chloe Waterman, Cathy Day, Scott Faber

Comment 13: Prioritize efforts to validate and refine models for estimating methane and nitrous oxide from agriculture

Agriculture is the largest source of anthropogenic methane and nitrous oxide emissions in the U.S. Agricultural soil management emissions rose from 316.0 MMT CO2eq to 345.3 MMT CO2eq between 1990 and 2019, although these values fell during 2020.[30] Despite some sectors' progress in curbing or slowing the growth of methane emissions, enteric fermentation emissions have risen from 163.5 to 175.2 MMT CO2eq between 1990 and 2020, and manure emissions have nearly doubled from 34.8 to 59.6 MMT CO2eq during this same period (*See Figure 1*).[31] Thus, these non-

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[28] Ibid.

[29] https://www.epa.gov/ghgreporting/rulemaking-notices-ghg-reporting

[30] EPA, 430-P-22-001, *DRAFT Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990–2020* 92–94 tbl.2-1 (2022), https://www.epa.gov/system/files/documents/2022-02/us-ghg-inventory-2022-main-text.pdf. This carbon dioxide equivalence is based on the 100-year global warming potential.

[31] *Id.*

CO2 greenhouse gas emissions are of growing importance and will continue to pose a threat to meeting climate targets in the absence of aggressive mitigation measures. An accurate and precise estimate of these emission sources is necessary to shape such efforts.

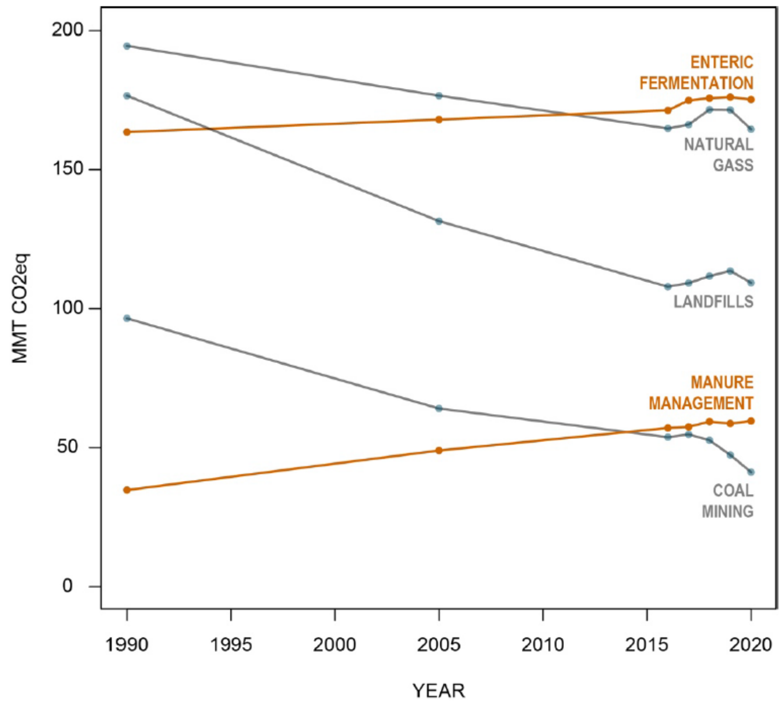

Figure 1. *Trends in U.S. anthropogenic methane emissions 1990-2020 showing increases methane emissions from animal agriculture over time. Data from draft Inventory.*

As noted in the Inventory, there are a number of challenges associated with estimating agricultural emissions, leading to wide uncertainty ranges for these major emission sources. These uncertainties are among the largest in the Inventory. For example, the 95% confidence interval[32] surrounding estimates of methane emissions from enteric fermentation and manure management range from nearly 20% below to 20% above the given values,[33] reflecting a critical need for model improvement (See Figure 2). Even more concerning, estimates of direct soil nitrous oxide emissions are only constrained to ± 33% of the given values, and the 95% confidence interval for indirect soil emissions ranges up to 145% above the given values.[34] These broad ranges of uncertainty have not improved substantially across successive annual inventories, reflecting slow progress on improving the precision of these critical estimates. EPA should accelerate efforts to improve underlying models, including the steps it outlines in the planned improvements sections of the Inventory.

[32] The range of values surrounding the estimate for which there is a 95% likelihood that the true value lies between.
[33] EPA, supra note 1, at 423–431 tbls.5-5 & 5-8.
[34] Id. At 458 tbl. 5-19.

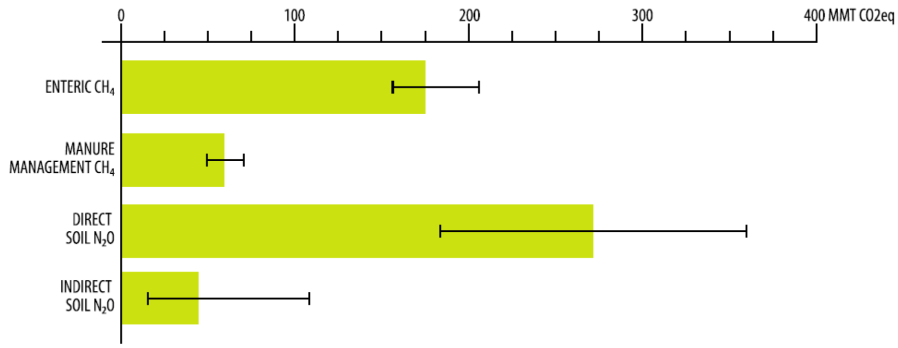

Figure 2. *U.S. 2020 agricultural greenhouse gas emissions with 95% confidence intervals showing large uncertainties in model estimates. Data from draft Inventory.*

Response: See response to Comment #2, above.

Comment 14: Should validate existing models with direct measurements of methane emissions, which reveal significantly higher methane emissions from agriculture than modeled estimates in the Inventory.

Several national-scale studies (*attached hereto as Attachments 1 & 2*) collecting direct top-down emission measurements suggest that annual animal methane emissions are 39-90% greater than bottom-up model predictions upon which EPA relies:

- Scot M. Miller et al., Anthropogenic emissions of methane in the United States, 110 Proceedings Nat'l Acad. Sci. 20018–22 (2013).

  A combination of comprehensive atmospheric methane observations, extensive spatial datasets, and high-resolution atmospheric transport modelling suggests that EPA's inventory underestimated methane emissions nationally by a factor of ∼1.5, and that emissions due to ruminants and manure are up to twice the magnitude of existing inventories.

- Kevin J. Wecht *et al.*, *Mapping of North American methane emissions with high spatial resolution by inversion of SCIAMACHY satellite data*, 119 J. Geophysical Rsch. 7741–56 (2014).

  Satellite observations paired with chemical transport modeling suggest that U.S. livestock emissions are 40% greater than estimated according to EPA's inventory, and that U.S. livestock emissions are 70% greater than the oil and gas emissions, in contrast to comparable values in EPA's inventory.

- Alexander J. Turner *et al.*, *Estimating global and North American methane emissions with high spatial resolution using GOSAT satellite data*, 15 Atmospheric Chemistry & Physics 7049–69 (2015). Space-borne methane observations indicate that anthropogenic U.S. methane emissions are approximately 1.5 times greater than as reported in EPA's inventory, with 29–44 % of emissions attributed to livestock.

Similarly, several regional-level studies within the U.S. (*See attached*) find similar patterns in which direct measurements surrounding areas of confined animal production suggest significantly higher emissions than values predicted from bottom-up models used by EPA:

- Seongeun Jeong *et al*., *Estimating methane emissions in California's urban and rural regions using multitower observations*, 121 J. Geophysical Rsch. 13,031–049 (2016).

  Atmospheric observations of methane emissions in California suggest values 1.2-1.8 times greater than those reported by the California Air Resources Board.

- Zichong Chen *et al*., *Source partitioning of methane emissions and its seasonality in the U.S. Midwest*, 123 J. Geophysical Rsch. 646–59 (2018).

  Anthropogenic methane emissions in the midwestern U.S. were observed to be 1.5 times greater than the bottom-up estimates from EPA's inventory, and livestock sources were underestimated by 1.8-fold in the inventory.

- Xueying Yu *et al*., *Aircraft-based inversions quantify the importance of wetlands and livestock for Upper Midwest methane emissions*, 21 Atmospheric Chemistry & Physics 951–71 (2021).

  Airborne measurements across seasons in the U.S. corn belt and upper midwest indicate that livestock emissions in the summer and winter are 25% higher than predicted in EPA's inventory, with particularly large discrepancies of 30-40% for dairies and hog farm estimates.

- Recent datasets relying on novel methods for direct measurement: Levi M. Golston et al., Variability of Ammonia and Methane Emissions from Animal Feeding Operations in Northeastern Colorado, 54 Env'tl Sci. & Tech. 11015–11024 (2020).

  Observations at mobile laboratories in Colorado show large discrepancies between measured methane and ammonia plumes downwind of confined animal feeding operations and model predictions.

Taken together, these and other studies suggest that EPA's bottom-up models are likely to underestimate U.S. animal methane emissions.8 EPA should integrate these existing direct measurements and explore opportunities for improving direct measurements, including through the use of novel remote sensing technologies, to refine and validate its models to correct for underestimation.

Response: See response to Comment #3, above.

Comment 15: Should include, in parallel with its current reporting, greenhouse gas emissions calculated according to 20-year global warming potentials.

As noted in the Inventory, there exist a range of possible global warming potentials associated with greenhouse gas emissions depending on the choice of timescale and climate feedback effects considered.9 These choices have a significant impact on calculations of methane emissions, as the global warming potential of methane is 25 at 100-year timescales (GWP100) and 86 at 20-year timescales (GWP20). Thus, shifting to evaluating emissions under policy-relevant timescales results in weighting methane emissions nearly three times more than as suggested under 100-year timeframes.

The use of a 20-year global warming potential is more relevant for policymakers, as climate action is urgent and policy planning often occurs on the scale of years or decades rather than centuries.10 While EPA's choice to use the 100-year timescale to report values in the Inventory aligns with the IPCC Fourth Assessment Report values, this makes it challenging for policymakers to easily recognize the significant need to mitigate methane emissions on policy-relevant timescales. The IPCC has consistently noted the need to appropriately tailor GWP choices to their appropriate policy contexts.11 Thus, the Inventory should report, in parallel, values computed according to GWP20. This shift has been adopted in policy contexts at the state level, such as in New York state's greenhouse gas inventory and in itsclimate planning.[35] Providing parallel information at the national scale will help align such efforts.

Response: See response to Comment #4.

Comment 16: Should expand its agricultural economic sector emissions estimates in Chapter 2.2 to include a more complete accounting of emissions related to agriculture, including emissions from the manufacture of fertilizer and otheragricultural inputs,land use, the carbon opportunity cost of agricultural land use, and waste.

In addition to estimates based on IPCC sectors, the Inventory includes emission estimates by *economic*s ector. These expanded classifications are highly valuable for policymakers seeking a more complete accounting of emissions related to agriculture, as they include emissions from on-farm combustion and electricity use. However, while these expanded estimates provide a more accurate estimate, they should be further refined to include additional emissions closely associated with agriculture. EPA should include within the agricultural economic sector emission estimate an accounting of emissions from fertilizer manufacturing and the manufacturing of other inputs used almost exclusively for agricultural purposes. Additionally, EPA should include in this estimate emissions related to agricultural land use, including losses of soil carbon andcarbon in vegetation due to land conversion and ongoing land use. Furthermore, EPA should expand this estimate to also include the carbon opportunity cost of ongoing agricultural land use, which quantifies the amount of carbon sequestration precluded through the use of land for agricultural purposes at the expense of sequestration that would have occurred in undisturbed vegetation.[36] Finally, EPA should include emissions from food and agricultural waste in its emission estimate for the agricultural economic sector. These changes would allow for a more complete and accurate reflection of agriculture'sbroad climate impact.

Response: See response to Comment #5, above.

Commenter: Our Children's Trust

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0012

Andrea Rodgers

Comment 17: Break National Inventory down by State

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[35] N.Y.S.Dep'tEnv'tConservation,*2021 Statewide Greenhouse Gas Emissions Report* (2021), https://www.decny.gov/docs/administrationpdf/ghgsumrpt21.pdf. *See also*, Robert W.Howarth *Methane emissions from fossil fuels: exploring recent changes in greenhouse-gas reporting requirements for the State of New York*, 17J. IntegrativeEnv'tSci. 69–81(2020), https://doi.org/10.1080/1943815X.2020.1789666.

[36] Matthew N. Hayeketal., *TheCarbon Opportunity Cost o fAnimal-Sourced Food Production on Land*, 4 Nature Sustainability 21 (2021), https://doi.org/10.1038/s41893-020-00603-4; *see also* Timothy D. Searchingeretal., *Assessing the Efficiencyof Changes in Land Use for Mitigating Climate Change*, 564 Nature 249,2 49 (2018), https://doi.org/10.1038/s41586-018-0757-z.

The EPA should take its annual country-wide report and break down emissions by state, comparable to the methodology employed by the U.S. Energy Information Administration ("EIA").[37] While some states conduct such territorial inventories, most do not. Of those that do (e.g., Hawaii, Oregon, and Utah), the methodology is inconsistent and the reporting intermittent. By reporting emissions by state, EPA would then provide states with clear and consistent information on the emissions occurring within a state's individual geographic boundaries, apprising state regulators of emissions, allowing policy makers to craft informed mitigation legislation and plans, and enabling the federal government to ascertain whether it is on track to meet climate commitments, such as its Nationally Determined Contribution ("NDC") under the Paris Agreement or the Biden Administration's commitment to achieve 100% carbon-free electricity by 2035, or whether certain states are impeding the federal government's ability to comply with its international commitments.

Response: EPA now compiles and publishes annual state-by-state GHG data (https://cfpub.epa.gov/ghgdata/inventoryexplorer/) consistent with the national Inventory and international reporting guidelines, meaning state GHG totals when summed, will equal totals in the national Inventory. Learn more about EPA's state-level GHG estimates at https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals. The methodology uses data from EIA's State Energy Data System (SEDS), but makes adjustments as needed for consistency with the national estimates. More information on adjustements is included in Chapter 2.1 of the methodology report describing how EPA disaggregrated national estimates available online at https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals.

Comment 18: Undercounting methane emissions

The EPA has been undercounting methane emissions. Methane emissions, along with additional carbon dioxide emissions, from flaring and venting at active oil and gas wells and leakage from abandoned wells must be fully accounted for in emissions.[38] Similarly, end-use of natural gas has significantly higher methane emissions than accounted for by the EPA.[39]

Response: Given the variability of practices and technologies across oil and gas systems and the occurrence of episodic events, it is possible that the EPA's estimates do not include all methane emissions from abnormal events. For many equipment types and activities, the EPA's emission estimates include the full range of conditions, including "super-emitters." For other situations, where data are available, emissions estimates for abnormal events are calculated separately and included in the GHG Inventory (e.g. Aliso Canyon leak event). The EPA continues to work through its stakeholder process to review new data from the EPA's Greenhouse Gas Reporting Program (GHGRP) and research studies to assess how emissions estimates can be improved. EPA notes that end use fugitive emissions have been included for the first time in this Inventory report.

[37] https://www.eia.gov/environment/emissions/state/

[38] Ramon A. Alvarez et al., *Assessment of Methane Emissions from the U.S. Oil and Gas Supply Chain*, 361 Science 186 (2018); James P. Williams et al., *Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States*, 55 Env't Science Tech. 563 (2021); Thomas Lauvaux et al., *Global Assessment of Oil and Gas Methane Ultra-Emitters*, 375 Science 557 (2022); https://insideclimatenews.org/news/24022022/texas-natural-gasflaring-venting/.

[39] Maryann R. Sargent et al., *Majority of US Urban Natural Gas Emissions Unaccounted for in Inventories*, 118 Proc. Nat'l Acad. Sciences e2105804118 (2021).

Comment 19: Black Carbon Soot

The EPA should include black carbon from fossil-fuel soot as a particulate-component of greenhouse gas emissions and measure its emission for each state. According to the EPA, black carbon is the second strongest emission with respect to a 20-year global warming potential.[40] While black carbon has a short lifetime in the atmosphere, its 20-year and 100-year global warming potential is an order to two orders of magnitude greater than that of methane, a gas the EPA does monitor.[41] Indeed, controlling black carbon and fossil-fuel soot emissions, which requires detailed knowledge on such emissions, is an important avenue to reducing global warming, with a faster climate response to reductions than for methane or carbon dioxide.[42]

Response: EPA publishes inventories on black carbon. More information can be found here: https://www3.epa.gov/airquality/blackcarbon/

Comment 20: Tropospheric ozone emissions

The EPA should document tropospheric ozone emissions. At lower levels in the atmosphere, ozone is a greenhouse gas[43] and thus should be documented as a greenhouse gas by the EPA in addition to its monitoring of ozone as an air pollutant.[44]

Response: As noted on EPA's ground-level ozone basics page, "tropospheric ozone is not emitted as a pollutant but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC). This happens when pollutants [NOx, NMVOCs] emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight." EPA does track air emissions of these precursors through its National Emissions Inventory (NEI) and also reports them in the national inventory report.

As indicated in section 2.3 of the national Inventory report, the "reporting requirements of the UNFCCC request that information be provided on emissions of compounds that are precursors to greenhouse gases, which include carbon monoxide (CO), nitrogen oxides (NOx), nonmethane volatile organic compounds (NMVOCs), and sulfur dioxide (SO_2). These gases are not direct greenhouses but can indirectly impact Earth's radiative balance, by altering the concentrations of other greenhouse gases (e.g., tropospheric ozone) and atmospheric aerosol (e.g., particulate sulfate)." Information on precursor emissions from EPA's NEI are recategorized from NEI Tier 1/Tier 2 source categories to those more closely aligned with IPCC categories summarized and reported in sections 2.3, 3.11, 4.27, 5.7, 6.2, 6.6 and 7.6 of the report.

Comment 21: Fossil fuels extracted from federal lands

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[40] https://www.igsd.org/black-carbon-ranked-number-two-climate-pollutant-by-us-epa/; Benjamin DeAngelo, *Black Carbon and Other "Short-Lived Climate Forcers": Climate Change Science*, Clean Air Act Advisory Committee, Mobile Sources Technical Review Subcommittee (2013).
[41] Mark Z. Jacobson, *Short-term Effects of Controlling Fossil-Fuel Soot, Biofuel Soot and Gases, and Methane on Climate, Arctic Ice, and Air Pollution Health*, 115 J. Geophysical Rsch. D14209, 19 (2010).
[42] *Id.* at 1.
[43] EIA, Energy and the Environment Explained: Greenhouse Gases, https://www.eia.gov/energyexplained/energyand-the-environment/greenhouse-gases.php.
[44] EPA, Ground-level Ozone Pollution, https://www.epa.gov/ground-level-ozone-pollution.

The EPA should draw on the methodology used by the U.S. Geological Survey[45] and Bureau of Land Management[46] to document the greenhouse gas emissions from fossil fuels extracted from federal lands to catalogue the emissions from all fossil fuels extracted within the United States.[47] Such data are critical for assessing means of curbing greenhouse gas emissions from a consumption and production standpoint, which are critical to meeting international emission pledges. Such data could be reported to the United Nations Framework Convention on Climate Change ("UNFCCC") as extra information, like what has been recommended in Chapter 5 of United Nations Environment Programme ("UNEP") co-published Production Gap Report.[48]

Response: The USGS/BLM report used methodologies consistent with EPA's national GHG Inventory. See methodology section starting on page 4 of the USGS/BLM report.

Comment 22: GWP Values

In terms of global warming potential ("GWP") of greenhouse gases, the EPA should use a 20-year GWP in addition to a 100-year GWP.[49] As has been made readily clear by the 2022 IPCC AR6 WGII report, climate change and its drastic impacts on humanity are occurring now and worsening in the coming decade.[50] Consequently, a 20-year GWP best addresses the current crisis; the seas are rising, the forests burning, and the hurricanes raging now, not in 100 years.

Response: See response to comment #4.

Comment 23: Report on interntional agreements to reduce GHG emissions

As part of its inventory, EPA should report on whether the federal government is complying with its own commitments to reduce GHG emissions through either international agreements or domestic policy.

Response: These comments are noted but are out of scope of this technical review. EPA refers the reviewer to recently published 7th U.S. national communication and 4th biennial report, titled "A Review of Sustained Climate Action" which reports on progress toward commitments under the UNFCCC and related agreements available online: https://unfccc.int/sites/default/files/resource/United%20States%207th%20NC%203rd%204th%20BR%20final.pdf.

Comment 24: Report on emission trajectory

[45] Matthew D. Merrill et al., USGS, *Federal Lands Greenhouse Gas Emissions and Sequestration in the United States: Estimates for 2005–14* (2018), https://pubs.er.usgs.gov/publication/sir20185131.
[46] BLM, *2020 BLM Specialist Report on Annual Greenhouse Gas Emissions and Climate Trends*, https://www.blm.gov/content/ghg/.
[47] Georgia Piggot et al., *Swimming Upstream: Addressing Fossil Fuel Supply under the UNFCC*, 18 Climate Policy 1189 (2018).
[48] SEI et al., *The Production Gap Report 2021* (2021), https://productiongap.org/2021report/.
[49] EPA, Understanding Global Warming Potentials, https://www.epa.gov/ghgemissions/understanding-globalwarming-potentials.
[50] IPCC, *Summary for Policymakers, in* Climate Change 2022: Impacts, Adaptation and Vulnerability (2022).

The best available science informs that Earth's energy balance can only be restored by returning the atmospheric CO_2 concentration to below 350 ppm by 2100.[51] Experts have opined that it is economically and technically feasible to achieve the science-based greenhouse gas emission reduction target of close to 100% by 2050, while simultaneously enhancing sequestration capacity of sinks to drawdown historical cumulative CO_2 emissions, placing the U.S. on an emissions trajectory consistent with returning atmospheric CO_2 to below 350 ppm by 2100.[52] In the inventory, EPA should report on whether the federal government's GHG emissions trajectory is consistent with the 350 ppm prescription, or whether its emissions are exacerbating Earth's energy imbalance.

Response: These comments are noted but are out of scope of this technical review of the national GHG Inventory. As noted in response to comment #22, EPA refers commenter to review the latest national communication and the latest long-term strategy submitted to the UNFCCC. Both reports are available online at following links:

- ***Latest National Communication/Biennial Report:*** ***https://unfccc.int/sites/default/files/resource/United%20States%207th%20NC%203rd%204th%20BR%20final.pdf***

- ***The Long-Term Strategy of the United States*** ***https://unfccc.int/sites/default/files/resource/US_accessibleLTS2021.pdf***

Comment 25: Impacts on children

Climate change is *already* adversely impacting the physical and mental health of American children through, among other impacts, extreme weather events, rising temperatures and increased heat exposure, decreased air quality, altered infectious disease patterns, and food and water insecurity.[53] Children are uniquely vulnerable to climate change impacts because of their developing bodies, higher exposure to air, food, and water per unit body weight, unique behavior patterns, dependence on caregivers, political powerlessness, and longevity on the planet.[54] The protection of constitutional rights of children, by following the science, is of the utmost importance and must be incorporated in all relevant EPA decisions and programs.

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[51] James Hansen et al., *Assessing "Dangerous Climate Change*": *Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature*, 8 PLOS ONE e81648 (2013)**,** https://doi.org/10.1371/journal.pone.0081648; Karina von Schuckmann et al., *Heat Stored in the Earth System: Where Does the Energy Go?*, 12 Earth Syst. Sci. Data 2013, 2014–15 (2020), https://doi.org/10.5194/essd-12-2013-2020.

[52] *See* Our Children's Trust, *Government Climate and Energy Policies Must Target <350 ppm Atmospheric CO2 by 2100 to Protect Children and Future Generations* (Mar. 2021); Mark Z. Jacobson et al., *100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-Sector Energy Roadmaps for the 50 United States*, 8 Energy & Envtl. Sci. 2093 (2015); Ben Haley et al., Evolved Energy Research, *350 PPM Pathways for the United States* (2019), https://www.ourchildrenstrust.org/s/350-PPM-Pathways-for-the-United-States-gk6k.pdf; James H. Williams et al., *Carbon-Neutral Pathways for the United States*, 2 AGU Advances e2020AV000284 (2021); Ben Haley et al., Evolved Energy Research, *350 Pathways for Florida* (2020), https://www.ourchildrenstrust.org/s/350-PPM-Pathways-Florida-Report-pa2t.pdf; Mark Z. Jacobson, *Zero Air Pollution and Zero Carbon From All Energy Without Blackouts at Low Cost in the Whole United States* (2021), http://web.stanford.edu/group/efmh/jacobson/Articles/I/21-USStates-PDFs/21-WWS-USATotal.pdf.

[53] IPCC, *Summary for Policymakers, in* Climate Change 2022: Impacts, Adaptation and Vulnerability (2022).

[54] Samantha Ahdoot, Susan E. Pacheco & Council on Environmental Health, *Global Climate Change and Children's Health*, 136 Pediatrics e1468 (2015); Rebecca Pass Philipsborn & Kevin Chan, *Climate Change and Global Child Health*, 141 Pediatrics e20173774 (2018); Wim Thiery et al., *Intergenerational Inequities in Exposure to Climate Extremes*, 374 Science 158 (2021).

Our Children's Trust represents twenty-one youth plaintiffs, including eleven Black, Brown,and Indigenous youth, in the constitutional climate lawsuit, Juliana v. United States, in which the Administrator, in his official capacity, and EPA are defendants. This case asserts that, through the government's past and ongoing affirmative actions that cause climate change, it has violated the youngest generation's constitutional rights to life, liberty, property, and equal protection of the law, as well as failed to protect essential public trust resources. In this litigation, federal courts have affirmed "that the federal government has long promoted fossil fuel use despite knowing that it can cause catastrophic climate change"[55] and "has long understood the risks of fossil fuel use and increasing carbon dioxide emissions".[56]

Under the 5th Amendment to the U.S. Constitution, the government is restrained from engaging in conduct that infringes upon fundamental rights to life, liberty, and property, and equal protection of the law, all of which includes a climate system that sustains human life and liberty. Under the Public Trust Doctrine, embedded in our Constitution and other founding documents, and in the very sovereignty of our Nation, U.S. residents (both present and future, i.e., Posterity) have a right to access and use crucial natural resources, like air and water. The U.S. government, and its executive agencies, have fiduciary duties as trustees to manage, protect, and prevent substantial impairment to our country's vital natural resources which the government holds in trust for present and future generations.[57]

Our children and future generations are suffering injury with long-lasting and potentially irreversible consequences at present levels of heating and thus EPA must do everything in its power to facilitate greenhouse gas emissions reductions in line with best available science. Moreover, all young people seeking environmental and climate justice, especially youth from frontline and environmental justice communities that have contributed the least to emissions and have long suffered from systemic environmental racism and social and economic injustices, must not only have their voices heard, but have their rights protected.

Response: These comments are noted but are out of scope of this technical review of the national GHG Inventory.

Commenter: The Fertilizer Institute

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0016

Ed Thomas

Comment 26: Amendment to Section 5

In Section 5 (Agriculture), subsection 5.4 (Agricultural Soil Management), EPA discusses planned improvements to the National Resource Ecology Laboratory's DayCent biogeochemical model.[58] In particular, EPA discusses model development "to represent the influence of nitrification inhibitors and slow-release fertilizers (e.g., polymer-coated fertilizers) on N_2O emissions."[59] TFI supports this effort. The use of enhanced-efficiency nitrogen fertilizers reduces N_2O emissions from nitrogen-fertilized soils

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[55] *Juliana v. United States*, 947 F.3d 1159, 1169 (9th Cir. 2020).
[56] *Juliana v. United States*, 947 F.3d 1159, 1169 (9th Cir. 2020).
[57] *Juliana v. United States*, 217 F. Supp. 3d 1224, 1254 (D. Or. 2016).
[58] *Draft Inventory* at 5-45.
[59] *Id.*

and should be considered as part of EPA's efforts to improve the *Draft Inventory* data.[60] However, TFI strongly recommends that EPA use industry terms and definitions consistent with the Association of American Plant Food Control Officials vocabulary. Therefore, TFI recommends that EPA amend the sentence quoted above to be revised as: "*to represent the influence of enhanced efficiency fertilizers, which include stabilized fertilizers (e.g. nitrification inhibitors and urease inhibotors), slow-release fertilizers (e.g., methylene urea or sulfur coated urea), and controlled release fertilizers (e.g., polymer-coated fertilizers) on N_2O emissions*."

Response: EPA agrees with the suggested text edit to be consistent with industry terminology. This edit has been incorporated on page 5-46 in Chapter 5 of the national GHG Inventory report.

Comment 27: Indirect emissions associated with urea-based fertilizer applications

As part of EPA's efforts related to the DayCent model, TFI also suggests improvements for indirect emissions associated with urea-based fertilizer applications. It is TFI's understanding that the DayCent model, in addition to considering direct N_2O emissions, also contains an indirect N_2O emissions component. The indirect N_2O component evaluates urea volatilization, with the ammonia being redeposited elsewhere. This redeposited ammonia is then considered to be a source of N_2O emissions. Because urease inhibitors significantly reduce the amount of ammonia that is lost (redeposited), EPA should account for the use of urease inhibitors when it determines the indirect N_2O emissions from urea application.

Response: EPA notes that the improvement suggestion aligns with EPA's current Planned Improvements described on page 5-46 in Chapter 5 of the final Inventory report.

Commenter: INNIO Waukesha Gas Engines, Inc.

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0018

Shelia Meehan

Comment 28: Vehicle emission factors

EPA tracks US greenhouse gas (GHG) emissions and their sources through two complementary programs – the Inventory of US Greenhouse Gas Emissions and Sinks (Inventory) and the Greenhouse Gas Reporting Program (GHGRP). The EPA indicates that while the two programs cover emissions from many of the same sources, they are not identical in their coverage, category, or methodologies. GHGI data is calculated by the EPA and submitted to the UN annually in accordance with the Framework Convention on Climate Change. GHGRP data is generated through the reporting of over 8000 facilities.

Each program uses EPA emission factors as shown in comparison table, Table 1[61] below. Both GHGI and GHGRP use a single input-based emission factor to estimate methane emissions from all-natural gas combustion; neither methodology distinguishes between rich-burn and lean-burn engines. Additionally, there is no consistency between the GHGI and GHGRP emission factors—1.27 lb/MMBtu (GHGI) versus

[60] *See, e.g.*, Ram Gurung, *et al.*, *Modeling Nitrous Oxide Mitigation Potential of Enhanced Efficiency Nitrogen Fertilizers From Agricultural Systems*, 801 Science of The Total Environment 149,342 (Dec. 20, 2021), *available at* https://www.sciencedirect.com/science/article/abs/pii/S0048969721044156?via%3Dihub.

[61] Vaughn, T. L; Luck, B; Williams, L; Marchese, A; Zimmerle, D; Methane Exhaust Measurements at Gathering Compressor Stations in the United States. Environmental Science & Technology; https://dx.doi.org/10.1021/acs.est.0c05492

0.002 lb/MMBtu (GHGRP). Both the GHGRP and the GHGI methodologies are underestimating actual methane emissions from gas engines.

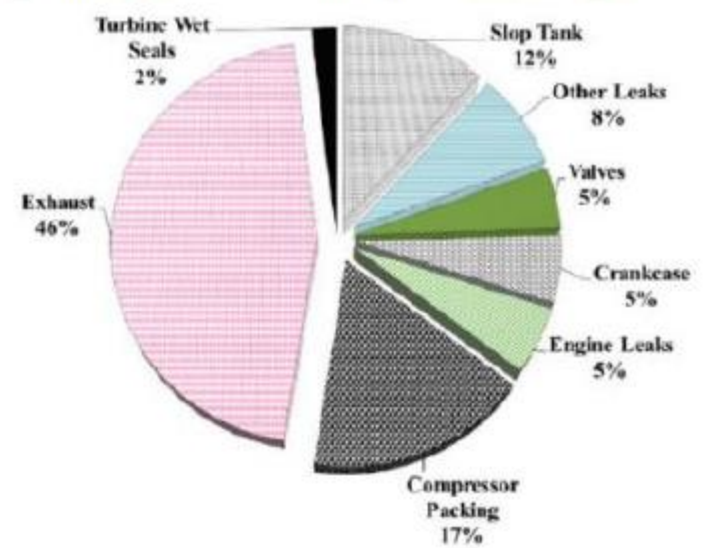
Table 1. Study-Measured and EPA Emission Factor Comparison[a]

	engines					
	2SLB	4SLB	4SRB	IGT	units	basis
study		1.15	0.10		lb/MMBtu	fuel input
AP 42	1.45	1.25	0.23	0.0086	lb/MMBtu	fuel input
GHGI[b]	1.27	1.27	1.27	0.0044	lb/MMBtu	fuel input
GHGRP	0.002	0.002	0.002	0.002	lb/MMBtu	fuel input

[a]The emission factors represent the quantity of unburned fuel emitted as CH_4 on a lb CH_4/MMBtu fuel input basis. [b]Based on underlying emission tests to exclude the effects of activity weighting, converted assuming 19.2 g/scf $CH_4 \approx$ 19.2 g/scf fuel, 1026 Btu/scf fuel, for comparison (see eq 5).

Per chart 1[62] below, methane slip from exhaust represents 46% of compressor site emissions. This data is based on research findings conducted to measure methane emissions from natural gas compressor stations and storage facilities.2 As a result, nearly half of a compressor station and or storage facility's emissions are significantly underestimated utilizing current emission factor methodologies.

Chart 1. Breakdown of Contributors to Overall Methane Emissions from All Sites Combined (without Estimates)



RIN 2060-AU35 titled Revisions and Confidentiality Determinations for Data Elements Under the Greenhouse Gas Reporting Rule was filed by the EPA on January 12, 2022 and is currently under review. According to the RIN Data Abstract, "this action would revise specific provisions in 40 CFR part 98 to improve the quality and consistency of the data collected under the rule, streamline and improve implementation, and clarify or propose minor updates to certain provisions that have been the subject of questions from reporting entities".

[62] Johnson, D.R; Covington, A.N; Clark, N.N; Methane Emissions from Leak and Loss Audits of Natural Gas Compressor Stations and Storage Facilities. Environmental Science & Technology; https://pubs.acs.org/journal/esthag

Revising methodologies for GHGI in alignment with current revisions in process for GHGRP would yield consistency across both programs and vastly improve the accuracy of methane emission estimates from natural gas fueled reciprocating engines. Inaccurate emission factors lead to misinformed equipment applications. If the goal of these programs is to accurately report and subsequently reduce emissions, emissions factors reflecting actual emissions is necessary in changing industry behavior. To ensure the highest level of accuracy, INNIO Waukesha Gas Engines, Inc. (INNIO Waukesha) recommends utilizing emission factors based on OEM specifications where available, or the use of specific AP-42 factors for rich-burn and lean-burn gas engines.

RIN 2060-AU35 will be under review until on or around April 12th and is not currently available or accessible by the public. It is the presumption of INNIO Waukesha that the revised reporting rule will include language specifying the use of OEM methane emission factors when available or a default to AP-42 factors specified for lean-burn and rich-burn engines – methodologies that will more accurately account for lean burn methane slip.

Response: The EPA continues to work through its stakeholder process to review new data from the EPA's Greenhouse Gas Reporting Program (GHGRP) and research studies to assess how emissions estimates can be improved and will assess new information on gas engines (such as any data on the national population of lean versus rich-burn engines) as it becomes available. The GHGRP is currently proposing revisions to improve the quality of the data collected and to establish or amend confidentiality determinations. For more information, please see https://www.epa.gov/ghgreporting/rulemaking-notices-ghg-reporting.

Commenter: American Petroleum Institute

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0020

Marcus Koblitz

Comment 29: Petroleum Systems

API supports the continued use of the Greenhouse Gas Reporting Program (GHGRP) submitted data to revise emission and activity factors associated with petroleum systems.

Pneumatic Controllers (PC) remain a significant source of emissions from Petroleum Systems. API appreciates the effort by EPA to update the PC data from GHGRP resubmissions, including the incorporation of updated PC counts and their assigned categories. However, the EPA does not employ updated emission factors as was recommended by API in its previous submission to the EPA of July 2nd, 2020. The dataset from the API study demonstrates that a stratified emission factor approach could be applied to intermittent PCs to account for properly functioning and malfunctioning PCs. Based on the 2022 Annex tables made available on EPA's website, the applicable emission factors have not been updated in the past five years.[63] API continues to request that EPA implement the recommended changes to the PC emission factors in order for them to be properly reflected as they flow through to the data being aggregated for use in the GHGI.

[63] EPA, "2017_ghgi_petroleum_systems_annex_tables.xlsx" Table 3.5-3. Published April 12, 2017.

Response: Data are currently unavailable to develop activity data at the national level for functioning and malfunctioning pneumatic controllers. Currently, data are only available on the total population of intermittent controllers and study results on the split between functioning and malfunctioning controllers can vary greatly.

Carbon Dioxide Transport, Injection, and Geologic Storage

API previously expressed interest in a more complete inclusion of emissions related to carbon capture, use, and storage (CCUS), as both a source and sink of greenhouse gases. We appreciate efforts taken by the EPA and this Administration to improve transparency in the estimation of greenhouse gas emissions associated with these activities and the emissions reduced through permanent geologic storage.[64] API and its members encourage EPA to conduct a more comprehensive stakeholder engagement opportunity to better collect data and feedback to support the incorporation of CCUS activity in the Inventory. CEQ's recently published guidance to facilitate CCUS included recommendations regarding the reporting of emissions related to CCUS activity, which should be reviewed by EPA.[65]

API previously published two guidance documents regarding the harmonization of the methodology for addressing GHG reductions from CCS projects. These guidelines follow the general framework adopted by the industry for GHG reduction projects, focusing on specific technical considerations while briefly addressing aspects with policy considerations.[66]

Response: The EPA reports information on Carbon Dioxide Transport, Injection, and Geological Storage in Box 3-6 of the national GHG Inventory report. The EPA continues to review new data from its GHGRP and other sources for consideration in updating emissions estimates from transport of CO_2 injection and storage. The EPA sought somment on some of the issues regarding reporting in the inventory during this past review and will continue to seek comments and will provide an update as appropriate in future submissions in recalculations and, where feasible in planned improvements.

Comment 30: Natural Gas Systems

API supports the continued use of GHGRP submitted data to revise emission and activity factors associated with natural gas systems. Additionally, API continues to support the use of PHMSA data to estimate emissions related to transmission and storage of natural gas. API supports revisions to the incorporation of Gas STAR and Methane Challenge data, specifically in the context of ensuring that inclusion of these reductions do not result in illogical negative emission estimates. Further, API supports continued management of reductions from past years if those reductions are in fact reflected by the incorporation of current, lower emission factors that reflect the permanence of efforts taken to reduce emissions under the Gas STAR and Methane Challenge programs.

Response: EPA notes API's feedback and support for the data uses and other updates.

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[64] 87 Fed. Reg. 8808
[65] 87 Fed. Reg. 8810
[66] Ritter, et al., "Harmonizing the quantification of CCS GHG emission reductions through oil and natural gas industry project guidelines." Energy Procedia, Vol. 1, Issue 1. 2009: (4451-4458). https://doi.org/10.1016/j.egypro.2009.02.261. International Petroleum Industry Environmental Conservation Association and American Petroleum Institute, "Oil and Natural Gas Industry Guidelines for Greenhouse Gas Reduction Projects, Part II: Carbon Capture and Geological Storage Emission Reduction Family," June 2007. https://www.api.org/~/media/Files/EHS/climate-change/Carbon-Capture-Geological-Storage-Emission-Reduction-Family.pdf

Comment 31: *Post-Meter Emissions*

API recognizes the need to include post-meter emissions to preserve alignment with the 2019 IPCC Guidelines.[67] API supports the approach for inclusion of post-meter emissions the EPA has taken as a distinct "Segment" of Natural Gas Systems. However, API does not support widespread application of the CH_4 emission factors from Fischer et al. (2018) due in part to the limited regional scope of that particular study.[68] API previously suggested a bifurcated approach that relies on Fischer et al. (2018) to provide an emission factor for California homes, while using the appliance focused dataset from the Merrin and Francisco (2019) study to estimate emissions for the remainder of the country. Such an approach would provide better characterization of the differences in delivery and use of natural gas in residences in different regions of the US. While the Fischer et al. (2018) factors may appear more comprehensive given the attempt to collect data on "quiescent whole-house emissions," inclusion of this specific element as a point of emphasis, or as justification for use of the Fischer et al. (2018) factor, does not appear to be appropriate. While it is possible that leaks can occur in the home beyond appliances, it is likely that anyone occupying such a home would detect any significant leak due to the odorization of natural gas in distribution systems. API encourages EPA to continue to support additional research to better characterize national residential post-meter emissions.

Response: EPA included post-meter fugitive emissions for the first time in this inventory. EPA relied on data from Fischer et al. 2018 instead of international default values available from IPCC. EPA assessed the Merrin and Francisco 2019 study noted in the comment and determined that it does not provide complete house-level emissions. For more information, please see the memo Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2020: Updates for Post-Meter Emissions, available at***https://www.epa.gov/system/files/documents/2022-04/2022_ghgi_update_-_meter.pdf.***

Comment 32: Abandoned Oil and Gas Wells

API has previously commented on estimation methodologies for emissions from abandoned oil and gas wells through the stakeholder process. API has previously stated and continues to believe that the count of abandoned wells developed by EPA is an overestimate. API contends that EPA should review and incorporate data provided by the Interstate Oil and Gas Compact Commission (IOGCC) in 2021 to establish a more accurate count of idle and orphan wells in the US.[69] Further, this resource can help to inform EPA on the regulatory structures in place to ensure proper plugging and maintenance of idle and orphan wells.

API notes that the designation of "Dry Wells" in the Enverus database indicates a production type rather than a status type. Hence, EPA's approach of considering all wells with no cumulative production as abandoned wells is likely leading to double counting of dry wells in the abandoned well category since they are embedded in the well status counts. Furthermore, EPA's assumption that dry wells are unplugged is neither consistent with the Enverus data nor State plugging requirements. Current Enverus data shows that 93% of dry holes are plugged.

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[67] IPCC, *2019 Refinement to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories*. (2019)

[68] Marc L. Fischer, Wanyu R. Chan, Woody Delp, Seongeun Jeong, Vi Rapp, Zhimin Zhu. An Estimate of Natural Gas, Methane Emissions from California Homes. Environmental Science & Technology 2018, 52 (17), 10205–10213; https://pubs.acs.org/doi/10.1021/acs.est.8b03217

[69] Interstate Oil & Gas Compact Commission, "Idle and Orphan Oil and Gas Wells: State and Provincial Regulatory Strategies," 2021. https://iogcc.ok.gov/sites/g/files/gmc836/f/documents/2022/iogcc_idle_and_orphan_wells_2021_final_web_0.pdf

Along these lines, API continues to recommend the use of the "western US" emission factor from the Townsend-Small et al. (2016) study for areas outside the Appalachian region, rather than the national average which would include the Appalachian region in the development of the emission factor.

Response: EPA has noted estimates provided by IOGCC in the text of the GHG Inventory. On the "dry wells" comment, abandoned wells are classified as dry abandoned wells if there is no cumulative production for a well, the "dry hole" Production Type in Enverus is not directly used for this step. The Well Status field in Enverus also does not have "dry well" or "dry hole" as an option, so that term is not relevant to analyses that consider the Well Status field. EPA does not assume that all dry abandoned wells are unplugged. The Well Status field is used to identify plugged versus unplugged abandoned wells and all abandoned wells are considered for this analysis (i.e., those classified as abandoned oil, abandoned gas, and abandoned dry wells) and so any wells that are classified as dry abandoned wells and that are plugged would necessarily be included in the estimate of abandoned wells that are plugged. In terms of emission factors, we expect additional data on emissions from abandoned wells to become available in the next several years and will review data as applicable for updates to our estimates.

Commenter: Xcel Energy Inc.

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0019

Frank P. Prager

Comment 33: Post Meter Emissions

Xcel Energy is an energy service holding company serving approximately 3.7 million electric customers and 2.1 million natural gas customers in eight states, including Colorado, Minnesota, Texas, New Mexico, Wisconsin, North Dakota, South Dakota, and Michigan. We are a vertically integrated electric generation, transmission, and distribution owner, as well as a natural gas local distribution company (LDC) owner with minor natural gas transmission and storage assets.

Xcel Energy was the first major U.S. energy provider to announce aggressive goals for reducing greenhouse gas emissions across three large sectors of the economy: electricity, natural gas use in buildings, and transportation. In 2018, we committed to delivering 100% carbon-free electricity to customers by 2050, with an interim goal of reducing carbon emissions 80% by 2030. In 2020, we pledged to power 1.5 million electric vehicles in our service areas by 2030. Most recently, in November of last year, our company announced a net-zero vision for natural gas by 2050, with an interim goal to reduce greenhouse gas emissions 25% by 2030. This 2030 commitment includes sourcing only certified low-methane emissions natural gas for both power generation and gas distribution and achieving net-zero methane emissions on the LDC. Taken as a whole, the scope of our net-zero vision for natural gas spans the entire supply chain from upstream production to delivery to customer meters as well as customer end use combustion. For more information, please see our report, Net-Zero Vision for Natural Gas, published in November of 2021.[70] Reducing emissions attributed to the natural gas supply chain is an important part of our clean energy vision as most Xcel Energy customers rely on natural gas for heating their homes and businesses. Natural gas is especially important in the colder climates we serve in the

[70] https://www.xcelenergy.com/staticfiles/xe-responsive/Net-Zero-Vision-for-Natural-Gas.pdf

Upper Midwest and Colorado where it remains the most affordable, dependable, and flexible home and building heating option.

We note that EPA updated its greenhouse gas inventory to include post-meter methane emissions for the first time within the Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020. Post-meter sources include leakage from piping and appliances in residential and commercial buildings, from internal piping at industrial plants and power stations, and from natural gas fueled vehicles although vehicles contribute to a much lesser extent.

For residential emissions, EPA used factors derived from a study by Fischer et al.[71] EPA acknowledges that they received comments from stakeholders expressing concern that Fischer's study of 75 California homes is not representative of national estimates of post-meter leaks. We agree with the concern that housing stock, appliance types, and appliance installation in California are not representative of national trends. EPA addresses this concern by considering similar studies but notes that these studies are insufficient in their coverage of appliance. Given the lack of studies on post-meter leakage and the geographic limitations of Fischer, EPA should delay inclusion of post-meter leakage until a broader study can be conducted in a range of U.S. climate zones.

For commercial, industrial, and vehicle post-meter emissions, EPA used default factors from the IPCC 2019 Refinement to the 2006 IPCC Guidelines.[72] The factor for leakage in the commercial sector is sourced from 2006 IPCC Guidelines[73] where it is indicted factors provided for gas end use on a per appliance basis were adapted from unpublished work 'based on data for a dozen countries including Russia and Algeria'. This data from other countries is 15 years old and does not reflect appliances in the US. Similarly, the leakage factor for industrial and power plants in the IPCC 2019 Refinement was sourced from 1996 Guidelines[74] which provides regional factors on a per gas consumed basis. However, data for the US, Canada, and Western Europe, which would be most representative for EPA's use, are not included and sources are more than 25 years old. While we are not aware of any current data sources for post-meter methane leakage at industrial and power plants in the US, the 1996 IPCC data is not representative.

The inaccuracy introduced by using these unrepresentative emissions factors is apparent when reviewing EPA's calculated emissions data in *Table 3-69: CH4 Emissions from Natural Gas Systems (kt)* of the draft inventory[75] which shows post meter methane leakage is nearly equivalent to methane leakage from the entire gas distribution system in the US. This is not a logical outcome when considering the differences between the length, size, and pressure of the distribution piping systems and customer piping systems. To examine this assertion, consider a hypothetical case with a conservative estimate of 80 feet of post meter piping per customer. By comparison, Xcel Energy's distribution system is at least double the size of the customer system by total miles of pipe. Additionally, the most common delivery pressure for residential customers, which make up approximately 90% of total customers, is 0.22 psig reduced from a typical distribution system

[71] https://pubs.acs.org/doi/10.1021/acs.est.8b03217
[72] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/2_Volume2/19R_V2_4_Ch04_Fugitive_Emissions.pdf
[73] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_4_Ch4_Fugitive_Emissions.pdf
[74] https://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref8.pdf
[75] Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020 – Main Text (epa.gov) Table 3-69 shows post meter sources contribute 459 kt of methane while the gas distribution system contributes 555 kt.

Response: Default emission factors became available to quantify emissions for this source in the 2019 Refinement to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC 2019 refinements). EPA reviewed available data and for residential appliance fugitive emissions relied on data from Fischer et al. 2018 instead of international default values available from IPCC. For more information, please see the memo Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2020: Updates for Post-Meter Emissions, available athttps://www.epa.gov/system/files/documents/2022-04/2022_ghgi_update_-_meter.pdf. EPA will continue to review data as it becomes available for potential updates to its post-meter estimates.

Commenter: National Family Farm Coalition

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0021

Antonio Tovar PhD

Comment 34: Report as actual emissions

The National Family Farm Coalition (NFFC) support Earthjustice, Friends of the Earth, and Our Children's Trust recommendations to: (1) prioritize efforts to validate and refine models for estimating methane and nitrous oxide from agriculture, (2) validate existing models with a growing body of evidence from direct measurements indicating actual methane emissions are significantly higher than model predictions, (3) include, in parallel with its current reporting, greenhouse gas emissions calculated according to 20-year global warming potentials, (4) expand its agricultural economic sector emissions estimate to include a more complete accounting of emissions related to agriculture, including emissions from the manufacture of fertilizer and other agricultural inputs, land use and the carbon opportunity cost of agricultural land use, 5) break down emissions by state comparable to the methodology employed by the U.S. Energy Information Administration, 6) include black carbon from fossil-fuel soot as a particulate-component of greenhouse gas emissions and measure its emission for each state, 7) document tropospheric ozone emissions, and 8) as part of its inventory, EPA should report on whether the federal government is complying with its own commitments to reduce GHG emissions through either international agreements or domestic policy.

The National Family Farm Coalition (NFFC) is an alliance of grassroots food producers- and advocate-led groups across 42 states, representing the rights and interests of independent family farmers, ranchers, and fisherfolk in Washington, DC. NFFC’s 32 state, national, and regional farm and rural organizations are bound by a common belief that communities have the right to determine how their food is grown and harvested; that everyone in the food system should receive fair prices or wages; that all producers have equitable access to credit, land, seeds, water, markets, and other resources; and, that our food and agriculture policies must support sustainable farming, ranching, and fishing practices.

Once again thank you for the opportunity and if you have any question regarding this comments please feel free to contact me

Response: See responses to Comments # 2, 3, 4, and 5.

Commenter: The National Association of Clean Water Agencies

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-00XX

Cynthia A. Finley, PhD.

Comment 35: Wastewater Treatment Emissions Estimates

The National Association of Clean Water Agencies (NACWA) appreciates this opportunity to comment on the U.S. Environmental Protection Agency's (EPA) draft *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020* (*Inventory*), and specifically Section 7.2, *Wastewater Treatment and Discharge (CRF Source Category 5D)*, as part of the public review process.

NACWA represents the interests of over 330 publicly owned wastewater treatment agencies nationwide, serving the majority of the sewered population in the US. NACWA members want to ensure that greenhouse gas (GHG) emissions from wastewater treatment facilities are characterized correctly in the *Inventory*, since the *Inventory* is a frequently cited reference for GHG information. The wastewater treatment category includes publicly owned treatment works (POTWs), septic systems and industrial wastewater treatment systems. NACWA's review focused on emissions from POTWs.

NACWA has submitted comments on the wastewater treatment section since the 2005 *Inventory*, and we appreciate the clarifications that EPA has made over the years for the emissions calculations and the factors that are used in the calculations. Since EPA uses guidelines published by the Intergovernmental Panel on Climate Change (IPCC) to calculate emissions for the *Inventory*, the basis of EPA's estimates did not change between the 2005 and 2018 *Inventories*. However, with the publication of the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* (*IPCC Refinements*), EPA's calculations changed in the 2019 *Inventory*. NACWA provided detailed comments about the calculation changes last year.

NACWA agrees with the Planned Improvements described in the *Inventory*, many of which the Association has recommended in past comments. To reflect US GHG emissions from POTWs more accurately, NACWA recommends that development of US- and treatment-specific methodologies and emission factors be prioritized, particularly for nitrous oxide. Previous IPCC guidance used different emissions factors depending on whether plants use N/DN processes, with lower emissions resulting from plants without N/DN. If the IPCC calculations for nitrous oxide are not updated, EPA should use US-specific factors to account for the presence or absence of N/DN processes at different treatment plants.

Actual nitrous oxide emissions are process-specific, with factors such as consistency of dissolved oxygen levels, system upsets, and supplemental carbon addition sources potentially playing a large role in the quantity of nitrous oxide formed. Further refinements are needed with respect to treatment process type to reflect actual conditions.

Response: As stated by the commenter, there are many factors affecting nitrous oxide emissions from wastewater treatment systems such as the temperature and dissolved oxygen concentration of the wastewater, and the specific operational conditions. EPA agrees that development of more specific emission factors based on type of system would be an improvement and will continue to evaluate available data. EPA is unlikely to develop emission factors that vary based on specific operating 21 parameters at the more than 16,000 centralized treatment plants in the U.S. as we lack activity data to appropriately use such factors. See also response to comment 56 on pp. 20-21. https://www.epa.gov/system/files/documents/2021-07/us-ghg-inventory-1990-2019-expert-review-comment-log.pdf.

NACWA also recommends that EPA focus on where wastewater discharges occur in the aquatic environment and how this affects GHG emissions. The current emissions factors apply to "estuaries," but further details describe "slow moving" aquatic systems. A large portion of wastewater discharges go to aquatic systems that are not “slow moving,” since discharge points for POTWs are usually selected to meet water quality objectives and to target dilution and movement of the receiving water – conditions that are not conducive for producing GHG emissions. A better understanding of how emissions depend on the discharge points would produce more accurate emissions estimates.

NACWA looks forward to reviewing EPA’s analysis of additional information sources that are outlined in the Planned Improvements, such as the North East Biosolids & Residuals Association (NEBRA) biosolids data and the ICIS-NPDES BOD and N effluent discharge data. In addition, the continued success of water conservation efforts in many parts of the US means that the standard 100 gallons/capita/day wastewater generation factor should be updated in the *Inventory* as soon as possible.

Thank you for your consideration of these comments. Please contact me at 202-533-1836 or *cfinley@nacwa.org* if you have any questions.

Response: EPA notes the commenter reiterates requests to consider emissions associated with discharge to the aquatic environment. For nitrous oxide emissions, the IPCC Tier 3 emission factor is applied to discharges to waterbodies that are impacted for nutrients. The IPCC Tier 1 emission factor is applied to all other wastewater discharges. For methane emissions, the two IPCC Tier 2 emission factors are used for discharges to reservoirs, lakes, and estuaries (0.114 kg CH_4/kg BOD) and all other discharges (0.021 kg CH_4/kg BOD). EPA acknowledges that the approach used to determine the approximate percent of waterbodies that are reservoirs, lakes, or estuaries was a high-level investigation and based on limited data and data sources. If the commenter is aware of a source that provides a quantitative estimation of POTW wastewater effluent discharged to the various waterbody types to provide context to a “large portion of wastewater” discharged to “not slow moving” aquatic system, EPA encourages the commenter to provide that source to further improve methane emissions estimates. See also response to comment #57 on p. 21 in response to previous comments: https://www.epa.gov/system/files/documents/2021-07/us-ghg-inventory-1990-2019-expert-review-comment-log.pdf.

Commenter: American Gas Association

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-00XX

Pamela A. Lacey

Comment 36: AGA Supports Gas STAR & Methane Challenge Adjustments

EPA’s Draft 2022 GHGI includes changes to reflect methane reductions achieved under the voluntary Natural Gas STAR and Methane Challenge programs. AGA does supports these changes.

Response: EPA acknowledges AGA’s comment.

Comment 37: AGA Recommends Postponing EPA’s Addition of Estimated Post-Meter Emissions Until Further Data and Analysis Can Be Developed and Applied

As proposed in EPA’s September 2021 Memorandum on GHGI “Updates Under Consideration for Post-Meter Emissions” (Post-Meter Memo), EPA has added estimates of post-meter residential, commercial, and industrial customer methane emissions as well as certain natural gas vehicle emissions to the Draft 2022 GHGI. EPA explains it is making this change from previous annual US. GHGIs in response to a recommendation in the 2019 Refinement to the 2006 Intergovernmental Panel on Climate Change

(IPCC) Guidelines for National Greenhouse Gas Inventories for natural gas systems (IPCC 2019). As we commented on October 29, 2021 on the proposal in EPA's Post-Meter Memo, AGA continues to recommend postponing the addition of post-meter emissions to the 2022 GHGI. The available studies reveal a fat tail distribution suggesting a small number of sources contribute a disproportionate amount of total emissions. However, the studies do not have a sufficiently large or representative data sample to provide reliable national emissions estimates. Current data is insufficient to represent U.S.-wide average methane emissions per natural gas house due to the small sample size, limited housing demographics, and importantly, a lack of data on seasonal variability.

AGA does support grouping such emissions estimates in a category for "other" emissions sources, as EPA has done in the Draft 2022 GHGI, but at a later time when more reliable data is available. It would not be appropriate to include these post-meter sources in the distribution segment because natural gas distribution ends at the customer meter. In addition, not all industrial and commercial customers are served by distribution lines.

Response: Default emission factors became available to quantify emissions for this source in the 2019 Refinement to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC 2019 refinements). EPA reviewed available data and for residential appliance fugitive emissions relied on data from Fischer et al. 2018 instead of international default values available from IPCC. For more information, please see the memo Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2020: Updates for Post-Meter Emissions, available athttps://www.epa.gov/system/files/documents/2022-04/2022_ghgi_update_-_meter.pdf. EPA will continue to review data as it becomes available for potential updates to its post-meter estimates.

Comment 38: AGA also recommends using PHMSA's public data for midstream activity rather than a proprietary data base

There are significant problems with EPA's proposal in the Draft 2022 GHGI to use a proprietary data (from Enverus) instead of PHMSA public date for midstream activity factors, including for counts of compressor stations and for miles of interstate and gas utility-operated intrastate transmission pipeline miles and numbers of compressor stations. Because it is a private, proprietary data base, there is a lack of transparency regarding how the activity counts were derived.

Response: EPA will continue to use the current approach for midstream data and will use the Enverus data set for QA/QC.

In our detailed comments, we will focus on EPA's Draft 2022 GHGI proposal for residential post-meter emissions.

I. Data Gaps, Small Sample Size, Orders of Magnitude Differences and Uncertainties Should Preclude Adding Residential Post-Meter Emissions Estimates to the GHGI Pending Further Research

In the Post-Meter Memo, EPA based its proposed emissions estimate for residential post-meter emissions on the 2.54 kg per natural gas house emission factor developed by the California Air

Resources Board (CARB) based on a 2018 study of 75 homes in California (Fischer et al.).[76] EPA is proposing not to use the IPCC's emission factor as it is based on European appliances and homes rather than U.S. homes and gas appliances. AGA agrees with that decision. However, we question the use of a study of only a limited number of California homes to represent the experience of homes across

the country in vastly different climates and with presumably different building Code requirements. Other studies EPA considered provide widely varying estimates and only serve to illuminate the range of data gaps and uncertainties.

In response to comments from AGA and other stakeholders that the Fischer et al. study conducted in California is not representative of national activity, EPA explains in the 2022 Draft GHGI that the agency reviewed other residential post-meter studies, including the Merrin and Francisco (2019) study conducted in Boston and Indianapolis. The agency note that whereas the Fischer et al. study covered emissions from passive house leaks and major and minor gas appliances, the other studies covered only emissions from major appliances.[77]

This leaves us puzzled regarding the source of the revised residential post-meter emissions estimate in Table 1 of the 2022 Draft GHGI of 2.27 kg methane per natural gas house (2.27 kg CH4/NG house) as compared to the Post-Meter Memo's estimate of 2.54 kg/NG house. EPA also analyzed a newer 2022 study by Lebel et al. (2022 Lebel Study)[78] in the 2022 Draft GHGI that was not evaluated in the Post-Meter Memo, but we are unsure as to how EPA used this study in calculating the revised estimate. The methodology is not explained. EPA has noted in section 3.6 of the Draft Annexes to the 2022 Draft GHGI that EPA plans to update its methodology for the final GHGI, but the agency has not offered an explanation for comment. AGA supports a lower estimate, though we believe this may still be overstated. In any event, EPA needs to explain the basis of the estimate more transparently.

Based on the analysis below of the five residential papers EPA considered (four evaluated in the 2021 Post-Meter Memo plus the 2022 Lebel et al. study evaluated in the 2022 Draft GHGI), AGA urges EPA to postpone adding an estimate of residential post-meter emissions to the GHGI until data gaps and uncertainties we outline below can be more reliably addressed.

1. **There are no consensus standard test methods or standard practices** for measuring and determining the flow rate or volume of methane emissions from end-use natural gas appliances. Differences in the types of measurement equipment used, performance-related attributes of the equipment, and standardization of the measurement protocols themselves should be addressed first before utilizing any individual study on these types of methane emissions. The standards development for testing protocols would be time-intensive work but essential to establish the credibility for estimating post-meter methane emissions.
2. **The use of a limited set of studies conducted on a small sample of homes is unlikely to be representative of a national U.S. estimate**.
3. **There are considerable data gaps, large uncertainties, and orders of magnitude difference**

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[76] See Post-Meter Memo page 10, section 6 "Preliminary National Emissions Estimates" and page 2 citing Marc L. Fischer et al, "An Estimate of Natural Gas Methane Emissions from California homes," 52 Environmental Science & Technology 2018 (17) 10205-10213 (2022) DOI: 10.1021/acs.est.8b0317.
2539, DOI: 10.1021/acs.est.1c04707.
[77] 2022 Draft GHGI, p. 105.
[78] Methane and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes. Eric D. Lebel, Colin J. Finnegan, Zutao Ouyang, and Robert B. Jackson. Environmental Science & Technology 2022 56 (4), 2529-2539.DOI: 10.1021/acs.est.1c04707 ("Lebel 2022") p. 2529.

among the available studies that EPA reviewed for these methane emissions estimates.

4. **There were no repeated tests to determine the reproducibility of the methods referenced or to determine whether emissions vary with time or environmental conditions such as seasonal temperature and weather changes.**

1990-2020 Time Series Should Reflect Phase Out of Pilot Light Appliances: To the extent these studies indicated higher emissions for gas appliances with pilot lights, any inclusion of an estimate of post meter emissions should reflect the fact that pilot lights have been largely phased out in gas appliances manufactured in the U.S. over the past 10 to 30 years, due to DOE's appliance energy efficiency standards under 10 C.F.R. Part 430.

II. Analysis of Residential Studies EPA Considered Demonstrates the Need for Further Research with More Robust, Representative

1. Analysis of 2022 Lebel Study

In Table 2 of the 2022 Draft GHGI, EPA provides the results of Lebel 2022, a study published in 2022 after publication of the September 2021 Post-Meter Memo. That study estimated methane emissions of 0.65 kg per natural gas appliance. During the Lebel 2022 study period (January 2020 – May 2021), methane emissions were measured from natural gas stoves in 53 homes in 7 California counties. The study focused on natural gas stoves and did not attempt to measure total methane emissions from households. Methane emissions were measured during all phases of stove use: steady-state-off (appliance not in use), steady-state-on (during combustion), and transitory periods of ignition and extinguishment. Measurement was conducted for each stove by creating and airtight static flux chamber using plastic sheets encapsulating the stove within each kitchen. The methods differed from both the previous Lebel 2020 study of hot water heaters and the Fischer et al. study of whole house emissions.

Lebel 2022 estimated 28.1 gigagrams of methane emissions per year (Gg/year) from natural gas stoves in the U.S. The total number of U.S. appliances, 43.4 million appliances (standard deviation: 1.3 million), was assumed to be the total number of stoves and any secondary cooktops nationally. Table 2 of the 2022 Draft GHGI provides a derivation of the Lebel 2022 results in terms of kg/appliances based on the study's estimate of total U.S. methane emissions (28.1 Gg/year) and the total population of appliances (43.4 million), resulting in an estimated methane emission factor of 0.65 kg/appliance.

The authors of the study noted that their results were long-tail skewed, where for example "the top *5 stoves* (9% of sampled units) emitting half (49%) of all steady-state -off emissions."[79] Given this long-tail skew, there is clearly a need to collect data from more than 53 homes in only one state to reduce uncertainties and develop a reliable estimate. The authors also did not explain the methodology for selecting the houses they investigated, which further draws into question whether this small sample is representative of appliances nationwide. Further, measurements from only 5 stoves should not drive what is likely to be an inflated emission factor for all stoves across the country.

Neither the article nor the Supplemental Information (SI) isolate the methane leakage to the appliance. The authors could not confirm where the leak came from. For instance, in a follow-up interview with NPR, one of the study authors observed that a readily available solution is to "Pull the stove out from the wall and tighten the connectors to the stove and to the nearby pipes". No such action of course should be undertaken by untrained i ndividuals, for safety reasons. If fittings were suspected of leaking,

[79] Leber 2022, p. 2534 (emphasis added).

the cause could have been identified by isolating the range from the gas pipe supply at the rear of the appliance and repeating the leakage measurements. Since the appliance was not isolated from the gas supply as part of this investigation, the specific source for the leaks cannot be identified.

The tests were performed on gas-leaking appliances or where gas leaks existed in the home gas piping, or at the connection of these two; making it impossible to determine which component contributed. With so many ignitor issues, it is an indication that appliances were in disrepair and were not maintained in accordance with manufacturers' recommendations – that typically call for annual servicing. When a correctly functioning gas appliance is properly installed and maintained, there would not be any gas leaks. All certified gas ranges are tested for leaks [with the Manufacturing and Productions Tests required by Section 6 of the ANSI Z21.1 · CSA 1.1 Standard, where subsections 6.1 b) and c)], and common multiple leak points are evaluated during the factory. Further, with a properly functioning gas appliance, the gas being supplied to the burner, including the raw gas being released during the 4 seconds safety standards allowance during ignition, will burn during the combustion process rather than be emitted. Minor residual gas slip is already accounted for in the GHGI.

The authors noted other "study limitations and recommendations for future directions." Because of sampling limitations from COVID-19, the authors noted they "were limited in where and how" they could sample homes and could not include a representative selection of low-income, multifamily homes. AGA would posit that they also did not have a sufficiently large or representative sample of single family homes. More comprehensive data on appliance usage and activity also should be collected to help scale the number of on/off pulses per day and average consumption periods. Due to the limited sample size, narrow demographics of stoves studied, lack of appliance usage data, lack of seasonal data and absence of data from any state other than California, the results of the study may not represent U.S.-wide emission profiles.

2. Analysis of Fischer Study of California-Only Homes, Using a Blower

The Fischer et al. paper[80] describes measured methane emission rates for whole-houses in California (with no gas appliances in operation) along with a subset of specific gas appliance methane emission rates. The study included measurements for 75 houses in California using a novel way to measure whole-house emissions using a blower door to draw air through the house along with a sensitive Los Gatos methane analyzer to measure methane concentrations indoors and outdoors and a sophisticated statistical treatment of the results to extrapolate the data to all of California. Controlled methane releases in each house were used to verify the method. The overall accuracy of the whole house measurements was not stated. However, there were no repeated tests on the same house at different times to determine the reproducibility of the method or to see if emissions vary with time or environmental conditions. The tests were conducted on a variety of house types and ages and appear to be reasonably representative of California housing stocks, but not housing in other parts of the country. No tests were conducted on apartments, although the extrapolation assumed that the single-family house results were also representative of multi-family structures. This assumption should be addressed in future studies. There was also no mention of houses with attached garages, although it can be assumed that many or most of the houses had attached garages. In some houses, it is possible that the gas furnace and water heater are located in an attached garage, but it isn't clear how the blower door tests were applied for these cases or whether this raises issues with how well the method works for

[80] *An Estimate of Natural Gas Methane Emissions from California Homes*, Marc L. Fischer, Wanyu R. Chan, Woody Delp, Seongeun Jeong, Vi Rapp, and Zhimin Zhu, Environmental Science & Technology 2018 52 (17), 10205-10213 DOI: 10.1021/acs.est.8b03217.

houses with attached garages. Finally, all of the houses were sampled in California, so there are uncertainties about how California houses compare to houses in other parts of the US, where building codes and practices might be quite different.

The test results showed a fat-tail distribution of measured emission rates with only a small number of high emission rate points. There appeared to be six points with whole house emissions greater than 15 scfm. The range of emissions was from near zero to a maximum rate near 35 scfm. This maximum rate is approximately 0.024 g/min.

Another important aspect of the results was that only a very small number of leaks were identified in only a few houses. Since appliances were not running during the whole house tests, this suggests that either pilot lights were the major source or that undetected leaks were a significant factor. Since natural gas is odorized in city distribution systems, it seems likely that homeowners would detect any significant pipe leaks and have those fixed immediately. In terms of the overall whole house emissions, pilot lights were estimated to account for only 25% of the total. However, the study made no attempt to reconcile the fact that very few leaks were detected, but leaks must account for 75% of whole house emissions. This is a significant weakness and efforts are needed to account for all sources in whole house emission measurements. There may also be issues associated with the effects of the negative pressure imposed by the blower door on pilot light or leak emissions. In other words, the blower used in the study may have blown the pilot out and caused the emissions.

The paper describes a sophisticated statistical treatment where a gamma function was fit to the data to account for the skewed distribution of measured rates and a Monte Carlo re-sampling method was used to estimate 5% and 95% confidence limits and “central” (mean?) values. As shown in Figure S5, for the whole house fit of the gamma function to the data, it appears that the higher emission rates lie above the best-fit line such that there might be a point where one gamma distribution fits the lower rates and a second-best fit with a great slope fits the higher rates. This seems to suggest that the higher emission rates were over-estimated using the gamma function to represent the leak rate distribution. Further work is needed to reduce the uncertainty in the higher end of the leak rate distribution. More measurements from more houses in areas across the U.S. would be required.

The Fischer et al. paper also describes results for single appliance emission rate measurements. These were derived from measuring the CH4 to CO2 ratio (with background levels subtracted) and by tracking natural gas consumption during each appliance test. The accuracy in this method was estimated to be ±11%, as noted in the Supplemental Information (SI). This is a reasonable approach and appears to be relatively accurate. A large number of water tank heaters (62) and stovetops (54) were measured, but only a few (2 to 6) of other appliances (dryer, furnace, tankless water heaters) were measured. Since there are about four natural gas appliances per house, more measurements of these other appliances are needed for a complete picture of appliance emissions. The measurements were focused on steady-state operations and, except for three tankless water heaters, the transient emissions from start-up and stop were not captured.

Overall, this research provides a valuable database of whole house and appliance methane emission rates. However, future work should address sampling across the U.S., and an effort to better represent the high end of the emission rate distribution is needed. For whole-house emissions, future work should also attempt to identify all sources in the house and reconcile the bottom-up contribution of leaks and pilot lights versus top-down whole-house emissions. More appliance measurements are needed beyond the stovetop and water tank heaters tested in this study.

3. Analysis of Merrin and Francisco 2019 Study in Boston and Indianapolis[81]

The Merrin and Francisco paper reports measurements of methane emission time series and totals for a variety of natural gas appliances. Approximately 100 different appliances were measured in homes in Boston, Indianapolis, and nearby locations. The results were used first to characterize the ignition, steady-state, and extinguishment phases of appliance operations. Then the data were extrapolated to estimate US total methane emissions by appliance type.

The primary value of this work is the characterization of appliance operation emission patterns (Figure 4) which shows spikes in emission during ignition and extinguishment and relatively constant emissions during steady-state operations. The authors provide box plots of the distribution of emission rates by appliance at steady-state (Figure 5) and also for the spike events (Figure 6). The box plots extend over an order of magnitude in most cases. These results are useful for understanding how emissions are similar or different for different types of appliances. Stove burners and tankless water heaters had the highest steady-state emissions per mass of natural gas consumed, while furnaces, boilers and water tank heaters were an order of magnitude less. However, when extrapolated nationwide, furnaces accounted for 39% of total appliance annual emissions and ovens contributed 17%. Other appliances were in the range 8% to 14% of the total U.S. estimate.

These measurements were collected by measuring exhaust gas methane concentrations with a Picarro analyzer, calculating the total exhaust gas flow rate based on combustion stoichiometry and measured CO2 exhaust gas concentrations, and estimating natural gas consumption rates based on appliance energy ratings.

There are serious issues with each of these steps. First, there were gaps in peak concentration measurements when the levels exceeded the instrument range. These were addressed by linear extrapolation from the within-range concentrations. This applied to some of the spike events for some appliances. Second, it isn't clear how accurate the exhaust gas flow rates were since they were not directly measured, and there was no attempt made to confirm the calculations with any specific measurement tests. Third, the natural gas consumption was estimated from the appliance rating, and no attempt was made to use the house gas meter to measure the gas consumption while the appliance was operated (as Fischer et al did in the whole house and appliance study). The authors noted that because of these uncertainties, the results were at best an order of magnitude estimate of emission rates for individual appliances. It should be noted that the steady-state results were 15 times (water heaters) and 3 times (stove top) smaller than the corresponding appliance measurements from Fischer et al. This may give some indication of the level of error in the results. Given this large degree of uncertainty, the extrapolated U.S. totals can only be considered as very preliminary estimates.

The distribution of measured emissions exhibited a skewed, fat-tail distribution for all appliances, and the authors assumed a log-normal distribution to estimate confidence limits. There were factors of two to three in the estimated confidence limits about the mean.[82]

Overall, this work is valuable for the characterization of appliance emission patterns and for comparing these patterns among different appliances. Because of the methods, confidence in the quantitative

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[81] *Unburned Methane Emissions from Residential Natural Gas Appliances*, Zachary Merrin and Paul W. Francisco, *Environmental Science & Technology* 2019 *53* (9), 5473-5482, .DOI: 0.1021/acs.est.8b05323.

[82] The authors provided graphs of the distribution in the Supplemental Information.

emission totals is low. These are difficult and time-consuming measurements to make, but more work is needed to reduce the measurement uncertainties and improve confidence in the extrapolated results.

4. Analysis of Lebel et al., 2020 Study of Natural Gas Water Heaters[83]

This paper describes a relatively comprehensive assessment of methane emissions from storage hot water heaters and tankless hot water heaters. This includes documentation of the emission data base as well extrapolation of these results to the US housing stock. Emission measurements, including spikes due to on/off events and steady state conditions, are reported for 35 California homes and water tank usage data are reported for 46 homes. The usage data were used as part of the extrapolation process for total US emissions.

The measurement approach and efforts to provide quality assurance of the methods were quite good. A custom-built high flow sampling system was used to capture all of the appliance exhaust. The total air flow rate was directly measured, and the dilution associated with the high flow reduced the exhaust concentrations of CH4 and CO2 to ranges suitable for measurement with a Picarro gas analyzer. Tests of the system with controlled CH4 releases showed a small bias of ~10% which was used to correct the measured emission rates. Although not stated, it appears the accuracy in the emission rate measurements were of order ±20%. Natural gas consumption was estimated from the CO2 levels in the exhaust flow and validated with readings from the residential gas meter. Overall, the approach used here and the associated quality assurance tests appear to provide emission data with a relatively high degree of accuracy compared to the methods used by Merrin and Francisco (2019) as noted above. The authors provide a quantitative comparison between the two studies in Table S7. However, the results do not exhibit a consistent positive or negative bias between the two studies for the different operation phases. This probably reflects differences in methods as well as differences in the population of hot water heaters sampled.

Emissions were measured for steady state off, the on pulse, steady state on, and the off pulse periods (see Figure 1). It should be noted that there were emissions due to pilot light incomplete combustion in the steady state off condition. In fact, for storage hot water heaters, the steady state off condition represented 96% of the total emissions. For each operation phase, there was a skewed distribution of emission rates as shown in Figures 2 and 4. During the off phase, storage tank heaters had much higher emissions than tankless heaters due to the pilot light, but for the pulse on/off and steady on phases, the tankless heaters had much higher emissions. On a per heater basis for the combined phases, the tankless heaters had emissions twice as high as the storage tank heaters. The emissions data were bootstrapped to provide estimates of the mean and confidence levels. When these individual emission rates were combined with usage data for both types of water heaters, the tankless heaters emitted at 0.93% of NG consumed while storage heaters emitted at 0.39% of NG consumed. However, because the tankless heaters are relatively new, these represent only 2% of all US heaters.

Overall, this study provides a good initial database for emissions from both storage and tankless water heaters as well as new data on the duty cycles of hot water usage in a number of homes. However, additional measurements in other locations are needed to address any regional differences and to improve estimates of the fat-tail portion of the emission rate distribution. There is also a need to obtain additional usage data for other locations to improve the activity factors used in a US inventory.

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[83] *Quantifying Methane Emissions from Natural Gas Water Heaters*, Eric D. Lebel, Harmony S. Lu, Simone A. Speizer, Colin J. Finnegan, and Robert B. Jackson, *Environmental Science & Technology* 2020 *54* (9), 5737-5745, DOI: 0.1021/acs.est.9b07189.

5. **Analysis of Saint-Vincent and Pekney, 2020 Literature Review**[84]

This is primarily a broad review paper of methane emissions from previous studies of natural gas sectors, with an emphasis on the distribution system (Section 3) and post-meter emissions (Section 4). There are no new emissions data provided in this paper.

It may be noted that considering only combustion efficiency of residential furnaces in the range of 50% (older units) to 95% (new units) along with the number of natural gas furnaces in the US yields methane emissions that are an extremely small percentage (<0.0005%) of the US annual methane budget.

The most useful portion of this paper is summarized in Table 5 where the authors compare annual budgets of residential CH4 emissions using the results from Fischer et al. (2019) and Merrin and Francisco (2020). For major appliances, the total CH4 annual rate is 30 Gg/yr from Merrin and Francisco, including all phases of operation of appliances, and 45 Gg/yr from Fischer et al. for only steady state appliance emissions. In comparison, Lebel et al. (2020) estimated 82 Gg/yr for only hot water heaters and, based on Fischer et al., the estimate for whole-house plus appliance emissions is 165 Gg/yr. These comparisons, while rough and somewhat indirect, provide some measure of the uncertainties that exist for residential post-meter emissions.

It is clear that much more work is needed to improve methodologies, to acquire better activity data, to investigate similarities and differences on a regional basis and to account with better accuracy the fat-tail distributions of emissions that are typical of all of these sources.

Response: Default emission factors became available to quantify emissions for this source in the 2019 Refinement to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC 2019 refinements). EPA reviewed available data and for residential appliance fugitive emissions relied on data from Fischer et al. 2018 instead of international default values available from IPCC. For more information, please see the memo Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2020: Updates for Post-Meter Emissions, available athttps://www.epa.gov/system/files/documents/2022-04/2022_ghgi_update_-_meter.pdf. EPA will continue to review data as it becomes available for potential updates to its post-meter estimates. EPA notes that due to timing of its publication, EPA did not review the Lebel 2022 study in the development of this inventory.

Commenter: Private Citizen

EPA Docket ID No.: EPA-HQ-OAR-2021-0001-0004

Brad Johnson

Comment 39: Methane Emissions

There is a growing body of scientific evidence that the EPA inventory of energy-sector methane emissions is a severe undercounting. Most recently, the International Energy Agency released the results of their Global Methane Tracker project on February 23, 2022, which reconciles the EPA methodology with satellite data and scientifically backed estimates for incomplete flaring, downstream fugitive emissions, and the like. The Global Methane Tracker finds that EPA is underestimating energy-sector methane pollution by 77 percent. This needs to be resolved.

[84] *Beyond-the-Meter: Unaccounted Sources of Methane Emissions in the Natural Gas Distribution Sector*, Patricia M. B. Saint-Vincent and Natalie J. Pekney, *Environmental Science & Technology* 2020 *54* (1), 39-49, DOI: 10.1021/acs.est.9b04657

Report:

https://www.iea.org/reports/global-methane-tracker-2022

Documentation:

https://iea.blob.core.windows.net/assets/b5f6bb13-76ce-48ea-8fdb-3d4f8b58c838/GlobalMethaneTracker_documentation.pdf

Response: Given the variability of practices and technologies across oil and gas systems and the occurrence of episodic events, it is possible that the EPA's estimates do not include all methane emissions from abnormal events. For many equipment types and activities, the EPA's emission estimates include the full range of conditions, including "super-emitters." For other situations, where data are available, emissions estimates for abnormal events are calculated separately and included in the GHG Inventory (e.g. Aliso Canyon leak event). The EPA continues to work through its stakeholder process to review new data from the EPA's Greenhouse Gas Reporting Program (GHGRP) and research studies to assess how emissions estimates can be improved. EPA notes that end use fugitive emissions have been included for the first time in this Inventory report.

EPA continues to track technologies and programs that monitor methane and consider how information from such approaches can be used to update the GHG Inventory. The 2019 Refinement to the 2006 IPCC Guidelines discusses atmospheric observations under "Quality Assurance, Quality Control, and Verification." The Refinement provides a discussion on available technologies and provides examples and approaches for use of satellite data to improve GHG inventories. It describes components needed to compare inventories with atmospheric measurement, which include measurements of atmospheric gas concentrations, inverse modeling tools, gridded inventory, and collaboration. It also describes procedures for using comparisons to inform GHG Inventories, including steps to take when there are discrepancies.

Comment 40: Methane Global Warming Potential

The EPA should be using the 20-year Global Warming Potential for methane, not the 100-year standard. A good discussion of the importance of why it is more accurate for global warming pollution considerations and the U.S. responsibilities under the Paris Agreement to use the shorter timespan can be found in:

* Rogelj, J., Schaeffer, M., Meinshausen, M., Shindell, D., Hare, W., Klimont, Z., Velders, G. J. M., Amann, M. and Schellnhuber, H.J. (2014). "Disentangling the effects of CO2 and short-lived climate forcer mitigation." Proceedings of the National Academy of Sciences 111 (46): 16325– 16330, doi: 10.1073/pnas.1415631111. https://www.pnas.org/doi/10.1073/pnas.1415631111

* Michelle Cain, Stuart Jenkins, Myles R. Allen, John Lynch, David J. Frame, Adrian H. Macey, Glen P. Peters, Methane and the Paris Agreement temperature goals, Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 10.1098/rsta.2020.0456, 380, 2215, (2021)

* Yang Ou, Christopher Roney, Jameel Alsalam, Katherine Calvin, Jared Creason, Jae Edmonds, Allen A. Fawcett, Page Kyle, Kanishka Narayan, Patrick O'Rourke, Pralit Patel, Shaun Ragnauth, Steven J. Smith, Haewon McJeon, Deep mitigation of CO2 and non-CO2 greenhouse gases toward 1.5 °C and 2 °C futures, Nature Communications, 10.1038/s41467-021-26509-z, 12, 1, (2021).

Response: See response to comment #4.

Commenter: Private Citizen

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0005

Stephen Pew

Comment 41: Methane Emissions

Stop using unrealistic assumptions in counting methane emissions from flaring, fracking and drilling. Stop under-counting.

Response: Given the variability of practices and technologies across oil and gas systems and the occurrence of episodic events, it is possible that the EPA's estimates do not include all methane emissions from abnormal events. For many equipment types and activities, the EPA's emission estimates include the full range of conditions, including "super-emitters." For other situations, where data are available, emissions estimates for abnormal events are calculated separately and included in the GHG Inventory (e.g. Aliso Canyon leak event). The EPA continues to work through its stakeholder process to review new data from the EPA's Greenhouse Gas Reporting Program (GHGRP) and research studies to assess how emissions estimates can be improved.

Commenter: Private Citizen

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0007

Melissa Floyd

Comment 42: Methane Emissions

Methane - which is a minimum of 25% and more likely closer to 70% stronger as a greenhouse gas is being undercounted by 77%? Something has to be done. This is low hanging fruit. The least we can do is know how hot the boiling water we are in is at the moment, as it will only get worse otherwise.

Response: Given the variability of practices and technologies across oil and gas systems and the occurrence of episodic events, it is possible that the EPA's estimates do not include all methane emissions from abnormal events. For many equipment types and activities, the EPA's emission estimates include the full range of conditions, including "super-emitters." For other situations, where data are available, emissions estimates for abnormal events are calculated separately and included in the GHG Inventory (e.g. Aliso Canyon leak event). The EPA continues to work through its stakeholder process to review new data from the EPA's Greenhouse Gas Reporting Program (GHGRP) and research studies to assess how emissions estimates can be improved. EPA notes that end use fugitive emissions have been included for the first time in this Inventory report.

Commenter: Private Citizen

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0008

Kirk Forst

Comment 43: Increased metrics and visibility into shale extraction and conversion to natural gas

My comment will focus around the natural gas systems, but this recommendation can also be applied to the petroleum systems that are sourced from the shale plays in the US. As stipulated in United Nations Framework Convention on Climate Change reporting guidelines (Link: https://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf), “the annual GHG inventory should be transparent, consistent, comparable, complete and accurate. “ I would add reporting should be as holistic as possible, meaning covering the breadth of that natural gas supply chain including the carbon sink removal (via the chemical high pressure hydraulic fracturing process), the net increased capacity after processing (producing plants) and the identified capacity of each and every transmission pipelines. I have captured these into three critical metrics below.

These suggested metrics will provide increased visibility of carbon sink removal, processing of net natural gas output and the transport capacity along transmission pipeline companies, shipping the natural gas to most regions of the United States and to export shipping facilities. For the EPA to collect this information presents a greater view into the overall natural gas supply chain relating to greenhouse reporting and carbon sinks. It also will provide increased cross reference checks to deteremine if segment trends are skewed or other gaps in the data sets in the greenhouse gas emissions and sinks report. Most critically, it will enable the EPA to more fully and accurately report on greenhouse emissions and sinks.

Recommendation 1.1: Include raw cubic feet extraction of shale slurry from carbon sink shale plays in the US

Being that this draft report is of US greenhouse gas emissions and sinks, I urge the EPA to include the shale play carbon sink reserves that are being mined as the source of natural gas for the natural gas systems (and the petroleum systems). The EIA provides estimates of total shale carbon sink reserves, which can be added in as a place holder for this report and then further validated from requiring actual reporting of each and every well in all shale plays within the US. Between the American Petroleum Institute and the EIA, a representative raw cubic feet shale slurry extraction should be available now. However, this is a critical metric that will provide transparency around the removal of the shale carbon sinks as well as present raw shale slury withdrawal metric that can be compared with the net natural gas output after processing (recommendation 1.2) and with the gross natural gas system transmission flows. **Most critical: Stable carbon shale sinks are being removed as an inventory of the US carbon sinks.** ***Not including this metric means we have ignored a vital carbon sink inextricably tied to the greenhouse gas emissions associated with natural gas systems*** (and oil systems).

Recommendation 1.2: Include MMBtu of natural gas output from processing refinement plants

Once the shale slurry is extracted from the ground, the shale slurry is pumped into a processing plant that separates the natural gas from the shale slurry. The natural gas is then pumped into gathering pipelines, while the waste shale slurry is disposed of. The waste shale slurry cannot be labeled as wastewater since it does not reflect water and instead highly viscous slurry (not even true liquid). The waste shale slurry is most commonly pumped into holding pools, but there is more daily output than what the capacity of the holding pools can contain (in the Marcellus shale alone - wells extracted 10 trillion cubic feet of shale slurry just for the year of 2018 according to EIA - roughly 27 billion cubic feet per day extracted) – see my previous comment with reference: https://downloads.regulations.gov/EPA-HQ-OAR-2022-0001-0006/attachment_1.pdf).

Recommendation 1.3: Include MMBtu full capacity of all transmission pipelines for each year

Each pipeline transmission company should be reporting each year their overall MMBtu transmission capacity of natural gas delivery as well as separating and identifying all project added MMBtu capacity for that year. This is a critical measure gap in terms of greenhouse gas emissions, only when this number is fully visible for each transmission pipeline company pipeline, this provides EPA a measure tool that can help determine if greenhouse gas emissions estimates are close to actuals or substantially skewed. Overall MMBtu is a critical measure component in order for the EPA have a transparent holistic view of greenhouse gas emissions and carbon sinks since emissions and sink erosion are directly related to net transmission pipeline capacity. Additionally, this needs to be publicly available metric that increases awareness of the current state of the natural gas system. It is also an indicator of whether or not greenhouse gas emissions are actually decreasing. ***If capacity is increasing, it is unlikely that methane emissions are decreasing*** (current EPA reporting indicates this contradiction, further discussed in trends).

Response: Carbon emissions from the extracted shale are included in the fossil fuel combustion data and in the fugitive natural gas and petroleum systems data in the GHG Inventory. Key input data for calculations for natural gas and petroleum systems included in the annex files available at https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems-ghg-inventory-additional-information-1990-2020-ghg.

Comment 44: EPA require all facilities in the natural gas systems to report annual methane emissions

I provided this recommendation to EPA in the comments before the recent rule proposal (link submissions: https://downloads.regulations.gov/EPA-HQ-OAR-2021-0295-0025/attachment_2.pdf and https://downloads.regulations.gov/EPA-HQ-OAR-2021-0295-0050/attachment_2.pdf) and then again after the rule proposal was published (link: https://downloads.regulations.gov/EPA-HQ-OAR-2021-0317-0428/attachment_1.pdf). There are many natural gas transmission facilities that do not report emissions, whether because they claim low emissions or that the facility is an electric compressor station. I have a small electric compressor station 2,000 feet away from the local high school driveway where I live. If you go to that high school driveway on any cold morning at 7am, it smells like a raging gas leak. Yet, the NJDEP and EPA do not include this stationary source emission facility (as if it doesn't exist) in the greenhouse gas emissions inventory. It does, and it is dangerous. (Compressor station 2,000 feet from high school is Texas Eastern Transmission Corp.'s Freehold Compressor station located at 110 Weston Rd, Somerset, NJ 08873 and is stated to be 5,000hp electric compressor station.) **Please reconsider enforcing that all natural gas facilities along the transmission pipelines are included in the greenhouse gas emissions as stationary sources.**

Another example on a slightly different theme where the compressor station is in the greenhouse gas emissions inventory, but underreported. The Tennessee Gas Pipeline Compressor station CS-325 is a great example. While CS-325 is in the GHG inventory database, the facility has reported less than 1.290 tons of methane emissions per year for the past 10 years despite upgrading the facility in 2009 with two Solar Taurus 70 turbines which identify in the specs, the turbine emits 4 tons of methane in the exhaust per year. This also means that those turbines have never vented or flared since their installation in 2009.

Very impossible. A similar example is Williams Transcontinental compressor station CS-505 where they report emissions at more than 820 tons of methane per year to FERC, but then report to EPA and NJDEP 2020 32.8 tons of methane emissions, which would indicate there were no venting or flaring for 2020 and CS-505 was operating at a low percentage of capable capacity. Note, CS-505 is the main feed from the Marcellus shale into Williams Transcontinental's Atlantic main pipeline.

In this recommendation, ***I urge the EPA to please consider mandating that all compressor station facilities must require methane emissions and start employing aggressive audits*** during peak operation ***using the OGI*** (optical gas imaging) measurements ***to combat the substantial underreporting from facilities***.

These two gaps are substantial flaws in reporting US greenhouse gas emissions and substantially contribute to why the methane emissions appear to be trending downward in decreasing methane emissions.

Response: This comment related to facility-level monitoring of methane emissions is noted but is out of scope of this technical review of the national GHG Inventory.

Comment 45: Require all methane emissions reported in tons per year as methane emissions

Even the UNFCCC states under Section G. that reporting of gas emissions should be presented as the gas in its emissions measurement. Currently in the transmission sector, facilities will lump in methane emissions into CO2e along with carbon dioxide and nitrous oxide (carbon dioxide equivalence using the IPCC AR4 multiplier of 25 as if the emission occurred 100 years ago) along with carbon dioxide. Additionally, facilities with natural gas fired turbines will lump the unburned methane emissions out the exhaust into a term UHC (unburned hydrocarbons). This EPA draft report also presents methane in CO2e measures. From the definition of CO2e, EPA is claiming that the emission occurred 100 years prior to the year that emission is identified as. This doesn't make sense.

Carbon dioxide equivalency is one of the single largest misunderstandings. How can any agency multiply methane emissions that occurred two years ago by 25 as if it was emitted 100 years ago? Methane global warming potential (GWP) changes each year and multiplying methane by the 100 year mark multiplier greatly distorts that relative GWP for that emission year. More will be covered on this in the next recommendation, but suffice it to say, ***it is critical that methane is not mapped to faulty equivalencies and instead reported as methane in tons per year.***

The same goes for UHC, which is often used to account for methane and other gases that are emitted in the smokestack of natural gas fired turbines as unburned hydrocarbons. This is akin to 1970s automobiles that would at times drip gasoline out the exhaust attributed to excess carburetor flow of fuel into the combustion pistons and not fully combusting. Williams Transcontinental and Tennessee Gas Pipeline both use this UHC notation frequently in their natural gas turbine specifications when submitting to FERC and EPA. Each company uses it differently and making different unique claims for the exact identical Solar Taurus 70 natural gas fired turbine – neither revealing actual unburned methane emissions (See CP20-493 and CP21-94 for details).

EPA has made progress with the updated rules, but I hope that EPA goes after all facilities in the transmission sector ensuring more accurate reporting is provided and ***in actual methane emissions measurements***. I urge the EPA to aggressively audit facilities to build increased integrity (QA/QC) of the EPA greenhouse gas emissions reporting.

There is no direct fixed methane CO2e equivalency and I urge EPA to eliminate this false misrepresentative presentation of IPCC AR4 CO2e 100-year multiplier in the Inventory of US greenhouse gas emissions and sinks.

Response: See response to comment #4.

Comment 46: EPA to segment and separate GWP (global warming potential) analysis into a dedicated team and function

I sent a note to IPCC about this yesterday. In IPCC AR6 recent release update, IPCC clearly states that the world is already at an irreversible point in climate change, we should be encouraging countries to ***not*** use CO2e AR4 100 year multiplier in methane emissions reporting, which creates a false and misleading equivalency.
There is no fixed GWP carbon equivalency for methane, it continually changes year over year starting at 120 times carbon at the emission moment and decreasing thereafter. To encourage agencies to use fixed GWP equivalency based on 100 years after emission suggests taking the context of methane emissions into thousands of year or higher perspective. Of course, that isn't true. It should be apparent that:

1. IPCC set the data range to start at 1990 (discounting previous yearly emissions), which is only 30 years;
2. Climate impacts and changes are becoming more visible and impacting to regions around the US now;
3. Methane impacts from emissions 2 years ago and ongoing into the future increasing emissions - all start at 120 times carbon dioxide potency at the moment of emission; and hence
4. Methane emissions are snowballing the aggregate cumulative (30 years) GWP impact exponentially - thereby dramatically increasing the likelihood of further exacerbated destabilized systems impacts into more pronounced cataclysmic damage to humans, environment and sustainability.

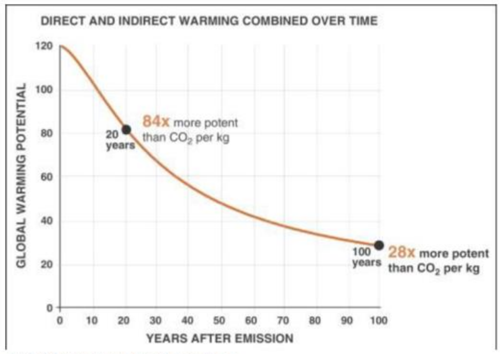
Methane's global warming potential starts at 120 times carbon dioxide at the moment of emission and then oxides over time, losing its potency. Other factors are captured in a recent published report:

> (link: https://royalsocietypublishing.org/doi/10.1098/rsta.2021.0104) "Methane emissions induce an atmospheric feedback by decreasing the hydroxyl concentration, thereby increasing methane's lifetime. The strength of this feedback factor, approximately 1.3–1.4, causes the lifetime of a marginal emission, known as the perturbation lifetime, to be significantly higher than the lifetime of methane already in the atmosphere [7,8]."

IPCC AR6 has posted revised raw data for methane to provide more accurate method of calculating the GWP for each year (link: https://github.com/chrisroadmap/ar6/tree/main/data_input/metrics). An implementation of the raw data points using jupyter notebook can be found at this link: https://zenodo.org/record/5661308.

What is GWP? Global warming potential is a cumulative measure where each greenhouse gas is mapped into carbon dioxide based aggregate based on the year of emission and the multiplier associated with each year thereafter up until present.

For carbon dioxide, it remains almost constant. There are notations of some carbon dioxide being absorbed into water, vegetation and soil; but that deviance is negligible since there are many other sources of CO2 emissions in addition to fossil fuel emissions. The GWP for carbon dioxide is cumulative, meaning each and every year is added progressively up until present day. So for the EPA, it has carbon dioxide emissions starting from 1990 up till 2020, the GWP is the summation of each and every year up to 2020. This is true for all fossil fuel carbon dioxide emissions and should all be aggregated together to assess the 2020 carbon dioxide GWP



IPCC AR4 methane GWP over time

For methane, the GWP for each year's emission is a separate array of decay over time as that original emission weakens in potency up to the current date.

Below is a table derived from the IPCC AR6 raw data:

Derived from raw data from IPCC AR6 Working Group
Fossil Fuel Methane GWP CO2 equivalency based on year since Year of Emission

Year	YoE	1	2	3	4	5	6	7	8	9
GWP	120	116.52	115.36	114.07	112.53	111.06	109.35	107.97	105.32	103.56
Year	10	11	12	13	14	15	16	17	18	19
GWP	101.40	99.59	98.04	96.11	93.85	91.86	89.59	87.97	86.10	84.35
Year	20	21	22	23	24	25	26	27	28	29
GWP	82.73	80.53	78.80	77.20	75.98	74.57	72.92	71.38	70.15	68.77
Year	30	31	32	33	34	35	36	37	38	39
GWP	67.38	66.34	64.89	63.96	62.81	61.71	60.66	59.65	58.69	57.53
Year	40	41	42	43	44	45	46	47	48	49
GWP	56.64	55.80	54.88	54.09	53.11	52.51	51.59	51.01	50.18	49.44
Year	50	51	52	53	54	55	56	57	58	59
GWP	48.92	48.14	47.47	46.82	46.37	45.76	45.16	44.58	44.02	43.44
Year	60	61	62	63	64	65	66	67	68	69
GWP	43.08	42.56	42.05	41.53	41.05	40.58	40.16	39.71	39.26	38.82
Year	70	71	72	73	74	75	76	77	78	79
GWP	38.45	38.04	37.67	37.42	37.08	36.68	36.37	35.98	35.68	35.32
Year	80	81	82	83	84	85	86	87	88	89
GWP	35.01	34.66	34.37	34.09	33.75	33.49	33.22	32.94	32.64	32.39
Year	90	91	92	93	94	95	96	97	98	99
GWP	32.14	31.88	31.63	31.38	31.15	30.88	30.66	30.42	30.20	29.98

To be conservative, the multipliers can start at year 1: 116.52, year 2: 115.36 all the way up to 2021 (year 32): 64.89. So for the year 1990 methane emissions, that amount would be multiplied by year 1 for 1990, year 2 for 1991 and so on up until 2021 and the resulting GWP annual points would be added together to form an aggregate GWP total. This process would be repeated for methane emissions in 1991, 1992 and so on. Each year would have a GWP summation for each and every year since the emission year. The resulting summation of all methane reported years are then added together to form the total GWP for all recorded methane emissions from 1990 through 2020 for the natural gas systems. The same can be repeated for methane emissions from other fossil fuel systems.

Visual excel sample (using EPA 2019 carbon sink data)

Year	EPA CO2e Methane	Actual methane	Aggregate	1990	1991	1992	1993	1994	1995	199
1990	776.87	31.07	3,728.99	3,728.99						
1991	781.78	31.27	7,392.64	3,640.10	3,752.54					
1992	780.52	31.22	10,975.56	3,594.84	3,634.23	3,746.49				
1993	770.71	30.83	14,344.94	3,507.31	3,549.66	3,588.56	3,699.41			
1994	777.03	31.08	17,947.80	3,485.20	3,536.08	3,578.78	3,618.00	3,729.75		
1995	767.70	30.71	21,127.92	3,395.73	3,443.33	3,493.60	3,535.78	3,574.53	3,684.95	
1996	760.81	30.43	24,249.13	3,310.80	3,365.26	3,412.43	3,462.25	3,504.06	3,542.46	3,651
1997	746.76	29.87	27,007.42	3,206.14	3,249.65	3,303.11	3,349.41	3,398.31	3,439.34	3,477
1998	731.67	29.27	29,523.71	3,062.03	3,141.35	3,183.99	3,236.36	3,281.73	3,329.64	3,369

In this excel example, I started with 120 multiplier for the first year and you can see each year's emission decrease over time (each emission starts in a separate column). Note that the 25 multiplier is first removed to normalize the methane emissions to actual methane emissions.

When the data is built out, you can see how methane starts looking small, but the cumulative increase grows almost exponentially. If we had prior 1990 data, the curve would accelerate faster.

Prediction and future modeling is a whole separate scenario. Additionally, in the IPCC AR6, the raw data provides different sets of data for fossil fuel emissions versus bio created methane. In my correspondence with an IPCC data scientist, it is clear that fossil fuel methane emissions is treated separately from bio produced methane. This is why I urge the EPA to create a department solely focused on analyzing and building out current full global warming potentials as well as beginning to model future GWP growth and impacts.

For methane, the CO2e 25 multiplier needs to be eliminated and methane emissions needs to be reported as methane emissions. Only then can the true and full GWP analysis can be performed for each sector of methane emissions. We keep thinking we have 30 to 100 years before things get bad, but if we look outside, the evidence is telling us we are doing it wrong and impacts are already occurring - much sooner than anticipated. ***We need to get this right and the EPA needs a team performing the full GWP analysis. This also needs to be discretely separate from emissions reporting.***

Response: This comment is out of scope of this technical review of the national GHG Inventory. EPA refers the commenter to the latest Assessment Reports from IPCC Working Group I available online here: https://www.ipcc.ch/working-group/wg1/.

Comment 47: EPA needs to provide full data sets as an appendix for each greenhouse gas emission

I wanted to rebuild my methane GWP example using the latest data set, which is different than 2019's greenhouse gas emission data set. However, there isn't a complete methane emissions data set for the natural gas system in this draft report. I urge the EPA to include full data sets of emissions in the appendix of the final 2020 Inventory of US greenhouse gas emissions and sinks. Please also include separate data sets for natural gas systems, coal systems and petroleum systems with an aggregate summary overall for methane and other greenhouse emissions discretely separate.

Response: This data in mass units of gas is available in Table 2-2 of Chapter 2 for all methane sources, and in Table 3-69 in Chapter 3, section 3.7 for Natural Gas Systems. Downloadable data for both tables will be available in the forthcoming csv versions of the report tables later in May. The main

report CSV tables will be posted under the side bar titled "View and Download GHG Inventory Data!" on this page: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2020. Additional data related to Table 3-69 is available in the .xlsx methodology annexes EPA has already posted here: https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems-ghg-inventory-additional-information-1990-2020-ghg.

Comment 48: Uncertainty Analysis of Emission Estimates assessment should be very low initially i.e. 25%

Given that this is the first year that EPA is adopting this new reporting format, I would encourage the EPA to rate itself low, especially considering that there still exist many gaps in greenhouse gas emissions reporting. Until EPA is able to audit and validate emission sources, especially in the fossil fuel sectors, there is substantial evidence indicating that the reporting updates from fossil fuel companies have been substantially low. I have detailed examples in previous EPA comments as well as in this comment (link: https://downloads.regulations.gov/EPA-HQ-OAR-2021-0317-0394/attachment_1.pdf). Many organizations have tracked super emitters that don't even exist in the EPA greenhouse gas inventory. The Quality Assurance and Quality Control almost needs to be tied to audits and data analysis reviewing over indicators that can point out contradictions in trends (my next recommendation) that indicate data flaws or inaccuracies.

The EPA has made substantial forward progress in this report and I hope substantial emphasis is made on aggressive QA and QC oversight that focuses on improved data, expanded scope of data and improved presentation.

Response: EPA is unclear what "new reporting format" the commenter is referencing.

See also response to Comment #46 related to inclusion of anomalous leak events, or superemitters in the national GHG Inventory.

This comment generally relates to the GHGRP data set. We note the verification steps taken in the GHGRP program in the text of the GHG Inventory, see for example page 3-79: "EPA has a multi-step data verification process for GHGRP data, including automatic checks during data-entry, statistical analyses on completed reports, and staff review of the reported data. Based on the results of the verification process, EPA follows up with facilities to resolve mistakes that may have occurred. The commenter may find it useful to review Annex 9 of the national GHG Inventory to understand use of GHGRP data in this report.

Chapter 1, section 1.6 includes more information on QA/QC procedures applied during compilation of the national GHG Inventory. Similarly, Chapter 1, Section 1.7 includes more information on the uncertainty analysis of the overall Inventory. Chapter 1 is available online here: https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-2022-chapter-1-introduction.pdf. Uncertainty information for specific source categories is discussed across the report under the specific source category.

Comment 49: Trends currently point out contradictions in the natural gas systems

I was always fascinated since I first viewed EPA methane emissions that it presented methane emissions as reducing year over year since 1995. Naturally, this directly contradicts the rapid growth in natural gas hydraulic fracturing wells, rapid growth in processing plants, rapid growth in gathering pipelines, rapid growth in transmission pipelines and rapid growth in end uses for natural gas. Even the blue hydrogen generation that presents the most astounding false conundrum of all (consuming more natural gas fuel input and additional heat using natural gas to produce a meager hydrogen output that doesn't account for all of the methane emissions from well through to transmission to the end use blue hydrogen facility).

Blue Hydrogen - Steam Methane Reforming

Inputs	**Outputs**
• 2.2 tons Methane From Natural gas • 4.9 tons of water • 5.7 MWh heat	• 1.1 ton Hydrogen • 6 tons Carbon Dioxide (CO2)

Additionally, since all of the electric compressor stations are not included in the greenhouse gas inventory, the emissions of those facilities are not accounted for, nor monitored to ensure that emissions are as minimal as the transmission pipeline companies' claim. TGP CP20-493 has a new electric compressor station CS-327 which is purported to emit more than 142 tons of methane a year, but since it is electric, it will not exist in the EPA greenhouse gas emissions and sinks inventory.

For TGP, they state they use electric compressor stations at every other facility for disaster redundancy to keep gas flowing (the concept seems contradictive, but that is a separate discussion). If TGP's statement is accurate, it means that at least half of all TGP compressors don't exist in EPA's greenhouse gas inventory. The state agencies can help there, but this is a serious gap and flaw in the greenhouse gas inventory. ***This is also a substantial contributor to the false offset in methane emissions from the existing EPA reporting of the natural gas systems that falsely indicates a decreasing trend.***

CS-327 *estimated* unreported Emissions

Kinder Morgan / Tennessee Gas Pipeline East 300 Upgrade Project	TGP CP20-493				NJDEP N.J.A.C. 7:27-17.9
	CS-327 Emission Sources		CS-327	CS-327	Thresholds
Air Contaminant	Fugitive	Venting	Emission Totals Tons per year	Emission Totals Pounds per year	Pounds per year
VOC	0.04	0.25	0.280736	561.4729	
2,2,4-Trimethylpentane	0.000635997	0.00394444	0.00458	9.160874	
Benzene	0.000471868	0.00292652	0.003398	6.796778	6
Ethylbenzene	0.000000671	0.00012724	0.000148	0.295512	19
n-Hexane	0.008144861	0.050514285	0.058659	117.3183	
Toluene	0.000369288	0.00229032	0.00266	5.319217	
Xylenes	0.00020516	0.0012724	0.001478	2.955121	
Total HAPs	0.01	0.06	0.071218		
CO_2	0.018464419	0.114516011	0.13298		
Methane (CH_4)	19.72	122.3031	142.0231		

As I pointed out earlier regarding TGP CS-325, TGP's annual methane emissions for that site for the past 10 years are virtually impossible emissions unless the two Solar Taurus turbines were not operating (which is highly doubtful). Williams Transcontinental does this too. So okay, ***how many natural gas fired compressor stations are preponderantly understating emissions in gross amounts?*** For the TGP, annual emissions should be at least 8 tons of methane per year for the two operating Solar Taurus turbines not including venting or flaring. Would anyone believe that no venting or flaring occurred over the past ten years? The emissions from venting is significant when performed. All told, a site with two turbines can emit over 120 tons of methane per year if the unburned methane emissions and venting are added in. Yet, TGP claims less than 1 ton for several years and less than 2 tons for most of the remainder years.

Snapshot from TGP's specifications of the two current operating Solar Taurus units at CS-325:

CP09-444 Resource Report 09 page 618 CS-325 proposed emissions with 2 Solar Taurus 70 units

2. Emission Calculations

		Proposed Primary Equipment			Existing Equipment			Facility	Total Project	Post-Project
		Unit 5	Unit 6	Em. Gen	Unit 7	Unit 8	Em. Gen			
Annual Heat Consumption (HHV)	(MMBTU/yr)	828,696	828,696	2,100	0	0	0		1,659,492	1,659,492
Annual Fuel Consumption	(MMscf/yr)	804	804	2.04	0.00	0.00	0.00		1,611	1,611
CO_2 Combustion Emissions	(ton)	48,070	48,070	122	0	0	0		96,262	96,262
CH_4 Combustion Emission Factor	(lb/MMBTU)	0.0086	0.0086	1.25	0.0086	0.0086	1.25			
CH_4 Combustion Emissions	(ton)	3.56	3.56	1.3	0.0	0.0	0.0		8	8
N_2O Combustion Emission Factor	(tonne/MMBTU)	0.0000038	0.0000038	0.0000014	0.0000038	0.0000038	0.0000014			
N_2O Combustion Emissions	(ton)	3.5	3.5	0.0	0.0	0.0	0.0		7	7
Total Combustion Emissions	**(tonne CO_2e)**	**44,627.97**	**44,627.97**	**141.2**	**0.0**	**0.0**	**0.00**		**89,397**	**89,397**
CH_4 Fugitive Emission Factor	(lb CH_4/yr)	467,660	467,660					135,260		
CH_4 Fugitive Emissions	(ton)	239	239		0	0		69	479	548
CO_2 Fugitive Emission Factor	(lb CO_2/yr)	27,014	27,014					7,945		
CO_2 Fugitive Emissions	(ton)	7	7	-	0	0		2	13	15
Total Fugitive Emissions	**(tonne CO_2e)**	**5,434**	**5,434**	**0**	**0**	**0**	**0**	**1,572**	**10,867**	**12,439**
CH_4 Vented Emission Factor	(lb CH_4/facility-yr)							223,758		
CH_4 Vented Emissions	(ton)							115		115
CO_2 Vented Emission Factor	(lb CO_2/yr)							6,386		
CO_2 Vented Emissions	(ton)							2		2
Total Vented Emissions	**(tonne CO_2e)**							**2,598**	**0**	**2,598**
Total Emissions	**(tonne CO_2e)**	**50,062**	**50,062**	**141**	**-**	**-**	**-**	**4,170**	**100,264**	**104,434**

In the 2009 installation, TGP acknowledged 3.56 tons of unburned methane emissions from each turbine. Yet when you look at methane reporting from TGP to NJDEP from 2010 all the way up to 2020, the emissions for this facility, less than 2 tons. Oh, and TGP projected 115 tons of methane vented every year. Strong example of gross exaggerated underreporting that I urge EPA to investigate. ***This is also a substantial contributor to the false offset in methane emissions from the existing EPA reporting of the natural gas systems that falsely indicates a decreasing trend.***

Due to the understated data input into the inventory and missing electric compressor stations in the EPA greenhouse gas emissions inventory, the trends are mostly likely incorrect. This is why it is critical for the EPA to aggressively pursue QA/QC overseeing emissions reporting and working with an independent auditing team solely focused on capturing snapshots of emissions at all of the facilities and performed during peak periods first and then off-peak periods secondly.

The only real trend seems to be that all transmission compressor stations that I have reviewed (with some that NGOs have independently audited) and are in the EPA GHG inventory is that these facilities have been underreporting their methane emissions for years. Is that trend consistent for all of the compressor stations? I hope this becomes an urgent priority for EPA.

Response: This comment generally relates to the GHGRP data set. We note the verification steps taken in the GHGRP program in the text of the GHG Inventory, see for example page 3-79: "EPA has a multi-step data verification process for GHGRP data, including automatic checks during data-entry, statistical analyses on completed reports, and staff review of the reported data. Based on the results of the verification process, EPA follows up with facilities to resolve mistakes that may have occurred."

Comment 50: Comment Wrap Up

I think EPA has put countless time and effort into this report and it is an excellent first start. I am grateful for the work and hope that the EPA review and consider my recommendations. I hope the EPA works to incorporate these recommendations as best effort into the current report, but then regroup teams and strategy to cut more incisively into the natural gas systems sectors to push for higher accuracy and auditing of stationary source methane emissions.

We are at a critical impasse in the United States. We have the IPCC telling us there is no return from the climate change destabilization and that it will get worse. Yet, we have the EPA inventory data claiming that "it's all good and decreasing." Situations that were predicted in 2000 to occur in 2100 are starting to occur now. That should be an alarm bell that the numbers are not correct and don't synch with IPCC's message. It is also due to the false equivalency used as IPCC AR4 100-year methane emission multiplier creating a false sense of low GWP impact.

IPCC does an excellent job going through all of the earth systems and applying modeling, just reading through the data is overwhelming, but cuticle in terms of the external dynamics, but missing the real data correlating GWP to earth systems. This is where EPA can correct the misinformation in the US. Work with FERC and state agencies to raise the awareness and push for improved accurate measurements in actual measurements, auditing and collecting of emissions from the natural gas supply chain infrastructure. Nobody is talking about the massive amounts of shale that has been chemically pressured fractured and removed from the ground, yet that is a carbon sink that is being dissolved away, right under our feet. ***It should be included in this report quantitatively.***

I reviewed the IPCC reporting guidelines and it did look they were recommending the CO2e, that is why I sent each working group and the Secretariat an email about this. Methane should not be reported in CO2e. There is no fixed equivalency. **Get rid of it.**

Another vantage point are the few operational NOAA continuous methane atmospheric monitors up and running. The data from these monitors is fascinating because some of the monitors can be totally attributed to fossil fuels due to the pure cycles of concentration. I am sure cows are not all emitting methane in unison seasonally… Seriously, there is urgency to get more atmospheric methane monitors up and running and that should also be added to this report as another check and balance. Current atmospheric monitors display increasing concentrations year over year and relative to each tower location, which is contradictory to the EPA current methane trend.

I very much appreciate your consideration, the effort from EPA as a whole towards due diligence regarding greenhouse gas emissions reporting. With all of the extreme rapid shifts in environment, we are seeing disrupted jet streams, increased temperature extremes colliding spelling out more tornadoes, white hurricanes and many new phenomena taking place that makes me wonder how much worse is it going to get? This 2022 winter season was redefining in terms of what winter is and distinctly unique across the regions in the US.

There is no going back, but there is raising awareness so that everyone can see that we should eliminate fossil fuels as soon as possible. Otherwise, what's the point?

Response: Carbon emissions from the extracted shale are included in the fossil fuel combustion data and in the fugitive natural gas and petroleum systems data in the GHG Inventory.

EPA continues to track technologies and programs that monitor methane and consider how information from such approaches can be used to update the GHG Inventory. The 2019 Refinement to the 2006 IPCC Guidelines discusses atmospheric observations under "Quality Assurance, Quality Control, and Verification." The Refinement provides a discussion on available technologies and provides examples and approaches for use of satellite data to improve GHG inventories. It describes components needed to compare inventories with atmospheric measurement, which include measurements of atmospheric gas concentrations, inverse modeling tools, gridded inventory, and

collaboration. It also describes procedures for using comparisons to inform GHG Inventories, including steps to take when there are discrepancies.

Commenter: Private Citizen

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0006

Kirk Forst

Comment 51: Re: Urging FERC to disregard false pretense from natural gas companies due to the unlawful and unprovoked Russian invasion of Ukraine. There are viable alternatives that FERC may assist in reinforcing the United States energy infrastructure and enabling US energy independence

Dear FERC Chairman Glick, FERC Commissioners and EPA:

I am one small voice, with little means, submitting my comment (my voice) to FERC and EPA in solidarity to soundly and fully extinguish the false notion of natural gas companies claiming that geopolitical realities should push FERC to ignore its 1999 policy statement and to enable these companies to expand their transmission lines without due diligence of validating the applicant's claims.

These companies are not trying to be netizens of the global community attempting to do 'good' or even companies interested in serving the customers they serve. These are companies that sponsor billions of gallons of water to be contaminated; they are companies that understate greenhouse gas (GHG) emissions at every fracturing well and at every producing and compressor facilities. In many cases, they are large conglomerate companies that even include competing transmission pipeline companies.

The mission of these companies is to maximize profits with the least cost for stripping natural resources (shale) and breaking down the shale to extract natural gas and then transporting via transmission pipelines to end uses where the natural gas is burned, emitting greenhouse gases and toxic air pollutants. This is worse than smoking, because it falls under the guise of energy infrastructure and is very addictive to a global economy built on fossil fuel energy.

The harvesting of shale, a stone bedrock that has been stable for a millennium until these energy companies figured out how to break down (chemically and physically) shale into a slurry output. This slurry is processed to separate the natural gas from waste output (which still contains methane and emits methane). The natural gas byproduct is transmitted over hundreds of miles of pipelines that requires many compressor facilities along the pipeline to move the natural gas to the designated endpoint (distribution pipeline, powerplants or other industries). Each and every facility point of this supply chain emits tons of greenhouse gases (GHG - primarily methane and carbon dioxide) as well as toxic air pollutants such as formaldehyde and benzene. All of this described supply chain is to enable customers to burn natural gas, emitting more GHG and toxic pollutants. In effect, natural gas hydraulic fracturing is the direct conversion of stable shale (natural carbon sinks buried deep in the United States) to increased atmosphere greenhouse gases and toxic air pollutants ***across the United States***.

At the core, a natural gas company's sole business focus contaminates the earth and water tables at the hydraulic fracturing wells, emits tons of GHG (primarily methane and carbon dioxide) and toxic air pollutants along the transmission pipelines and increases the global dependency on natural gas as each company expands its natural gas transmission and shipment capacity. A business that creates both near term impact to the American people's health and environment, as well as, increasing the GHG emissions that are snowballing the effects of climate change. An industry that is more toxic and more substantially impacting in increasing the existential threat to human survivability than tobacco could ever be. Isn't it time we recognize natural gas for what it is?

Natural gas is a fossil fuel and natural gas isn't clean as elected officials and energy PR firms falsely state.

Put simply, these companies are not here for people, environment or global geopolitical issues. They are here to make money off of a highly toxic sourced and transmission of natural gas just to enable people to burn more natural gas. At some point, we need to reconcile this blatant contradiction where an industry's sole business purpose creates harm to humans and environment both immediately and more critically, longer term posing self-annihilation. At some point, this can no longer be justified.

In the recent submission, Accession Number 20220303-5041, TC Energy, Enbridge, Williams and Kinder Morgan urge FERC to consider:

Meeting energy security

- There are many means to meet Energy security that don't involve increasing natural gas emissions throughout the United States. These are outlined in IPCC AR6 release this past week that don't involve natural gas, but since these companies are only focused on their business expansion, are not presented, discussed or encouraged for FERC to pursue. Additionally, these other means, such as renewable sources are proliferating in spite of the fossil fuel industry push to add more natural gas capacity.
- Current FERC policy update doesn't change FERC policies, but instead focuses on validating what companies claim and requiring that companies provide greenhouse gas emissions forecasts and impacts on environmental justice communities. Basically, reinforcing the 1999 FERC Policies.

Environmental policy priorities

- Again, the FERC policy update doesn't change the environmental policy or even the priorities, but rather ensures that FERC will validate claims made by an applicant company proposing to trench miles of pipes and build or modify facilities along the transmission pipeline.
- That we have agencies that are supposed to incorporate environmental impact as a balance to reckoning with dirty natural gas industry, where many of the emissions, contamination and rapid erosion and conversion of natural shale carbon sinks to atmosphere GHG and pollutants are ignored. Something Commissioner Glick, in his 3/3/2022 testimony, admits has been lost in the FERC Environmental Impact Statements and instead the false and misleading submissions from the natural gas applicants as facts.

Urge the Commission to immediately certificate the natural gas infrastructure projects pending before it and move to simplify the approval process instead of introducing new ambiguities.

- Basically, these companies are requesting that their projects are fast track approved without any assessment of impact to the communities, to the GHG emissions, to the toxic air pollutant emissions, to the increased ground water contamination, to the environmental destruction caused by trenching pipelines and build/expand facilities.
- The only ambiguities are the false notions from natural gas transmission companies proposing projects that ultimately have devastating impact on health, environment and long term human

survivability.

It is ironic that these companies assert that these are new policies. The irony is that the policies are just reinforcing existing 1999 FERC Policy. Which one of these companies would like to step forward and suggest that equitable justice should not be considered or perhaps that FERC's new determination on limiting the previously carte blanche eminent domain to condemn private property? How about these companies that have signed on to Accession Number 20220303-5041 submission instead lower their natural gas prices to help America instead of raising the price along with global prices?

Additionally, when will these companies be more transparent about the full project impacts? If it isn't required by FERC, these companies and the overall natural gas industry will never release data on overall impact to the communities, the environment and to climate change.

Such as:

- Overall increased capacity at all facilities from wellsite to processing, to all facilities along transmission lines.
    - When an expansion project is proposed, the company only details the sites that have to change. The company doesn't identify the increased capacity operation that will occur at all of the upstream facilities.
    - When an expansion project is proposed, the increased capacity of natural gas harvested and increased contamination of water in gallons are never detailed.
    - None of the emissions from compressor stations (electric and natural gas fired) are ever validated or audited. Instead, every company elects to provide minimized emission estimates and some GHG emissions falsely detailed as UHC (unburned hydrocarbons) or CO_2e (misrepresented equivalence of methane as if it were emitted 100 years ago).
- Companies do not aggregate all MMBtu consumption at every facility proposed work location along with the proposed added MMBtu capacity for distribution – so we don't have an overall added capacity.
- Companies do not aggregate all toxic air pollutions at all proposed site work locations to provide an overall increase of toxic air pollution emissions.
- Companies do not aggregate all GHG emissions as actual full emissions of each greenhouse gas in its specific measurement emissions across every facility proposed work location.

Another quote: "One of its primary roles of the Commission is to help shepherd the responsible development of natural gas transmission capacity in the United States at just and reasonable rates." If FERC did pursue responsible development of natural gas transmission capacity, it would be reducing natural gas **now** and working with other agencies to implement alternative available-now measures.

What has been vividly on display is that the US and Global allies are still too dependent on the fossil fuel industry. These natural gas companies are leveraging that dependency to push for carte blanche approval of all projects. That as IPCC AR6 has thoroughly detailed that we are already at an irreversible substantial effect on climate change and environmentally damaging significant footprint. Natural gas rapid growth in the US shale plays has outpaced water supplies, rapidly increased methane atmospheric load and ***isn't fully assessed by any agency in the US*** as to the overall damage every expansion project has on the environment, human health, clean water and atmospheric climate change impact.

Recently, I was reviewing 2018 numbers for the Marcellus Shale area which are not fully detailed and interspersed across many internet resources. There were two numbers that are frightening and not detailed nor reviewed at FERC:

American Petroleum Institute put Marcellus shale projected water consumption (and contamination) for **2018** at 54.68 million gallons per day (Mgal/d) or **19.97 billion gallons annually** (source: https://www.api.org/~/media/Files/News/Letters-Comments/2018/Appendix-A-to-APIs-Comments-to-DRBC-3-30-2018.pdf).

EIA states that **Natural Gas Gross Withdrawals** and **production** for **2018** specifically for Pennsylvania, West Virginia and Ohio (Marcellus Shale states) at **10,118,039 million cubic feet** (MMCF). (source: https://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_FGS_mmcf_a.htm)

These numbers are most likely understated since all companies under report data when no agency is validating the activities. Basic math puts the 2018 added project at consuming 2 gallons for every MMBtu added. Yet, the Marcellus Shale Coalition put the ratio at a range from .60 to 5.8 (2013 reference link: https://marcellus.cas.lehigh.edu/sites/marcellus.cas2.lehigh.edu/files/hanna.pdf). Naturally, the real number is probably closer to 5. Just think about it, in Marcellus Shale area alone, ***in one year - 2018, 20 billion gallons of water was contaminated with chemicals and injected in the ground to remove 10 trillion cubic feet of shale slurry.*** Who is watching the fissures created year over year? Who is watching the chemical slurry waste disposal? Who is watching the contamination of water table entry points, miles away from each and every hydraulic fracturing well? Who is watching the actual methane emissions in waste slurry ponds, processing facilities and all other compressor facilities?

Currently, all of these companies deny wrongdoing until someone else proves it. This is identical to the tobacco industry. Do we have to wait another 10 years before any agency starts calling out this eminent disaster occurring right before our eyes?

I would like to thank Commissioner Glick for his clear-eyed Senate hearing Testimony March 3, 2022 (link: https://cms.ferc.gov/media/testimony-chairman-richard-glick-hearing-review-fercs-recent-guidance-natural-gas-pipelines). How the revised policy only reinforces the 1999 FERC policy.

FERC 2/17/2022 Policy Update

https://ferc.gov/news-events/news/fact-sheet-updated-pipeline-certificate-policy-statement-pl18-1-000

Updated Pipeline Certificate Policy Statement

1. **Consider all existing relevant factors for project need instead of treating applicant's submissions as conclusive proof;**
2. **Impacts on existing customers subsidizing the project;**
3. **Impacts on existing pipelines & their customers including captive customers of existing pipelines who will end up paying for unsubscribed capacity on existing pipelines that results from overbuilding of new lines;**
4. **Environmental impacts along with all other impacts as defined in the existing Natural Gas Act.**
5. **Impacts on landowners to reduce blind carte blanche eminent domain to condemn private land**
6. **Impacts on Environmental Justice Communities**
7. **Assessing Public Benefits and Adverse Effects**

https://ferc.gov/news-events/news/fact-sheet-interim-greenhouse-gas-ghg-emissions-policy-statement-pl21-3-000

Interim Greenhouse Gas (GHG) Emissions Policy Statement

- **A project's reasonably foreseeable GHG emissions will be based on a projection of the amount of capacity that actually will be used, the projected utilization rate and any other factors impacting the quantification of project emissions.**
- **Quantifying GHG Emissions including following CEQ regulations, reasonably foreseeable emissions and consider evidence relating to project's estimated GHG emissions.**
- **the Commission will consider proposals by the project sponsor to mitigate all or a portion of the project's climate change impacts, and the Commission may condition its authorization on the project sponsor further mitigating those impacts.**

The FERC Policy update reflects the 1999 Certificate Policy Statement that the Commission would "consider all relevant factors reflecting on the need for the project." - the Commission's prior approach was a position in which the precedent agreements filed by a *project developer were treated as conclusive proof* ***of the need for a proposed project.***

I urge FERC to disregard the comments from elected officials spouting false statements, from the energy companies creating a false 'clean' dialogue from a business that's only focus is to emit more methane and carbon dioxide.

I urge both FERC and EPA to require all emissions to be provided as measures of that emission, not converted to aggregate equivalencies (carbon equivalency 100 years from emission date) or combinations (such as unburned hydrocarbon). So for example that methane must be reported as methane emissions in tons per year.

I urge FERC and EPA to start an awareness campaign to the US communities and to the elected officials to create the dialogue and share the facts of the dangers associated with this industry that converts natural shale carbon sinks to carbon dioxide, methane, benzene and formaldehyde emissions.

FERC Natural GAS Act and NEPA actually enable stronger policy, but I understand this has to be phased in. I just urge both FERC and EPA to start focusing on protecting the environment and protecting human long-term survivability ***now***. Like cigarettes, agencies will soon find the courage to state these industries are threatening our existence and viability.

Sincerely,

Kirk Frost

Response: This comment is noted but is out of scope of this technical review of the national GHG Inventory. See also response to Comment #4.

Commenter: Private Citizen

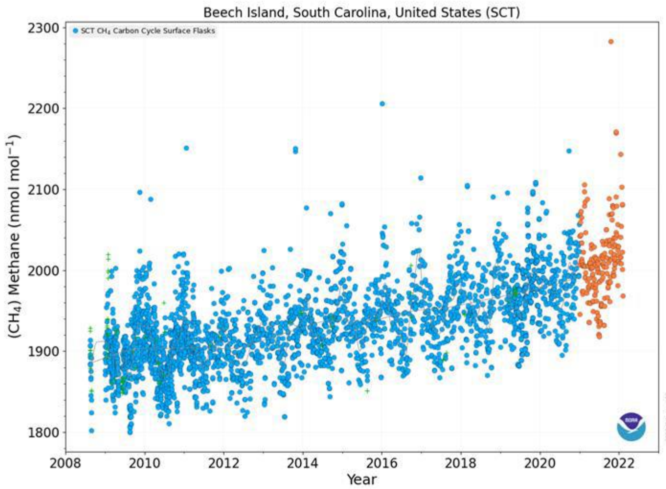
EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0015

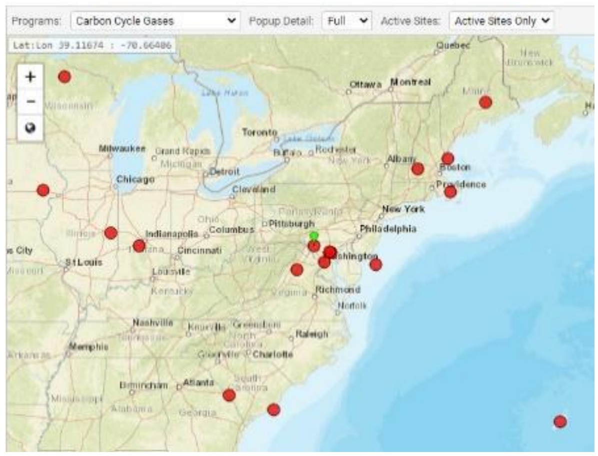
Kirk Frost

Comment 52: Global Warming Potential (GWP) title needs to be Warming Potential (WP)

On the EPA website, it states (my highlighting): “The Global Warming Potential (GWP) was developed to allow comparisons of the global **warming impacts of different gases**. Specifically, it is a measure of **how much energy the emissions of 1 ton of a gas will absorb over a given period of time**, relative to the emissions of 1 ton of carbon dioxide (CO2).” (Link: https://www.epa.gov/ghgemissions/understanding-global-warming-potentials)

As we can see from NOAA’s methane atmospheric concentration monitors (link: https://gml.noaa.gov/dv/iadv/), the concentration of methane varies from region to region and is influenced by the various sources of the methane emissions in each region. Warming Potential measures “the heat absorbed by any greenhouse gas in the atmosphere, as a multiple of the heat that would be absorbed by the same mass of carbon dioxide (CO2).” (Link: https://en.wikipedia.org/wiki/Global_warming_potential) This is highly dependent on the regional methane emission sources. IPCC actually presents different data sets for direct fossil fuel emissions, natural bio methane emissions and emissions that are a combination of both sources. The NOAA’s methane concentration monitoring can indicate how close to being cyclic the methane concentration is, which can be tied directly to human behavior causes (fossil fuel emissions) through heating and energy consumption that is seasonal. Unfortunately, most of NOAA methane atmospheric monitoring locations in the Northeast US do not collect methane emissions and none use real time monitoring towers (in Situ Observatory). For example, Beach Island SC uses manual flask captured measures.





Each monitoring point demonstrates different concentration amounts of methane, but every site I have reviewed demonstrates a highly cyclic (seasonal) pattern and also increasing concentration year over year.

We need more methane atmospheric monitoring installed, especially near shale plays. This is a methane measure that should be included in the EPA greenhouse gas emissions and sinks. Additionally, since each methane atmosphere measuring point gives a direct indication of methane emissions and warming potential specific to that area (at most 100-mile diameter area). Since methane warming varies from region to region and is demonstrated by NOAA's few methane monitor locations, it critical to use the term methane warming potential, not methane global warming. It is true we are seeing global warming, but the warming potential is dependent on the regional area.

Finally, the term Global Warming Potential automatically enables elected officials, agency representatives (such as several commissioners in FERC) and the greater United States public to conclude it is a global issue and not relative to US concentrations. This is a severe miscommunication that encourages false and misrepresentative dialogue to the public in the US. We can speak of Global Warming and Climate Change, but when we are reviewing methane emissions, it needs to be a discussion of Methane Warming Potential (MWP) relative to areas in the United States. This is critical for the EPA to correct in order to educate and engage the US public.

Terminology is critical. Current terminology is enabling elected officials, agencies and commissions, to mislead the public that greenhouses gases in the US are not a problem. The fact that the EPA shows its methane emissions as decreasing is also another false flag that needs to be corrected, but I have already pointed that out to the EPA in prior comments. The EPA should instead state estimated methane emissions are provided with a 25% certainty, acknowledging that:

1. Many stationary sources in the fossil fuel supply chains are missing (detailed in prior comments)
2. Existing stationary sources are only estimates provided by the stationary source owner
3. There are examples (as I have provided in previous comments) that owners or underreporting emissions
4. There are no auditing or validation measures currently place, but will be once the EPA employs the OGI (optical gas imaging) process for auditing fossil fuel facility methane emissions.

Hence, we need to bring the accountability of fossil fuel methane emission within the US to the US agencies and commissions and denote it as methane warming potentials tied to each shale play and the natural gas transmission systems from those shale plays in the United States.

Response: These comments related to refinement of terminology to refer to warming potential of gases, EPA regulations and facility-level monitoring and reporting are noted but are out of scope for this technical review of the national GHG Inventory.

Comment 53: Warming Potential Analysis must be discretely separate from greenhouse gas emissions reporting

Warming Potential Analysis (WPA) is a discrete separate discipline than greenhouse gas emissions reporting. WPA involves many areas of science cover broad systems of the earth in relation to the atmosphere and sunlight. Whereas, gas emissions reporting involves disciplines of natural gas combustion and fugitive emissions along with substantial data analysis to identify faulty reporting from the stationary sources as well as live audits of actual emissions. Both disciplines require different skillsets, education and knowledge and the two produce very different results. WPA produces a region's WP for each greenhouse gas emission and from what source (fossil fuels, naturally occurring bio emissions and landfills) and to what total cumulative extent of warming potential for a specified area based off of all systems and dynamics relative to that region. Greenhouse gas emissions reporting focuses on sources of emissions, capturing the best efforts for natural emissions as well as enforcing and auditing greenhouse gas emissions from anthropogenic sources.

Currently, the EPA provides little insight into WPA and instead uses the CO2e for methane and other greenhouse gases as if that were to presuppose warming potential. WPA is entirely separate from emissions reporting and I urge that the EPA first focus on the greenhouse gas emissions reporting as just that, reporting the actual emissions of the entire natural gas system, the coal system and the oil system in each greenhouse gas as the measurement of that gas (i.e. methane reported as methane emissions – no other false equivalence or rolled up term).

Response: These comments related to conducting a warming potential analysis are noted but they are out of scope for this techncial review of the national GHG Inventory

Comment 54: Urge the EPA to eliminate the misrepresentative AR4 GWP 100-year multiplier in emissions reports

I continue to raise this point in most of my comments and will continue until the EPA removes this false misrepresentation of methane as carbon dioxide. Since most agencies use the EPA standards and requirements for greenhouse gas emissions reporting, it is critical that the EPA eliminate this CO2e AR4 100-year mapping of methane to carbon dioxide as a fixed 100-year multiplier.

There is no fixed equivalency between methane and carbon dioxide. Even the EPA website states that this warming potential "is a measure of how much energy the emissions of 1 ton of a gas will absorb **over a given period of time**" (as referenced above) in section a.).

A recent study captures more articulately, "Methane emissions induce an atmospheric feedback by decreasing the hydroxyl concentration, thereby increasing methane's lifetime. The strength of this feedback factor, approximately 1.3–1.4, causes the lifetime of a marginal emission, known as the perturbation lifetime, to be significantly higher than the lifetime of methane already in the atmosphere [7,8]." (link: https://royalsocietypublishing.org/doi/pdf/10.1098/rsta.2021.0104)

The IPCC provides data sets for calculating the methane warming potential for each year of methane after that completely contradicts the CO2e equivalency. Additionally, we need to see methane emissions reported in measurements of methane emissions, no equivalencies. When the EPA is able to fully assess Methane Warming Potential Analysis, then produce the complete WPA presentation separate from the methane emissions.

Get rid of CO2e AR4 25 multiplier for reporting methane emissions into a false equivalency. Please enforce that all other agencies remove this false reporting.

Response: These comments related to conducting a methane warming potential analysis are noted but they are out of scope for this technical review of the national GHG Inventory.

Comment 55: Urge EPA to work with other Federal Agencies and Commissions regarding Climate Change analysis and accurate emissions

In my previous comment, I presented four compressor station examples where 2 stations that demonstrate the underreporting of methane emissions as virtually impossible (TGP CS-325 and Transco CS-505) and 2 stations that demonstrate emissions from electric compressors that do not exist in the EPA greenhouse gas stationary sources of emissions, despite substantial methane emissions (Texas Eastern Transmission Corp.'s Freehold Compressor station and TGP CS-327).

Applicants for transmission expansion projects submit to FERC contradicting specifications for the identical turbine used (example CP20-493 and CP21-94 both giving conflicting specifications for the Solar Taurus 70 turbine). Yet, FERC will not compare identical turbines from different FERC projects. EPA doesn't provide any input on these contradictions either.

All Federal agencies need to coordinate, collaborate and enforce a more concise reporting of emissions or pressing the transmission pipelines to substantiate their claims with real live publicly available methane emissions monitoring of the turbines.

This is also true for climate change analysis and warming potential. All scientists acknowledge that carbon dioxide warming potential is cumulative, meaning that each year's emissions are added to the next year and so on. So where is the analysis of full cumulative carbon dioxide warming potential for existing carbon dioxide emissions from existing facilities and also for new transmission expansion projects in terms of existing and added carbon dioxide warming potential?

Response: These comments on analysis of full cumulative carbon dioxide warming potential for existing carbon dioxide emissions from existing facilities and for new transmission expansion projects are noted but they are out of the scope for this technical review of the national GHG Inventory.

Commenter: Private Citizen

EPA Docket ID No.: EPA-HQ-OAR-2021-0001-0013

Coralie Pryde

Comment 56: Methane Global Warming Potential

Unfortunately, I only heard about this comment period today (March 11, 2022), so I cannot give this draft document the time and attention it deserves. I will, however comment on one aspect that I think is very important.

The report uses a Global Warming Potential (GWP) for methane of 25. This is roughly the average GWP over 100 years, although many researchers consider a range of 28-34 more relevant,
Using this value does not take into account the very much higher GWP of methane in the first decade, or even the first year, after it is released. Estimates of methane GHP for the first month or so after methane is emitted are highly uncertain, but have been estimated to be as high as 500. For the first year GWP is probably >120. For the first decade, it appears to be at least 110. (https://www.gti.energy/wp-content/uploads/2019/02/CMR-Implications-Using-Different-GWP-Time-Horizons-White-Paper-2019.pdf For 20 years, the GWP is usually estimated to be ~ 87.

I believe that in the climate crisis we are now beginning to experience, GWP20 or better , GWP10 would be more relevant, [NOTE: the reference listed above suggests that using the Global Temperature Potential (GTP) would be better for measuring the effects of methane, but that won't be done in this comment.]

Our current timeline asks that we get to zero net emissions by 2050 to avoid going above 1.5 °C. But the latest IPCC report says that we will pass that temperature by 2040. Based on the trends in these reports, I have little doubt that that date will move to 2035 before long.

We also need to consider that the temperature in the Arctic is rising far faster than the global average. We are already seeing methane being released as ponds thaw in the Arctic. There are also the huge gas emission craters formed in western Siberia. Although I am a chemist, rather than an atmospheric scientist, I can only believe that the increasing incidence of such phenomena indicates that we are fast approaching a tipping point in which the release of methane stored in our soil, lakes and oceans will overwhelm any attempts to control global warming.

If we are to control global warming at all, we must do as this last IPCC report indicated and make very large and immediate reductions in methane emissions. The easiest way to do that is to reduce emissions from gas and oil drilling. If emissions from these processes cannot be reduced to around one percent of total within the decade, all new drilling should be banned. Taking such a radical step can only be done if everyone understands the dire effects of methane. Listing the GWP100 disguises this effect. Listing GWP10 would at least make it clear.

At at least one point in the draft report, a reasonable estimate for GWP10 for methane needs to be listed and discussed in terms of the absolute necessity of reducing methane emissions.

Response: See response to comment #4.

Commenter: Private Citizen

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0017

Agnes Marsala

Comment 57: Report as actual emissions

Dear Administrator Regan,

Thank you for the positive changes at EPA in terms of actually being an agency focused on protecting the environment. The EPA is making significant progress in closing the unaccounted for methane emissions gap that exist in the natural gas supply chain with the new rules proposed.

I think all emissions should be reported as actual emissions from each greenhouse gas and denoted as estimate or actual measurement verified.

Emissions reporting could then be followed by true global warming potential (GWP) analysis that is separate from emissions. GWP means carbon dioxide emissions are cumulative and additive each year starting from first recorded emissions and methane emissions are 120 times carbon dioxide in the first year of emission and decays each year thereafter .

Finally, please continue to press for the reporting of methane emissions from leaks in both extraction and delivery.

Thank you for all your efforts to navigate the rapidly changing world of GHG emissions. Your work is vital to helping bring about a more sustainable world.

Sincerely,

Agnes Marsala

Response: EPA appreciates the commenter's perspectives and refers commenter to response to Comment #4.

Commenter: Private Citizen

EPA Docket ID No.: EPA-HQ-OAR-2022-0001-0024
Nancy LaPlaca

Comment 58: Methane GWP

For nearly seven years, since the IPCC released its 4th Assessment in 2013-2014 (and then 5th Assessment a few years later), I have wondered why does the EPA use the GWP (Global Warming Potential) for CH4 (methane) from 2007, and not 2014 and subsequent years?

I am afraid the answer is that if the EPA used the correct GWP, i.e. 80x CO2 per AR4 (4th Assessment Report) it would have shut down new natural gas power plants in the U.S. It's pretty obvious now how much damage is being done by CH4.

In NC, where I live, Duke Energy didn't even have HEARINGS on its "automatic" permits for coal plants converted to natural gas. This is simply not the way to honestly assess whether CH4 is worse for the climate than CO2, which it clearly is.

We are currently experiencing abrupt climate change, and we must quit the fantasy that CH4 is somehow less harmful to our climate than CO2.

In a nutshell: use the correct GWGP for CH4, which is at least 80, per AR4, AR5 and now AR6. I also want to add that the corruption of our regulatory system by utilities is a terrible problem. After 15 years of fighting stupidity from "clean" coal to CCS (Carbon Capture and Sequestration), and desperately trying to keep utilities from killing solar, it's way beyond the time for change.

My humanity is much more important than my profession. I am terribly worried that my stepkids and grandkids are going to live in a climate that is, frankly, unlivable, around 2040.

Response: See response to Comment #4.