

**Financial Assistance  
Notice of Funding Opportunity  
Part 1**



**U.S. DEPARTMENT *of* ENERGY**

**Department of Energy (DOE)  
Hydrocarbons and Geothermal Energy Office  
Advancing Oil and Natural Gas Production and Delivery  
Notice of Funding Opportunity Number: DE-FOA-0003634  
Application due: September 22, 2026, 5 p.m. ET**

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## Before You Begin

### A. Navigating the Notice of Funding Opportunity

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To reduce the burden on applicants in the Notice of Funding Opportunity (NOFO) process and limit the length of the NOFO information requests, we separated the NOFO into two parts.

The NOFO Part 1 describes the DOE program goals and evaluation criteria, eligibility, and other components specific to each funding opportunity. NOFO Part 2 includes the fixed DOE requirements that generally do not change from NOFO to NOFO, including standard information for the application phase, expectations for award negotiations, and post-award requirements. You must review both parts before applying. To assist you in the process, you will find references throughout this document to additional information in Part 2.

You must also take several one-time actions before applying. Some of these actions may take several weeks, so be sure to allow yourself enough time to complete them. If you don't complete all required steps, it could interfere with application and negotiation deadlines or your ability to receive an award if selected. If you already completed these one-time registrations, make sure they are active and up to date. All registrations are free. You can find additional information about registration in [NOFO Part 2, Required Registrations](#).

Hyperlinks are provided for the applicant's ease of reference. Links, and the information contained in them, may change over time. It is up to an individual applicant to make sure that they have the current information that is contained in the links.

This announcement is published with NOFO Part 2 Version 4.0.

## I. Basic Information

### A. Key Facts

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Issuing Agency                     | Department of Energy (DOE), Hydrocarbons and Geothermal Energy Office (HGEO), Division of Transport and Storage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Funding Opportunity Title          | Advancing Oil and Natural Gas Production and Delivery                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Announcement Version</b>        | Initial                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Funding Opportunity Number         | DE-FOA-0003634                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Funding Instrument                 | Cooperative Agreements or Other Transaction Agreement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Expected Total Available Funding   | \$81,875,000 (\$65,500,000 Federal Funding, \$16,375,000 Cost Share)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Assistance Listing Number and Name | 81.089 Fossil Energy Research and Development                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Announcement Type                  | Research and Development                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Funding Opportunity Description    | <p>DOE's HGEO is seeking applications to advance cost-effective technologies for improving the efficiency, reliability, and resilience of the United States (U.S.) oil and natural gas supply chain. This funding opportunity spans research and development efforts focused on enhancing resource utilization, modernizing infrastructure, and accelerating digital transformation within the sector.</p> <p>This NOFO may remain open for up to 72 months, with review cycles possibly occurring approximately every year, while funding lasts. The details of this NOFO (including descriptions of closed Topic Areas) are subject to change in future review cycles.</p>                                                                                                                                                                                                                                                                                                    |
| Program Goals & Objectives         | <p>This NOFO aims to achieve significant advancements across the U.S. oil and natural gas supply chain (from extraction to processing, transport, and end-use) by focusing on specific, measurable outcomes: increasing natural gas utilization through technologies that capture and convert previously flared or vented gas, thereby recapturing valuable resources and reducing waste; reducing economic losses via innovative capture and re-use solutions; enhancing equipment performance and longevity in midstream and downstream operations; and decreasing operational costs through automation, predictive maintenance, and optimized resource management. These efforts aim to reduce wasted natural gas, improve infrastructure efficiency and reliability, accelerate the adoption of advanced digital technologies such as data analytics, artificial intelligence (AI), machine learning (ML), Digital Twins, Internet of Things (IoT), and Edge Computing.</p> |

### KEY DATES

*All deadlines are 5 p.m. ET*

**Notice of Funding Opportunity Issue Date:**

**July 22, 2026**

**Application Deadline:**

**September 22, 2026**

**Anticipated Selection Notification Date:**

**December 11, 2026**

**Anticipated Award Date:**  
**March 1, 2027**

**Estimated Period of Performance for Topic Area 1a:**  
**March 1, 2027–February 28, 2029**

**Estimated Period of Performance for Topic Areas 1b & 2:**  
**March 1, 2027–February 28, 2031**

**Estimated Period of Performance for Topic Area 3:**  
**March 1, 2027–February 28, 2032**

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           | Collectively, these outcomes will reinforce the U.S. position as a global leader in energy technology and responsible hydrocarbon resource management, ensuring a stable, affordable, and secure American energy future while prioritizing domestic innovation and job creation.                                                                                                                                                                                                            |
| Topic Areas               | <ul style="list-style-type: none"> <li>• Topic Area 1: Enhanced Resource Utilization and Production Technologies (ERUPT) <ul style="list-style-type: none"> <li>○ Topic Area 1a: Laboratory Validation of Catalysts and Unit Operations</li> <li>○ Topic Area 1b: Field Validation of Full System Prototypes</li> </ul> </li> <li>• Topic Area 2: Resilient Infrastructure Technologies Enhancement (RITE)</li> <li>• Topic Area 3: Hydrocarbon Infrastructure Test Sites (HITS)</li> </ul> |
| Eligible Applicants       | <ul style="list-style-type: none"> <li>• Domestic Entities (Institutes of higher education; for-profit entities; non-profit entities; state and local government entities and Indian Tribes)</li> </ul>                                                                                                                                                                                                                                                                                     |
| eXCHANGE URL and Helpdesk | <u><a href="#">DOE: NETL eXCHANGE: Funding Opportunities</a></u><br><a href="mailto:NETL-ExchangeSupport@hq.doe.gov">NETL-ExchangeSupport@hq.doe.gov</a>                                                                                                                                                                                                                                                                                                                                    |
| NOFO URL and Email        | <u><a href="#">NETL eXCHANGE FOR DE-FOA-0003634</a></u><br><u><a href="mailto:NOFO3634@netl.doe.gov">NOFO3634@netl.doe.gov</a></u>                                                                                                                                                                                                                                                                                                                                                          |

## 1. Funding Details

### **Multiple Topic Areas**

Approximate total available funding including all Topic Areas: \$65,500,000 in Federal funding

### **Topic Area 1: Enhanced Resource Utilization and Production Technologies**

#### **Topic Area 1a: Laboratory Validation of Catalysts and Unit Operations**

- Approximate total available Federal funding: \$7,500,000
- Approximate number of awards: 5
- Approximate Federal dollar amount of individual awards: \$1,500,000
- Minimum cost share required: 20% of the total project costs
- Approximate award project period: 24 months
- Anticipated length of budget periods: 24 months

#### **Topic Area 1b: Field Validation of Full System Prototypes**

- Approximate total available Federal funding: \$18,000,000
- Approximate number of awards: 3
- Approximate Federal dollar amount of individual awards: \$6,000,000
- Minimum cost share required: 20% of the total project costs
- Approximate award project period: 48 months
- Anticipated length of budget periods: 18 to 24 months

### **Topic Area 2: Resilient Infrastructure Technologies Enhancement**

- Approximate total available Federal funding: \$12,000,000
- Approximate number of awards: 4
- Approximate Federal dollar amount of individual awards: \$3,000,000
- Minimum cost share required: 20% of the total project costs
- Approximate award project period: 48 months
- Anticipated length of budget periods: 18 to 24 months

### **Topic Area 3: Hydrocarbon Infrastructure Test Sites**

- Approximate total available Federal funding: \$28,000,000
- Approximate number of awards: 4
- Approximate Federal dollar amount of individual awards: \$7,000,000
- Minimum cost share required: 20% of the total project costs
- Approximate award project period: 60 months
- Anticipated length of budget periods: 18 to 24 months

| Topic Area   | Number of Awards | Cost Share % | Federal Funding Per Award* | Cost Share Per Award** | Total Funding Per Award | Total Federal Funding Per Topic Area | Total Cost Share Per Topic Area | Total Funding Per Topic Area |
|--------------|------------------|--------------|----------------------------|------------------------|-------------------------|--------------------------------------|---------------------------------|------------------------------|
| 1a           | 5                | 20%          | \$1,500,000                | \$375,000              | \$1,875,000             | \$7,500,000                          | \$1,875,000                     | \$9,375,000                  |
| 1b           | 3                | 20%          | \$6,000,000                | \$1,500,000            | \$7,500,000             | \$18,000,000                         | \$4,500,000                     | \$22,500,000                 |
| 2            | 4                | 20%          | \$3,000,000                | \$750,000              | \$3,750,000             | \$12,000,000                         | \$3,000,000                     | \$15,000,000                 |
| 3            | 4                | 20%          | \$7,000,000                | \$1,750,000            | \$8,750,000             | \$28,000,000                         | \$7,000,000                     | \$35,000,000                 |
| <b>TOTAL</b> |                  |              |                            |                        |                         | <b>\$65,500,000</b>                  | <b>\$16,375,000</b>             | <b>\$81,875,000</b>          |

\*The Federal funding per award is the maximum amount of Federal funding an award can receive in each Topic Area.

\*\*The cost share per award must meet or exceed 20% of the total award value.

## 2. Period of Performance

For Topic Area 1a, we anticipate making awards under one budget period. Project continuation will depend on several elements, including satisfactory performance throughout the period of performance and our Go/No-Go decision. You can find a complete list of post-award requirements and more information on the Go/No-Go review in [NOFO Part 2, Award Administration Information](#).

For Topic Areas 1b, 2, and 3, we anticipate making awards under multiple budget periods. If applicable, project continuation will depend on available funding and our Go/No-Go decision which will be made at the conclusion of a budget period. You can find a complete list of post-award requirements and more information on the Go/No-Go review in [NOFO Part 2, Award Administration Information](#). Funding for all budget periods, including the initial budget period, is not guaranteed.

## B. Executive Summary

DOE's HGEO is launching a funding opportunity, "Advancing Oil and Natural Gas Production and Delivery," with the primary goal of driving significant advancements across the U.S. oil and natural gas supply chain (from extraction to processing, transport, and end-use). This program aims to enhance national energy security, economic competitiveness, and technological leadership by improving the efficiency, reliability, and performance of the U.S. oil and natural gas sector. This will be achieved through several key objectives, including increasing natural gas utilization by capturing and converting flared or vented gas, thereby recapturing valuable resources and reducing waste; reducing economic losses through innovative solutions; enhancing equipment performance and longevity in midstream and downstream operations; and decreasing operational costs using automation and predictive maintenance, data analytics, AI, ML, and optimized resource management. These efforts will also specifically support the responsible development of our nation's abundant unconventional oil and natural gas resources.



This funding opportunity is designed to engage a broad range of stakeholders committed to advancing hydrocarbon technologies and infrastructure, including researchers, technology developers, industry partners, and entities involved in the oil and natural gas value chain. Eligible applicants include domestic entities such as institutions of higher education, for-profit and non-profit organizations, state and local government entities, and Indian Tribes (as defined in section 4 of the Indian Self-Determination and Education Assistance Act, 25 U.S.C. § 5304)<sup>1</sup>. DOE and non-DOE Federally Funded Research and Development Centers<sup>2</sup> (FFRDCs) are eligible to participate as subrecipients. The program strongly encourages applications that demonstrate a clear path to commercialization and emphasize domestic manufacturing and job creation, reinforcing America's global leadership in energy technology and responsible resource management.

This initiative supports investment in three key Topic Areas: Enhanced Resource Utilization and Production Technologies (ERUPT), including field validation of full system prototypes and cross-cutting technologies for unconventional resources; Resilient Infrastructure Technologies Enhancement (RITE), and Hydrocarbon Infrastructure Test Sites (HITS), emphasizing industry collaboration for field validation. These collective efforts will strengthen the position of the U.S. as a leader in energy technology and responsible resource management, ensuring a stable, affordable, and secure energy future for all Americans.

This NOFO may, at DOE's discretion and contingent on availability of funding, remain open for up to 72 months, with review cycles occurring approximately every year. The potential for multiple open periods is meant to accommodate the community of applicants, who may need time to find the appropriate mix of partners to develop effective teams, to identify high potential field sites, perform critical due diligence on those sites, and establish site access and project partnership commitments before applying. Requirements for Topic Areas previously closed are subject to change.

## **C. Agency Contact Information**

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For questions relating to this NOFO, email us at [NOFO3634@netl.doe.gov](mailto:NOFO3634@netl.doe.gov).

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<sup>1</sup> "Indian Tribe," as defined in section 4(e) of the Indian Self-Determination and Education Assistance Act ([25 U.S.C. § 5304](#)), means any Indian tribe, band, nation, or other organized group or community, including any Alaska Native village or regional or village corporation as defined in or established according to the Alaska Native Claims Settlement Act ([85 Stat. 688](#)) [[43 U.S.C. § 1601, et seq.](#)], is eligible for the special programs and services provided by the United States to Indians because of their status as Indians.

<sup>2</sup> FFRDCs are Federally funded research and development centers that conduct research for the U.S. government. You can find a list of FFRDCs at <https://nces.nsf.gov/resource/master-gov-lists-ffrdc>.

## II. Eligibility

To be considered, your submission must meet the criteria set forth below. If your application does not meet these eligibility requirements, it will be removed from consideration for any award. DOE will not determine eligibility for potential applicants before the application due date. The information in this document is specific to this NOFO. You can find the eligibility requirements that apply to all NOFOs in [NOFO Part 2, Eligibility](#).

### A. Eligible Applicants

#### 1. Domestic Entities

The following types of domestic entities are eligible to participate as a recipient or subrecipient of this NOFO:

- Institutions of higher education (as defined in [Title 20 U.S.C. § 1001](#))
- For-profit organizations
- Nonprofit organizations
- State and local government entities
- Indian Tribes (as defined in section 4 of the Indian Self-Determination and Education Assistance Act, 25 U.S.C. § 5304)

To qualify as a domestic entity, the entity must be:

- Organized, chartered, or incorporated (or otherwise formed) under the laws of a state or territory of the U.S. or under the laws of the U.S.
- Have majority domestic ownership and control
- Have a physical place of business in the U.S.

#### Participant Limitations

Participation of the following entities is limited as follows:

- Provided there is no conflict, DOE FFRDCs are eligible to apply for funding as a subrecipient but are not eligible to apply as a recipient
- Non-DOE FFRDCs are eligible to participate as a subrecipient but are not eligible to apply as a recipient
- Federal agencies and instrumentalities (other than DOE) are eligible to participate as a subrecipient but are not eligible to apply as a recipient
- The National Energy Technology Laboratory (NETL) is not eligible for award under this announcement and may not be proposed as a subrecipient on another entity's application. An application that includes NETL as a recipient or subrecipient will be considered non-responsive.

#### 2. Foreign Entity Participation

In general, foreign entities are not eligible to apply as either a recipient or subrecipient. In limited circumstances, we may approve a waiver to allow a foreign entity to participate as a recipient or subrecipient.

A foreign entity may apply to this NOFO, but the application must be accompanied by an explicit written waiver request. Likewise, if you want to include a foreign entity as a subrecipient, you must submit a separate explicit written waiver request in your application for each proposed foreign subrecipient. *NOFO Part 2, Application Content Requirements*, explains the requirements for submitting a foreign entity waiver request. DOE's determination of a waiver request is final and you cannot appeal an adverse decision on a waiver request.

### **3. Performance of Work in the United States**

All work for the awards under this NOFO must be performed in the United States. To request a waiver of this requirement, you must submit an explicit waiver request in the application. Without an approved waiver, such costs will not be allowed under the award. *NOFO Part 2, Application Content Requirements*, lists the requirements for submitting a foreign work waiver request.

### **4. Ineligible Participants**

The following entities are ineligible for this NOFO as a recipient, subrecipient, or subcontractor:

- In accordance with 2 C.F.R. § 200.214, Entities banned from doing business with the U.S. government, such as entities debarred, suspended, or otherwise excluded from or ineligible for participating in Federal programs (2 C.F.R. § 200.214)
- Entities identified on the Department of the Treasury Office of Foreign Assets Control Treasury's Sanctions Program Specially Designated Nationals list. ([OFAC – Sanctions List Service \[treas.gov\]](#))
- Nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995

#### **Entity of Concern Prohibition**

Entities of Concern are prohibited from participating in projects under this NOFO. You can find details and definitions in *NOFO Part 2, Eligibility, Other Eligibility Information, Entity of Concern Prohibition*.

## **B. Limitation on Number of Applications Eligible for Review**

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You can submit more than one application to this NOFO, provided that each application describes a unique, scientifically distinct project as determined by DOE.

## **C. Cost Sharing**

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You must follow through on the estimated cost share commitments you proposed in your application if selected for award negotiations. You can find more information on cost sharing in *NOFO Part 2, Eligibility*.

## 1. Cost Share Requirements

The cost share must be at least 20% of the total project costs<sup>3</sup> for research and development.<sup>4</sup>

Applications that do not meet the minimum required cost share will be deemed ineligible during the initial compliance review. The cost share must come from nonfederal sources unless otherwise allowed by law.

The cost share percentage is calculated by dividing the *cost share* by the *total allowable project costs* for the award. Total allowable project costs include the government share (including FFRDC costs, if applicable) and cost share. You can find a cost share information sheet and sample cost share calculation in [NOFO Part 2, Eligibility—Cost Sharing, Cost Share Calculation Examples](#).

## 2. Unallowable Cost Share Sources

The recipient or subrecipients may not use the following sources to meet cost share obligations including but not limited to:

- Cost share derived from Federal sources (unless otherwise authorized by law).
- Cost share that does not meet:
  - Requirements set forth in 2 C.F.R. § 200.306 and 910.130
  - Cost principles set forth in 2 C.F.R. § 200.400–476 and 2 C.F.R. § 910.352
  - For State Energy Programs, requirements set forth in 10 C.F.R. § 420
- Cost share derived from the DOE loan program
- Revenues or royalties from the prospective operation of an activity beyond the project period
- Proceeds from the prospective sale of an asset of an activity
- Federal funding or property (e.g., Federal grants, equipment owned by the Federal Government)
- Expenditures that were reimbursed under a separate Federal program
- Cash or in-kind contributions used to meet cost share requirements for another Federal project or program
- Existing data as an in-kind contribution (e.g., data owned by an entity that is not routinely sold commercially but is instead donated to the project and assigned a value)

## D. FFRDC Eligibility Criteria

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### 1. DOE and Non-DOE FFRDCs as a Subrecipient

As long as no conflict exists, DOE and non-DOE FFRDCs may be proposed as subrecipients on another entity's application subject to the following guidelines.

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<sup>3</sup> Total project costs are the sum of the government share, including Federal Funded Research and Development Center (FFRDC) costs if applicable, and the recipient share of project costs.

<sup>4</sup> Energy Policy Act of 2005, Pub. L. 109-58, sec. 988. Also see 2 C.F.R. § 200.306 and 2 C.F.R. § 910.130 for additional cost sharing requirements.

***Authorization for non-DOE FFRDCs***

The Federal agency sponsoring the FFRDC must authorize in writing the FFRDC's participation on the proposed project, and you must submit this authorization with the application. The FFRDC's use must be consistent with its authority under its award.

***Authorization for DOE FFRDCs***

The cognizant contracting officer for the FFRDC must authorize in writing the FFRDC's participation on the proposed project, and you must submit this authorization prior to any award. The FFRDC's use must be consistent with the contractor's authority under its award.

***Funding, Cost Share, and Sub-Award with FFRDCs***

The recipient and FFRDC must enter into an appropriate sub-award agreement that will govern, among other things, how the recipient funds the FFRDC portion of the work under its DOE award. This agreement must be fully executed before the FFRDC starts work directly related to the financial assistance award. The DOE funding office will fund the DOE FFRDC and/or non-DOE FFRDC participating as a sub-awardee under the DOE financial assistance award to the recipient.

You should prepare the budgets in your application using rates that would fund the FFRDCs through sub-awards. Your cost share requirement will be based on the total cost of the project, including the applicant's, all subrecipient's, and all FFRDC's portions of the project.

***Responsibility***

The recipient is the responsible authority for settling and satisfying all contractual and administrative issues, including but not limited to disputes and claims arising out of any agreement between the recipient and the FFRDC.

***Limit on FFRDC Effort***

The FFRDC effort, in aggregate, must not exceed 20% of the total project cost.<sup>5</sup>

## **III. Program Description**

### **A. Program Purpose**

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This funding opportunity aims to drive transformative advancements across the U.S. oil and natural gas supply chain, contributing significantly to national energy security, economic competitiveness, and technological leadership. It focuses on modernizing infrastructure, minimizing product losses, and enhancing the value and utilization of hydrocarbon resources for the public good, including abundant and affordable energy for all Americans. This program continues to emphasize resilient energy systems and responsible resource management through technological innovation. It builds upon congressional

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<sup>5</sup> Total project cost is the sum of the government share, including FFRDC costs if applicable, and the recipient share of project costs.

directives for reducing natural gas losses and advancing data analytics. At the same time, it encourages industry-driven initiatives and technological advancements that lead to measurable reductions in product losses and improved efficiency.

This NOFO supports the goals laid out above by investing in key Topic Areas: Enhanced Resource Utilization and Production Technologies (Topic Area 1), Resilient Infrastructure Technologies Enhancement (Topic Area 2), and Hydrocarbon Infrastructure Test Sites (Topic Area 3). By doing so, it directly translates technological advancements into tangible benefits for all Americans, including a more stable and affordable energy supply; increased job opportunities in a technologically advanced energy sector; and a stronger, more reliable infrastructure that underpins economic prosperity and national security.

## **B. Program Goals and Objectives**

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This NOFO is seeking applications to address the critical need for improving the efficiency, reliability, and performance of the U.S. oil and natural gas supply chain. The program aims to achieve significant outcomes including the reduction of wasted natural gas, enhanced utilization of challenging hydrocarbon streams (e.g., sour gas, stranded natural gas liquids), modernization of infrastructure to minimize product losses and improve deliverability, and acceleration of digital transformation across the sector. Advancements related to improving efficiency, reliability, and performance will emphasize advanced catalysts, separation technologies, AI, ML, digital twins, and advanced materials to create a more resilient, cost effective and efficient energy system. Successful projects will deliver measurable impacts such as a substantial reduction in flared and vented gas, increased profitability from historically difficult wells, improved infrastructure integrity and efficiency, and enhanced worker safety. These achievements will directly contribute to national energy security and economic competitiveness by lowering operational costs, ultimately benefiting the public good by ensuring a stable and affordable energy supply for all Americans and strengthening the nation's energy independence, as aligned with DOE and the HGEO goals and objectives.

Detailed technical descriptions of the Topic Areas are provided in the sections that follow.

## **C. Expected Performance Goals**

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This NOFO is designed to achieve transformative advancements across the U.S. oil and natural gas supply chain. By investing in the technologies outlined in the Topic Areas of this NOFO, the Transport and Storage program anticipates significant, quantifiable impacts that collectively contribute to national energy security, economic competitiveness, and technological leadership.

Performance goals and expected outcomes include:

1. Enhanced resource utilization and economic value:
  - Substantial reduction in wasted natural gas, aiming to increase its use to 80% by 2035.



- Mitigation of natural gas product loss, and the resulting economic losses associated with flared and vented natural gas, targeting the reduction of approximately \$1.5 billion in annual flaring losses.
  - Increased profitability and production from wells historically limited by high contaminant concentrations (e.g., H<sub>2</sub>S, natural gas liquids), including unlocking production from an estimated 7,500 remaining wells in the eastern Delaware Basin.
  - Reduced treatment costs for sour gas by over 20% compared to existing methods, making domestic production more economically viable in challenging reservoirs.
2. Modernized and resilient infrastructure:
- Significant improvement in the overall efficiency of the U.S. natural gas delivery system, targeting a 2% increase (from 92% to 94%) by 2030.
  - Increased system integrity and reliability by addressing chronic issues such as corrosion and product loss, aiming for a 2% to 3% increase in pipeline deliverability due to reduced friction and corrosion impacts.
  - Enhanced equipment performance and longevity, including a 10% increase in compressor horsepower and performance due to improved equipment efficiency, and a 25% increase in engine thermal efficiency.
  - Substantial reduction in operational disruptions and maintenance costs, targeting at least a 20% reduction through the integration of digital technologies and predictive analytics.
3. Accelerated digital transformation and operational excellence:
- Rapid acceleration of the adoption and deployment of advanced digital technologies such as data analytics, AI, ML, Digital Twins, IoT, and Edge Computing within the upstream and midstream sectors.
  - Increased saleable hydrocarbon throughput by 10% to 20% and operational expenditure (OPEX) reductions of 15% or more through the validation of integrated digital and physical optimization systems.
  - Improved operational uptime and drawdown stability by 20% or more and reduced workover frequency and repair costs due to enhanced monitoring and predictive maintenance.
  - Establishment of standardized datasets and replicable models to de-risk technology adoption, accelerate industry uptake, and facilitate financing, particularly for small and mid-size operators.

Collectively, these outcomes will reinforce the U.S.' position as a global leader in energy technology and responsible hydrocarbon resource management, ensuring a stable, affordable, and secure energy future.

## **D. Topic Areas**

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### **Topic Area 1: Enhanced Resource Utilization and Production Technologies**

Topic Area 1 will fund the development, testing, and validation of advanced technologies to improve the utilization of natural gas and natural gas liquids (NGLs) that are currently being lost through operational inefficiencies and/or technology gaps. Specifically,

the targets are natural gas lost to flaring and venting, sour gas that is stranded due to its composition, and NGLs that are stranded due to a lack of effective separation and processing solutions. These challenges will be addressed by projects in two Sub-Topic Areas:

- Topic Area 1a: Laboratory Validation of Catalysts and Unit Operations
- Topic Area 1b: Field Validation of Full System Prototypes

Over the last 10 years, flaring and venting of natural gas associated with oil production across the U.S. has resulted in a lost monetary value of almost \$15 Billion (industrial price). A significant quantity of the Nation's domestic natural gas resource is wasted when oil production outpaces natural gas infrastructure buildout. Advanced chemical conversion technologies that produce valuable industrial chemicals and materials (e.g., methanol, acetic acid) from natural gas, otherwise flared, could increase natural gas utilization while simultaneously supporting the domestic chemical supply chain.

Over 85% of Permian Basin natural gas contains hydrogen sulfide ( $H_2S$ ) at concentrations up to 100 ppm, and over 40% contains concentrations up to 10,000 ppm. Handling sour gas requires costly, permit-intensive, specialized pretreating facilities. The costs and complexities can lead to significant volumes of natural gas being left unproduced or flared. Modular sour gas treatment systems, scalable for economic well pad operation, could overcome technical challenges and provide lower-cost solutions, increasing utilization of sour gas streams.

In 2023, approximately 40% of domestic natural gas production was associated gas containing varying amounts of NGLs (e.g., ethane, butane, and propane). High equipment costs for efficient separation and impurity removal often lead operators to utilize lower-cost alternative disposal mechanisms, including flaring these valuable liquid hydrocarbons along with associated gas. Flexible upstream processing solutions are required to improve the economics of full NGL recovery or to enable cost-effective extraction of propane and butane while rejecting ethane into the sales line.

It is anticipated that awarded projects will be required to collect sufficiently detailed cost and performance data to support the scalability and economic viability of the proposed technology solutions.

### **Topic Area 1a: Laboratory Validation of Catalysts and Unit Operations**

The objective of Topic Area 1a is to apply computational approaches (e.g., AI/ML, computational fluid dynamics) and process intensification R&D approaches to rapidly develop and validate new catalysts, reactor systems, and separation technologies—at the laboratory through prototype-scale—to increase the production and deliverability efficiency of hydrocarbons containing high sulfur and/or excess NGLs. Research efforts of interest may include but are not limited to:

#### **Natural Gas Product Loss**

- Employ AI and quantum-scale simulation technologies to design and optimize new catalysts and high-performance support structures (e.g., catalytic



membranes), identify new molecular configurations, and discover new reaction pathways to convert associated natural gas and/or NGLs into valuable products.

- High throughput synthesis and experimental testing of catalysts (e.g., nano-, multi-functional), hybrid reactors (e.g., membranes, microwave plasma), and new chemical pathways (e.g., direct conversion) that will enable decentralized associated gas and/or NGL utilization.

#### **Sour Gas Treatment Solutions**

- Develop and test new materials and separation technologies with the potential for highly efficient and low-cost treatment of sour gas streams (including H<sub>2</sub>S and CO<sub>2</sub>), including novel membranes, advanced sorbents, and new separation operations.
- Design and prototype pretreatment equipment and corrosion resistant materials suitable for gas streams with high levels of hydrogen sulfide.

#### **Optimizing NGL Utility**

- Discover and validate novel gas separation materials and methodologies supporting lower cost NGL recovery.
- Explore potential new chemical intermediates and processes capable of lowering the cost of storage, transport, and utilization of excess NGLs from wet natural gas streams.
- Validate potential new chemical conversion concepts and marketable products that transform separated NGLs and/or other gas condensates to high value chemicals (e.g., ethylene)

Applications must describe the impact of the proposed project based on laboratory-scale validation of the catalytic reaction, gas treatment process, or NGL recovery and utilization operation. For catalyst development and chemical conversion, this includes direct comparison to a representative industrial catalyst or process as a base case using relevant metrics such as turnover frequency, reaction rate, conversion, percentage yield, and selectivity. Corrosion rates for new material developments for acid gas should be compared to industry-standard corrosion-resistant alloys and coatings currently used for acid gas treatment. For new gas processing methods for acid gas and NGL recovery, relevant metrics such as removal efficiency, mass transfer efficiency, treated gas purity, acid gas slip, and NGL component recovery rates should be compared to existing industrial methods. A 15% or higher improvement in performance metrics is desired for new technologies.

- Applications should describe the anticipated level of improvement in overall energy efficiency for chemical conversion reactions or gas processing operations.
- Applications should define the potential economic benefits for the new technologies in terms of anticipated profit from industrial chemical production or reduced gas treatment costs.

Technologies proposed for research under Topic Area 1a should exhibit a **beginning Technology Readiness Level (TRL)<sup>6</sup> of 3** (technology concept and/or applications formulated) at the time of application submission and the proposed research should support delivering an **ending TRL of 5** (component and/or breadboard validation in relevant environment) by the end of the project.

All projects selected under Topic Area 1a will be required to complete a technology maturation plan (TMP) that describes the current TRL of the proposed technology/technologies, relates the proposed work to maturation of the technology, describes the expected TRL at the end of the project, and describes any known post-project R&D necessary to further mature the technology. Projects selected under Topic Area 1a will also be required to complete a techno-economic analysis (TEA) by the end of the project that demonstrates the economic feasibility of the technology/technologies and identifies economic and design hurdles that can be addressed with future research development.

To augment the TMP and TEA, projects selected under Topic Area 1a will be required to implement the DOE developed Adoption Readiness Level (ARL) framework<sup>7</sup> focused on technology commercialization, including the utilization of the Adoption Readiness Assessment tool for all technology solutions to be validated in the project. The ARL Framework is complementary to the TRL framework and is focused on identifying risks and opportunities to support the successful commercialization of new technologies.

### **Topic Area 1b: Field Validation of Full System Prototypes**

The objective of Topic Area 1b is **field testing** across multiple oil and gas (O&G) production basins and well sites to confirm the precommercial validation of new modular decentralized gas conversion systems, sour gas processing, and other innovative direct utilization applications that validate the profitable use of unused or underutilized natural gas streams. Research efforts of interest may include but are not limited to:

#### **Natural Gas Product Loss**

- Precommercial validation of economic potential (including product take-off, transport, and side product and waste stream disposal) of new advanced reactor concepts operating at decentralized and off-grid locations.
- Validation of AI-powered autonomous control schemes for optimal operational efficiency and adaptation to variable well gas streams.
- Other on-site innovative energy systems that utilize raw associated streams by other means, such as distributed electrical power generation with grid synchronization, or other valorization opportunities.

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<sup>6</sup> TRLs are a standardized 1-to-9 scale used by the DOE and other Federal agencies to assess the maturity of a technology. The TRL scale can be found in the [Technology Readiness Levels](#) section at the end of this NOFO.

<sup>7</sup> The [Adoption Readiness Levels framework](#) is a tool to assess the commercialization risks facing a technology as it crosses the research, development, demonstration, and deployment (RDD&D) continuum to reach successful commercialization.

**Sour Gas Treatment Solutions**

- Field testing of innovative sour gas (including H<sub>2</sub>S and CO<sub>2</sub>) processing systems capable of achieving output of pipeline quality natural gas and increasing gas takeaway.
- New sour gas treatment systems that fully mitigate the requirement for acid gas injection well construction and permitting.
- Demonstrating safe and direct use of corrosive sour gas streams for the benefit of operators or the surrounding infrastructure, including distributed electrical power sellback, remote data center support, or other onsite utilization of the thermal content of the sour gas.

**Optimizing NGL Utility**

- Field validation low cost NGL fractionation and recovery systems that offer alternative NGL utilization options based on market conditions.
- Testing integrated system designs that valorize “stranded NGLs” with innovative on-site NGL utilization, including fuel use, chemical and refrigeration applications, or chemical conversion to high value chemical intermediates or finished products.
- New methods for maximizing stable oil volumes through facility-level natural gas/oil technology advancements that enable increased NGL transport, lower downstream refining costs, and/or improve monetization of crude resources.

Applications must estimate the economics for the proposed field operation, including full consideration of the transport of produced chemicals, acidic or hazardous waste stream disposal, delivery of NGLs, and routing pipeline gas to sale. Overall profitability metrics should include an explanation of the approach and must directly use data generated during well site field testing of the decentralized gas conversion systems, gas processing, or other direct utilization applications of underutilized natural gas sources. Overall targets include 20% reduction in gas treatment costs and an 80% increase in the use of underutilized natural gas sources including flares, acid gas, and wet gas sources.

- Applications should describe anticipated level of improvement in the overall profitability of the specific well site where the technology is demonstrated. This includes the estimated total capitalized costs, the fixed and variable operating costs for the new technology, and the expected improvement in wellhead cash flow for the field test well site. This estimation must be contextualized by appropriate sensitivity analysis included for key variables such as production volume, natural gas and chemical market prices, drilling costs, and transport costs. New technologies should target at least a 10% improvement in wellhead cashflow.
- Applications should define the economic pathway to viability for the equipment and technologies proposed in the project, including relevant aspects related to scaling catalyst production and commercial mass manufacturing of advanced membrane or other materials.

Topic Area 1b research and technologies will conclude with field tests to validate performance, confirm practicality, and gather data to verify financial benefits to accelerate adoption by operators and service companies. **As such, applications must include a letter of intent from an industry partner providing access to a relevant field site for prototype testing. [Letter(s) of commitment will be required prior to actual award if selected for award negotiation.] Project teams under Topic Area 1b must include a business that intends to pursue the commercialization of the proposed technology if the results of the field tests and economic assessments are viable.**

Technologies proposed for research under Topic Area 1b should exhibit a **beginning [TRL of 5](#)** (component and/or breadboard validation in relevant environment) at the time of application submission and the proposed research plan should support delivering an **ending [TRL of 7](#)** (system, subsystem, and/or component deployment and testing in an operational environment) by the end of the project.

All projects selected under Topic Area 1b will be required to complete a **TMP** that describes the current TRL of the proposed technology/technologies, relates the proposed work to maturation of the technology, describes the expected TRL at the end of the project, and describes any known post-project R&D necessary to further mature the technology. Projects selected under Topic Area 1b will also be required to complete a **TEA** by the end of the project that demonstrates the economic feasibility of the technology/technologies and identifies economic and design hurdles that can be addressed with future research development.

To augment the TMP and TEA, projects selected under Topic Area 1b will be required to implement the DOE developed **ARL framework** focused on technology commercialization, including the utilization of the Adoption Readiness Assessment tool for all technology solutions to be validated in the project. The ARL Framework is complementary to the TRL framework and is focused on identifying risks and opportunities to support the successful commercialization of new technologies.

## **Topic Area 2: Resilient Infrastructure Technology Enhancement**

The objective of Topic Area 2 is to develop, validate, and field test advanced technologies to enhance the durability, reliability, and deliverability of the U.S. oil and natural gas supply chain by improving existing facility-level equipment and associated transport infrastructure, while paving the way for next-gen infrastructure. Specifically, the targets are areas of infrastructure that are subject to chronic leaks, corrosion-related failures, and unplanned downtime due to equipment operating failures.

Aging infrastructure and harsh operating environments lead to significant economic losses within the U.S. oil and natural gas supply chain. Nearly \$875.3 million in product value is squandered annually due to product losses across the natural gas production, processing, and transportation sectors. Industry faces \$1.372 billion in annual costs from corrosion impacts to pipelines, facilities, and equipment. This cost breaks down into \$589 million for surface pipelines and facilities, \$463 million for downhole tubing, and \$320 million in related capital expenditures. This problem is worsening as the industry moves into

deeper, higher-pressure, and more acidic environments. Furthermore, total annual losses from unplanned equipment failures per plant peaked at about \$240 million in FY22, highlighting the financial risk during periods of high commodity prices. Investments in resilient technologies are crucial to mitigate these pervasive issues and improve operational efficiency.

Research efforts and technologies of interest may include but are not limited to:

- Development and field validation of novel, high-efficiency engines and compressors, as well as cost-effective compressor retrofit solutions, to reduce product and heat losses, including an increase in compressor horsepower and performance by 10% and engine thermal efficiency by 25%.
- Development and field validation of technologies to improve performance and operation of production, processing, and transportation equipment such as storage tanks, dehydrators, valves, piping, and other infrastructure elements, with a target of increasing the overall efficiency of the U.S. natural gas delivery system by 2% (from 92% to 94%) by 2030.
- Development of advanced methods for leveraging AI/ML to optimize compressor and engine performance in real-time, aiming to reduce equipment maintenance costs by 20% by integrating AI/ML approaches, such as digital twins, into legacy infrastructure.
- Development, enhancement, and field validation of advanced materials (e.g., coatings, composites, specialized alloys) resistant to corrosion and friction to improve the deliverability of natural gas and NGLs, with a target of increasing pipeline deliverability by 2% to 3%.

Applications must estimate the impact of the proposed facility-level equipment designs and retrofits on equipment relative to an industry baseline. For engines and compressors metrics include specific power, leakage rate, and thermal, mechanical, and isentropic efficiency. For equipment such as storage tanks, dehydrators, valves, or piping, performance metrics can include improved leakage rates or some other relevant transport efficiency metric related to reduced corrosion rates or less pressure drop from frictional losses. Concepts should target a 50% reduction in product losses caused by leaks or operational venting. Individual equipment improvement targets include 10% increase in compressor performance, 25% increase in engine thermal efficiency, and 20% lower equipment maintenance costs.

- Applications should describe the anticipated level of improvement in hydrocarbon delivery using the data from the facility-level equipment design or transport infrastructure technology evaluated during the field test.
- The estimated infrastructure-wide efficiency improvements for the proposed project shall properly include a measure of the energy content of the hydrocarbon entering the infrastructure impacted by the technology relative to the energy delivered to a relevant midstream or downstream handoff. An overall increase in hydrocarbon infrastructure efficiency of 2% is desired.

Topic Area 2 research and technologies will conclude with **field tests** to validate performance, confirm practicality, and gather data to verify financial benefits to accelerate

adoption by operators and service companies. **As such, applications must include a letter of intent from an industry partner providing access to a relevant field site for prototype testing. [Letter(s) of commitment will be required prior to actual award if selected for award negotiation.] Project teams under Topic Area 2 must include a business that intends to pursue the commercialization of the proposed technology if the results of the field tests and economic assessments are viable.**

Technologies proposed for research under this topic area should exhibit a **beginning TRL<sup>8</sup> of 5** (component and/or breadboard validation in relevant environment) at the time of application submission and the proposed research plan should support delivering an **ending TRL of 7** (system, subsystem, and/or component deployment and testing in an operational environment) by the end of the project.

All projects selected under Topic Area 2 will be required to complete a **TMP** that describes the current TRL of the proposed technology/technologies, relates the proposed work to maturation of the technology, describes the expected TRL at the end of the project, and describes any known post-project R&D necessary to further mature the technology. Projects selected under Topic Area 2 will also be required to complete a **TEA** by the end of the project that demonstrates the economic feasibility of the technology/technologies and identifies economic and design hurdles that can be addressed with future research development.

To augment the TMP and TEA, projects selected under Topic Area 2 will be required to implement the DOE developed **ARL framework<sup>9</sup>** focused on technology commercialization, including the utilization of the Adoption Readiness Assessment tool for all technology solutions to be validated in the project. The ARL Framework is complementary to the TRL framework and is focused on identifying risks and opportunities to support the successful commercialization of new technologies.

### **Topic Area 3: Hydrocarbon Infrastructure Test Sites (HITS)**

The objective of Topic Area 3 is to increase the production efficiency and deliverability of the oil and natural gas supply chain by establishing and leveraging both controlled<sup>10</sup> and actively operating production, processing, and transportation facilities to validate innovative continuous monitoring technologies, AI-supported digital twins, and advanced analytics and control systems. HITS will act as a full-scale, field-based validation platform to accelerate the commercial readiness of advanced surface hydrocarbon operations.

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<sup>8</sup> TRLs are a standardized 1-to-9 scale used by the DOE and other Federal agencies to assess the maturity of a technology. The TRL scale can be found in the [Technology Readiness Levels](#) section at the end of this NOFO.

<sup>9</sup> The [Adoption Readiness Levels framework](#) is a tool to assess the commercialization risks facing a technology as it crosses the RDD&D continuum to reach successful commercialization.

<sup>10</sup> Existing research facilities that replicate oil & gas production and processing operations, including representative equipment, that mimic operating facilities and can be used as an initial testing ground for new technologies in a controlled environment.



This topic area specifically seeks applications to establish a physical field test site(s) where applicants will evaluate the performance of infrastructure optimization systems. Applications must have a defined physical location for testing and evaluation.

The U.S. hydrocarbon infrastructure is characterized by its vastness and complexity, including approximately 3 million miles of pipelines, over 900,000 producing wells, approximately 1,700 natural gas pipeline compressor stations with 5,000–7,000 compressors, and an additional 13,000–15,000 smaller upstream and 2,000–3,000 downstream compressors. The continued safe and efficient operation of this infrastructure is critical to the economic health of the nation and the energy security and safety of all U.S. citizens. Aging surface facilities, variable operating conditions, and fragmented data environments currently limit hydrocarbon throughput and increase operating expenses. Over the last 20 years, pipeline incidents have cost the industry approximately \$12 billion, with an average of \$1 million per incident. A single day of downtime at a liquified natural gas (LNG) facility could cost approximately \$25 million. Moreover, O&G infrastructure is increasingly vulnerable to cyberattacks. HITS addresses these challenges by providing a unique, integrated, and realistic test environment, analogous to the successful hydraulic fracture test sites (HFTS) for subsurface R&D but focused on surface infrastructure optimization. This approach is vital to de-risk and accelerate the commercialization of advanced digital and physical technologies, particularly for small and mid-size operators who often lack the resources for in-house development and validation.

This topic area seeks applications to test and evaluate upstream and midstream field-scale infrastructure optimization systems at physical field test site(s) to increase saleable hydrocarbons, reduce OPEX, and extend asset life across oil, natural gas, NGL, and LNG sectors. R&D areas that could be considered for evaluation at the field test site(s) may include, but are not limited to:

- Establishing integrated production field testbeds spanning crude oil, natural gas, and NGL with quantified throughput and OPEX improvements. This could include systematic closed-loop testing of novel infrastructure deliverability and product loss prevention technologies under full operating pressures and flow conditions, within a test site that replicates actual infrastructure facilities.
- Deploying multi-asset field test sites that allow real-time comparison of baseline and optimized configurations across hydrocarbon stabilization, separation, compression, pump down, and water-handling systems—generating measurable improvements in saleable product volumes and cost reduction per barrel of oil equivalent processed. This could include the testing of high-density data-acquisition systems that feed AI/ML model development and rapid proof-of-concept validation of modular O&G transportation technologies, within a test site that replicates actual infrastructure facilities.
- Installation of, and iteration on, new or emerging sensors and control systems, utilizing configurable test bays within a test site that replicates actual infrastructure facilities. This could include validating corrosion/erosion, leak diagnostics, and automated chemical-management solutions for pipeline and facility performance, testing advanced inline and fiber-based sensing



technologies, automated inhibitor systems, and integrity analytics to reduce failure events, minimize deferred production, and extend infrastructure lifespan without increasing chemical spend.

- Retrofitting of existing production well pads or operating production facilities to allow for the evaluation of precommercial and “best-in-class” optimization technologies under real-world conditions, to quantify impacts on deliverability and flow assurance.
- Implementing predictive monitoring and reliability technologies to reduce unplanned failures and extend asset life, integrating sensors, ML, and edge analytics to forecast events such as pump failures, compressor downtime, tank-level upsets, and water-system overloads—enabling planned interventions, reduced repair frequency, and significant run-life extension.
- Rigorous validation of multiphase flow, pressure, and emission sensors at existing production well pads or operating production facilities, to quantify measurement accuracy and establish industry best-practice guidelines.
- Embedment of mature digital twins, advanced analytics, and AI/ML command-and-control suites into live production, processing, and transportation assets to prove full-scale operational gains in terms of throughput, OPEX reduction, and extended asset life. This could include deploying digital twin models to optimize gathering, stabilization, pressure management, and compression configuration, creating high-fidelity, continuously updated models of surface networks and facility components to test operational scenarios, improve choke and compressor setpoints, reduce bottlenecks, and maximize hydrocarbon flow under varying field conditions.
- Development and validation of technologies that accelerate the implementation of digital transformation for upstream and midstream transportation facilities, leveraging cutting-edge approaches such as AI, ML, IoT, advanced analytics, and automation. By integrating these technologies, the program aims to create “smart facilities” that are self-optimizing, predictive, and resilient, ultimately transforming the oil and natural gas value chain. This includes specific R&D areas such as:
  - Digital Twin Development: High-fidelity modeling, data synchronization, physics-informed AI, scalability, interoperability, and real-time model updating/calibration in harsh O&G environments.
  - Predictive Analytics: Anomaly detection, remaining useful life prediction, and production forecasting, including explainable AI and Physics-Informed AI tailored for O&G.
  - Edge Computing and Cloud Integration: Robust, ruggedized, and energy-efficient edge hardware and software for real-time processing, secure edge AI/ML optimization, and enhanced cybersecurity for the edge-to-cloud continuum.
  - Autonomous Systems: Development of robotic systems for inspection and maintenance, and advanced remote operations capabilities utilizing HITS as a validation platform. This also includes advancing operator decision support and efficient deployment with human-machine collaboration tools, introducing intuitive automation

interfaces, mobile-assisted field workflows, and real-time operational guidance systems that increase workforce efficiency, reduce troubleshooting time, and decrease time-to-action for critical operating decisions.

Applications must estimate the infrastructure wide improvement for the proposed advanced digital technology based on the evaluation at the HITS. Specific overall targets include 10 to 20% increase in hydrocarbon throughput and a 20% reduction in pipeline and facility downtime.

- Intelligent real-time control and autonomous operational optimization systems should measure improvements in terms of reduction in OPEX. Technologies should target a 15% reduction in operating costs.
- Predictive analytics, digital twins, and distributed data processing systems for anomaly detection, remaining useful life prediction, or production forecasting should quantify improvement in machine active operation compared to total scheduled operation time. Technologies should target a 20% increase in equipment uptime.
- Autonomous systems for robotic inspection and maintenance should be quantified in terms of reduced workover frequency and lower repair cost.

HITS host environments may include a combination of facility types, such as existing operator assets, university research facilities, private consortium facilities, national lab facilities, and/or hybrid public-private partnerships. However, the field-based validation platform must ultimately be tested at operational assets in the upstream/midstream O&G sector.

Applications under Topic Area 3 must address how the test site will accelerate commercialization and adoption by a broad range of O&G operators, especially small and mid-size operators.

**Applications under Topic Area 3 must also include letter(s) of intent from industry partner(s) providing access to field site(s) for hosting the HITS. [Letter(s) of commitment will be required prior to actual award if selected for award negotiation.] Test sites must be representative of the operating conditions of real-world oil and natural gas production, processing, and transportation facilities.**

Projects selected under Topic Area 3 will be required to perform an assessment and tracking of the [TRL](#)<sup>11</sup> of individual technologies deployed at the test sites to assess technical risks and facilitate technology maturity. This will be documented through the completion of a **TMP** that describes the current TRL of the proposed technologies, relates the proposed work to maturation of the technologies, describes the expected TRLs at the end of the

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<sup>11</sup> TRLs are a standardized 1-to-9 scale used by the DOE and other Federal agencies to assess the maturity of a technology. The TRL scale can be found in the [Technology Readiness Levels](#) section at the end of this NOFO.

project, and describes any known post-project R&D necessary to further mature the technologies.

To augment the TMP, projects selected under Topic Area 3 will also be required to implement the DOE developed **ARL framework**<sup>12</sup> focused on technology commercialization, including the utilization of the Adoption Readiness Assessment tool for all technology solutions to be validated in the project. The ARL Framework is complementary to the TRL framework and is focused on identifying risks and opportunities to support the successful commercialization of new technologies.

## **E. Applications Specifically Not of Interest**

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DOE will not review or consider the following types of applications as determined by DOE without appeal (also refer to the [Responsiveness Review](#) section below):

### **General (All Topic Areas)**

- Applications that fall outside the technical parameters specified in [Background and Context](#) and [Topic Areas](#)
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics); project concepts or approaches not based on established scientific principles.
- Applications that do not clearly articulate how the proposed technology or project outcomes will strengthen U.S. energy security, economic competitiveness, domestic manufacturing, or job creation within the U.S. oil and natural gas sector.
- Applications with no cost share commitment letters at the time of submission.
- Applications proposing technologies that are already commercially mature and widely deployed within the U.S. oil and natural gas upstream or midstream sectors, without demonstrating novel application or significant advancement beyond current best practices.

### **Topic Area 1**

- Applications focused solely on traditional, centralized, large-scale amine treatment or cryogenic NGL recovery without novel, modular, cost-reducing, or intensified aspects.
- Solutions for H<sub>2</sub>S treatment that generate large volumes of difficult-to-dispose-of waste products (e.g., spent scavengers that are incompatible with produced water) without a clear, cost-effective disposal or valorization strategy.
- Technologies that do not offer a clear economic pathway for the utilization of challenging streams, or where the proposed valorization significantly undervalues the feedstock.
- Applications for chemical conversion to fuels (e.g., gasoline, diesel) from natural gas or NGLs.

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<sup>12</sup> The [Adoption Readiness Levels framework](#) is a tool to assess the commercialization risks facing a technology as it crosses the RDD&D continuum to reach successful commercialization.

- Technologies that fall outside the requested TRLs specified in the Topic Area.
- Applications for projects under Topic Area 1b that do not include a letter of intent from an industry partner providing access to a relevant field site for prototype deployment and testing.

**Topic Area 2**

- Technologies for general efficiency improvements that are not specifically tailored to the unique operating conditions (e.g., pressures, temperatures, fluid compositions, remoteness) encountered in the U.S. Oil & Gas upstream/midstream sectors.
- Projects focused solely on sensor development without integration into a system that improves operational performance, predicts failures, or reduces costs.
- AI/ML applications that are generic or lack domain-specific physical models (unless demonstrating a novel approach to physics-informed AI), or applications that do not adequately address data quality, explainability, or cybersecurity for industrial deployment.
- Applications for technologies primarily addressing downstream refining or end-use applications outside the scope of upstream/midstream production, processing, and transportation infrastructure.
- Solutions that increase complexity or cost without providing a clear, quantifiable benefit in terms of efficiency, reliability, deliverability, or safety.
- Technologies that fall outside the requested TRLs specified in the topic area.
- Applications for projects that do not include a letter of intent from an industry partner providing access to a relevant field site for prototype deployment and testing.

**Topic Area 3**

- Applications that focus solely on developing new sensor hardware without demonstrating its integration into a comprehensive monitoring, analysis, and control system validated at a facility scale.
- Digital technology solutions (AI/ML, Digital Twins, Edge Computing) that are generic and lack specific adaptation, validation, or benefits for the unique challenges of the upstream/midstream O&G sector (e.g., harsh environments, remote operations, specific data heterogeneity).
- Applications that do not include both a physical field test site location(s) and a set of technologies / methodologies that are to be evaluated at the test site(s).
- Applications for projects that do not include a letter of intent from an industry partner providing access to a relevant field site for prototype deployment and testing.

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**F. Statutory Authority**

The programmatic authorizing statutes are:

- DOE Organization Act, 42 U.S.C. § 7101., et seq. (Public Law 95-91), as amended

- Energy Policy Act of 2005, Public Law 109-58, Title IX, Subtitle F, § 961 as amended (codified at 42 U.S.C. § 16291)
- 42 U.S.C. § 7256(a), 42 U.S.C. § 7256(g)

Awards made under this announcement are subject to the OMB Guidance for Federal Financial Assistance (e.g, 2 C.F.R. Part 200) as adopted and DOE's Financial Assistance Regulations, 2 C.F.R. Part 910. Other Transaction Awards are authorized by 42 U.S.C. § 7256. DOE may negotiate other transaction (OT) agreement when Secretary of Energy determines that the use of a standard cooperative agreement, grant, or contract is not feasible or appropriate for a project. For information on other transaction agreements, see <https://www.energy.gov/management/other-transaction-authority>.

## IV. Application Content and Form

This section includes application information specific to this NOFO. Refer to **NOFO Part 2, *Application Content and Form***, for standard information that applies to all DOE NOFOs, such as formatting and content requirements and other requirements.

### A. Use and Disclosure of Application Information

In addition to the information provided in **NOFO Part 2, *Use and Disclosure of Application Information***, for compliance with implementation of Presidential Memorandum Simplifying the Funding of Energy Infrastructure and Critical Mineral and Material Projects<sup>13</sup>, the Department of Energy may share and use within the Government any application information provided by or on behalf of the applicant. Accordingly, in accordance with applicable law and notwithstanding any other provisions herein, by submitting an application or agreeing to a financial assistance arrangement with the Department of Energy under this NOFO, the applicant is providing consent for any properly marked trade secret, confidential, proprietary, privileged or otherwise sensitive application information provided by or on behalf of the applicant to be disclosed to the Executive Office of the President and relevant Agencies offering loans, grants, equity, guarantees or other Federal funding, for the purposes of the Presidential Memorandum on Simplifying the Funding of Energy Infrastructure and Critical Mineral and Material Projects.

### B. Summary

The application process includes a single submission phase: application.

| Application Submission Phase | Eligibility for Submission                                                                          |
|------------------------------|-----------------------------------------------------------------------------------------------------|
| Application                  | Must be submitted by the specified due date and time to be eligible for comprehensive merit review. |

<sup>13</sup> [Presidential Memorandum Simplifying the Funding of Energy Infrastructure and Critical Mineral and Material Projects](#)

## C. Application Content Requirements

Each application must be limited to a single concept. Applications must conform to the following requirements and must not exceed the stated page limits. **NOFO Part 2, *Application Content and Form***, includes a complete list of application requirements. You can find detailed guidance on the content and form of NOFO-specific requirements in the [Summary of Application Requirements](#) table below.

### 1. Covered Individual Definition, Designation, and Responsibility

Several of the Application Content Requirements in the table below and in the NOFO Part 2 are required for Covered Individuals.

For this NOFO, *Covered Individual* is an individual who:

- Contributes in a substantive, meaningful way to develop or execute the scope of work of a project proposed for funding by DOE
- Is designated as a Covered Individual by DOE.

DOE designates as Covered Individuals any:

- Principal investigator (PI)
- Project director (PD)
- Co-principal investigator (Co-PI)
- Co-project director (Co-PD)
- Project manager
- Any individual functionally performing as a PI, PD, Co-PI, Co-PD, or project manager
- Technical staff (e.g., postdoctoral fellows/researchers and graduate students)

DOE may further designate Covered Individuals during award negotiations or the award period of performance.

If selected, throughout the life of the award, you have an ongoing responsibility to submit:

- Current and pending support disclosure statements and resumes or biosketches for any new Covered Individuals
- Updated disclosures if a current and pending support disclosure statement, resume, or biosketch previously submitted to DOE changes

### 2. Summary of Application Requirements

| Component                                   | File Format | Page Limit | File Name                                      |
|---------------------------------------------|-------------|------------|------------------------------------------------|
| Application for Federal Assistance (SF-424) | PDF         | n/a        | ControlNumber_LeadOrganization_424             |
| Technical Volume                            | PDF         | 20         | ControlNumber_LeadOrganization_TechnicalVolume |



|                                                                             |          |             |                                                                  |
|-----------------------------------------------------------------------------|----------|-------------|------------------------------------------------------------------|
| <b>Letters of Commitment / Intent</b>                                       | PDF      | 1 page each | ControlNumber_LeadOrganization_LOCs                              |
| <b>Impacted Indian Tribes Documentation</b>                                 | PDF      | n/a         | ControlNumber_LeadOrganization_ImpactedTribes                    |
| <b>Statement of Project Objectives</b>                                      | MS Word  | 8           | ControlNumber_LeadOrganization_SOPO                              |
| <b>Project Management Plan</b>                                              | PDF      | 8           | ControlNumber_LeadOrganization_PMP                               |
| <b>Budget Information Non-Construction Programs (SF-424A)</b>               | PDF      | n/a         | ControlNumber_LeadOrganization_SF-424A                           |
| <b>Budget Justification Workbook</b>                                        | MS Excel | n/a         | ControlNumber_LeadOrganization_Budget_Justification              |
| <b>Subrecipient Budget Justification</b>                                    | MS Excel | n/a         | ControlNumber_LeadOrganization_Subrecipient_Budget_Justification |
| <b>Work Application for FFRDC, (see <a href="#">DOE O 412.1A</a>)</b>       | PDF      | n/a         | ControlNumber_LeadOrganization_WP                                |
| <b>Authorization for Non-DOE or DOE FFRDCs</b>                              | PDF      | n/a         | ControlNumber_LeadOrganization_FFRDCAuth                         |
| <b>Waiver for Foreign Entity Participation</b>                              | PDF      | n/a         | ControlNumber_LeadOrganization_FEW                               |
| <b>Performance of Work in the United States (Foreign Work Waiver)</b>       | PDF      | n/a         | ControlNumber_LeadOrganization_FWW                               |
| <b>Biosketch (for each Covered Individual)</b>                              | PDF      | n/a         | ControlNumber_LeadOrganization_Biosketch                         |
| <b>Current and Pending Support (for each Covered Individual)</b>            | PDF      | n/a         | ControlNumber_LeadOrganization_CPS                               |
| <b>Digital Persistent Identifier (for each Covered Individual)</b>          | n/a      | n/a         | Include in Current & Pending Support                             |
| <b>Research Security Training Requirement (for each Covered Individual)</b> | n/a      | n/a         | Include in Current & Pending Support                             |
| <b>Transparency of Foreign Connections</b>                                  | PDF      | n/a         | BusinessSensitive_ControlNumber_LeadOrganization_TFC             |
| <b>Potentially Duplicative Funding Notice</b>                               | PDF      | n/a         | ControlNumber_LeadOrganization_PDFN                              |
| <b>Locations of Work</b>                                                    | Excel    | n/a         | ControlNumber_LeadOrganization_LOW                               |
| <b>Environmental Questionnaire</b>                                          | PDF      | n/a         | ControlNumber_LeadOrganization_ENV                               |
| <b>Disclosure of Lobbying Activities, if applicable (SF-LLL)</b>            | PDF      | n/a         | ControlNumber_LeadOrganization_SF-LLL                            |
| <b>Certification Regarding Lobbying (OMB 4040-0013)</b>                     | PDF      | n/a         | ControlNumber_LeadOrganization_Cert Lobbying                     |
| <b>Summary for Public Release</b>                                           | PDF      | 1           | ControlNumber_LeadOrganization_Summary                           |

|               |                      |   |                                      |
|---------------|----------------------|---|--------------------------------------|
| Summary Slide | MS<br>Power<br>Point | 1 | ControlNumber_LeadOrganization_Slide |
|---------------|----------------------|---|--------------------------------------|

### 3. Impacted Indian Tribes Documentation

For any application that potentially impacts Indian Tribes,<sup>14</sup> including when the potentially impacted Indian Tribe is the applicant, you must submit additional documentation:

- For projects sited on Tribal lands<sup>15</sup> or intersecting with Tribal subsurface rights:
  - You must submit documentation of support from the relevant Indian Tribes with the application. See below for requirements for documentation of Tribal support.
- For applications potentially impacting Indian Tribes' resources and reserved rights in other ways:
  - We encourage you to submit documentation of support from the relevant Indian Tribes. You must, at a minimum, provide documentation confirming that an authorized representative from each potentially impacted Indian Tribe is aware of the application's nature and its potential impacts to the Indian Tribe. See below for helpful resources for evaluating potential impacts and requirements for documenting Tribal awareness.

We encourage you to reach out to Indian Tribes as early as possible to give them ample time to evaluate and respond. Documentation will not be scored; however, if you do not submit documentation of an Indian Tribe's awareness or a letter of support, it may result in determining your application ineligible, non-responsive to the NOFO, not subject to further review, or not otherwise subject to selection or award.

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<sup>14</sup> Indian Tribe as defined in 25 U.S.C. § 5304 and includes Alaska Native Villages and Alaska Native Corporations.

<sup>15</sup> Tribal land is as defined in 25 U.S.C. §§ 3501(2), (3), (4)(A) and (13).

| Documentation of Tribal Support                                                                                                                                           |                                                                                                                                                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Item                                                                                                                                                                      | Criteria                                                                                                                                                                                                                                             |
| Letter of Support from Tribal Leadership                                                                                                                                  | The letter must be signed by an authorized representative <sup>16</sup> of the Indian Tribe and express support for the project. The signers must be holding their positions while the NOFO is open for applications or when subsequently submitted. |
| Tribal Council Resolution, Board Resolution, or similar act passed by the legislative body of the Tribal government or Board of Directors of an Alaska Native Corporation | Must express support for the project.                                                                                                                                                                                                                |

| Documentation of Tribal Awareness                          |                                                                                                                                                                                                             |
|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Item                                                       | Criteria                                                                                                                                                                                                    |
| Any Documentation of Tribal Support (see above)            | See above                                                                                                                                                                                                   |
| An email reply or documentation of certified mail delivery | Must demonstrate that an authorized representative <sup>19</sup> of the Indian Tribe is the one who was notified and made aware of the nature of the project and its potential impacts to the Indian Tribe. |

The following resources and guidance may be useful to help determine if a project may impact Indian Tribe resources or reserved rights and to find the appropriate contacts. These resources are not exhaustive, and many Indian Tribes have resources or reserved rights that extend beyond their Tribal lands or are covered within treaties, statutes, or case-law. You should do additional research, while respecting Tribal privacy over sacred sites. Any outreach, impact assessment, and mitigation plans must be documented and made available to DOE on request after award selection or during award negotiation. If the applicant is an Indian Tribe, we recommend these resources and guidance be used to ascertain impacts to other Indian Tribes.

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<sup>16</sup> An authorized representative must be an elected official or designated leader according to the traditions, constitution, or charter of the Indian Tribe, or someone with relevant delegated authority within the Tribal government. Examples include Chief, Chairman, Chairwoman, Governor, Nation Representative, President, Chief Executive Officer, Chief Financial Officer, Speaker of the Council, Speaker of the Congress, Tribal administrator.

| Resources for Evaluating a Project's Potential Impact on an Indian Tribe                                                                    |                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Item                                                                                                                                        | Location                                                                                                                                                                                |
| Map of Indian Lands                                                                                                                         | <a href="https://bia-geospatial-internal.geoplatform.gov/indianlands/">https://bia-geospatial-internal.geoplatform.gov/indianlands/</a>                                                 |
| Tribal Directory Assessment Tool (TDAT)                                                                                                     | <a href="https://egis.hud.gov/TDAT/">https://egis.hud.gov/TDAT/</a>                                                                                                                     |
| Tribal Treaties Database                                                                                                                    | <a href="https://treaties.okstate.edu/">https://treaties.okstate.edu/</a>                                                                                                               |
| Directory of Federally Recognized Tribes and Tribal leaders                                                                                 | <a href="https://www.bia.gov/service/tribal-leaders-directory">https://www.bia.gov/service/tribal-leaders-directory</a>                                                                 |
| Best Practices for Identifying and Protecting Tribal Treaty Rights, Reserved Rights, and Other Similar Rights in Federal Regulatory Actions | <a href="#">Best Practices For Identifying And Protecting Tribal Treaty Rights, Reserved Rights, And Other Similar Rights In Federal Regulatory Actions And Federal Decision-Making</a> |

| Guidance on Assessing Potential Impacts to Indian Tribe Resource or Reserved Rights                                           |                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Type of Action                                                                                                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                    | Mitigation                                                                                                                                                                |
| <b>Research and Development</b>                                                                                               | <ul style="list-style-type: none"> <li>Identify any resources you will quantify or model on or near Tribal land, traditional homelands, Tribal historic sites, sacred sites, or in areas where an Indian Tribe maintains rights to these resources</li> <li>Identify which Indian Tribes may be impacted</li> <li>Explain any instances of uncertainty or need for confidentiality</li> </ul> | Explain any actions you took to mitigate or address any potential impacts identified, including engaging with the potentially impacted Indian Tribes, in the application. |
| <b>Surface Impacts</b>                                                                                                        | <ul style="list-style-type: none"> <li>Identify any Indian Land (as defined in 25 U.S.C. § 3501), traditional homelands, or Tribal historic and sacred sites that will be crossed or are near to the proposed infrastructure</li> <li>Identify which Indian Tribes might be impacted</li> <li>Explain any instances of uncertainty or confidentiality</li> </ul>                              |                                                                                                                                                                           |
| <b>Subsurface Resource Activities (e.g., carbon sequestration, oil &amp; gas, geothermal, critical minerals, groundwater)</b> | <ul style="list-style-type: none"> <li>Identify any Tribal mineral rights, subsurface, or water rights at or near the proposed project location</li> <li>Explain any relevant studies already performed, such as groundwater studies</li> <li>Identify which Indian Tribes might be impacted</li> </ul>                                                                                       |                                                                                                                                                                           |

|                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                            | <ul style="list-style-type: none"> <li>• Explain any instances of uncertainty and any potential for subsurface resource migration that has been considered</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| <b>Other Actions Not Categorized Above</b> | <ul style="list-style-type: none"> <li>• Identify any other proposed actions that may impact an Indian Tribe’s resources or reserved rights. Tribal resources and reserved rights include, and are not limited to: <ul style="list-style-type: none"> <li>○ An Indian reservation or land (as defined in 25 U.S.C. § 3501)</li> <li>○ Intersecting Tribal sub-surface rights</li> <li>○ Historic homelands they were removed from</li> <li>○ Cultural sites</li> <li>○ Sacred sites</li> <li>○ Water rights</li> <li>○ Mineral and other subsurface rights</li> <li>○ Fishing rights</li> <li>○ Hunting rights.</li> </ul> </li> <li>• Identify the Tribes potentially impacted and any sources of uncertainty or confidentiality</li> </ul> |  |

We may share any application that could impact Indian Tribes with those Indian Tribes, subject to any proper Proprietary Information markings on the submission. Accordingly, you should include a “Notice of Restriction on Use and Disclosure of Information” to identify any Proprietary Information described in **NOFO Part 2 Use and Disclosure of Applicant Information**. After selection, you may be asked to include a “Notice of Restriction on Disclosure and Use of Data” to identify any Proprietary Information. For the purposes of Indian Tribes, properly marked application information will be used or disclosed for evaluation purposes when we must determine if the proposed project impacts an Indian Tribe, and we will only share that information with the potentially impacted Tribes.

Data you submit once under award that could impact Indian Tribes may be shared with the potentially impacted Indian Tribes, subject to any restrictions included on properly marked data per the award terms.

If you or DOE determines an Indian Tribe will be impacted, you must provide information on the project location, potential impacts, and how you will engage with Indian Tribes during the performance period of the agreement and, if necessary, after the end of the agreement. In addition to your engagement, we will determine if formal government-to-government consultation could be appropriate, and we will conduct that consultation accordingly.

#### 4. Technical Volume

The Technical Volume must conform to the following content and form requirements and address the technical review criteria in [Technical Review Criteria](#).

You must provide sufficient citations and references to the primary research literature to justify the claims and approaches made in the Technical Volume. However, DOE and reviewers are under no obligation to review cited sources.

The Technical Volume to the application may not be more than 20 pages, including the cover page; table of contents; all citations, charts, graphs, maps, photos, or other graphics and all information below. You should consider the weight of each technical review criteria (see [Technical Review Criteria](#)) when preparing the Technical Volume.

| Technical Volume Content Requirements Overview                             |                                                     |
|----------------------------------------------------------------------------|-----------------------------------------------------|
| Section                                                                    | Approximate Percent Content of the Technical Volume |
| Cover Page                                                                 | N/A                                                 |
| Table of Contents                                                          | 3%                                                  |
| Project Objectives                                                         | 5%                                                  |
| Build America, Buy America (BABA) Requirements for Infrastructure Projects | 2%                                                  |
| Technical Review Criteria Discussion                                       | 60%                                                 |
| Relevance and Outcomes and Impacts                                         | 10%                                                 |
| Roles of Participants                                                      | 5%                                                  |
| Multiple Principal Investigators                                           | 5%                                                  |
| Facilities and Other Resources                                             | 5%                                                  |
| Equipment                                                                  | 5%                                                  |
| Bibliography (not included in page limitation)                             | N/A                                                 |

### Cover Page:

- The project title
- Specific NOFO Topic Area
- Technical and business points of contact (email addresses and telephone numbers)
- Senior or key personnel and other Covered Individuals
- The project team, including recipient name, entity type, and names of all team member organizations
- The proposed project locations
- The proposed total Federal funding level, cost share, and performance period
- The proposed Federal funding level and cost share for each project participant
- Statements regarding confidentiality

### Table of Contents:

- Include, at a minimum, all the required sections identified below



**Project Objectives**

- Provide a clear, concise statement of the specific objectives or aims of the proposed project

**Build America, Buy America (BABA) Requirements for Infrastructure Projects:**

- Include a short statement in the first two pages of the SOPO on whether the project will involve construction, alteration, maintenance, or repair of public infrastructure in the United States
- See [Build America, Buy America](#) and [2 C.F.R. § 184](#) for definitions and other information regarding Infrastructure Projects and the Buy America Requirement

**Technical Review Criteria Discussion**

We will evaluate and consider only the applications that address separately each of the technical review criterion and sub-criterion.

- Address each of the technical review criterion and sub-criterion listed in [Technical Review Criteria](#)
- Provide enough information so that reviewers can evaluate the application based on these technical review criteria

**Relevance and Outcomes and Impacts**

- Explain the relevance of the effort to the objectives in the program announcement and the expected outcomes or impacts
- Include a clear statement of the importance of the project in terms of the utility of the outcomes and the target community of beneficiaries in the justification

**Roles of Participants**

- For multi-organizational or multi-investigator projects, describe:
  - The roles and the work to be performed by each participant and investigator
  - Business agreements between the applicant and participants
  - How the various efforts will be integrated and managed

**Multiple Principal Investigators**

- The applicant must indicate if the project will include multiple PIs
- If you designate multiple PIs, the application must:
  - Identify the Contact PI/Project Coordinator
  - Provide a "Coordination and Management Plan" that describes the organization structure of the project as it pertains to the designation of multiple PIs. This plan should, at a minimum, include:
    - Process for making decisions on scientific or technical direction
    - Publications
    - Intellectual property issues
    - Communication plans
    - Procedures for resolving conflicts
    - PIs' roles and administrative, technical, and scientific responsibilities for the project

**Facilities and Other Resources**

- Identify the facilities (e.g., office, laboratory, computer) to be used at each performance site listed
- Indicate the facilities' capacities, pertinent capabilities, relative proximity, and extent of availability to the project, if applicable
- Describe only those resources directly related to the proposed work
- Provide any information about other resources available to the project, such as machine and electronics shops

**Equipment**

- List important items of equipment already available for this project
- Note the location and pertinent capabilities of each, if appropriate
- Describe comparable equipment, if any, already at your organization to any equipment you are proposing to acquire, and explain why you cannot use it for this project

**Bibliography (not included in page limitation)**

- Provide a bibliography for any references cited in the Technical Volume section, if applicable
- Include only bibliographic citations

**5. Biographical Sketch**

Every Covered Individual at the applicant and subrecipient levels must submit a biographical sketch (biosketch). Use [SciENCv \(Science Experts Network Curriculum Vitae\)](#) to produce a DOE-compliant PDF version of the biosketch. The biosketch does not have page limits, though some fields in SciENCv have character limitations for consistency.

Use the NOFO-Specific Biosketch Instructions and the [NSPM-33, Implementation Guidance Pre- and Post-Award Disclosures Relating to the Biographical Sketch and Current and Pending \(Other\) Support](#)<sup>17</sup> to develop the biosketch.

Instructions for First-Time SciENCv Users:

1. Navigate to [SciENCv \(Science Experts Network Curriculum Vitae\)](#)
2. To log in, click More Options, Login.gov, then sign in
3. From the dashboard, click Manage SciENCv, then click Create New Document
4. Select DOE Biographical Sketch
5. From there, it's an easy web interface to add education and work history
6. When ready, click Download PDF, which will prompt the user to certify their responses, then the document will download and can be added to the NOFO application

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<sup>17</sup> This table supersedes in its entirety Table 2a and Paragraph 7 of the Disclosure Requirements and Standardization Section of the NSPM-33 Implementation Guidance.

The biosketch and CPS Common Forms must together include a list of all sponsored activities, awards, and appointments, whether:

- Paid or unpaid
- Full-time, part-time, or voluntary
- Faculty, visiting, adjunct, or honorary
- Cash or in-kind
- Foreign or domestic
- Governmental or private-sector
- Directly supporting your research
- Indirectly supporting your research by supporting students, research staff, space, equipment, or other research expenses.

Every covered individual must also identify all connections with malign foreign talent recruitment programs.

Please note the following:

- All definitions in the biosketch except Covered Individual (which is defined in the *NOFO Part 1, Application Content and Form—Application Content Requirements, Covered Individual Definition, Designation and Responsibility*) are available at: [NSPM-33, Definitions](#).
- If the NOFO-Specific Biosketch Instructions conflict with the [NSPM-33, Implementation Guidance Pre- and Post-Award Disclosures Relating to the Biographical Sketch and Current and Pending \(Other\) Support](#), follow the DOE NOFO-Specific Biosketch Instructions.

| DOE/NSA NOFO-Specific Biosketch Instructions                 |                                                                                                                                                                                                                                     |
|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Persistent Identifier (PID) of the Covered Individual</b> | <p>The PID field is required for all NOFOs and awards for R&amp;D activities or technical assistance to support R&amp;D activities.</p> <p>For NOFOs and awards that do not meet the criteria above, the PID field is optional.</p> |
| <b>Appointments and Positions Reporting Timeframe</b>        | <p>Identify all domestic and foreign professional appointments and positions, both inside and outside the primary organization. There should be no lapses in time over the past 10 years or since age 18, whichever is shorter.</p> |
| <b>Products: Limitation on Number Provided</b>               | <p>List up to 10 products most closely related to the proposed project.</p>                                                                                                                                                         |

### 6. Current and Pending (Other) Support

Current and pending (other) support (CPS Common Form) helps us identify potential duplication, overcommitment, potential conflicts of interest or commitment, and all other sources of support.

Every Covered Individual at the applicant and subrecipient levels must submit a CPS Common Form. Use [SciENCv \(Science Experts Network Curriculum Vitae\)](#) to produce a DOE-compliant PDF version of the CPS Common Form. The *CPS* Common Form does not have page limits, though some fields in SciENCv have character limitations for consistency.

Use the [NSPM-33 Implementation Guidance Pre- and Post-award Disclosures Relating to the Biographical Sketch and Current and Pending \(Other\) Support](#)<sup>18</sup> and the DOE NOFO-Specific CPS Instructions below to develop the CPS Common Form. The *CPS Common Form* and the *Biosketch Common Form* must together include a list of all sponsored activities, awards, and appointments, whether:

- Paid or unpaid
- Provided as a gift with terms or conditions
- Full-time, part-time, or voluntary
- Faculty, visiting, adjunct, or honorary
- Cash or in-kind
- Foreign or domestic
- Governmental or private-sector
- Directly supporting your research
- Indirectly supporting your research by supporting students, research staff, space, equipment, or other research expenses.

All connections with malign foreign talent recruitment programs in current and pending support.

Please note:

- All definitions in the CPS Common Form, except Covered Individual (which is defined in the *NOFO Part 1, Application Content and Form—Application Content Requirements, Covered Individual Definition, Designation and Responsibility*) are available at: [NSPM-33, Definitions](#).
- If the DOE NOFO-Specific CPS Instructions conflict with [NSPM-33, Implementation Guidance Pre- and Post-Award Disclosures Relating to the Biographical Sketch and Current and Pending \(Other\) Support](#), follow the DOE NOFO-Specific CPS Instructions.

| DOE/NNSA NOFO-Specific CPS Instructions |                                                                                                                          |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <b>Persistent Identifier (PID) of</b>   | The PID field is required for all NOFOs and awards for R&D activities or technical assistance to support R&D activities. |

<sup>18</sup> This table supersedes in its entirety Table 2a and Paragraph 7 of the Disclosure Requirements and Standardization Section of the NSPM-33 Implementation Guidance.

|                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>the Covered Individual</b>                                                    | For NOFOs and awards that do not meet the criteria above, the PID field is optional.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Reporting Timeframe for Applications, Projects, and In-Kind Contributions</b> | Disclose only <b>current</b> and <b>pending</b> support, as defined in the “Status of Support” field of the SciENCv CPS Common Form.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Types of Applications and Active Projects to Disclose</b>                     | In addition to the guidance listed above, consulting activities must be disclosed under the applications and active projects section of the form when any of the following scenarios apply: <ul style="list-style-type: none"> <li>• The consulting activity will require the Covered Individual to perform research as part of the consulting activity</li> <li>• The consulting activity does not involve performing research but is related to the Covered Individual’s research portfolio and may have the ability to impact funding, alter time or effort commitments, or otherwise impact scientific integrity</li> <li>• The consulting entity has provided a contract that requires the Covered Individual to conceal or withhold confidential financial or other ties between the Covered Individual and the entity, irrespective of the duration of the engagement</li> </ul> |
| <b>Disclosure Instructions for In-Kind Travel</b>                                | Follow the disclosure instructions for travel in <a href="#">NSPM-33, Implementation Guidance Pre- and Post-Award Disclosures Relating to the Biographical Sketch and Current and Pending (Other) Support</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Current and Pending (Other) Support Addendum</b>                              | The Current and Pending (Other) Support Addendum is <b>not</b> required for this NOFO.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

### D. Additional Requirements

Program-specific requirements that apply to awards funded under this NOFO are identified below. Standard requirements are described in **NOFO Part 2, *Additional Requirements***.

| Funding Restrictions                                      |             |                                        |
|-----------------------------------------------------------|-------------|----------------------------------------|
| Title                                                     | Location    | Additional Information                 |
| <b>Buy America Preference for Infrastructure Projects</b> | NOFO Part 1 | Applies to awards made under this NOFO |
| <b>Allowable Costs</b>                                    | NOFO Part 2 | Applies to awards made under this NOFO |
| <b>Pre-Award Costs</b>                                    | NOFO Part 2 | Applies to awards made under this NOFO |

|                                                                                   |             |                                                                        |
|-----------------------------------------------------------------------------------|-------------|------------------------------------------------------------------------|
| <b>Performance of Work in the United States (Foreign Work Waiver Requirement)</b> | NOFO Part 2 | Applies to awards made under this NOFO                                 |
| <b>Foreign Travel</b>                                                             | NOFO Part 2 | Foreign Travel is not allowed for awards made under this NOFO          |
| <b>Equipment and Supplies</b>                                                     | NOFO Part 2 | Purchasing American-made equipment and supplies applies to this award. |

### 1. Buy America Preference for Infrastructure Projects

Awards funded through this NOFO that are for or contain construction, alteration, maintenance, or repair of public infrastructure in the United States require that:

- All iron, steel, and manufactured products used in the infrastructure project are produced in the United States
- All construction materials used in the infrastructure project are manufactured in the United States

Refer to the [DOE's Standard Terms and Conditions](#) and [2 C.F.R. Part 184](#) to determine whether the Buy America Preference applies and if we should consider the Buy America Preference in the proposed project's budget and schedule. The Buy America Preference does not apply to prime recipients that are for-profit entities.

## V. Submission Requirements and Deadlines

You **must** take several one-time actions before applying to this NOFO. Some of these tasks may take several weeks. These requirements are outlined in detail in the [NOFO Part 2, Required Registrations](#).

### A. Submission Date and Times

You must submit all required submissions to the eXCHANGE site identified in the [Key Facts](#) section of this NOFO no later than 5 p.m. ET on the dates provided in the [Key Facts](#) section.

**Applicants are strongly encouraged to submit all required application documents at least 48 hours before the submission deadline.** Under normal conditions (i.e., at least 48 hours before the submission deadline), set aside at least one hour to submit application documents. Once you submit the application documents, you can revise or update your submission before the deadline passes. If you change any of your documents, you must resubmit them before the deadline. We will not extend the submission deadline for server or connection congestion.

### B. Intergovernmental Review

This NOFO is not subject to Executive Order 12372, Intergovernmental Review of Federal Programs.



## VI. Application Review Information

### A. Standards for Application Evaluation

Eligible applications will be evaluated based on this NOFO and the guidance in the “[DOE Merit Review Guide for Financial Assistance](#),” effective October 1, 2020.

### B. Responsiveness Review

We will not review or consider the following concept papers and applications:

- Project concepts or approaches identified as NOT of interest (see the [Applications Specifically Not of Interest](#) section above)
- Applicants and applications that do NOT meet the Eligibility Criteria in NOFO Parts 1 and 2

### C. Review Criteria

#### 1. Compliance Criteria

All submissions for concept papers and applications must:

- Comply with the content and form requirements listed in *NOFO Parts 1 and 2, Application Content Requirements and Submission Requirements and Key Dates*
- Include all required documents
- Be uploaded successfully submitted in the eXCHANGE site indicated in the [Key Facts](#) section at the beginning of this NOFO
- Meet the submission deadlines stated in [Key Facts](#) no later than 5 p.m. ET

DOE will not review or consider submissions submitted that:

- Are not submitted through the correct eXCHANGE site for this NOFO
- Are submitted after the due date and time
- Are incomplete

#### 2. Technical Review Criteria

Applications will be evaluated against the technical review criteria shown below. All sub-criteria are of equal weight.

| Review Criterion Overview             |        |
|---------------------------------------|--------|
| Criterion                             | Weight |
| Scientific and Technical Merit        | 45%    |
| Technical Approach and Understanding  | 25%    |
| Technical and Management Capabilities | 30%    |

**Criterion 1: Scientific and Technical Merit (45%)**

- Degree to which the current state of the proposed technology and/or methodology is clearly described and the extent to which the application specifically and convincingly demonstrates how the applicant will advance the technology and/or methodology through the proposed work.
- Feasibility and impact of the proposed concept and the degree to which the proposed work is based on sound scientific and engineering principles. This includes the sufficiency of technical detail in the application to assess whether the proposed work is scientifically meritorious and revolutionary, including relevant data, calculations, and discussion of prior work with analyses that support the viability of the proposed work.
- Degree to which the application convincingly demonstrates significant improvements of the proposed technology over existing or baseline technologies/methods and includes calculation methods to show that the performance targets set forth in the topic area can be met or exceeded.
- Extent to which the proposed technology and approach supports the objectives, requirements, and target specifications and metrics set forth in the topic area.

**Criterion 2: Technical Approach and Understanding (25%)**

- Feasibility, appropriateness, rationale, and completeness of the proposed Statement of Project Objectives, such that there is a logical progression of work aligning with the objectives of the topic area and includes task descriptions adequately describing the activities to be completed and how they would be accomplished.
- The adequacy and completeness of the Project Management Plan (PMP) in establishing baselines (technical scope, budget, schedule) and in managing project performance relative to those baselines; defining the actions that will be taken when these baselines must be revised; and identification of project risks and strategies for mitigation. This also includes the reasonableness of the project schedule to integrate all tasks/subtasks and achieve key project objectives as reflected by well-defined, quantifiable, and verifiable critical path milestones and key project decision points including defined targets for what constitutes successful achievement.
- The extent to which the technical approach is financially viable and the proposed budget is commensurate with the proposed level of effort, such that the budget is anticipated to be neither excessive nor insufficient to reasonably execute the technical approach and achieve the intended results.

**Criterion 3: Technical and Management Capabilities (30%)**

- The degree to which the applicant clearly includes and describes an organizational structure for the project team that is in line with the topic area objectives and explains the: roles and responsibilities of team members, how the project team will be integrated to achieve the project objectives, the approach to communication among participants and with DOE, the process for making decisions on technical direction, procedures for resolving conflict, and questions regarding intellectual property.
- The adequacy and relevance of the applicant's and participating organization's corporate experience (not the individual personnel's experience) in managing projects

of similar nature and complexity to that specifically proposed in the application, within budget and on schedule.

- Credentials, capabilities, experience, and availability of key personnel from the applicant and partnering organizations to carry out their specifically identified role within the proposed project.
- Adequacy and availability of the proposed facilities, equipment, and field site(s) to perform project tasks and meet the objectives of the topic area.

## **D. Other Selection Factors**

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In addition to the above criteria, the Selection Official may consider the following program policy factors to determine which applications to select for award negotiations:

- The degree to which the proposed project exhibits technological diversity when compared with the existing DOE project portfolio and other projects selected from the subject NOFO
- The degree to which the proposed project, including proposed cost share, optimizes the use of available DOE funding to achieve programmatic objectives
- The level of industry involvement and demonstrated ability to accelerate commercialization and overcome key market barriers
- The degree to which the proposed project is likely to lead to increased high-quality employment and manufacturing in the U.S.
- The degree to which the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty
- The degree to which the proposed project, or group of projects, represent a desired distribution of upstream and midstream oil and natural gas assets across the U.S. (considering past awards and current applications)
- The degree to which the proposed project will procure U.S. iron, steel, manufactured products, and construction materials
- The degree to which the proposed project demonstrably advances the DOE policy priorities
- The degree to which the applicant contributes to a broad range of recipients likely to produce immediately demonstrable results and recipients with the potential for potentially longer-term, breakthrough results, consistent with the objectives of the NOFO.
- The degree to which the proposed project contributes to the variety of organizations and organization types and sizes selected from the subject NOFO when compared with the existing DOE project portfolio
- The degree to which the proposed project has broad public support from the communities most directly impacted by the project
- The degree to which the proposed project avoids duplication and overlap with other publicly or privately funded work
- The degree to which the proposed project supports complementary efforts or projects, which, when taken together, will best achieve the research goals and objectives
- The degree to which the proposed project enables new and expanding market segments

- The degree to which the project’s solution or strategy will maximize deployment or replication

## VII. Selection and Award Notices

The **NOFO Part 2, *Selection and Award Notices***, provides information on notifications for concept papers (if applicable), applications, award negotiations, and post-selection information requests.

## VIII. Award Administration Information

### A. Post-Award Requirements and Administration

DOE requires all award recipients to follow and accept requirements governed by laws and policies—both Federal and DOE. These post-award requirements include:

- National and administrative policy requirements
- National Assurance Policies
- Financial assistance general certifications and representations
- Build America, Buy America requirements
- Davis-Bacon Act requirements
- Fraud, waste, and abuse requirements
- Safety, security, and regulatory requirements
- Environmental review with the National Environmental Policy Act requirements

Please review the [DOE’s Standard Terms and Conditions](#), the [sample Federal Assistance Reporting Checklist](#), and standard [Intellectual Property \(IP\) Provisions](#) to better understand post-award requirements and administration.

Post-award requirements and administration that apply to awards funded under this NOFO are identified below. Detailed descriptions of standard requirements are provided in **NOFO Part 2, *Post-Award Requirements and Administration***. Detailed descriptions of NOFO-specific requirements are provided below the table.

| Post Award Requirements and Administration |             |                                               |
|--------------------------------------------|-------------|-----------------------------------------------|
| Title                                      | Location    | Additional Information                        |
| Cybersecurity Plan                         | NOFO Part 1 | Does not apply to awards made under this NOFO |
| Government Rights in Data                  | NOFO Part 1 | Applies to awards made under this NOFO        |
| Real Property and Equipment Continued Use  | NOFO Part 2 | Applies to awards made under this NOFO        |
| Program Down-Select                        | NOFO Part 2 | Does not apply to awards made under this NOFO |

|                                         |             |                                        |
|-----------------------------------------|-------------|----------------------------------------|
| Go/No-Go Review                         | NOFO Part 2 | Applies to awards made under this NOFO |
| Energy Data eXchange                    | NOFO Part 2 | Applies to awards made under this NOFO |
| Invoice Review and Approval             | NOFO Part 2 | Applies to awards made under this NOFO |
| Cost-Share Payment                      | NOFO Part 2 | Applies to awards made under this NOFO |
| U.S. Manufacturing Commitments          | NOFO Part 2 | Applies to awards made under this NOFO |
| Subject Invention Utilization Reporting | NOFO Part 2 | Applies to awards made under this NOFO |
| Data Management and Sharing Plan (DMSP) | NOFO Part 2 | Applies to awards made under this NOFO |

### 1. Government Rights in Data

You can find the U.S. Government rights to application information in the [Use and Disclosure of Application Information](#) sections of Part 1 and Part 2. The U.S. Government rights to data produced under an award or used in the performance of the award varies according to the following classifications.

#### Limited Rights Data:

*Limited-Rights Data* are data (other than computer software) developed at private expense that embody trade secrets or are commercial or financial and confidential or privileged. For limited-rights data used in the performance of an award, the U.S. Government may inspect such data to verify the limited-rights data and restricted rights assertion or to evaluate work performance. However, award recipients are not normally required to deliver such data. For awards that require an award recipient to deliver limited-rights data and to ensure the protection of such data, you must properly mark these data as described in the award's intellectual property terms and conditions. Limited-rights data may be required to be delivered for the performance of independent technical reviews and assessment.

#### Unlimited Rights:

*Unlimited-Rights Data* are data first produced under an award or are unmarked data delivered to the U.S. Government as part of an award. *Unlimited rights* mean the U.S. Government has the right to (in any manner and for any purpose whatsoever and to have or permit others to) take the following actions with these data:

- Use
- Disclose
- Reproduce
- Prepare derivative works
- Distribute copies to the public

- Perform publicly and display publicly.

**Patentable Information:**

In addition to any other protection allowed under the award, invention disclosures and other patentable information may be protectable from public disclosure for a reasonable time to allow you to file a patent application.

**Protected Data:**

Despite the unlimited rights the U.S. Government normally obtains in data first produced under an award, under special statutory authority and with DOE concurrence, certain categories of data first produced under awards resulting from this NOFO may be marked as *protected data*. Protected data are technical data or commercial or financial data first produced under the award that, if obtained from and first produced by a nonfederal party, would be privileged or confidential. These data are protected from public disclosure for up to 2 years after the data were first produced. To qualify as protected data, we must agree with the classification, and you must properly mark the data as set forth in the award's intellectual property terms and conditions.

## IX. Other Information

Please see [NOFO Part 2, Other Information](#), for additional information, acronyms, and requirements that apply to all DOE NOFOs.

### A. Technology Readiness Levels

| Technology Readiness Level | TRL Definition                                                             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TRL 9                      | Actual system operated over the full range of expected mission conditions. | The technology is in its final form and operated under the full range of operating mission conditions. Examples include using the actual system with the full range of wastes in hot operations.                                                                                                                                                                                                                                                                              |
| TRL 8                      | Actual system completed and qualified through test and demonstration.      | The technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning. Supporting information includes operational procedures that are virtually complete. An Operational Readiness Review (ORR) has been successfully completed prior to the start of hot testing. |



|              |                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TRL 7</b> | Full-scale, similar (prototypical) system demonstrated in relevant environment            | This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment. Examples include testing full-scale prototype in the field with a range of simulants in cold commissioning. Supporting information includes results from the full-scale testing and analysis of the differences between the test environment, and analysis of what the experimental results mean for the eventual operating system/environment. Final design is virtually complete.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>TRL 6</b> | Engineering/pilot-scale, similar (prototypical) system validation in relevant environment | Engineering-scale models or prototypes are tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing an engineering scale prototypical system with a range of simulants. Supporting information includes results from the engineering scale testing and analysis of the differences between the engineering scale, prototypical system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. TRL 6 begins true engineering development of the technology as an operational system. The major difference between TRL 5 and 6 is the step up from laboratory scale to engineering scale and the determination of scaling factors that will enable design of the operating system. The prototype should be capable of performing all the functions that will be required of the operational system. The operating environment for the testing should closely represent the actual operating environment. |
| <b>TRL 5</b> | Laboratory scale, similar system validation in relevant environment                       | The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high-fidelity, laboratory scale system in a simulated environment with a range of simulants and actual waste. Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|              |                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              |                                                                                             | <p>eventual operating system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>TRL 4</b> | <p>Component and/or system validation in laboratory environment</p>                         | <p>The basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of ad hoc hardware in a laboratory and testing with a range of simulants and small scale tests on actual waste. Supporting information includes the results of the integrated experiments and estimates of how the experimental components and experimental test results differ from the expected system performance goals. TRL 4–6 represent the bridge from scientific research to engineering. TRL 4 is the first step in determining whether the individual components will work together as a system. The laboratory system will probably be a mix of on hand equipment and a few special purpose components that may require special handling, calibration, or alignment to get them to function.</p> |
| <b>TRL 3</b> | <p>Analytical and experimental critical function and/or characteristic proof of concept</p> | <p>Active R&amp;D is initiated. This includes analytical studies and laboratory-scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative tested with simulants. Supporting information includes results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. At TRL 3 the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants.</p>                                                                                                                                                                                                                                                                                                       |

|              |                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              |                                                  | Components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement physical experiments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>TRL 2</b> | Technology concept and/or application formulated | <p>Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies.</p> <p>Supporting information includes publications or other references that outline the application being considered and that provide analysis to support the concept. The step up from TRL 1 to TRL 2 moves the ideas from pure to applied research. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate the basic scientific observations made during TRL 1 work.</p> |
| <b>TRL 1</b> | Basic principles observed and reported           | <p>This is the lowest level of technology readiness. Scientific research begins to be translated into applied R&amp;D. Examples might include paper studies of a technology's basic properties or experimental work that consists mainly of observations of the physical world. Supporting Information includes published research or other references that identify the principles that underlie the technology.</p>                                                                                                                                                                                                                                                                                            |

## B. Acronyms

| Acronym | Definition                   |
|---------|------------------------------|
| AI      | Artificial Intelligence      |
| ARL     | Adoption Readiness Level     |
| BABA    | Build America, Buy America   |
| CFD     | Computational Fluid Dynamics |
| CFR     | Code of Federal Regulations  |

|                  |                                                           |
|------------------|-----------------------------------------------------------|
| CO <sub>2</sub>  | Carbon Dioxide                                            |
| CPS              | Current and Pending (Other) Support                       |
| DMSP             | Data Management and Sharing Plan                          |
| DOE              | Department of Energy                                      |
| ERUPT            | Enhanced Resource Utilization and Production Technologies |
| ET               | Eastern Time                                              |
| FFRDC            | Federally Funded Research and Development Centers         |
| FY               | Fiscal Year                                               |
| HITS             | Hydrocarbon Infrastructure Test Sites                     |
| H <sub>2</sub> S | Hydrogen Sulfide                                          |
| HGEO             | Hydrocarbons and Geothermal Energy Office                 |
| IP               | Intellectual Property                                     |
| IoT              | Internet of Things                                        |
| LNG              | Liquefied Natural Gas                                     |
| ML               | Machine Learning                                          |
| NETL             | National Energy Technology Laboratory                     |
| NGLs             | Natural Gas Liquids                                       |
| NOFO             | Notice of Funding Opportunity                             |
| NNSA             | National Nuclear Security Administration                  |
| NSPM             | National Security Presidential Memorandum                 |
| O&G              | Oil and Gas                                               |
| OFAC             | Office of Foreign Assets Control                          |
| OMB              | Office of Management and Budget                           |
| OPEX             | Operational Expenditure                                   |
| ORR              | Operational Readiness Review                              |
| OT               | Other Transaction                                         |
| PD               | Project Director                                          |
| PID              | Persistent Identifier                                     |
| PI               | Principal Investigator                                    |
| PMP              | Project Management Plan                                   |
| R&D              | Research and Development                                  |
| RDD&D            | Research, Development, Demonstration, and Deployment      |
| RITE             | Resilient Infrastructure Technology Enhancement           |
| SciENCv          | Science Experts Network Curriculum Vitae                  |
| SOPO             | Statement of Project Objectives                           |
| TDAT             | Tribal Directory Assessment Tool                          |
| TEA              | Techno-Economic Analysis                                  |
| TMP              | Technology Maturation Plan                                |
| TRL              | Technology Readiness Level                                |

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|        |                    |
|--------|--------------------|
| U.S.   | United States      |
| U.S.C. | United States Code |