Methane Emissions Contribute to Both Near- and Longer-Term Climate Damages

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Dr. Ilissa B. Ocko, PhD
Senior Climate Scientist
Environmental Defense Fund
1875 Connecticut Ave NW, Ste 600
Washington, DC 20009

This report aims to enhance public understanding of climate impacts over all timescales, both near- and long-term.

Methane is a considerable driver of near-term climate change, responsible for a quarter of the warming we are experiencing today.[1] This year's emissions of methane from human activities will contribute 30% more to warming over the next 10 years than this year's emissions of carbon dioxide from fossil fuels.[2] Globally, around a quarter of human-emitted methane comes from the oil and gas sector,[3] and current trends suggest that methane from global oil and gas will soon overtake livestock as the dominant source from human activities.[4] Domestically, the EPA recognizes that the oil and gas sector is the largest industrial source of methane emissions in the United States, accounting for nearly one-third of U.S. methane emissions.[5] However, the actual amount of emissions is almost certainly higher, as studies show the EPA underestimates methane emissions from the oil and natural gas section by approximately sixty percent,[6] and

[1] Calculation from Shindell et al. 2009 of fraction of total positive radiative forcing that methane emissions are responsible for; Shindell, D.T., Faluvegi, G., Koch, D.M., Schmidt, G.A., Unger, N. and Bauer, S.E., *Improved attribution of climate forcing to emissions*, 326(5953) SCIENCE 716-718 (2009).

[2] Calculation based on current emissions of methane and carbon dioxide Environmental Protection Agency, Global Anthropogenic Non-CO2 Greenhouse Gas Emissions: 1990-2030 (2012); International Energy Agency World Energy Outlook (2018), atmospheric lifetimes from IPCC, 2013: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* ("IPCC AR5 2013") ") (Chapter 8: Myhre, G., Shindell, D., Bréon, F.-M., Collins, W., Fuglestvedt, J., Huang, J., Koch, D., Lamarque, J.-F., Lee, D., Mendoza, B., Nakajima, T., Robock, A., Stephens, G., Takemura, T., and Zhang, H.: Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocke, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2013), and radiative properties for CO2 and methane indirect from IPCC AR5 2013 (WGI Chapter 8 – Myhre et al. 2013) and methane direct from Etminan, M., Myhre, G., Highwood, E. J., & Shine, K. P. (2016), *Radiative forcing of carbon dioxide, methane, and nitrous oxide: A significant revision of the methane radiative forcing*, Geophysical Research Letters, 43(24).

[3] EPA GLOBAL ANTHROPOGENIC NON-CO2 GREENHOUSE GAS EMISSIONS: 1990-2030, *available at* https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases/global-anthropogenic-non-co2-greenhouse-gasemissions.

[4] Projections calculated from emissions data from livestock from Food and Agriculture Organization (FAO), *available at* http://www fao.org/faostat/en/#home; and emissions data from oil and gas from International Energy Agency World Energy Outlook 2018, *available at* https://www.iea.org/weo2018/.

[5] *Overview of Greenhouse Gases: Methane Emissions*, EPA.GOV, https://www.epa.gov/ghgemissions/overview-greenhouse-gases#methane (last visited Oct. 8, 2019).
[6] Ramon A. Alvarez, et al, *Assessment of Methane Emissions from the U.S. Oil and Gas Supply Chain*, 361 SCIENCE 186, 186 (2018), *available at* https://science.sciencemag.org/content/361/6398/186 (last accessed Oct. 8, 2019).

nearly two percent of those emissions happens during extraction and delivery.[7] Of all methane sources from human activities, reducing waste of gas from oil and gas operations—whether that waste is through venting, flaring, or leaking—presents an important opportunity considering its cost-effectiveness, technological availability, and immediate impacts on climate.

For the same mass of carbon dioxide (CO_2) and methane emissions, methane can trap 120 times more heat than CO_2, both directly from methane as a greenhouse gas and indirectly from the production of further greenhouse gases: tropospheric ozone, stratospheric water vapor, and CO_2.[8] Over a twenty-year period, this number drops to 84 as methane dissipates from the atmosphere more quickly than CO_2.[9] The latest science suggests that methane absorbing shortwave radiation in addition to longwave significantly increases its radiative potency by nearly 25%.[10] Including the shortwave component in calculations, the twenty-year number jumps from 84 to 96.

Further, through the creation of tropospheric ozone, methane contributes to ground-level ozone, which is harmful to humans and is linked to short- and long-term negative health effects, including shortness of breath, decreased lung function, and chronic obstructive pulmonary disease (COPD). Ozone also aggravates existing cardiovascular and respiratory conditions, such as asthma, emphysema, and bronchitis, with long-term exposure increasing the risk of death from these conditions. As nearly one in three Americans are exposed to harmful levels of ozone,[11] reducing methane emissions would directly enhance human health while improving air quality and mitigating climate change.[12]

Methane only lasts for approximately a decade in the atmosphere (though its effects can last much longer),[13] because it is oxidized on average after 12.4 years, breaking down and forming

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[7] J.A. Littlefield, et al., *Synthesis of Recent Ground-level Methane Emission Measurements from the U.S. Natural Gas Supply Chain*, 148 Journal of Cleaner Production 118, 118 (2017).

[8] IPCC AR5 2013, Myhre, Gunnar et al*., Anthropogenic and Natural Radiative Forcing*, *available at* http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf.

[9] *Id.*

[10] Etminan, M., Myhre, G., Highwood, E. J., & Shine, K. P. (2016). Radiative forcing of carbon dioxide, methane, and nitrous oxide: A significant revision of the methane radiative forcing. Geophysical Research Letters, 43(24).

[11] U.S. GLOBAL CHANGE RESEARCH PROGRAM, IMPACTS, RISKS, AND ADAPTATION IN THE UNITED STATES 518, D.R. REIDMILLER, ET AL . (eds., 4th ed, 2018).

[12] *Id.* at 512.

[13] For example, as discussed below, oceans absorb 90% of the excess heat trapped by greenhouse gases. Therefore, even though the methane is gone and no longer trapping additional heat in the atmosphere, the

other chemical species.[14] Methane reductions, therefore, can rapidly slow the rate of warming.[15] Even though methane forms tropospheric ozone, another strong greenhouse gas, when it oxidizes, the ozone does not last long in the atmosphere, contributing to the immediacy of the climate benefits of reduced methane.

It is crucial to limit both the rate of near-term warming and long-term warming, in order to reduce warming impacts during our lifetimes and for generations to come. Both near- and long-term warming are associated with specific sets of damages, and all must be reduced. Near-term warming impacts infrastructure, plant and animal species survival rates,[16] extreme events, and sea level rise.[17] Long-term warming impacts glacial melt, permafrost melt, tipping points, shifts in biomes, and more. Carbon dioxide is the main driver of long-term warming because of its long atmospheric lifetime.[18] Methane emissions are an important driver of near-term warming, and so taking immediate steps to reduce methane emissions can help to immediately impact warming rates.[19] Conversely, allowing near-term methane emissions to persist will accelerate this harmful warming.[20]

warming that it had caused is now in the oceans, contributing to sea level rise decades to come. Hu, A., Xu, Y., Tebaldi, C., Washington, W.M. and Ramanathan, V., *Mitigation of short-lived climate pollutants slows sea-level rise*, 3 NATURE CLIMATE CHANGE 730 (2013).

[14] Myhre, *supra* note 8.

[15] Shoemaker, J.K., Schrag, D.P., Molina, M.J. and Ramanathan, V., *What role for short-lived climate pollutants in mitigation policy?*, 342(6164) SCIENCE 1323-1324 (2013); Shindell, D., Kuylenstierna, J.C., Vignati, E., van Dingenen, R., Amann, M., Klimont, Z., Anenberg, S.C., Muller, N., Janssens-Maenhout, G., Raes, F. and Schwartz, J., *Simultaneously mitigating near-term climate change and improving human health and food security*, 335(6065) SCIENCE 183-189 (2012).

[16] Settele, J. et al., *Terrestrial and Inland Water Systems*, CLIMATE CHANGE 2014: IMPACT, ADAPTION, AND VULNERABILITY. CONTRIBUTION OF WORKING GROUP II TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2014), *available at* http://www.ipcc.ch/pdf/assessmentreport/ar5/wg2/WGIIAR5-Chap4_FINAL.pdf.

[17] Hu et al., *supra* note 13.

[18] Myhre et al., *supra* note 8.

[19] Shindell et al., *supra* note 15.

[20] *Id.*

Warming to date has already negatively impacted every continent and every ocean,[21] and resulted in tropical island villages disappearing,[22] Arctic houses sinking,[23] coral reefs dissolving and dying,[24] mosquito seasons growing weeks longer,[25] and worsened extreme heat events yielding high death tolls.[26] Continuing methane emissions will likely result in more pronounced impacts in the future. Further warming also enhances the risk that the climate surpasses irreversible tipping points that could render long-term climate stabilization difficult or impossible.[27] Immediate methane reductions can therefore also mitigate long-term warming and make it easier to stabilize global warming below 1.5 °C.[28] But inaction may cause permanent damage or irreversible impacts for thousands of years.[29]

Reducing emissions of methane will also help to limit sea level rise. Ninety percent of heat that is trapped in the atmosphere gets absorbed by the oceans.[30] While methane only lasts for about a decade in the atmosphere, a substantial fraction of the atmospheric heating that methane causes during this period is absorbed by the oceans, where the warming signal lasts

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[21] IPCC, CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY, SUMMARY FOR POLICY MAKERS, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf

[22] Albert, S., Leon, J.X., Grinham, A.R., Church, J.A., Gibbes, B.R. and Woodroffe, C.D*., Interactions between sea-level rise and wave exposure on reef island dynamics in the Solomon Islands*, 11(5) ENVIRONMENTAL RESEARCH LETTERS 054011 (2016).

[23] ALASKA CLIMATE CHANGE IMPACT MITIGATION PROGRAM, https://www.commerce.alaska.gov/web/dcra/planninglandmanagement/accimp.aspx.

[24] Muehllehner et al., *Dynamics of carbonate chemistry, production, and calcification of the Florida Reef Tract (2009-2010): Evidence for seasonal dissolution*, 30(5) GLOBAL BIOGEOCHEMICAL CYCLES 661, 661-688 (2016); ONLY 7% OF THE GREAT BARRIER REEF HAS AVOIDED CORAL BLEACHING, http://www.coralcoe.org.au/media-releases/only-7-of-the-great-barrier-reef-has-avoided-coral-bleaching.

[25] *Id.*

[26] EXPLAINING EXTREME EVENTS FROM A CLIMATE PERSPECTIVE, https://www.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-societybams/explaining-extreme-events-from-a-climate-perspective/; WORLD WEATHER ATTRIBUTION, https://wwa.climatecentral.org/analyses/.

[27] Lenton, T.M., Held, H., Kriegler, E., Hall, J.W., Lucht, W., Rahmstorf, S. and Schellnhuber, H.J., *Tipping elements in the Earth's climate system*, 105(6) PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 1786-1793 (2008).

[28] W.J. Collins, et al*., Increased Importance of Methane Reduction for a 1.5 Degree Target*, Env't Res. Letters, 13, 054002, https://iopscience.iop.org/article/10.1088/1748-9326/aab89c (last visited Oct. 8, 2019); *see also* IPCC, SUMMARY FOR POLICYMAKERS OF IPCC SPECIAL REPORT ON GLOBAL WARMING OF 1.5 C APPROVED BY GOVERNMENTS, Chapter 2 (Oct. 8, 2018), *available at* http://www.ipcc.ch/sr15/chapter/chapter-2/.

[29] *U.S. Global Change Research Program* at 1357.

[30] IPCC, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, SUMMARY FOR POLICY MAKERS (2013), http://www.climatechange2013.org/images/report/WG1AR5 SPM FINAL.pdf.

far longer than in the atmosphere. Accordingly, near-term methane emissions can cause sea level rise for decades to come.[31]

In the three years since EPA issued the New Source Rule, existing oil and gas sources have emitted 33.4 million metric tons of methane.[32] This is equivalent to the 20-year[33] climate impact of nearly 600 million passenger vehicles driving for one year or over 3,000 billion pounds of coal burned. Federal emissions guidelines could have prevented 12.2 million metric tons of these methane emissions,[34] equivalent to the climate impact of over 200 million passenger vehicles driving for one year or over 1,000 billion pounds of coal burned.[35]

Each additional year EPA delays the adoption of federal emissions guidelines for existing sources will allow methane emissions that would otherwise be prevented. For example, in 2021, existing sources will emit 9.8 million metric tons of methane.[36] This is equivalent to the 20-year[37] climate impact of over 170 million passenger vehicles driving for one year or nearly 900 billion pounds of coal burned. Federal emissions guidelines could prevent 3.6 million metric tons of these methane emissions,[38] equivalent to the climate impact of over 60 million passenger vehicles driving for one year or over 330 billion pounds of coal burned.[39] Once released, methane emissions cannot be removed from the atmosphere and will contribute to both near- and longer-term climate damages, including impacts associated with an increased rate of warming, sea level rise, and others.

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[31] Hu et al., *supra* note 13.

[32] *See* Dr. Renee McVay and Hillary Hull (2019). Assessment of Harm to the Public from a Continued Delay by EPA Promulgating Methane Guidelines for Existing Sources. EDF.

[33] Calculation uses the IPCC AR5 WGI 20-year GWP. The latest science, *see* n. 10, *supra*, suggests that this GWP is 14% higher than what is reported in the IPCC and therefore the number of vehicles would be over 680 million and the number of pounds of coal burned would be over 3,500 billion.

[34] *See* Dr. Renee McVay and Hillary Hull (2019). Assessment of Harm to the Public from a Continued Delay by EPA Promulgating Methane Guidelines for Existing Sources. EDF.

[35] Updated for the latest science, *see* n. 10, *supra*, the number of vehicles would be nearly 250 million and the number of pounds of coal burned would be over 1,200 billion.

[36] *See* Dr. Renee McVay and Hillary Hull (2019). Assessment of Harm to the Public from a Continued Delay by EPA Promulgating Methane Guidelines for Existing Sources. EDF.

[37] Updated for the latest science, *see* n. 10, *supra*, the number of vehicles would be nearly 200 million and the number of pounds of coal burned would be over 1 trillion.

[38] *See* Dr. Renee McVay and Hillary Hull (2019). Assessment of Harm to the Public from a Continued Delay by EPA Promulgating Methane Guidelines for Existing Sources. EDF.

[39] Updated for the latest science, *see* n. 10, *supra*, the number of vehicles would be over 70 million and the number of pounds of coal burned would be over 370 billion.