Draft National Landscape of High-Impact Crosscutting Opportunities for Next-Generation Harsh Environment Materials and Manufacturing Process Research, Development, and Demonstration Request for Information

DATE: January 16, 2024
SUBJECT: Request for Information on Harsh Environment Materials

Description

The Advanced Materials and Manufacturing Technologies Office (AMMTO) in the U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy (EERE) has released a request for information (RFI) on a draft of the *National Landscape of High-Impact Crosscutting Opportunities for Next-Generation Harsh Environment Materials (HEMs) and Manufacturing Process Research, Development, and Demonstration*. The focus of this draft is to identify the highest-impact investment opportunities for high-performance materials designed for harsh service environments. It aims to survey the opportunities to accelerate the design, development, and manufacturing of globally competitive, crosscutting, next-generation HEM components engineered for demanding service applications through capabilities development and transformative research. Advanced, high-performance HEM components with an extended life and higher reliability are needed to achieve energy efficiency gains, emissions reductions, and lower overall costs through improvements in electric energy production/conversion, energy storage, and energy utilization technologies.

Background

The *National Landscape of High-Impact Crosscutting Opportunities for Next Generation Harsh Environment Materials (HEMs) and Manufacturing Process Research, Development, and Demonstration* draft document can be accessed via EERE Exchange.

Purpose

The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders on issues related to the draft document on harsh environment materials research, development, and demonstration. This feedback will help to ensure AMMTO's investments in this space are optimally positioned to address opportunities

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and challenges related to electric energy production/conversion, energy storage, and energy utilization technologies. AMMTO is specifically interested in information on:

- A framework for prioritizing research and development (R&D) as well as ways to maximize impact of the identified opportunities.
- Additional/unidentified significant opportunities, challenges, and enablers to improve energy production/conversion, energy storage, and energy utilization technologies through advancements in materials and manufacturing methods.
- Technology advancement needed to achieve AMMTO objectives.
- Prioritization of future AMMTO investments, including data that support this prioritization.

Disclaimer and Important Notes

This RFI is not a Notice of Funding Opportunity (NOFO); therefore, AMMTO is not accepting applications at this time. AMMTO may issue a NOFO in the future based on or related to the content and responses to this RFI; however, AMMTO may also elect not to issue a NOFO. There is no guarantee that a NOFO will be issued as a result of this RFI. Responding to this RFI does not provide any advantage or disadvantage to potential applicants if AMMTO chooses to issue a NOFO regarding the subject matter. Final details, including the anticipated award size, quantity, and timing of AMMTO-funded awards, will be subject to congressional appropriations and direction.

Any information obtained as a result of this RFI is intended to be used by the government on a nonattribution basis for planning and strategy development; this RFI does not constitute a formal solicitation for proposals or abstracts. Your response to this notice will be treated as information only. AMMTO will review and consider all responses in its formulation of program strategies for the identified materials of interest that are the subject of this request. AMMTO will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that AMMTO is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI. Responses to this RFI do not bind AMMTO to any further actions related to this topic.

Confidential Business Information

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Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery two well-marked copies: one copy of the document marked "confidential" including all the information believed to be confidential, and one copy of the document marked "nonconfidential" with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Evaluation and Administration by Federal and Nonfederal Personnel

Federal employees are subject to the nondisclosure requirements of a criminal statute, the Trade Secrets Act, 18 USC 1905. The government may seek the advice of qualified nonfederal personnel. The government may also use nonfederal personnel to conduct routine, nondiscretionary administrative activities. The respondents, by submitting their response, consent to AMMTO providing their response to nonfederal parties. Nonfederal parties given access to responses must be subject to an appropriate obligation of confidentiality prior to being given the access. Submissions may be reviewed by support contractors and private consultants.

Request for Information Categories and Questions

You may answer as few or as many of the questions below as you would like, but please focus on the aspects that are most pertinent to you or your field. For each response, please identify the category to which you are responding.

Category 1: **Landscape Framework and Impact**

The strategic framework landscape document lays out AMMTO's vision, mission, and objectives for advancing materials and manufacturing technologies, as well as a framework for prioritizing its investments. For reference, they are summarized as follows.

Vision

AMMTO envisions a globally competitive U.S. manufacturing sector that accelerates the adoption of innovative materials and manufacturing technologies. In order to maximize energy security, manufacturing competitiveness, and community benefits, the United States must remain the leader in advanced materials and manufacturing innovation for technologies of relevance across the energy sector.

Mission

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The mission of AMMTO is to inspire people and drive innovation to transform materials and manufacturing for America's energy future. Novel materials have improved properties, such as high-strength and high-temperature performance, which improve the functionality or extend the lifetime of products that use them, increase their life cycle energy and material efficiency, and/or expand their range of use environments. Accordingly, our work in the HEM space is to drive development and demonstration of advanced high-performance materials and manufacturing technologies needed to achieve improvements and lower costs in electric energy production/conversion, energy storage, and energy utilization.

Objectives

As described in the executive summary of the landscape document, harsh environment materials are vital for the United States because these materials are crucial to industries that contribute nearly a half-trillion dollars to the annual U.S. gross domestic product. The materials and components are also crucial to the security of the U.S. energy sector, job creation, and strength of the U.S. manufacturing sector. Therefore, our objective is to deliver a framework that will provide guidance to AMMTO in developing strategies to drive R&D in high-performance, harsh-environment materials and manufacturing technologies of broad interest across the department, fostering collaboration and synergy between AMMTO and other DOE programs.

Framework for Prioritization of Research and Development

To prioritize where to focus finite R&D resources, the landscape draft proposes a framework for how AMMTO prioritizes investment to drive real-world impacts.

This framework includes the following three-step approach:

- Assessing the potential impacts from advancing specific materials and manufacturing technologies.
- Identifying the transformation pathway and the barriers to deployment.
- Considering timeline for deployment and scaling.

Questions Related to Category 1: Landscape Framework and Impact

- The following questions are regarding overall scope and framing:
    - What could make the landscape document more effective at conveying and realizing the desired benefits of improved materials performance in clean energy technologies, as well as in the areas of community benefits, U.S. energy and

supply chain securities, job creation, and strengthening of the U.S. manufacturing base?

- How should these benefits be assessed (either quantitatively or qualitatively) when AMMTO makes prioritization decisions?

- The five focus areas: (1) functional surface technologies, (2) materials integration into energy systems, (3) high-performance materials, (4) new paradigm materials manufacturing processes, and (5) materials and process development acceleration tools are distinct but related concepts. As we communicate across different subsectors, what language or terminology resonates most with your industry? For example, would you define materials integration differently than how it is presented in this framework?

- Regarding framework for prioritization:

  - What changes should be made to the considerations for prioritizing AMMTO work on HEM research, development, demonstration, and deployment?

  - Please include any data sources or other relevant references that would support a different view/results for materials performance needs for advanced material and manufacturing technologies for a clean energy economy.

- Regarding impact:

  - How could the landscape document improve focus on areas and technologies at each level of scientific and technological maturity from basic science to applied R&D to maximize impact? How can it work together as a system across technology maturity levels?

  - How could the landscape document improve the information given (e.g., the granularity or level of detail, transparency, justification, or location/presentation) on the target metrics specified throughout for technologies and system/resource levels?

Category 2: Additional/Unidentified Significant Opportunities, Challenges, and Enablers

The landscape document highlights significant crosscutting opportunities, challenges to overcome, and enablers for advancing materials and manufacturing technologies in a way that

enables or facilitates greater efficiency, lower emissions, or greater cost competitiveness within the energy and industrial/manufacturing sectors.

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Questions Related to Category 2

- Related to pathway specific crosscutting opportunities and challenges outlined throughout Chapter 2 (State of Harsh Environment Landscape) and Chapter 3 (Resource Allocation over the Five Landscape Focus Areas):
    - What additions or changes should be made to the opportunities and challenges listed in Chapter 2 and/or Chapter 3?

Category 3: Accelerating R&D, Scale Up, Qualification, Standardization, and Deployment of New Technologies

The landscape document is primarily centered on the need for technical innovation, but also some consideration is given to innovation in scaling the technologies, accelerating qualification, and standards development. It is important that these technologies are eventually deployed across energy and industrial applications in a relatively short time frame to have the largest positive impact as possible on the nation's aggressive energy goals.

Questions Related to Category 3

- Are the proposed time frames for the technology advancements appropriate and/or realistic?
- Are there other strategies that would be more effective for accelerating R&D, scale up, qualification, standardization, and deployment of innovative technologies to unlock promised benefits for clean energy production, energy storage, and energy utilization?

Category 4: Energy Efficiency and Renewable Energy Focus Areas

The landscape document identifies AMMTO's HEM focus areas that are synergistic with other DOE/EERE programs for developing advanced materials and manufacturing methods as well as related challenges and the technology advancements needed.

Questions Related to Category 4

- What changes or additions are needed to AMMTO's activities or focus areas presented in Chapter 2 and/or Chapter 3 to deliver the highest potential impact?

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- Regarding the advanced materials and manufacturing needs for energy production, energy storage, and energy utilization technologies discussed in Chapter 2, please discuss any gaps, inconsistencies, inaccuracies, other HEM material needs, or other needed modifications to any of the following:

    - Steam and gas turbomachinery
    - Nuclear energy
    - Concentrating solar power
    - Geothermal energy
    - Marine and hydroelectric power
    - Wind energy
    - Hydrogen infrastructure and economy
    - Industrial efficiency and decarbonization
    - Electrical and thermal energy storage technologies
    - Material integration and joining.

- Regarding focus area (1), functional surface technologies, please discuss any gaps, inconsistencies, inaccuracies, or other needed modifications to the opportunities, metric targets, or technical advancements in surface treatments, coatings, claddings, films, or surface engineering.

- Regarding focus area (2), materials integration into energy systems, please discuss any gaps, inconsistencies, inaccuracies, or other needed modifications to the opportunities, metric targets, or technical advancements in joining and bonding, or other materials integration technologies.

- Regarding focus area (3), high-performance materials, please discuss any gaps, inconsistencies, inaccuracies, or other needed modifications to the opportunities, metric targets, or technical advancements in materials.

- Regarding focus area (4), new paradigm materials manufacturing processes, please discuss any gaps, inconsistencies, inaccuracies, or other needed modifications to the opportunities, metric targets, or technical advancements in materials synthesis, processing, and fabrication.

- Regarding focus area (5), materials and process development acceleration tools, please discuss any gaps, inconsistencies, inaccuracies, or other needed modifications to the opportunities and technical advancements in smart manufacturing methodologies (e.g., in situ sensors, digital twins,

robotics/automation, artificial intelligence), modeling and simulation capabilities, accelerated qualification/certification, or other facets.

Category 5: Other Feedback

Questions Related to Category 5

Please provide feedback on any other aspect of the *National Landscape of High-Impact Crosscutting Opportunities for Next Generation Harsh Environment Materials and Manufacturing Process Research, Development, and Demonstration*. This feedback could include how the current framework might be applicable or extended to even broader material classes to help AMMTO develop an overarching next-generation materials and processes strategy.

- On what basis and how might the different materials fabrication processes best be analyzed and compared to ensure the most cost-competitive method is selected that delivers the desired results with material multiscale structures, properties, and performance?

- What are the most significant challenges and best strategies for using physics-based (deterministic) computational approaches and machine learning (probabilistic) approaches most effectively, either independently or coupled together, to provide a framework for more efficient materials discovery, design, and development?

- Are there additional enabling/ancillary technologies and/or are accessible and standardized data repositories needed that are not discussed in the landscape, which can be used to facilitate the development of new and improved high-performance HEM components satisfying predefined criteria without an unsupported cost penalty?

Request for Information Response Guidelines

Responses to this RFI must be submitted electronically to **harshmaterialsrfi@ee.doe.gov** no later than **5:00 p.m. (Eastern Time) on March 15, 2025**. Responses must be provided as attachments to an email. It is recommended that attachments with file sizes exceeding 25 megabytes be compressed (i.e., zipped) to ensure message delivery. Responses must be provided as a Microsoft Word (.docx) attachment to the email, and no more than 10 pages in length, 12-point font, and with 1-inch margins. Only electronic responses will be accepted.

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Please identify your answers by responding to a specific question or topic if applicable. You may answer as many or as few questions as you wish.

EERE will not respond to individual submissions or publish a compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed.

Please provide the following information at the start of your response to this RFI:

- Company/institution name
- Company/institution contact
- Contact's address, phone number, and email address
- Type of organization (e.g., academic, national laboratory, government, industry, nongovernment organization, other).

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