U.S. Department of Energy
Advanced Research Projects Agency-Energy

Announcement of Teaming Partner List for Upcoming Funding Opportunity Announcement: A New Nitrogen Cycle in Agriculture for Bioenergy Crops

The Advanced Research Projects Agency-Energy (ARPA-E) is considering issuing a Funding Opportunity Announcement (FOA) to support development of plant and/or microbial technologies that will allow for a 50% reduction in nitrous oxide (N_2O) emissions by reducing the application of synthetic nitrogen (N) fertilizer. The purpose of this announcement is to facilitate the formation of new project teams to respond to a potential FOA. The FOA will provide specific program goals, technical metrics, and selection criteria. The FOA terms are controlling.

In the United States, agriculture contributes to 11.2% of total greenhouse gas (GHG) emissions annually.[1,2] N_2O is the main GHG produced by this sector, and it is a potent GHG with 273 times the greenhouse potential of carbon dioxide (CO_2) gas, accounting for 5.6% of total U.S. GHG emissions.[3,4] In agricultural systems, N_2O originates from the conversion of applied N fertilizer by soil microorganisms.[5] The high emissions of N_2O from agricultural soils contributes to the overapplication of N fertilizer, a common practice to achieve high crop productivity and yield.[6,7] This problem is more acute in the cultivation of ethanol bioenergy crops (e.g., corn, sorghum), which accounts for 52% of all U.S. fertilizer demand.[8,9,10] For the purposes of this Teaming Partner List, the overarching goal of ARPA-E's potential program would be to reduce N_2O emissions in the agricultural sector by 50% by 2030, based on the

[1] U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022," 2024, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.
[2] USDA Economic Research Service, "Agriculture, Including Electricity Use, Accounted for an Estimated 11.2 Percent of U.S. Greenhouse Gas Emissions in 2020," July 11, 2022, https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=104206.
[3] Piers Forster et al., "Changes in Atmospheric Constituents and in Radiative Forcing," 2007, https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg1-chapter2-1.pdf.
[4] U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022."
[5] Rodney T Venterea et al., "Challenges and Opportunities for Mitigating Nitrous Oxide Emissions from Fertilized Cropping Systems," *Frontiers in Ecology and the Environment* 10, no. 10 (December 2012): 562–70, https://esajournals.onlinelibrary.wiley.com/doi/10.1890/120062.
[6] N.K. Fageria and V.C. Baligar, "Enhancing Nitrogen Use Efficiency in Crop Plants," in *Advances in Agronomy*, vol. 88 (Elsevier, 2005), 97–185, https://linkinghub.elsevier.com/retrieve/pii/S0065211305880046.
[7] Alison J. Eagle et al., "Fertilizer Management and Environmental Factors Drive N_2O and NO_3 Losses in Corn: A Meta-Analysis," *Soil Science Society of America Journal* 81, no. 5 (September 2017): 1191–1202.
[8] USDA National Agricultural Statistics Service, "2021 Agricultural Chemical Use Survey - Corn," May 2021, https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Chemical_Use/2021_Field_Crops/chemhighlights-corn.pdf.
[9] USDA National Agricultural Statistics Service, "2019 Agricultural Chemical Use Survey - Sorghum," May 2020, https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Chemical_Use/2019_Field_Crops/chem-highlights-sorghum-2019.pdf.
[10] USDA Economic Research Service, "Fertilizer Use and Price," October 30, 2019, https://www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx.

emissions level in 2005. This goal would be achieved by developing plant and/or microbial technologies that collectively allow for a reduction of N inputs without compromising yield, saving $6.4 billion in operational costs for U.S. farmers.[11] Additionally, technologies arising from this program would potentially reduce the carbon intensity score of corn and sorghum-derived biofuels to help achieve the U.S. target of producing 35 billion gallons of sustainable aviation fuel (SAF) by 2050.[12] This program would support ARPA-E statutory goals by: improving energy security through reduction of imports of foreign synthetic N fertilizer;[13] reducing agriculturally derived N_2O and CO_2 emissions that contribute 37 million to 78 million metric tons of CO_2 equivalent;[2] and improving energy efficiency by lowering carbon intensity for ethanol and ethanol-derived SAFs by 14-23%.[14]

Examples of technologies specifically of interest in the application to corn and/or sorghum, either as standalone solutions or in combination, include but are not limited to the following:

- Crop breeding and plant genetic engineering approaches to reduce the requirement of applied N or to prevent N loss to the environment;
- Microbial approaches to increase the delivery of N to plants;
- Systemic approaches to facilitate delivery of N by designed interactions between plant and microbes; and
- Other additional technologies to couple N fertilizer reduction and N_2O emissions mitigation by combining elements of plant and/or microbial bio-design.

To validate that proposed technologies achieve the overarching goal of the potential program, ARPA-E anticipates requiring field testing and in-field N_2O measurement as part of technology development.

ARPA-E held a workshop on this topic in November 2023. Information on this workshop can be found at https://arpa-e.energy.gov/events/new-nitrogen-cycle-bioenergy-crop-production-workshop.

Expertise in the following non-exhaustive list of technical areas may be useful in responding to the potential FOA:

- Agronomy
- Plant breeding
- Plant and microbial bioinformatics
- Microbiology
- Metagenomics
- Metabolic engineering
- Plant biology
- Plant physiology
- N_2O measurement

[11] Gary Schnitkey et al., "Fertilizer Prices, Rates, and Costs for 2023," September 27, 2022, https://farmdocdaily.illinois.edu/2022/09/fertilizer-prices-rates-and-costs-for-2023.html.
[12] Decision Innovation Solutions, "Sustainable Aviation Fuel for the Future: What Does Iowa Have to Gain?," January 2024, https://iowarfa.org/wp-content/uploads/2024/03/240112-Iowa-Sustainable-Aviation-Fuel-for-the-Future.pdf.
[13] U.S. Geological Survey, "Mineral Commodity Summaries," 2021.
[14] The estimate of $6.4 billion is based on the target metrics for fertilizer reduction for corn and sorghum, and the total cost of N fertilizer in 2022.

As a general matter, ARPA-E strongly encourages outstanding scientists and engineers from different organizations, scientific disciplines, and technology sectors to form new project teams. Interdisciplinary and cross-sector collaboration spanning organizational boundaries enables and accelerates the achievement of scientific and technological outcomes that were previously viewed as extremely difficult, if not impossible.

The Teaming Partner List is being compiled to facilitate the formation of new project teams and will be available on ARPA-E eXCHANGE (http://arpa-e-foa.energy.gov), ARPA-E's online application portal, starting in June 2024. The Teaming Partner List will be updated periodically until the close of the Full Application period to reflect new Teaming Partners who have provided their information.

Any organization that would like to be included on this list should complete all required fields in the following link: https://arpa-e-foa.energy.gov/Applicantprofile.aspx. Required information includes the following: Organization Name, Contact Name, Contact Address, Contact Email, Contact Phone, Organization Type, Area of Technical Expertise, and Brief Description of Capabilities.

By submitting a response to this Notice, you consent to the publication of the above-referenced information. **By facilitating this Teaming Partner List, ARPA-E does not endorse or otherwise evaluate the qualifications of the entities that self-identify for placement on the Teaming Partner List.** ARPA-E will not pay for the provision of any information, nor will it compensate any respondents for the development of such information. Responses submitted to other email addresses or by other means will not be considered. **This list is completely voluntarily to participate in and utilize.** ARPA-E will not identify or facilitate connections through the teaming list and participation in the list has no bearing whatsoever on the evaluation of applications submitted to the potential FOA.

This Notice does not constitute a FOA. No FOA exists at this time. Applicants must refer to the FOA, expected to be issued by July 2024, for instructions on submitting an application and for the terms and conditions of funding.