Testimony of John Fitzgerald
On behalf of Methane Action—MethaneAction.org—
And Remineralize the Earth
To the Senate Subcommittee on Interior, Environment, & Related Agencies

Regarding: The programs of the EPA, DOI/BLM, and USDA/Forest Service
On Removing Methane and other Greenhouse Gases From the Atmosphere

Mr. Chairman and Members of the Subcommittee,

In this testimony, Methane Action and Remineralize the Earth, not for profit organizations, summarize our detailed recommendations[1] for removing methane and other major greenhouse gases from the atmosphere and beginning the governance of these methods. These recommendations are from scientists, lawyers, economists and engineers with expertise in the rapidly evolving science and policy of methane removal.[2] The world must rapidly reduce emissions, of potent short-lived climate pollutants (SLCPs)[3] such as methane, which is over 80 times more powerful than CO_2 in its impact period of 20 years. Methane is now at twice its preindustrial levels in the atmosphere and rising every year, and a burst of methane could erupt at any time from the melting permafrost and shallow waters off Siberia. Therefore, we must develop and deploy methods of converting or removing methane and other "SLCPs" responsibly and soon.

This Subcommittee has the power to take the lead. We recommend that you include in your FY23 bill the language below to create a Climate Restoration Program and that your Committee Report include descriptions of the removal methods below to guide the EPA, though the agency could adjust the details. To come within your §302(b) allocation, you could reduce the amounts appropriated for grazing on public lands and for harvesting mature forests on public lands by an amount equal to the budget enhancement for the Climate Restoration Program.

Suggested Bill Language:

ENVIRONMENTAL PROTECTION AGENCY

SCIENCE AND TECHNOLOGY

After adding $34,800,000 to the section total, insert: "Of the funds included under this heading, no less than $34,800,000 shall be allocated for the establishment of a Climate Restoration Program beginning with the research, development, assessment and deployment of methods for the long term removal, oxidizing or destroying methane and other greenhouse gases both near and far from their sources, including but not limited to,

[1] We have provided, e.g., a memo to your staff under the title "Catalog of Research Needs".
[2] (See, E.g., scientists' letter of April 2021 at MethaneAction.org).
[3] Mitigating climate disruption in time: A self-consistent approach for avoiding both near-term and long-term global warming. Dreyfus, G. B., Xu, Y., Shindell, D. T., Zaelke, D., & Ramanathan, V. (2022). *Proceedings of the National Academy of Sciences*, *119*(22), e2123536119. https://doi.org/10.1073/pnas.2123536119

filters, oxidation, photocatalysis, bacterial action, enhanced rock weathering, and regenerative agriculture to improve soil health and carbon drawdown, as further described in the report accompanying this Act."

Suggested Committee Report Language: Several of the following Climate Restoration research programs could cover more than one year with contracts or grants committed or obligated in FY23. These examples are illustrative and not meant to be definitive or exhaustive. All are expected to be cost-effective. For comparing the cost of removing methane and other climate-forcing gases, the term "CO_2 equivalent" (CO_2-eq) refers to removing an amount of the gas that has global warming potential equivalent to an equal amount of CO_2.

1. Zeolite surfaces. Zeolites are porous, high surface area alumina-silicate minerals whose ability to adsorb CO_2 is known. The methane-oxidizing catalysts copper (Cu)- and iron (Fe)-zeolites have recently been shown to oxidize methane.[4] Scientists have screened almost 100,000 zeolite structures as potential methane sorbents. Relatively low-temperature methane oxidation has already been shown in zeolites such as Cu-ZSM-5 (copper) and Fe-ZSM-5 (iron), with iron zeolites able to oxidize methane at room temperature. Higher temperatures and pressures generally lead to greater conversion efficiencies. Stanford University and Massachusetts Institute of Technology (MIT) are both developing versions. (MIT's research is partially funded to date by DOE/ARPA-E)**.** Cost effectiveness: Target of $50-100 per metric ton of CO_2-eq**.** Funds needed: **$1,000,000**

2. Photocatalytic surfaces (small scale urban solar chimneys). Photocatalysts are metal oxide minerals which, when activated by sunlight or by artificial UV-light, are able to oxidize organic pollutants and greenhouse gases at room temperature.[5] The smaller the size of the nanoparticles, and the larger the surface area and porosity, the faster the oxidation rate. Several are proven to fully oxidize methane, such as modified zinc oxide or titanium dioxide. Trials would be conducted on the ventilation system of an agricultural facility for cattle. Then a prototype would be tested on a landfill. Cost effectiveness: Estimate of $166 per metric ton of CO_2-eq by 2030 with a target of $100 by 2040. Funds needed: **$5,500,000**

3. Photocatalytic large-scale solar chimneys and solar chimney power plants. Large solar chimneys can be built to cause heated air to updraft, which provides flowing air that can generate electricity through a turbine, comparable to a wind turbine.[6] The structure and

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[4] Methane removal and atmospheric restoration. Jackson, R. B., Solomon, E. I., Canadell, J. G., Cargnello, M., & Field, C. B. (2019). *Nature Sustainability*, *2*(6), 436-438. https://doi.org/10.1038/s41893-019-0299-x; Atmospheric- and Low-Level Methane Abatement via an Earth-Abundant Catalyst. Rebecca J. Brenneis, Eric P. Johnson, Wenbo Shi, and Desiree L. Plata, 29 December 2021, *ACS Environment Au*. https://doi.org/10.1021/acsenvironau.1c00034

[5] The comprehensive performance analysis on a novel high-performance air-purification-sterilization type PV-Trombe wall. Yu, B., Li, N., Yan, C., et al. (2022). *Renewable Energy*, *182*, 1201-1218. https://doi.org/10.1016/j.renene.2021.11.029; A new double-skin façade system integrated with TiO2 plates for decomposing BTEX. *Building and Environment*, *180*, 107037. Li, H., Zhong, K., & Zhai, Z. J. (2020). https://doi.org/10.1016/j.buildenv.2020.107037

[6] Removal of non-CO2 greenhouse gases by large-scale atmospheric solar photocatalysis. De Richter, R., Ming, T., Davies, P., Liu, W., & Caillol, S. (2017). *Progress in Energy and Combustion Science*, *60*, 68-96. https://doi.org/10.1016/j.pecs.2017.01.001; Ming, Tingzhen, et al. "Solar chimney power plant integrated with a photocatalytic reactor to remove atmospheric methane: A numerical analysis." *Solar Energy* 226 (2021): 101-111. https://doi.org/10.1016/j.solener.2021.08.024

coatings on the solar chimney allow flowing air to be cleansed of methane and other GHGs via photocatalytic coatings or other methods. Cost effectiveness, as in 2 above. **$3,000,000**

4. Iron salt aerosols demonstration phase. Many ships burn low-cost bunker fuels that contain metals including iron that may have the favorable side effect of enhancing the naturally occurring chlorine atom oxidation of methane.[7] The mix of particle-phase iron, sunshine, and sea spray (containing natural chloride) generates chlorine atoms that oxidize methane in the ship's plume. University researchers are prepared to demonstrate this mechanism using a combination of laboratory experiment, reaction system modeling, large scale prototype, and field observations. After appropriate assessment, consultation, permitting and governance, practitioners could potentially harness its power to control methane **at scale**, in order to substantially reduce global atmospheric methane concentrations. This approach would take advantage of shipping traffic and the large volumes of air that are in contact with diluted ship plumes. Cost-effectiveness: Potentially below $9 per metric ton of CO_2-eq. Full environmental impact assessment should be completed. Methane Action has had a template for such assessments prepared by an independent consultant. Funds needed: **$3,500,000**

5. Chlorine based photochemical removal at point sources. This method generates methane-oxidizing chlorine atoms using low-cost light sources and recycles the chlorine within a closed reactor. Cost-effectiveness: Modeling based on power requirement results in a price of $9 per ton of CO_2-eq. Funding needed: $2 million for a prototype to test at livestock barns and a coal mine vent. Funds needed: **$2,000,000**

(See detailed Catalog of Research Needs sent to Subcommittee staff for items 6-10 and 16.)

11. Surface-based Photocatalytic Enhanced Methane Oxidation (SPEMO). Given the environmental justice and public health co-benefits of this approach that would reduce ground level ozone pollution as well, the Committee expects the EPA, in cooperation with the Secretaries of Interior and State, and USAID, to contract for research and development of SPEMO to lower methane emissions from coal mines, oil wells and animal farms, and apply photocatalytic coating to buildings, windows, rooftops, and photovoltaic panels, or in a ventilated conduit to reduce methane in the atmosphere as a complement to commercial photocatalytic coatings already being used because of their self-cleaning property and ability to reduce urban pollution such as nitrogen oxides and volatile organic compounds. Funds needed: **$3,000,000**

12. Capturing methane at Arctic seeps—Field Test. The U.S. start-up Frost Methane is successfully using recycled parachutes to capture and flare methane from seeps in Arctic lakes. Through collaboration with a large dredging company, develop and test a low-cost structure made of stones and sand that can capture methane seeps in the Arctic Ocean (especially in the shallow parts of the Siberian Sea). A typical project covers a circular field of 200-meter diameter, guiding the methane to an exit point where the gas is captured and flared. Cost-range: Using seep emission of 176 g/m^2/day, estimate of cost: $6.7–$25/ton CO_2-eq. Broad field-testing would require a larger budget but this step would measure the results at a research facility and plan the broader field tests. Funds needed: **$100,000**

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[7] A nature-based negative emissions technology able to remove atmospheric methane and other greenhouse gases. Ming, T., de Richter, R., Oeste, F. D., Tulip, R., & Caillol, S. (2021). *Atmospheric Pollution Research*, *12*(5), 101035. https://doi.org/10.1016/j.apr.2021.02.017; Wittmer, J., & Zetzsch, C. (2017). Photochemical activation of chlorine by iron-oxide aerosol. *Journal of Atmospheric Chemistry*, *74*(2), 187-204. https://doi.org/10.1007/s10874-016-9336-6

13. Agricultural and silvicultural methane removal while enhancing production and nutrition. In cooperation with USDA, the Committee expects the EPA to contract for an evaluation of methane and other greenhouse gases sequestration, uptake, oxidation and other long-term removal methods in agricultural and forestry, including, but not limited to, the methods described below: a) Rice—With a goal of cutting methane emissions from rice cultivation in half and enhancing plant growth, contract in FY 2023 for a test of the methane removal impact of various additives to rice, including iron sulfates, already approved for organic farming to enhance yields, fight plant chlorosis, and improve the nutritional value of rice by enhancing iron levels in conjunction with other changes in rice farming practice such as targeting the flooding of fields more efficiently. The production of rice, a basic staple for nearly half the world population, produces about 8% of global methane emissions and 2.5% of radiative forcing, and these are expected to double by 2100. b) Livestock—Methods of reducing the emissions of methane from cows, sheep and other livestock range from adding food supplements made of red seaweed (U.S.) to planting native plants that reduce methane generation in sheep that graze on those plants (France). Active methane removal from livestock barns and coalmines is to be tested in Denmark. We expect the EPA to conduct a broad livestock methane reduction and removal research and demonstration program in cooperation with relevant agencies. Funds needed: **$7,000,000**

14. Methane mitigation via wetlands management. Wetlands are 31% of total methane emissions. In cooperation with USDA and the Army Corps of Engineers, the EPA is expected to contract for an investigation of relative wetland emissions of methane, through field surveys and laboratory experiments, to determine how alternative management practices could reduce greenhouse gas emissions and restore natural ecosystems. **$1,500,000**

15. Comprehensive assessment of atmospheric methane sources, sinks and solutions. The Committee expects the EPA, in consultation with the Secretary of State, to report to the Committees of jurisdiction by July 1, 2024, (1) an assessment of the size and changes in global emissions and sinks of methane; (2) an analysis of the likely impact of atmospheric methane on climate change and other problems; (3) a review of each major source and sink to determine options to affect their impact; (4) a review of promising, and currently practicable, technologies, programs, policy and regulatory changes to reduce atmospheric methane levels, by emissions reduction or removal, and for each proposed technology or policy change, their readiness, likelihood of success, barriers, cost-effectiveness, and co-benefit analysis; and (5) national and global plans for atmospheric reduction and removal with goals, recommendations, and regulatory and land management options. **$2,000,000**

17. Establish Governance of GHG removal methods. The Committee expects the Administrator of the EPA, in cooperation with the Secretary of State and the U.S. Trade Representative, to pursue a Methane Declaration to support the assessment, deployment and governance of methods of restoring the climate by reducing atmospheric methane and other climate forcing agents to historically healthy levels. The Declaration should be implemented in support of, but not necessarily under, the UNFCCC and its protocols and accords, other conservation and trade agreements, and United Nations' offices.
Funds needed: **$5,000,000**