Notice of Intent No. DE-FOA-0002996

Notice of Intent to Issue
Funding Opportunity Announcement No. DE-FOA-0002997

The Office of Energy Efficiency and Renewable Energy (EERE) intends to issue, on behalf of the Industrial Efficiency and Decarbonization Office (IEDO), a funding opportunity announcement (FOA) titled "IEDO FY23 Multi-topic FOA."

This FOA will advance the Biden Administration's goals to achieve carbon-pollution-free electricity by 2035 and to "deliver an equitable, clean energy future, and put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050"[1] to the benefit of all Americans. The U.S. Department of Energy (DOE) is committed to pushing the frontiers of science and engineering, catalyzing clean energy jobs through research, development, demonstration, and deployment (RDD&D), and ensuring environmental justice and inclusion of underserved communities.

This funding opportunity is part of an integrated industrial decarbonization technology development strategy for DOE's basic and applied research offices. Rooted in the principles identified in the *2022 Industrial Decarbonization Roadmap*, DOE is building an innovation pipeline to accelerate the development and adoption of industrial decarbonization technologies with investments spanning foundational science; research, development, and demonstrations (RD&D); and technical assistance and workforce development. DOE's highly coordinated RD&D investments – leveraging resources and expertise from the Offices of Energy Efficiency and Renewable Energy, Fossil Energy and Carbon Management (FECM), Nuclear Energy (NE), and Science (SC) – are designed to achieve deep decarbonization across the industrial sector, targeting both industry-specific innovations and crosscutting technologies. This technology development strategy complements the demonstration and deployment efforts led by DOE's Offices of Clean Energy Demonstrations (OCED) and Manufacturing and Energy Supply Chains (MESC) and the Loan Programs Office (LPO).

Decarbonizing the industrial sector is critical to achieving the administration's climate goals. In 2020, the industrial sector accounted for 33% of the nation's primary energy use and 30% of energy-related carbon dioxide (CO_2) emissions.[2] However, the industrial sector is considered one of the most difficult to decarbonize because of the diversity and complexity of energy inputs, processes, and operations. Achieving net-zero emissions across the U.S. economy by 2050 will require an aggressive, multidimensional approach to eliminating industrial emissions.

[1] Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad," January 27, 2021.
[2] U.S. Energy Information Administration, Annual Energy Outlook 2021 with Projections to 2050, 2021.

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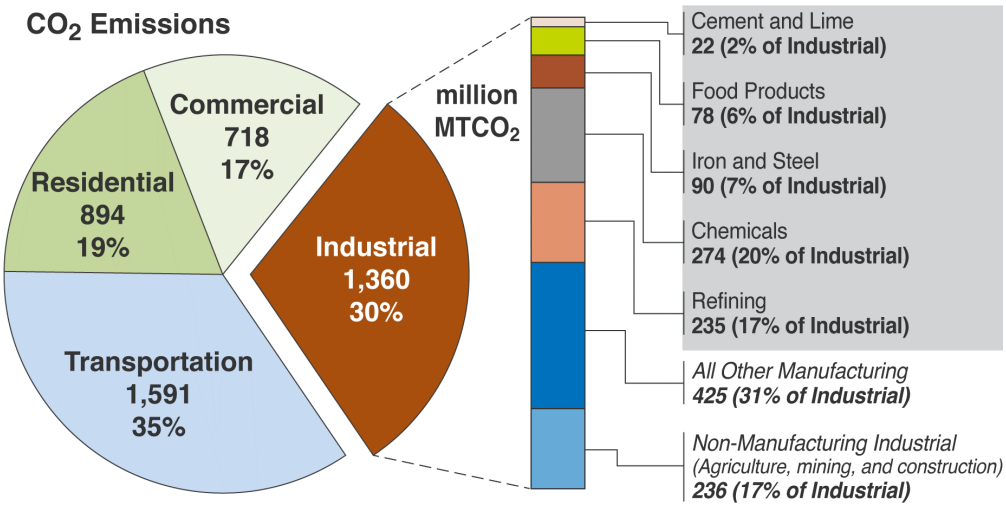

Figure 1. U.S. primary energy-related CO_2 emissions in 2020, in millions of metric tons, by end-use sector (left pie chart) and by industrial subsector (right stacked chart) from DOE's *Industrial Decarbonization Roadmap*.

The DOE *Industrial Decarbonization Roadmap* identifies strategies to reduce industrial emissions across five of the most energy- and carbon-intensive subsectors (Figure 1). Together, these industries represent approximately 51% of energy-related CO_2 emissions in the U.S. industrial sector and 15% of total U.S. CO_2 emissions economy-wide. To reduce emissions across these sectors, the *Roadmap* focuses on accelerating innovation and adoption in four key pathways: energy efficiency technologies; industrial electrification technologies; low-carbon fuels, feedstocks, and energy sources (LCFFESs); and carbon capture, utilization, and storage (CCUS) technologies. IEDO supports the adoption of these and other innovative technologies and practices that enable the industrial sector to cost-effectively reduce greenhouse gas (GHG) emissions.

To support the industrial decarbonization approaches identified in the *Roadmap*, DOE recently launched the Industrial Heat Energy Earthshot™, a new effort aimed at dramatically reducing the cost, energy use, and carbon emissions associated with industrial heat demand. The Industrial Heat Shot seeks to develop cost-competitive solutions for industrial heat with at least 85% lower GHG emissions by 2035. If this target is achieved, the U.S. industrial sector will be on course to reduce its carbon-equivalent emissions by 575 million metric tons by 2050, roughly equal to the annual emissions generated by all passenger cars currently on the road.

In addition to consuming significant amounts of energy and generating GHG emissions, many processes used in industrial facilities produce air pollutants with harmful health impacts on surrounding communities – particularly for racial and ethnic minority groups and lower-income

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Americans.[3, 4] Projects funded through the anticipated FOA are expected to address community-level impacts to help ensure the benefits of investments to decarbonize industry will flow to disadvantaged communities.[5]

By accelerating the development and adoption of sustainable technologies that increase efficiency and eliminate industrial GHG emissions, the research, development, and prototype or pilot-scale technology validation and demonstration (RD&D) activities to be funded under this FOA will contribute to a clean and equitable energy economy, bolster the technological and economic competitiveness of domestic manufacturing, and boost the viability and competitiveness of U.S. industrial technology exports.

In support of these goals, IEDO provides funding, management, and the strategic direction necessary for a balanced national program of research, development, demonstration, technical assistance, and workforce development to drive improvements in energy, materials, and production efficiency and to accelerate decarbonization across the industrial sector.

IEDO works closely with the Advanced Materials and Manufacturing Technologies Office (AMMTO), whose vision is a competitive U.S. manufacturing sector that accelerates the adoption of innovative technologies in support of a clean, decarbonized economy. This FOA is anticipated to include one subtopic that will directly support AMMTO's goals in manufacturing and scale-up of materials technologies that enable industrial efficiency and decarbonization.

This FOA will advance the strategies identified in the *Industrial Decarbonization Roadmap*[6] and Industrial Heat Energy Earthshot™ and will focus on cross-sector approaches for industrial decarbonization (thermal processing, exploratory cross-sector topics, and low-carbon fuels utilization), along with high-GHG-emitting subsectors (such as chemicals, iron and steel, food and beverage, cement and concrete, and forest products). The focus will include both energy-related emissions and non-energy-related process emissions (e.g., CO_2 from the calcination process in cement production). Cross-sector approaches include RD&D on components and

[3] Liu, et al., "Disparities in Air Pollution Exposure in the United States by Race/Ethnicity and Income, 1990–2010," *Environmental Health Perspectives* (2021), https://doi.org/10.1289/EHP8584; Tessum, et al. "PM2.5 polluters disproportionately and systemically affect people of color in the United States," *Science Advances* (2021), https://doi.org/10.1126/sciadv.abf4491.

[4] DOE Office of Economic Impact and Diversity, "How Energy Justice, Presidential Initiatives, and Executive Orders Shape Equity at DOE," January 3, 2022, https://www.energy.gov/diversity/articles/how-energy-justice-presidential-initiatives-and-executive-orders-shape-equity.

[5] Executive Office of the President, "Justice40 Initiative," Sec. 223 of *Tackling the Climate Crisis at Home and Abroad*, Executive Order 14008 of January 27, 2021, https://www.federalregister.gov/d/2021-02177/p-163.

[6] DOE, Industrial Decarbonization Roadmap, September 7, 2022, https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap.

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equipment systems, technologies with broad applications across the industrial sector, and the integration of technology in industry-specific conditions.

Many of the topics and areas of interest covered in this anticipated FOA are similar in scope to those included in DE-FOA-0002804 (Industrial Efficiency and Decarbonization FOA, henceforth "FY22 FOA"). Full applications submitted to the FY22 FOA are currently under review. For topic areas within this FOA with substantially similar areas of interest as the FY22 FOA, applicants that responded to the FY22 FOA are strongly discouraged from resubmitting largely identical applications to those currently under review.

This FOA and its associated projects are distinct from any existing or forthcoming efforts funded under the Bipartisan Infrastructure Law or Inflation Reduction Act, including activities related to Industrial Demonstration Program.[7]

It is anticipated that the FOA may include the topics listed below. The anticipated topics in this FOA align with DOE's shared strategic framework for development of industrial decarbonization technologies: (1) energy efficiency (advanced by all topics); (2) industrial electrification (Topics 1, 3, 4, 5, and 8); (3) low-carbon fuels, feedstocks, and energy sources (Topics 2, 3, 4, 5, 6, 7, and 8); (4) carbon capture, utilization, and storage (Topics 4 and 7); and (5) manufacturing technology innovation (Topic 3).

Topic 1: Decarbonizing Industrial Heat

Process heating, or thermal processing, consumes more energy and releases more GHG emissions than any other industrial process, accounting for 31% of energy use and 51% of energy-related GHG emissions for the manufacturing sector. In support of DOE's Industrial Heat Shot, this topic is anticipated to focus on developing equipment to decarbonize thermal processes across the industrial sector. Potential areas of interest include electrification of industrial heat, innovative low- and no-heat processes, and industrial heat pumps.

Topic 2: Low-Carbon Fuels Utilization RD&D

Low-carbon fuels, feedstocks, and energy sources present a significant opportunity for decarbonization of hard-to-abate industrial subsectors. This topic is anticipated to focus on innovations to develop equipment capable of utilizing low-carbon fuels, such as hydrogen and

[7] Section 41008 of the Bipartisan Infrastructure Law (officially known as the Infrastructure Investment and Jobs Act [Public Law 117-58]) and Section 50161 of the Inflation Reduction Act authorized appropriations for demonstration projects that test and validate industrial emissions reduction technologies and invest in facility projects and retrofits. Associated activities will be led by the DOE Office of Clean Energy Demonstrations (https://oced-exchange.energy.gov/FileContent.aspx?FileID=b89ac88f-754b-4e72-95d7-0164da255299).

hydrogen blends. Potential areas of interest include mitigating hydrogen combustion impacts on material and product quality; developing hydrogen-based combustion systems; and developing low-carbon-input, flexible combined heat and power (CHP).

Topic 3: Exploratory Cross-Sector R&D

Exploratory research and development (R&D) is focused on emerging R&D areas for technologies and materials that enable industrial decarbonization. Technologies and materials of interest improve the efficiency, flexibility, and resilience of connected systems, thereby driving adoption of decarbonization technologies.

Subtopic 3a: Enabling Flexible Industrial Energy Use

Emerging transformational technologies can enable long-term industrial decarbonization by maintaining manufacturing resilience and economic competitiveness while integrating renewable energy into industrial manufacturing processes. Anticipated areas of interest for this topic include industrial load flexibility and thermal energy storage systems.

Subtopic 3b: Enhanced Thermal Conductivity Materials

It is anticipated that Subtopic 3b will be funded and managed by AMMTO.

Enhanced thermal conductivity materials can improve the performance and efficiency of electrified thermal processing equipment. This subtopic is anticipated to focus on materials with thermal conductivity exceeding 10 W/m-K (watts per meter-Kelvin) and moderate to high electrical conductivity.

Topic 4: Decarbonizing Chemicals

The chemicals industry supports over 25% of the U.S. GDP and emits the most carbon of any U.S. manufacturing subsector. This topic is anticipated to focus on decarbonization technologies for high-volume chemicals with significant CO_2 emissions. Approaches include advanced separations processes, advanced reactor systems, and dynamic catalyst science.

Topic 5: Decarbonizing Iron and Steel

Steel is a vital material for many economic sectors, with uses in transportation, homes, commercial buildings, and industrial equipment. This topic is anticipated to focus on decarbonization opportunities in iron and steel production. Potential areas of interest include enabling decarbonization through innovative manufacturing technologies,

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electrifying existing manufacturing processes, overcoming challenges associated with utilizing hydrogen in steelmaking, and addressing scrap contaminants in recycling.

Topic 6: Decarbonizing Food and Beverage Products

The food and beverage industry employed 1.7 million workers to produce and ship nearly $900 billion of products in 2018. This topic is anticipated to focus on low- and zero-carbon solutions for process heating, cooling, and refrigeration in a wide variety of energy-intensive food and beverage operations.

Topic 7: Decarbonizing Cement and Concrete

Approximately 60% of the cement industry's total GHG emissions are direct process emissions resulting from clinker production. This topic is anticipated to focus on addressing cement's direct process emissions. Potential areas of interest include sustainably sourced supplementary cementitious materials (SCMs) for clinker substitutions and blended cements; novel decarbonized production processes for Portland cement or lime; novel, low-carbon, non-ordinary Portland cement formulations; and CO_2 mineralization.

Topic 8: Decarbonizing Forest Products

The U.S. forest products industry is the third-largest consumer of energy in the U.S. manufacturing sector and contributes 8% of total energy-related emissions from U.S. manufacturing. This topic is anticipated to focus on decarbonization opportunities. Potential areas of interest include innovative paper-forming and novel dewatering or drying technologies; and innovative fiber preparation, pulping, and chemical recovery processes.

EERE envisions awarding multiple financial assistance awards in the form of cooperative agreements. The estimated period of performance for each award will be approximately three years.

This notice of intent is issued so that interested parties are aware of EERE's intention to issue this FOA in the near term. All the information contained in this notice is subject to change. EERE will not respond to questions concerning this notice. Once the FOA has been released, EERE will provide an avenue for potential applicants to submit questions.

EERE plans to issue the FOA in or about March 2023 via the EERE eXCHANGE website: https://eere-eXCHANGE.energy.gov/. If applicants wish to receive official notifications and information from EERE regarding this FOA, they should register in EERE eXCHANGE. When the FOA is released, applications will be accepted only through EERE eXCHANGE.

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In anticipation of the FOA's release, applicants are advised to complete the following steps, which are **required** for application submission:

- Register and create an account in EERE eXCHANGE at https://eere-eXCHANGE.energy.gov. This account will allow the user to apply to any open EERE FOAs that are currently in EERE eXCHANGE.

  To access EERE eXCHANGE, potential applicants will be required to have a Login.gov account. As part of the eXCHANGE registration process, new users are directed to create an account in Login.gov. Please note that the email address associated with Login.gov must match the email address associated with the eXCHANGE account. For more information, refer to the Exchange Multi-Factor Authentication (MFA) Quick Guide in the Manuals section of eXCHANGE.

  It is recommended that each organization or business unit, whether acting as part of a team or as a single entity, use only one account as the contact point for each submission. Questions related to the registration process and use of the EERE Exchange website should be submitted to EERE-eXCHANGESupport@hq.doe.gov.

- Register with the System for Award Management (SAM) at https://www.sam.gov. Designating an electronic business point of contact (EBiz POC) and obtaining a special password, called an MPIN, are important steps in SAM registration. Please update your SAM registration annually. Upon registration, SAM will automatically assign a Unique Entity ID (UEI).

  NOTE: Because of the high demand of UEI requests and SAM registrations, entity legal business name and address validations are taking longer than usual to process. Entities should start the UEI and SAM registration process as soon as possible. If entities have technical difficulties with the UEI validation or SAM registration process, they should use the HELP feature on SAM.gov. SAM.gov will work entity service tickets in the order in which they are received and asks that entities not create multiple service tickets for the same request or technical issue. Additional entity validation resources can be found here: GSAFSD Tier 0 Knowledge Base - Validating your Entity.

- Register in FedConnect at https://www.fedconnect.net/. Creating an organization account requires the organization's SAM MPIN. For more information about the SAM MPIN or other registration requirements, review the FedConnect Ready, Set, Go! Guide at https://www.fedconnect.net/FedConnect/Marketing/Documents/FedConnect_Ready_Set_Go.pdf.

- Register in Grants.gov (http://www.grants.gov/) to receive automatic updates when

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amendments to a FOA are posted. However, please note that applications will not be accepted through Grants.gov. All applications must be submitted through EERE eXCHANGE.

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