Financial Assistance
Notice of Funding Opportunity
Part 1

U.S. DEPARTMENT *of* ENERGY

Department of Energy (DOE)
Hydrocarbons and Geothermal Energy Office
Improved Oil and Gas Recovery and Produced Water Management Technologies
Notice of Funding Opportunity Number: DE-FOA-0003627

Application due: September 08, 2026, 5:00 p.m. ET

Modifications
All Modifications to the Notice of Funding Opportunity (NOFO) are highlighted in green, in the body of the NOFO

Mod. No.	Date	Description of Modification
000001	07/06/2026	Revised the Application due date from October 05, 2026, to September 08, 2026.

000002	07/10/2026	• Revised Section II Eligibility, C. Cost Sharing, **1. Cost Share Requirements -** removed cost share requirement for demonstration level projects.
		• Revised Section III Program Description, D. Topic Areas, **1. Topic Area 1a, 2. Topic Area 1b, 3. Topic Area 1c, 4. Topic Area 2 -** revised to clarify letter(s) of intent from industry partner(s) are required at the time of application and letter(s) of commitment will be required prior to the actual award if selected for award negotiation.
		• Revised Section III Program Description, D. Topic Areas, **2. Topic Area 1b, 3. Topic Area 1c, 4. Topic Area 2, -** removed the requirement for proposals to include a technoeconomic assessment.
		• Revised Section IV. Application Content and Form, C. Application Content Requirements, **2. Summary of Application Requirements -** revised Application Content Requirements Table to include letters of intent and/or commitment are required with the application.

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Before You Begin

A. Navigating the Notice of Funding Opportunity

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 do not 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, *Submission Requirements and Deadlines*.

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, Hydrocarbons and Geothermal Energy Office, Divisions of Production & Transportation and Storage
Funding Opportunity Title	Improved Oil and Gas Recovery and Produced Water Management Technologies
Announcement Version	Initial Announcement
Funding Opportunity Number	DE-FOA-0003627
Funding Instrument	Cooperative Agreements or Other Transaction Agreement
Expected Total Available Funding	Federal Funds – Up to $150,000,000 Cost Share Funds – Minimum 20% - $37,500,000 Total Project Funds - $187,500,000
Assistance Listing Number and Name	81.089 Fossil Energy Research and Development
Announcement Type	Research and Development
Funding Opportunity Description	The objective of this Notice of Funding Opportunity (NOFO) is to seek proposals for specific research and development (R&D) projects to improve recovery efficiency from unconventional oil and natural gas reservoirs and to advance technologies for the treatment of flowback and produced water from oil and natural gas production operations. 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.
Program Goals & Objectives	Despite increasing energy demand, recovery efficiency for oil and natural gas from unconventional reservoirs can average less than 10 percent. This NOFO will enable rapid field deployment of a variety of novel technologies and processes related to improving primary and enhanced recovery efficiency with the goal of significantly improving resource recovery and accelerating industry uptake.

KEY DATES

All deadlines are 5:00 p.m. ET unless indicated otherwise

Notice of Funding Opportunity Issue Date:
July 06, 2026

Application Deadline:
September 08, 2026

Anticipated Selection Notification Date:
January 27, 2027

Anticipated Award Date:
May 03, 2027

Estimated Period of Performance:
May 03, 2027 – May 02, 2032

	This NOFO will also support the field testing and validation of water treatment technologies of produced water from oil and natural gas production operations to avoid deep well injection and potential issues with induced seismicity and interaction with underground sources of drinking water.
Topic Areas	Multiple Topic Areas: • Topic Area 1a: Field Test Site Research and Development of Technologies for Enhanced Recovery from Unconventional Oil and Gas Reservoirs • Topic Area 1b: Advanced Characterization of Fracture Propagation, Proppant Behavior, and Well Diagnostics • Topic Area 1c: Enhanced Recovery of Oil and Gas from Unconventional Reservoirs Using Carbon Dioxide (CO_2) • Topic Area 2: Advanced Field-Testing of Multi-Scale Produced Water Treatment Technologies & Processes
Eligible Applicants	• Domestic Entities (Institutions of higher education; for-profit entities; non-profit entities; state and local government entities and Indian Tribes)
eXCHANGE URL and Helpdesk	https://netl-exchange.energy.gov NETL-ExchangeSupport@hq.doe.gov
NOFO URL and Email	DOE: NETL eXCHANGE: Funding Opportunities DE-FOA-0003627@netl.doe.gov

1. Funding Details

Multiple Topic Areas

Approximate total available funding including all topic areas: Federal Funds – Up to $150,000,000; Minimum 20% Cost Share Funds – $37,500,000 Total Project Funds - $187,500,000

Topic Area 1a: Field Test Site Research and Development of Technologies for Enhanced Recovery from Unconventional Oil and Gas Reservoirs

- Approximate total available funding: Federal Funds – Up to $30,000,000; Minimum 20% Cost Share Funds - $7,500,000; Total Project Funds - $37,500,000
- Approximate number of awards: 0-2
- Approximate dollar amount of individual awards: Federal Funds – Up to $15,000,000; Minimum 20% Cost Share Funds - $3,750,000; Total Project Funds - $18,750,000
- Minimum cost share required: 20% of the total project costs
- Approximate award project period: 60 months
- Anticipated length of budget periods: 12-24 months

Topic Area 1b: Advanced Characterization of Fracture Propagation, Proppant Behavior, and Well Diagnostics

- Approximate total available funding: Federal Funds – Up to $36,000,000; Minimum 20% Cost Share Funds - $9,000,000; Total Project Funds - $45,000,000
- Approximate number of awards: 0-3
- Approximate dollar amount of individual awards: Federal Funds – Up to $12,000,000; Minimum 20% Cost Share Funds - $3,000,000; Total Project Funds - $15,000,000
- Minimum cost share required: 0% of the total project costs
- Approximate award project period: 60 months
- Anticipated length of budget periods: 12-24 months

Topic Area 1c: Enhanced Recovery of Oil and Gas from Unconventional Reservoirs Using CO_2

- Approximate total available funding: Federal Funds – Up to $60,000,000; Minimum 20% Cost Share Funds - $15,000,000; Total Project Funds - $75,000,000
- Approximate number of awards: 0-3
- Approximate dollar amount of individual awards: Federal Funds – Up to $20,000,000; Minimum 20% Cost Share Funds - $5,000,000; Total Project Funds - $25,000,000
- Minimum cost share required: 20% of the total project costs
- Approximate award project period: 60 months
- Anticipated length of budget periods: 12-24 months

Topic Area 2: Advanced Field-Testing of Multi-Scale Produced Water Treatment Technologies & Processes

- Approximate total available funding: Federal Funds – Up to $24,000,000; Minimum 20% Cost Share Funds - $6,000,000; Total Project Funds - $30,000,000
- Approximate number of awards: 0-2
- Approximate dollar amount of individual awards: Federal Funds – Up to $12,000,000; Minimum 20% Cost Share Funds - $3,000,000; Total Project Funds - $15,000,000
- Minimum cost share required: 20% of the total project costs
- Approximate award project period: 60 months
- Anticipated length of budget periods: 12-24 months

2. Period of Performance

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

This NOFO directly supports the directives of President Trump's [1]Executive Order 14154, titled "Unleashing American Energy" and [2]Secretarial Order "Unleashing the Golden Era of Energy Dominance" Its primary goal is to significantly enhance the efficiency and water management issues of domestic oil and natural gas production.

The NOFO focuses on two critical areas of research and development (R&D). First, it seeks innovative proposals to boost recovery efficiency from unconventional oil and natural gas reservoirs. While global energy demand continues to rise, current recovery efficiency from these crucial unconventional resources frequently fall below 10 percent. This funding opportunity aims to accelerate the field deployment of novel technologies and processes designed to improve recovery, with the ultimate objective of substantially increasing resource recovery and promoting rapid industry adoption.

Second, the NOFO will advance technologies for the treatment of flowback and produced water generated during oil and natural gas production. A significant challenge in the industry is the sustainable management of this water, which is often disposed of through deep well injection. This practice can lead to concerns regarding induced seismicity and potential contamination of underground sources of drinking water. Therefore, this NOFO will support the field testing and validation of advanced water treatment technologies, aiming to provide viable alternatives to deep well injection and mitigate associated water management issues.

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

For questions relating to this NOFO, email us at DE-FOA-0003627@netl.doe.gov.

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*.

[1] See Unleashing American Energy – The White House
[2] See Secretary Wright Acts to "Unleash Golden Era of American Energy Dominance" | Department of Energy

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)[3]

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 United States or under the laws of the United States
- Have majority domestic ownership and control
- Have a physical place of business in the United States

Participant Limitations

Participation of the following entities is limited as follows:

- Provided there is no conflict, DOE FFRDCs[4] 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.
- 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.

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[3] "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.

[4] 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://ncses.nsf.gov/resource/master-gov-lists-ffrdc.

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 Concept Papers and Applications Eligible for Review

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

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[5] for research and development.[6] ~~The cost share must be at least 50% of the total project cost for any demonstration level project proposed.~~

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 Federal Funded Research and Development Center [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)

[5] 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.

[6] 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.

D. FFRDC Eligibility Criteria

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.

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.[7]

III. Program Description

A. Program Purpose

Despite increasing energy demand, recovery efficiency from unconventional oil and natural gas reservoirs can average less than 10 percent. Rapid field testing of a variety of novel

[7] Total project cost is the sum of the Government share, including FFRDC costs if applicable, and the recipient share of project costs.

technologies and processes will support the goal of accelerating industry uptake of advanced approaches for improving primary recovery efficiency from these reservoirs.

In 2025, the Permian Basin was estimated to have produced approximately 22 million barrels per day of water associated with oil and natural gas production (produced water). The continued increase in water cut from Permian Basin wells highlights the key need for highly scalable technologies for produced water treatment and the need for opportunities for the beneficial use of treated produced water to avoid the need for deep well injection disposal and the related potential for induced seismicity and interaction with underground sources of drinking water.

The Advanced Oil and Gas Production Research program within the HGEO is addressing these challenges through the release of this NOFO DE-FOA-0003627, titled "Improved Oil and Gas Recovery and Produced Water Management Technologies." This NOFO aims to help the U.S. oil and natural gas industry achieve two important objectives: (1) improve the recovery efficiency of U.S. unconventional oil and natural gas resources and (2) improve the efficiency of processes for managing, treating and reusing oilfield water produced during the development of such resources.

In order to meet the requirements of President Trump's Executive Order 14154, titled "Unleashing American Energy" and Secretarial Order "Unleashing the Golden Era of Energy Dominance," this NOFO seeks proposals for specific R&D projects to improve recovery efficiency from unconventional reservoirs and to advance technologies for the treatment and beneficial use of flowback and produced water from oil and natural gas production operations, in support of lowering energy costs for the American consumer, supporting liquified natural gas exports to American allies, and continued American energy dominance.

This NOFO supports the goals laid out above by focusing on field deployment and validation of a variety of transformational technologies, tools, and processes that will accelerate rapid industry uptake of solutions for improving hydrocarbon resource recovery and water management practices. The cooperative agreements funded through this NOFO will leverage industry collaboration to provide robust data and improved "best practices" for more effective domestic resource development.

B. Program Goals and Objectives

This NOFO is looking for applications to address programmatic objectives to improve oil and natural gas production volume by increasing recovery efficiency in unconventional reservoirs and transforming produced water into an economic resource. These objectives will be addressed through the development, field deployment, and validation of advanced technologies, tools, and processes through projects supported by industry collaboration. Detailed technical descriptions of the topic areas are provided in the sections that follow.

Specifically, this NOFO seeks proposals for research focused on improving oil and natural gas recovery efficiency that include field deployment and validation of (1) improved hydraulic fracturing methods and process characterization that may include alternative working

fluids and proppants, and (2) enhanced oil and natural gas recovery methods that may include a variety of injected fluids and methods (Topic Area 1).

Novel enhanced oil and natural gas recovery technologies and processes may include, but are not limited to, the injection of supercritical or gaseous carbon dioxide (CO_2), various hydrocarbon mixtures and/or surfactants, and the application of advanced fracturing or refracturing fluids, proppants, and methods.

Additionally, this NOFO seeks proposals to advance oilfield produced water management and treatment methods that could include field deployment and testing of improved multi-scale produced water treatment technologies (Topic Area 2).

Field deployment and validation of multi-scale produced water treatment technologies and processes will focus on the objective of developing a centralized, multi-stage water treatment facility using customizable treatment trains to produce different levels of treated effluent for a variety of beneficial use purposes. Such a facility will target a broad range of contaminants, including solids, chemical impurities, and biological components.

The NOFO will seek to improve oil and natural gas recovery efficiency in unconventional reservoirs through:

- Enhanced oil recovery (EOR) or enhanced gas recovery (EGR) field-based R&D to validate the effectiveness of injectants such as surfactants, or other fluids/additives (not CO_2) during huff-n-puff (HnP) or similar processes. (Topic Area 1a)
- Field test sites focused on demonstrating novel techniques for improving production from unconventional oil and natural gas reservoirs. (Topic Area 1a)
- Field test site investigations focused on advanced characterization of fracture propagation, proppant transport and placement, enhanced diagnostics, and well completion design "best practices." (Topic Area 1b)
- Field deployment and validation of advanced refracturing, conformance control, and well completion technologies focused on improving recovery efficiency in unconventional oil and natural gas reservoirs. (Topic Area 1b)
- Field based R&D on the use of supercritical carbon dioxide ($scCO_2$) and gaseous CO_2 in HnP treatments or in pattern floods to enhance oil recovery or gas recovery from unconventional reservoirs. Such field-based R&D is to be focused on providing significant new understandings of the relationships among fluid type, fluid injection rate, injection pressure, reservoir pressure, injection volume, soak time, conformance, flowback protocols and incremental recovery. (Topic Area 1c)

The NOFO will also seek to support the field testing and validation of water treatment technologies to support beneficial use of flowback and produced water through:

- Large-scale deployable solutions with integrated approaches. Field based R&D on pilot-scale produced water treatment technologies and processes through advanced field-testing methods for large scale (15,000 to 50,000 barrels of water per day) treating over a period longer than 1 year (not including design or construction time).

Development of a centralized, multi-stage water treatment facility using customizable treatment trains to produce different levels of treated effluent for a variety of beneficial use purposes. Such a facility will be capable of targeting a broad range of contaminants, including solids, chemical impurities, and biological components.

C. Expected Performance Goals

Overarching performance goals for all topic areas target the Office of Oil and Gas program objectives, executed through a structured, well-informed, stage-gate approach that includes multiple budget periods.

The key performance goals for Topic Areas 1a, 1b, and 1c projects include:

- Field-based technology readiness levels (TRLs) of 5 at project start and a minimum of 7 at project end;
- Detailed techno-economic assessment of the costs, potential benefits, and practical challenges of wider deployment of the demonstrated technologies, tools, and processes, completed as part of the cooperative agreement, based on a knowledgeable assessment of current and future industry trends;
- Evaluation of the weighted impact on overall recovery efficiency of the multiple technologies, tools, and processes deployed during the project.

The key performance goals for Topic Area 2 cooperative agreements include:

- Field-based TRLs of 5 at project start and a minimum of 7 at project end;
- Detailed techno-economic assessment of the costs, potential benefits, and practical challenges of wider deployment of the demonstrated technologies, tools, and processes, completed as part of the cooperative agreement, based on a knowledgeable assessment of current and future industry trends;
- Evaluation of the scalability and efficiency of the demonstrated produced water treatment technologies when utilized to support an appropriate array of beneficial use opportunities.

Any verifiable metric data for hydrocarbon and water production provided to DOE after completion of the project will be used to analyze effectiveness of technologies in order to accelerate broad industry adoption.

Specific technical performance requirements for each topic area and subtopic are described in NOFO Section III.D (Topic Areas) and application requirements are articulated in NOFO Section IV.C.4 (Application Technical Volume Specific Requirements).

D. Topic Areas

There are four Topic Areas in this NOFO:

- Topic Area 1a: Field Test Site Research and Development of Technologies for Enhanced Recovery from Unconventional Oil and Gas Reservoirs
- Topic Area 1b: Advanced Characterization of Fracture Propagation, Proppant Behavior, and Well Diagnostics

- Topic Area 1c: Enhanced Recovery of Oil and Gas from Unconventional Reservoirs Using CO_2
- Topic Area 2: Advanced Field-Testing of Multi-Scale Produced Water Treatment Technologies & Processes

1. Topic Area 1a – Field Test Site Research and Development of Technologies for Enhanced Recovery from Unconventional Oil and Gas Reservoirs

What are commonly referred to as unconventional reservoirs (i.e., oil-bearing and gas-bearing shales and other tight rocks that are being developed via long horizontal laterals coupled with high volume hydraulic fracturing) are exhibiting recoveries that are often less than 10 percent of the original hydrocarbons in place. For this NOFO, an unconventional oil and gas reservoir is considered a geological formation where hydrocarbons are tightly trapped due to low permeability (typically less than 1 millidarcy [mD]) requiring specialized extraction methods like hydraulic fracturing and horizontal drilling for economic production. Given the fact that these formations are laterally and vertically extensive in multiple producing basins, the potentially producible domestic oil and natural gas resource is significant, and the inability to recover a larger portion of that resource constitutes a major economic loss extending over decades.

Unconventional oil EOR is still in an early development phase, but dozens of pilot projects have been carried out. According to Texas Railroad Commission data, as of August 2024 there had been 37 permitted unconventional oil EOR pilot projects in the Eagle Ford play alone. However, many of these projects have been terminated and many were considered technically and/or economically unsuccessful. Ten unconventional oil EOR pilot projects have been recently concluded or are still in operation in the Permian Basin, and a handful have been conducted or are being planned for the Williston Basin (North Dakota) and others in Oklahoma basins. To the degree that companies have revealed their performance via publications to date, it appears that some have seen technical success, but economic success appears to have been limited.

Nearly all of these EOR pilot projects have involved the cyclic injection of EOR fluids, most often natural gas, which is often referred to as HnP. Many pilot projects have had serious problems with gas migration into natural or created fracture systems, bypassing the shale matrix and preventing the bottomhole pressure buildup required to reach minimum miscibility pressure and enable EOR.

Unconventional oil producers have been testing a variety of fluids for their effectiveness in HnP EOR applications: rich gas, propane, NGLs, water-alternating-gas, rich gas plus surfactant combinations, etc. Understanding the best approach for using these injectants in HnP applications in different geologic situations (e.g., soak times, injection rates, injectant volumes, pressures) remains an important research topic.

The potential for enhanced gas recovery by gas injection in shale plays has been the subject of numerical simulation modeling but limited pilot testing. Shale gas reservoirs containing heavier hydrocarbon fractions (wet-gas and liquid-rich reservoirs) are the most likely potential candidates for enhanced recovery due to the higher added value of condensates, when compared to natural gas. Methane (CH_4), nitrogen (N_2) and carbon dioxide (CO_2; not of interest

for this Topic Area – see Topic Area 1c) injection in both HnP and pattern flooding operation modes has been performed. The mechanism of production enhancement for each gas varies: CO_2 can preferentially adsorb into the shale matrix, releasing hydrocarbons, N_2 injection induces the release of hydrocarbons solely by partial pressure reduction, and CH_4 also prompts desorption of heavier hydrocarbons by partial pressure reduction.

The objective of Topic Area 1a is to demonstrate and validate the use of novel methods for improving oil recovery from unconventional oil reservoirs and for improving gas recovery from unconventional gas reservoirs.

Research efforts of interest include:

- Field based R&D of any of a variety of injectants in HnP treatments or in pattern floods to improve oil recovery or gas recovery from unconventional reservoirs. Such field based R&D to be focused on providing significant new understandings of the relationships among fluid type, fluid injection rate, injection pressure, reservoir pressure, injection volume, soak time, conformance, flowback protocols and incremental recovery.
- Field based R&D of novel treatments and techniques for improving production from unconventional oil and natural gas reservoirs, including but not limited to improved completion, conductivity, and/or conformance.

Proposals must include the following:

- Estimation of the impact of the proposed project on recovery and economic metrics including explanation of the approach and data used in making the estimation (prior lab tests, prior field pilot tests, prior production or economic simulations, economic information, sensitivity analyses, etc.).
    - Applications should describe anticipated level of improvement in the estimated ultimate recovery (EUR) uplift and percentage increase in the recovery factor that could result from the proposed project (during project operations and at future commercial operation scale).
    - Applications should define the economic pathway to viability for the technologies and/or approaches proposed as part of the project. This should include both estimated cost of implementation at the project pilot scale for the cost per incremental unit recovered ($/Δbbl and/or $/ΔMcf) but also anticipated cost per incremental unit recovered ($/Δbbl and/or $/ΔMcf) for future commercial operations (assuming implementation of researched approaches and technologies and taking into consideration factors such as distance from injectant source in relation to oil/gas reservoirs).
- In addition to initial projections of these factors within the proposal, the application should describe plans for updating these factors based on results seen from the project (including definition of the data to be collected and methods to be used in updating / refining projections)
- Evidence (letter(s) of intent ~~commitment~~) at the time of application and letter(s) of commitment prior to award if selected) from an industry partner or partners willing to permit access to and use of a well or wells and approval to obtain, analyze, and publish data collected as part of the project.

- Narrative of the initial plans/scope for field deployment and validation protocols of all utilized techniques as well as description of how the project would advance to detailed final plans during the initial phase of the project. Note: Development / project team acceptance of detailed plans (in coordination with Department of Energy representatives) should be reflected as a go/no-go point within the project scope
- Methodology for validating the impact of technologies deployed during the project on overall recovery efficiency and improvement.
- Evidence of a detailed understanding of the geological character of the proposed injection area, relevant production history, core and log data, and well completion histories on wells involved in the pilot and offsets.
- If employing HnP operations, a detailed discussion on the planned number of injection, soak [if applicable] and production cycles per well (multiple cycles anticipated) that would sufficiently demonstrate enhanced recovery throughout the project lifecycle.
- Detailed discussion on how the planned number of HnP cycles was determined.
- Discussion of any planned project approach for: geometry mapping of the targeted resource volumes initially in place, geometry mapping of resource volumes produced, the resource depletion domain architecture in relation to the stratigraphy and well/fracture geometry architecture, and volumetric mapping of the remaining resource domain architecture.
- Plans for the injection of volumes sufficient to definitively determine the technical and economic potential of any flooding method being pilot tested.
- Plans for long term production data gathering, both pre- and post-injection, including well testing, logging (including enhanced flow evaluation), and produced fluid sampling and monitoring.
- Detailed discussion of the anticipated injectant source for the project, the location of that source relative to the project site, the planned transportation method to move injectant to the project site, compatibility of the injectant with the field site reservoir, and any characteristics of the injectant and any associated contaminants that could affect project success.
- Well level production allocation plan that includes details of proposed methods, Quality Assurance/Quality Control (QA/QC), and uncertainty bounds.
- Detailed discussion of how artificial intelligence/machine learning/data analytics, model validation, and data governance will be used to add value to the proposed project.

Technologies proposed for research under this subtopic should exhibit a beginning TRL of 5 (laboratory scale, similar system validation in relevant environment), and the proposed research plan should support delivering an ending TRL of 7 (full-scale, similar [prototypical] system demonstrated in relevant environment). Note that the TRLs listed are for the project's proposed technologies and not necessarily the overall field test site. See Other Information for TRL table.

Applications must include a letter(s) of intent ~~commitment~~ from industry partner(s) providing access to a relevant field site(s) for testing. [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 facilities in unconventional plays as applicable to the proposed technology. Location of the field site must be within the

United States. Applications that do not provide one or more letters of intent ~~commitment~~ from an industry partner(s) for access to a commercial site and/or well for field testing will be deemed non-responsive under the NOFO and will not be reviewed.

Applicants are encouraged to propose project teams comprised of multiple organizations that include industry participants, academic research organizations, technology developers, and service providers.

Fundamental laboratory research related to a proposed field pilot employing methods in a specific play or plays may be part of the overall proposal, but such research must be accompanied by a field test to validate the fundamental research.

While applications may propose the use of DOE funds for prototype deployment and/or research activities, DOE funds shall not be used for site development activities (e.g. production well drilling) on awards resulting from this Topic Area. Also, proposed projects should not directly include the drilling of new oil/gas production wells and/or new hydraulic fracturing for a new oil/gas well due to potential NEPA/environmental issues. Proposed projects could include drilling of monitoring/observation well(s) for diagnostics related to the proposed project contingent on adequately addressing NEPA/environment issues and the well(s) being necessary for the proposed research project while also not being directly related to commercial production/revenue. Proposed projects should try to use existing wells as applicable.

2. Topic Area 1b – Advanced Characterization of Fracture Propagation, Proppant Behavior, and Well Diagnostics

Although the development of unconventional oil and natural gas plays has grown dramatically over the past two decades, there remains a distinct lack of understanding related to where operators are leaving recoverable resources behind after well production has declined. Understanding and characterizing the reservoir domains where depletion has occurred and where hydrocarbon saturations remain undrained is key to increasing overall recovery of the resource beyond the less-than-10% levels currently achieved.

Some of the most important questions are related to proppant transport and placement; we still do not know for certain where the proppant is going and how it is distributed within fractures and across the stimulated reservoir volume. Hydraulic geometries of the created fractures are known to be very large, but proppant transport, distribution, and fracture conductivity within the hydraulic geometry are not well understood. Based on what has been observed in limited field experiments, a large portion of the hydraulic dimensions of fractures are not being effectively propped.

Some wells, even after being fractured multiple times, still exhibit virgin reservoir volumes, an indication of our limited understanding of how many fractures are created, what their geometries actually are, and how much of the geometries are “effective” and contributing to production. Post project coring at DOE’s controlled field-based hydraulic fracturing research program at the Hydraulic Fracturing Test Site (HFTS) 1 showed virgin pressure and little proppant. Quasi-distributed pressure monitoring at the HFTS 2 site showed limited depletion of some of the target stratigraphy, and significant “out-of-zone” resource depletion beyond the

targeted stratigraphy. There appears to be a lot of unstimulated rock volume surrounding unconventional fracked wells and the depletion of architecture domain is not well understood. Understanding this depletion domain is critical for assessing EOR opportunities and application designs.

The primary objective of Topic Area 1B is to carry out field test site investigations focused on advanced characterization of fracture propagation, proppant transport and placement, enhanced diagnostics, scientifically based well completion design "best practices", and characterizing the depletion domain architectures during production.

Research efforts of interest include:

- Field based R&D novel fracturing fluids, additives and techniques, as well as novel proppants (including but not limited to lightweight, ultralightweight and neutrally buoyant proppants), to increase the effectiveness of hydraulic fracturing and/or refracturing treatments. Focus areas could include novel combinations of fluids, proppants and treatment techniques to demonstrate and validate methods to ensure fractures are effectively propped across the majority of the created fracture area.
- Field based R&D of technologies related to improving conformance control, zonal fluid flow technologies, and completion technologies that can improve stimulation distribution effectiveness, increase recovery efficiency, and/or control fluid flow within the wellbore and fracture systems in unconventional reservoirs. Focus areas for technology development could include, but are not limited to, conformance control, and advanced fluid flow control and optimization for each stage of a well's life to reduce the impact from frac hits and other disruptive effects related to recovery efficiency, in addition to permanent and/or temporary downhole technologies to enhance recovery efficiency, reduce costs and improve personnel safety.
- Field based R&D of technologies related to improving fracture diagnostics and modeling content to improve hydraulic fracture geometry that is closely tied to recovery efficiency.
- Innovative and breakthrough technologies for improved subsurface characterization, visualization, and diagnostics of the fracturing process.
- Improved technologies for characterization and/or monitoring of fracture propagation.
- Improved technologies for advancing understanding and effectiveness of proppant transport and placement.
- Enhanced diagnostic methods for determining production performance at the perforation cluster level.
- Development or updates of best practices for improving uniformity and/or stimulation distribution effectiveness of hydraulic fractures systems.
- Improved technologies for subsurface measurement or imaging of effective stimulated reservoir volume throughout the lifecycle of a well and improved fracture diagnostic tools (for direct measurement of fracture dimensions, orientation and proppant distribution)
- Innovative and transformational digital technology (e.g., machine learning and artificial intelligence) applications focused on fracture characterization, proppant transport and placement, and fracture diagnostics.

- Innovative applications of recent advances in subsurface sensors, high performance computing, and data analytics to fracture characterization, proppant transport and placement, and fracture diagnostics.

Proposals must include the following:

- Estimation of the anticipated impact of the proposed project on recovery and economic performance metrics, including an explanation of the methodologies, assumptions, and supporting data used in developing these estimates (e.g., prior laboratory testing, field pilots, production simulations, reservoir modeling, economic analyses, sensitivity analyses, and/or other relevant technical data).
    - Applications should describe the anticipated level of improvement in fracture characterization, reservoir contact efficiency, and uncertainty reduction related to fracture geometry, drainage patterns, and production forecasting that could result from the proposed project during both project operations and future commercial deployment. Metrics may include reductions in uncertainty related to stimulated reservoir volume, fracture half-length, drainage area, reservoir contact efficiency, estimated ultimate recovery, and/or other technically relevant performance indicators compared to current industry methods.
    - Applications should define the economic pathway to viability for the proposed technologies and/or approaches. This should include both estimated pilot-scale implementation costs and anticipated commercial-scale costs expressed as cost per incremental unit recovered ($/Δbbl and/or $/ΔMcf), assuming broader deployment of the proposed technologies or approaches.
    - In addition to initial projections included in the proposal, applications should describe how technical and economic assumptions will be updated throughout the project based on operational performance data, including the specific data to be collected and the methodologies that will be used to refine future projections.
- Evidence (letter(s) of intent ~~commitment~~ at the time of application and letter(s) of commitment prior to award if selected) from an industry partner or partners willing to permit access to and use of a well or wells and approval to obtain, analyze, and publish data collected as part of the project.
- Narrative of the initial plans/scope for field deployment and validation protocols of all utilized techniques as well as description of how the project would advance to detailed final plans during the initial phase of the project. Note: Development / project team acceptance of detailed plans (in coordination with Department of Energy representatives) should be reflected as a go/no-go point within the project scope
- Methodology for validating the impact of technologies deployed during the project on overall recovery efficiency and improvement.
- Evidence of a detailed understanding of the geological character of the proposed test site, relevant production history, core and log data, and well completion histories on wells involved in the pilot and offsets.
- Plans for relevant, long term production data gathering, both pre- and post-project, including well testing, flow allocation technologies, and produced fluid sampling and monitoring as necessary to quantify the impact of the demonstrated technology.

- Well level production allocation plan that includes details of proposed methods, QA/QC, and uncertainty bounds.
- Detailed discussion of how artificial intelligence/machine learning/data analytics, model validation, and data governance will be used to add value to the proposed project.

While applications may propose the use of DOE funds for prototype deployment and/or research activities, DOE funds shall not be used for site development activities (e.g. production well drilling) on awards resulting from this Topic Area. Also, proposed projects should not directly include the drilling of new oil/gas production wells and/or new hydraulic fracturing for a new oil/gas well due to potential NEPA/environmental issues. Proposed projects could include drilling of monitoring/observation well(s) for diagnostics related to the proposed project contingent on adequately addressing NEPA/environment issues and the well(s) being necessary for the proposed research project while also not being directly related to commercial production/revenue. Proposed projects should try to use existing wells as applicable.

Technologies proposed for research under this subtopic should exhibit a beginning TRL of 5 (laboratory scale, similar system validation in relevant environment), and the proposed research plan should support delivering an ending TRL of 7 (full-scale, similar [prototypical] system demonstrated in relevant environment). Note that the TRLs listed are for the project's proposed technologies and not necessarily the overall field test site. Other Information for TRL table.

~~Proposals must include a preliminary techno-economic assessment of the expected costs and practical operational challenges of applying the proposed methods, based on a reasonable forecast of industry trends. This analysis, along with any verifiable metric data for hydrocarbon and water production provided to DOE after completion of the project will be used to analyze effectiveness of technologies in order to accelerate broad industry adoption.~~

Applications must include a letter(s) of intent ~~commitment~~ from industry partner(s) providing access to a relevant field site(s) for testing. [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 facilities in unconventional plays as applicable to the proposed technology. Location of the field site must be within the United States. Applications that do not provide one or more letters of intent ~~commitment~~ from an industry partner(s) for access to a commercial site and/or well for field testing will be deemed non-responsive under the NOFO and will not be reviewed.

Applicants are encouraged to propose project teams comprised of multiple organizations that include industry participants, academic research organizations, technology developers, and service providers.

Fundamental laboratory research related to a proposed field pilot employing novel methods in a specific unconventional oil play or plays may be part of the overall proposal, but such research must be accompanied by a field test to validate the fundamental research.

3. Topic Area 1c – Enhanced Recovery of Oil and Gas from Unconventional Reservoirs Using CO_2

What are commonly referred to as unconventional reservoirs (i.e., oil-bearing and gas-bearing shales and other tight rocks that are being developed via long horizontal laterals coupled with high volume hydraulic fracturing) are exhibiting recoveries that are often less than 10 percent of the original hydrocarbons in place. For this NOFO, an unconventional oil and gas reservoir is considered a geological formation where hydrocarbons are tightly trapped due to low permeability (typically less than 1 mD) requiring specialized extraction methods like hydraulic fracturing and horizontal drilling for economic production. Given the fact that these formations are laterally and vertically extensive in multiple producing basins, the potentially producible domestic oil resource is significant, and the inability to recover a larger portion of that resource constitutes a major economic loss extending over decades.

While unconventional oil producers have been testing a variety of fluids for their effectiveness in HnP cyclical injection/production EOR applications: rich gas, propane, NGLs, water-alternating-gas, rich gas plus surfactant combinations, etc., not all of these have been tried in all of the three major unconventional oil plays (Permian, Eagle Ford, Bakken). Understanding the best approach for using these injectants in HnP applications in different geologic situations (e.g., soak times, injection rates, injectant volumes, pressures) remains an important research topic.

These efforts are challenged by the lack of a complete understanding of precisely how oil and natural gas are stored in and produced from complex, highly fractured, low matrix permeability rocks. In addition, many of the detailed results of EOR pilot tests carried out in unconventional reservoirs during the past decade have been held proprietary, delaying the broader application of successful applications.

Few of the EOR tests carried out to date have utilized CO_2 as a miscible injectant, in part due to the continued lack of sufficient volumes of low-cost CO_2 available, and the potential for its application remains largely undefined. The objective of Topic Area 1C is to demonstrate and validate the use of supercritical carbon dioxide ($scCO_2$) or CO_2 gas as an injectant for EOR and/or enhanced gas recovery (EGR) processes in unconventional reservoirs.

Through this Topic Area, DOE is looking to fund research designed to test the potential for using CO_2 as an EOR/EGR injectant in unconventional reservoirs through field test site projects and publicly sharing the results.

Research efforts of interest include:

- Field based R&D on the use of $scCO_2$ or CO_2 as an injectant in HnP treatments or in pattern flooding programs to enhance oil recovery from unconventional oil reservoirs
- Field based R&D on the use of $scCO_2$ or CO_2 as an injectant to enhance natural gas recovery from unconventional reservoirs.

Proposals must include the following:

- Estimation of the impact of the proposed project on recovery and economic metrics including explanation of the approach and data used in making the estimation (prior

lab tests, prior field pilot tests, prior production or economic simulations, economic information, sensitivity analyses, etc.).
    - Applications should describe anticipated level of improvement in the EUR uplift and percentage increase in the recovery factor that could result from the proposed project (during project operations and at future commercial operation scale).
    - Applications should define the economic pathway to viability for the technologies and/or approaches proposed as part of the project. This should include both estimated cost of implementation at the project pilot scale for the cost per incremental unit recovered ($/Δbbl and/or $/ΔMcf) and cost per unit of CO_2 utilized per incremental barrel recovered ($/ton CO2 per Δbbl and/or $/ton CO_2 per ΔMcf) but also anticipated cost per incremental unit recovered ($/Δbbl and/or $/ΔMcf) and cost per unit of CO_2 utilized per incremental barrel recovered ($/ton CO2 per Δbbl and/or $/ton CO_2 per ΔMcf) for future commercial operations (assuming implementation of researched approaches and technologies and taking into consideration factors such as distance from CO2 or other EOR / EGR injectant source in relation to oil/gas reservoirs).
    - In addition to initial projections of these factors within the proposal, the application should describe plans for updating these factors based on results seen from the project (including definition of the data to be collected and methods to be used in updating / refining projections).
- Evidence (letter(s) of intent ~~commitment~~ at the time of application and letter(s) of commitment prior to award if selected) from an industry partner or partners willing to permit access to and use of a well or wells and approval to obtain, analyze, and publish data collected as part of the project.
- Narrative of the initial plans/scope for field deployment and validation protocols of all utilized techniques as well as description of how the project would advance to detailed final plans during the initial phase of the project. Note: Development / project team acceptance of detailed plans (in coordination with Department of Energy representatives) should be reflected as a go/no-go point within the project scope
- Methodology for validating the impact of technologies deployed during the project on overall recovery efficiency and improvement.
- Evidence of a detailed understanding of the geological character of the proposed injection area, relevant production history, core and log data, and well completion histories on wells involved in the pilot and offsets.
- Description of any project plans for detailed geometry mapping of the target resource volumes initially in place, geometry mapping of resource volumes produced, the resource depletion domain architecture in relation to the stratigraphy and well/fracture geometry architecture, and volumetric mapping of the remaining resource domain architecture.
- If employing HnP operations, a detailed discussion on the planned number of injection, soak [if applicable] and production cycles per well (multiple cycles anticipated) that would sufficiently demonstrate enhanced recovery throughout the project lifecycle.
- Detailed discussion on how the planned number of HnP cycles was determined.
- Plans for the injection of volumes of CO_2 sufficient to definitively determine the technical and economic potential of any flooding method being pilot tested.

- Plans for long term production data gathering, both pre- and post- CO_2 injection, including well testing, logging (including enhanced flow evaluation), and produced fluid sampling and monitoring.
- Detailed discussion of the anticipated CO_2 source for the project, the location of that CO_2 source compared to the project site, the planned transportation method to move CO_2 to the project site, compatibility of the CO_2 with the field site reservoir, and any characteristics of the anticipated source CO_2 stream and any associated contaminants that could affect the project success.
- Well level production allocation plan that includes details of proposed methods, QA/QC, and uncertainty bounds.
- Detailed discussion of how artificial intelligence/machine learning/data analytics, model validation, and data governance will be used to add value to the proposed project.

While applications may propose the use of DOE funds for prototype deployment and/or research activities, DOE funds shall not be used for site development activities (e.g. production well drilling) on awards resulting from this Topic Area. Also, proposed projects should not directly include the drilling of new oil/gas production wells and/or new hydraulic fracturing for a new oil/gas well due to potential NEPA/environmental issues. Proposed projects could include drilling of monitoring/observation well(s) for diagnostics related to the proposed project contingent on adequately addressing NEPA/environment issues and the well(s) being necessary for the proposed research project while also not being directly related to commercial production/revenue. Proposed projects should try to use existing wells as applicable.

~~Proposals must include a preliminary techno-economic assessment of the expected costs and practical operational challenges of applying the proposed EOR methods, based on a reasonable forecast of industry trends. This analysis, along with any verifiable metric data for hydrocarbon and water production provided to DOE after completion of the project will be used to analyze effectiveness of technologies in order to accelerate broad industry adoption.~~

Technologies proposed for research under this subtopic should exhibit a beginning TRL of 5 (laboratory scale, similar system validation in relevant environment), and the proposed research plan should support delivering an ending TRL of 7 (full-scale, similar [prototypical] system demonstrated in relevant environment). Note that the TRLs listed are for the project's proposed technologies and not necessarily the overall field test site. See Other Information for TRL table.

Applications must include a letter(s) of intent ~~commitment~~ from industry partner(s) providing access to a relevant field site(s) for testing. [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 facilities in unconventional plays as applicable to the proposed technology. Location of the field site must be within the United States. Applications that do not provide one or more letters of intent ~~commitment~~ from an industry partner(s) for access to a commercial site and/or well for field testing will be deemed non-responsive under the NOFO and will not be reviewed.

Applicants are encouraged to propose project teams comprised of multiple organizations that include industry participants, academic research organizations, technology developers, and service providers.

Fundamental laboratory research related to a proposed field pilot employing CO_2 EOR methods in a specific unconventional oil play or plays may be part of the overall proposal, but such research must be accompanied by a field test to validate the fundamental research.

4. Topic Area 2 – Advanced Field-Testing of Multi-Scale Produced Water Treatment Technologies & Processes

In 2025, the Permian Basin was estimated to produce approximately 22 million barrels per day of water associated with oil and natural gas production. The continued increase in water cut from the Permian Basin production highlights the key need for highly scalable technologies for produced water treatment that can support opportunities for the reuse of treated produced water to avoid deep well injection and the potential related issues with induced seismicity and interaction with underground sources of drinking water.

This NOFO seeks to support the field testing and validation of produced water treatment technologies at high throughput scale, over a period longer than 1 year (not including design or construction time). The focus is on the ultimate development of a centralized, multi-stage water treatment facility using customizable treatment trains to produce different levels of treated effluent for a variety of uses and capable of targeting a broad range of contaminants, including solids, chemical impurities, and biological components.

The primary objective of Topic Area 2 is to develop advanced multi-scale produced water treatment technologies and processes and demonstrate them through field-testing over a period longer than one year.

Research efforts of interest include:

- Field based R&D on scalable, low-energy desalinization processes for very high total dissolved solids (TDS) produced water.
- Long-term pilot-scale field tests of novel membrane and osmosis technologies, low-temperature thermal technologies, and/or hybrid treatment trains that resist fouling and wetting.
- Integrated water treatment facilities capable of treating large quantities of water at high throughput rates (15,000 to 50,000 barrels of water per day).
- Field based R&D on novel, robust, real-time, water quality monitoring systems to inform treatment methodologies, operational controls and discharge/disposal compliance. In particular, water sensors and component analysis methods are needed that address the issue that grab samples take days or weeks to analyze and are a bottleneck for efficient monitoring and control of treatment facilities.
- Field based R&D on zero-liquid discharge, low energy crystallization, and/or other technologies for waste management and disposal.
- Field based R&D on technologies/processes to extract lithium, iodine, acids/bases and/or other valuable (or harmful) materials from produced water.

- Multidisciplinary research efforts specifically designed to fill existing data gaps in the research literature, that can help inform policy decisions.

Proposals must include the following:

- Estimation of the anticipated impact of the proposed project on produced water management economics and operational performance using prior field data, laboratory testing, modeling, pilot field tests, economic analyses, and/or sensitivity analyses. Applications should clearly describe the assumptions, methodologies, and supporting data used to develop these estimates.
    - Applications should quantify expected improvements relative to current industry practices, where applicable to the proposed project, using clearly defined economic and operational performance metrics. These metrics may include, but are not limited to:
        - cost per barrel of produced water treated ($/bbl treated)
        - cost per barrel of produced water reused ($/bbl reused)
        - cost per barrel of produced water transported ($/bbl transported)
        - cost per barrel of produced water disposed ($/bbl disposed)
        - reduction in freshwater demand associated with oil and gas operations
        - reduction in trucking requirements, transportation distances, or related logistics costs
        - reduction in total lifecycle produced water management costs, including treatment, transportation, storage, reuse, and disposal where applicable
    - Applications should clearly distinguish between projected pilot-scale economics and anticipated commercial-scale economics and describe the pathway toward broader commercial deployment. Applications should also describe how project performance data will be collected and used to refine technical and economic projections throughout the period of performance.
- Details regarding the anticipated water quality of the proposed treatment system effluent produced as part of the project (during project operations and at future commercial operation scale).
    - Applications should describe the water quality of the proposed treatment system effluent produced as part of the project in relation to the Treated Produced Water Reference Thresholds by Beneficial Use Table in Section IX Other Information as applicable for the proposed beneficial use of the effluent. The Treated Produced Water Reference Thresholds by Beneficial Use Table in Section IX is provided as a reference to represent current understanding of thresholds for various end use cases for this NOFO. Projects should improve current state-of-the-art technology to enhance the ability to reach or exceed such thresholds and/or provide reductions in cost and/or time to reach such thresholds.
    - Applications should clearly define the baseline water quality requirements applicable to the intended end use of the treated water and demonstrate how the proposed technology will meet those requirements. Baseline comparisons should account for applicable Federal, state, and local regulatory requirements, including relevant U.S. Environmental Protection Agency effluent limitation guidelines and discharge standards, such as those established under 40 CFR Part 435, where applicable, as well as any more stringent state, Tribal, or local regulatory

requirements governing treatment, reuse, discharge, storage, transportation, or disposal.
    - Applications should clearly identify the intended end use of the treated water (e.g., hydraulic fracturing reuse, agricultural use, industrial use, surface discharge, beneficial reuse, or disposal preparation) and define the applicable water quality standards, operational specifications, and regulatory thresholds associated with that end use. Applicants should also describe how treatment performance will be measured and validated, including the specific water quality parameters being evaluated (e.g., total dissolved solids, oil and grease, total suspended solids, metals, organics, bacteria, or other relevant constituents) to demonstrate compliance with applicable requirements and operational viability.
    - In addition to initial projections of these factors within the proposal, the application should describe plans for updating these factors based on results seen from the project (including definition of the data to be collected and methods to be used in updating / refining projections).
- Schematics and/or diagrams of the proposed facility lay out with the various anticipated components/equipment identified.
- Details regarding the anticipated rate of produced water treatment (gpm and/or barrels of water per day) of the proposed technology during the project and anticipated treatment rate of a future commercial system based on the proposed technology.
- Details regarding the anticipated amount of produced water (gallons) that is anticipated to be treated as part of the project and the treatment capacity of a future commercial system based on the proposed technology.
- Details regarding plans to detail the characterization of the produced water before treatment and after treatment.
- Details regarding the anticipated quantity and purity of resource (lithium, iodine, acid/bases, etc.) and/or harmful materials from the produced water treatment waste for the project and anticipated for a future commercial system based on the proposed technology.
- Details regarding the potential beneficial use of the produced water treated by the proposed technology based on the characteristics of the treatment system effluent. Details regarding the plan of action for the proposed treatment system effluent produced as part of the project.
- Details regarding the proposed systems treatment targets and the extent to which those targets would allow the beneficial use of the system's effluent in what areas of the country (which states/regions) and for what purpose (agricultural irrigation, livestock watering, industrial applications, discharge to surface water, etc.).
- Details regarding the applicability of the proposed treatment system to a variety of produced waters from various basins/geographical areas.
- Clearly outline the anticipated duration of the field work associated with the project, including but not limited to running time of treatment operation of the proposed system.
- Details regarding how the proposed technology is different and/or an advancement over current commercially available systems.
- Identification of "Fit-for-Purpose" standards to meet beneficial use process needs. Development or updates of best practices.

- Detailed discussion of how the proposed project would use artificial intelligence / machine learning / data analytics, model validation, and data governance to add value to the proposed project.
- Detailed discussion regarding a viable plan for real world scalability considerations, including offtake/take away plans, pipeline capacity, rights of way, and permitting.

Applicants are encouraged to propose projects comprised of multiple organizations that include industry, academic, and research organizations participants, in order to more rapidly disseminate research and project results among a broader industry and scientific audience and to facilitate wider commercialization of technologies and innovative approaches across regions/basins.

~~Proposals must include a technoeconomic assessment of the costs and practical challenges of successfully applying proposed methods based on current and future industry trends. Any verifiable metric data provided to DOE after completion of the project will be used to analyze effectiveness of technologies in order to accelerate broad industry adoption.~~

Technologies proposed for research under this Topic Area should exhibit a beginning TRL of 5 (laboratory scale, similar system validation in relevant environment) and the proposed research plan should support delivering an ending TRL of 7 (full-scale, similar (prototypical) system demonstrated in relevant environment). Note that the TRL levels listed are for the project's proposed technologies and not necessarily the overall field site/lab. Other Information for TRL table.

Applications must include a letter(s) of intent ~~commitment~~ from industry partner(s) providing access to produced water feedstock and a relevant field site(s) for testing. [Letter(s) of commitment will be required prior to actual award if selected for award negotiation.] Location of the field site must be within the United States. Applications that do not provide one or more letters of intent ~~commitment~~ from an industry partner(s) will be deemed non-responsive under the NOFO and will not be reviewed.

E. Applications Specifically Not of Interest

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):

- 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
- All Topic Areas – Applications with no cost share commitment letters at the time of submission.
- All Topic Areas – Technologies that fall outside the requested TRLs specified in the Topic Area.
- All Topic Areas – Solutions that increase complexity or cost without providing a clear, quantifiable benefit in terms of efficiency, reliability, deliverability, or safety.

- All Topic Areas – Applications focused entirely on computer simulation.
- Topic Area 1a – Technologies that use CO_2 as fluid/additives for EOR or EGR.
- Topic Area 1c – Technologies that use anything other than CO_2 as the main injection fluid and/or mobility control additives for EOR or EGR.
- Topic Areas 1a, 1b, 1c, and 2 – Applications that do not include a team that includes at least one operating industry partner providing access to the required relevant field sites.
- Topic Areas 1a, 1b, 1c, and 2 - Applications that do not include a field test in a relevant environment supported by one or more letters of intent ~~commitment~~ to provide site access from an industry partner(s) needed for the completion of the project,
- Topic Areas 1a, 1b, and 1c - Applications for field test sites in sparsely characterized unconventional oil and gas formations in undrilled or marginally drilled basins where little or no leasing or other indication of industry interest has been recorded.
- Topic Area 1c – Applications that include any intentional fracturing/re-fracturing or proppant.

F. Statutory Authority

The programmatic authorizing statutes are:

- DOE Organization Act, Public Law 95-91, as amended, (codified as 42 U.S.C. § 7101, et seq.)
- Energy Policy Act of 2005, Public Law 109-58, § 961, as amended (codified as 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, 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 submission phases: 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.

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
Letters of Intent and/or Commitment	PDF	1 page each	ControlNumber_LeadOrganization_LOCs
Impacted Indian Tribes Documentation	PDF	n/a	ControlNumber_LeadOrganization_ ImpactedTribes
Statement of Project Objectives	MS Word	8	ControlNumber_LeadOrganization_SOPO
Project Management Plan	PDF	8	ControlNumber_LeadOrganization_PMP
Budget Information Non-Construction Programs (SF-424A)	PDF	n/a	ControlNumber_LeadOrganization_SF-424A
Budget Justification Workbook	MS Excel	n/a	ControlNumber_LeadOrganization_Budget_Justification
Subrecipient Budget Justification	MS Excel	n/a	ControlNumber_LeadOrganization_Subrecipient_Budget_Justification
Work Proposal for FFRDC, (see DOE O 412.1A)	PDF	n/a	ControlNumber_LeadOrganization_WP
Authorization for Non-DOE or DOE FFRDCs	PDF	n/a	ControlNumber_LeadOrganization_FFRDCAuth
Waiver for Foreign Entity Participation	PDF	n/a	ControlNumber_LeadOrganization_FEW
Performance of Work in the United States (Foreign Work Waiver)	PDF	n/a	ControlNumber_LeadOrganization_FWW
Biosketch (for each Covered Individual)	PDF	n/a	ControlNumber_LeadOrganization_Biosketch
Current and Pending Support (for each Covered Individual)	PDF	n/a	ControlNumber_LeadOrganization_CPS
Digital Persistent Identifier (for each Covered Individual)	n/a	n/a	Include in Current & Pending Support

Research Security Training Requirement (for each Covered Individual)	n/a	n/a	Include in Current & Pending Support
Transparency of Foreign Connections	PDF	n/a	BusinessSensitive_ControlNumber_LeadOrganization_TFC
Potentially Duplicative Funding Notice	PDF	n/a	ControlNumber_LeadOrganization_PDFN
Locations of Work	Excel	n/a	ControlNumber_LeadOrganization_LOW
Environmental Considerations Summary	PDF	n/a	ControlNumber_LeadOrganization_EnvSum
Environmental Impact Volume	PDF	n/a	ControlNumber_LeadOrganization_EIV
Environmental Questionnaire	PDF	n/a	ControlNumber_LeadOrganization_ENV
Disclosure of Lobbying Activities, if applicable (SF-LLL)	PDF	n/a	ControlNumber_LeadOrganization_SF-LLL
Certification Regarding Lobbying (OMB 4040-0013)	PDF	n/a	ControlNumber_LeadOrganization_Cert Lobbying
Summary for Public Release	PDF	1	ControlNumber_LeadOrganization_Summary
Summary Slide	MS Power Point	1	ControlNumber_LeadOrganization_Slide

3. Impacted Indian Tribes Documentation

For any application that potentially impacts Indian Tribes,[8] including when the potentially impacted Indian Tribe is the applicant, you must submit additional documentation:

- For projects sited on Tribal lands [9] 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

[8] Indian Tribe as defined in 25 U.S.C. § 5304 and includes Alaska Native Villages and Alaska Native Corporations.

[9] Tribal land is as defined in 25 U.S.C. §§ 3501(2), (3), (4)(A) and (13).

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.

Documentation of Tribal Support	
Item	**Criteria**
Letter of Support from Tribal Leadership	The letter must be signed by an authorized representative[10] 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[10] 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.

[10] 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	https://bia-geospatial-internal.geoplatform.gov/indianlands/
Tribal Directory Assessment Tool (TDAT)	https://egis.hud.gov/TDAT/
Tribal Treaties Database	https://treaties.okstate.edu/
Directory of Federally Recognized Tribes and Tribal leaders	https://www.bia.gov/service/tribal-leaders-directory
Best Practices for Identifying and Protecting Tribal Treaty Rights, Reserved Rights, and Other Similar Rights in Federal Regulatory Actions	Best Practices For Identifying And Protecting Tribal Treaty Rights, Reserved Rights, And Other Similar Rights In Federal Regulatory Actions And Federal Decision-Making

Guidance on Assessing Potential Impacts to Indian Tribe Resource or Reserved Rights		
Type of Action	**Assessment**	**Mitigation**
Research and Development (R&D)	• 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 • Identify which Indian Tribes may be impacted • Explain any instances of uncertainty or need for confidentiality	Explain any actions you took to mitigate or address any potential impacts identified, including engaging with the potentially impacted Indian Tribes, in the application.
Surface Impacts	• 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 • Identify which Indian Tribes might be impacted • Explain any instances of uncertainty or confidentiality	
Subsurface Resource Activities (e.g., carbon sequestration, oil & gas, geothermal, critical	• Identify any Tribal mineral rights, subsurface, or water rights at or near the proposed project location • Explain any relevant studies already performed, such as groundwater studies • Identify which Indian Tribes might be impacted	

minerals, groundwater)	• Explain any instances of uncertainty and any potential for subsurface resource migration that has been considered	
Hydropower, Offshore Wind, or Other Water Related Projects	• Identify any Tribal resources or reserved rights (e.g., water, fishing, or other treaty rights) that could be impacted by the proposed project • Identify any Tribal historic sites, sacred sites, or relevant vistas that could be impacted by the project • Identify the potentially impacted Indian Tribes and explain any sources of uncertainty or confidentiality	

Other Actions Not Categorized Above	• 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:
	  ○ An Indian reservation or land (as defined in 25 U.S.C. § 3501)
	  ○ Intersecting Tribal sub-surface rights
	  ○ Historic homelands they were removed from
	  ○ Cultural sites
	  ○ Sacred sites
	  ○ Water rights
	  ○ Mineral and other subsurface rights
	  ○ Fishing rights
	  ○ Hunting rights.
	• Identify the Tribes potentially impacted and any sources of uncertainty or confidentiality	

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 *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. Properly marked application information will only 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.

Cover Page:

- The project title
- Specific NOFO topic areas (if applicable)
- Technical and business points of contact
- The project team, including recipient name, entity type, and names of all team member organizations
- The proposed project locations
- The proposed Federal funding level, cost share, and performance period
- Senior and key personnel and other individuals
- 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 statement of project objective (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 (as listed in section VI.C.2 of this document).

- Address each of the merit review criterion and sub-criterion listed in Technical Review Criteria
- Provide enough information so that reviewers can evaluate the application based on these merit 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 Project Narrative 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[11] 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

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*

[11] This table supersedes in its entirety Table 2a and Paragraph 7 of the Disclosure Requirements and Standardization Section of the NSPM-33 Implementation Guidance.

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/NNSA NOFO-Specific Biosketch Instructions	
Persistent Identifier (PID) of the Covered Individual	The PID field is required for all NOFOs and awards for R&D activities or technical assistance to support R&D activities. For NOFOs and awards that do not meet the criteria above, the PID field is optional.
Appointments and Positions Reporting Timeframe	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.
Products: Limitation on Number Provided	List up to 10 products most closely related to the proposed project.

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[12] to develop the CPS Common Form. The CPS Common Form and the biosketch 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

[12] This table supersedes in its entirety Table 2a and Paragraph 7 of the Disclosure Requirements and Standardization Section of the NSPM-33 Implementation Guidance.

- 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	
Persistent Identifier (PID) of the Covered Individual	The PID field is required for all NOFOs and awards for R&D activities or technical assistance to support R&D activities. For NOFOs and awards that do not meet the criteria above, the PID field is optional.
Reporting Timeframe for Proposals, Projects, and In-Kind Contributions	Disclose only **current** and **pending** support, as defined in the "Status of Support" field of the SciENcv CPS Common Form.
Types of Proposals and Active Projects to Disclose	In addition to the guidance listed above, consulting activities must be disclosed under the proposals and active projects section of the form when any of the following scenarios apply: • The consulting activity will require the Covered Individual to perform research as part of the consulting activity • 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 • 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

Disclosure Instructions for In-Kind Travel	DOE's in-kind disclosure requirements for the "Travel supported/paid by an external entity to attend a conference or workshop" line of the table titled NSPM-33, Implementation Guidance Pre- and Post-Award Disclosures Relating to the Biographical Sketch and Current and Pending (Other) Support differs as follows: Disclosure is required for: • "Travel supported/paid by an external entity to attend a conference or workshop" located in a foreign country of concern (FCOC) • "Travel supported/paid by an external entity to attend a conference or workshop" when the supporting/paying external entity is located in an FCOC Disclosure is **not** required for: • "Travel supported/paid by an external entity to attend a conference or workshop" that is **not** located in an FCOC • "Travel supported/paid by an external entity to attend a conference or workshop" when the supporting/paying external entity is **not** located in an FCOC https://www.nsf.gov/bfa/dias/policy/disclosures_table/may2024.pdf
Current and Pending (Other) Support Addendum	The Current and Pending (Other) Support Addendum is **not** 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**
Buy America Preference for Infrastructure Projects	NOFO Part 1	Applies to awards made under this NOFO
Allowable Costs	NOFO Part 2	Applies to awards made under this NOFO
Pre-Award Costs	NOFO Part 2	Applies to awards made under this NOFO
Performance of Work in the United States (Foreign Work Waiver Requirement)	NOFO Part 2	Applies to awards made under this NOFO

Foreign Travel	NOFO Part 2	Foreign Travel is **not** allowed for awards made under this NOFO
Equipment and Supplies	NOFO Part 2	Purchasing American-made equipment and supplies applies to this award.
Davis-Bacon Act Requirements	NOFO Part 2	Applies to awards made under this NOFO

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. § 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 [13]Executive Order 12372, "Intergovernmental Review of Federal Programs".

[13] See Executive Order 12372--Intergovernmental review of Federal programs and eCFR :: 24 CFR 570.612 -- Executive Order 12372.

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 Deadlines.*
- 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

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

The Technical Evaluation Committee and Federal Merit Review Panel members will use the following evaluation criteria in conducting their evaluations of applications subjected to comprehensive merit review.

Review Criterion Overview	
Criterion	**Weight**
Criterion 1	45%
Criterion 2	25%

Criterion 3	30%

Criterion 1: Scientific and Technological 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;
- 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 technical approach and the proposed level of effort, such that the proposed 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

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 demonstration and 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 United States
- 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 will procure U.S. iron, steel, manufactured products, and construction materials
- The degree to which the proposed project demonstrably advances the President's 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
- The degree to which the project promotes increased coordination with nongovernmental entities for demonstration of technologies and research applications to facilitate technology transfer

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 Standard Terms and Conditions (Ver 2) , 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 NOFO Part 1 and NOFO 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 assessments as part of substantial involvement.

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 5 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.
TRL 7	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.
TRL 6	Engineering/pi lot-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.
TRL 5	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 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.
TRL 4	Component and/or system validation in laboratory environment	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.
TRL 3	Analytical and experimental critical function and/or characteristic proof of concept	Active R&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. 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.
TRL 2	Technology concept and/or application formulated	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. 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.
TRL 1	Basic principles observed and reported	This is the lowest level of technology readiness. Scientific research begins to be translated into applied R&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.

B. Treated Produced Water Reference Thresholds by Beneficial Use Table

This reference identifies the principal water-quality constituents of concern and the established Federal and state regulatory thresholds that apply to common beneficial uses of treated produced water. The values listed below are existing promulgated standards and recommended criteria; they are not new performance targets created by this NOFO.

The five constituents listed for each use case are not an exhaustive list of all parameters that may apply under a final NPDES, UIC, or state reuse authorization.

1. Agricultural Use — Irrigation of Non-Edible Crops, Forage, and Fiber

Constituent	Established Threshold	Source
Oil & Grease	≤ 35 mg/L (daily max)	40 C.F.R. § 435.52 — Subpart E (ag/wildlife use, west of 98th meridian)
Total Dissolved Solids (TDS)	500 mg/L (drinking-water Secondary MCL); ag thresholds set by state	40 C.F.R. § 143.3 ; state ag-use codes
Chloride	250 mg/L (drinking-water Secondary MCL)	40 C.F.R. § 143.3
Sodium / SAR	Site-specific; SAR evaluated jointly with EC per the EPA Tool	EPA Pollutant Concentration Tool for Agricultural and Wildlife Water Use (Feb 2024)
Boron	Crop-specific; values published in EPA 2012 Reuse Guidelines and WRAP 2.0 (2026)	EPA Guidelines for Water Reuse, EPA/600/R-12/618 (2012); EPA WRAP 2.0 (April 2026)
TDS — research observation only*	≤ 1,000 mg/L observed as a working reference point for non-edible-crop irrigation in limited pilot studies	NMPWRC greenhouse alfalfa study (2024–2025); CSU/Borch wheat irrigation study (2021). NOT an established regulatory or DOE-adopted standard — see note below.

***** *The 1,000 mg/L TDS value is a research observation drawn from limited pilot studies (the NMPWRC nine-month greenhouse alfalfa study and the CSU/Borch wheat irrigation work) and is provided here for awareness only. It is not a regulatory threshold, an industry-consensus standard, or a performance target adopted by DOE under this NOFO. Existing pilot studies are limited in duration and scale; extended large-scale field-pilot studies are required to support a defensible standard. Applicants should not treat this value as a design target.*

2. Livestock and Wildlife Watering

Constituent	Established Threshold	Source
Oil & Grease	≤ 35 mg/L (daily max)	40 C.F.R. § 435.52 — Subpart E

Constituent	Established Threshold	Source
Total Dissolved Solids (TDS)	Species-specific livestock thresholds published in the EPA Tool	EPA Pollutant Concentration Tool for Agricultural and Wildlife Water Use (Feb 2024)
Sulfate	250 mg/L (Secondary MCL); livestock-specific values in EPA Tool	40 C.F.R § 143.3 ; EPA Pollutant Concentration Tool (2024)
Nitrate (as N)	10 mg/L (Primary MCL — applicable for any potable crossover)	40 C.F.R. § 141.62
Selenium	0.005 mg/L (chronic, freshwater aquatic life)	EPA National Recommended Water Quality Criteria (CWA §304(a))

3. Surface-Water Discharge (NPDES Permit)

Constituent	Established Threshold	Source
Oil & Grease	Onshore (Subpart C): zero discharge. Offshore (Subpart A): ≤ 42 mg/L daily / ≤ 29 mg/L monthly avg. Ag/wildlife (Subpart E): ≤ 35 mg/L daily max.	40 C.F.R. Part 435
pH	6.0 – 9.0	40 C.F.R. § 401.16 ; state water quality standards
Chloride	230 mg/L (chronic); 860 mg/L (acute) — freshwater aquatic life	EPA National Recommended Water Quality Criteria (CWA §304(a))
Total Suspended Solids (TSS)	Site-specific NPDES limits set by permitting authority	40 C.F.R. § 122.44; state NPDES program
Whole Effluent Toxicity (WET)	No reasonable potential to cause acute or chronic toxicity at receiving-water dilution	40 C.F.R. § 122.44(d); EPA WET Test Methods (EPA-821-R-02-012/013)

4. Aquifer Recharge (Underground Sources of Drinking Water)

Constituent	Established Threshold	Source
USDW boundary (TDS)	USDW = aquifer with TDS < 10,000 mg/L (lower-quality aquifers); recharge of higher-quality USDW typically requires ≤ 500 mg/L (Secondary MCL)	40 C.F.R. § 144.3
All NPDWR MCLs	All National Primary Drinking Water Regulations apply to recharge of a USDW	40 C.F.R. Part 141 (Subparts B, F, G, I) and applicable UIC permit
Benzene (and BTEX)	0.005 mg/L (Primary MCL for benzene)	40 C.F.R. § 141.61
Radium-226 + Ra-228	5 pCi/L (combined; Primary MCL)	40 C.F.R. § 141.66
PFOA, PFOS	4.0 ng/L each (Primary MCL); HI for mixtures	40 C.F.R. Part 141 — PFAS NPDWR (April 2024 final rule)

5. Industrial Reuse — Cooling, Boiler Feed, and High-Purity Process Water

Constituent	Established Threshold	Source
High-purity electronics / semiconductor process water	Type E-1 through E-5 grades defined by line width (resistivity ≥ 18 MΩ·cm; TOC ≤ 1 ppb for advanced fabs)	ASTM D5127-13 (Reapproved 2018) — Standard Guide for Ultra-Pure Water Used in the Electronics and Semiconductor Industries; SEMI F63
Reagent / boiler / electrolyzer feedwater	Type I (≥ 18 MΩ·cm); Type II (≥ 1 MΩ·cm); Type III; Type IV — depending on application	ASTM D1193 — Standard Specification for Reagent Water
Industrial boiler feedwater (drum boilers, 0–2,000 pounds per square inch gauge (psig))	Pressure-class–specific limits for hardness, dissolved O_2, Fe, Cu, silica, TOC, oily matter (e.g., total hardness < 0.3 mg/L as $CaCO_3$ at low pressure; effectively zero at high pressure)	ASME Consensus Operating Practices for Control of Feedwater/Boiler Water Chemistry in Modern Industrial Boilers (CRTD-34)

Constituent	Established Threshold	Source
Cooling-tower / building water systems (Legionella risk)	Risk-managed water management program; biocide residual, monitoring, and control measures defined by site-specific plan	ASHRAE Standard 188-2018 — Legionellosis: Risk Management for Building Water Systems
Onsite reuse / industrial reclaimed-water treatment system certification	Treatment-system performance certified for water reuse end use (Class C/Class B/Class A as applicable)	NSF/ANSI 350 — Onsite Residential and Commercial Water Reuse Treatment Systems; AWWA G480 — Water Reuse Program Operation and Management

6. References (Established Sources Cited)

Federal Regulations and EPA Guidance

[1] U.S. Environmental Protection Agency. Water Reuse Action Plan (WRAP) 2.0, launched April 2026 — current EPA framework for advancing water reuse, with explicit focus on industrial reuse, AI/data-center cooling, and energy-sector applications. https://www.epa.gov/waterreuse/water-reuse-action-plan-20

[2] U.S. Environmental Protection Agency. Pollutant Concentration Tool for Agricultural and Wildlife Water Use, February 2024 — companion to 40 C.F.R Part 435 Subpart E. https://www.epa.gov/eg/oil-and-gas-extraction-effluent-guidelines

[3] U.S. Environmental Protection Agency. Effluent Limitations Guidelines and Standards for the Oil and Gas Extraction Point Source Category, 40 C.F.R Part 435 (Subparts A, C, D, E, F). https://www.ecfr.gov/current/title-40/chapter-I/subchapter-N/part-435

[4] U.S. Environmental Protection Agency. National Primary Drinking Water Regulations, 40 C.F.R Part 141 — including the April 2024 final rule for PFAS (PFOA, PFOS, PFHxS, PFNA, HFPO-DA).

[5] U.S. Environmental Protection Agency. National Secondary Drinking Water Regulations, 40 C.F.R Part 143 .

[6] U.S. Environmental Protection Agency. Underground Injection Control Program, 40 C.F.R Part 144 (USDW definition at 40 C.F.R § 144.3.).

[7] U.S. Environmental Protection Agency. National Pollutant Discharge Elimination System (NPDES) — 40 C.F.R. § 122.44 (effluent limitations and other permit conditions); 40 C.F.R. § 401.16 (pH effluent limit); 40 C.F.R. Part 403 (pretreatment).

[8] U.S. Environmental Protection Agency. National Recommended Water Quality Criteria — Aquatic Life and Human Health, Clean Water Act §304(a). https://www.epa.gov/wqc/national-recommended-water-quality-criteria-tables

[9] U.S. Environmental Protection Agency. 2012 Guidelines for Water Reuse, EPA/600/R-12/618 — most recent comprehensive EPA technical document on water reuse; framework being updated under WRAP 2.0.

[10] U.S. Environmental Protection Agency. Whole Effluent Toxicity (WET) Test Methods, EPA-821-R-02-012 (acute) and EPA-821-R-02-013 (chronic).

Industry-Consensus Standards

[11] ASTM International. ASTM D5127-13 (Reapproved 2018) — Standard Guide for Ultra-Pure Water Used in the Electronics and Semiconductor Industries.

[12] ASTM International. ASTM D1193 — Standard Specification for Reagent Water (Types I, II, III, IV).

[13] ASME. Consensus Operating Practices for Control of Feedwater/Boiler Water Chemistry in Modern Industrial Boilers (CRTD-34) — pressure-class–specific limits for industrial water-tube boilers (0–2,000 psig drum pressure).

[14] ASHRAE. Standard 188-2018 — Legionellosis: Risk Management for Building Water Systems (cooling towers, evaporative condensers, building water systems).

[15] NSF/ANSI 350 — Onsite Residential and Commercial Water Reuse Treatment Systems.

[16] AWWA. G480 — Water Reuse Program Operation and Management.

[17] SEMI F63 — Guide for Ultrapure Water Used in Semiconductor Processing.

State Regulations

[18] Applicable state water-quality standards, NPDES regulations, and Class II / Class V Underground Injection Control rules in the state where the project is sited (e.g., New Mexico 20.6.4 NMAC; Texas 30 TAC 307; Colorado Reg. 84; Pennsylvania Chapter 95). Where state requirements are more stringent than the federal floor, the state requirement governs.

Cited Research Studies (informational only — not adopted as DOE standards)

[19] New Mexico Produced Water Research Consortium (NMPWRC), New Mexico State University. Greenhouse alfalfa irrigation studies using treated produced water (2024–2025). Limited duration (nine-month greenhouse) https://nmpwrc.nmsu.edu

[20] Miller, H.; Trivedi, P.; Borch, T., et al. Colorado State University and Colorado School of Mines. Wheat irrigation studies using treated produced water and the effect on plant immune response (2021).