**U.S. Department of Energy**

**Request for Information (RFI)**

**Potential Prize Competition titled “Water Security Grand Challenge Beneficial Use of Produced and Flowback Water from Oil & Natural Gas Resource Extraction in the Permian Basin”**

**Issue Date:** 10/26/2020

**Closing Date:** 12/9/2020 8:00 P.M. Eastern Time

**SUMMARY**: The U.S. Department of Energy (DOE) invites public comment providing information and feedback on a potential prize competition with the goal of advancing technology that will 1) make treated and untreated produced water available for non-oilfield and oilfield use, and 2) reduce the volume of oilfield flowback and produced water that is disposed of in Salt Water Disposal wells (SWDs) within the Permian Basin by promoting respective beneficial use within other industries. Through this potential prize competition, DOE would seek demonstrations of higher Technology Readiness Level (TRL) technologies that treat produced water to specified quality, volume, and cost standards for use within other industries or demand centers outside of oil and natural gas, that enable the achievement of the prize goal. Specifically, the intent is to identify the value proposition that will encourage oil and natural gas exploration and production companies, field service companies, technology developers, state and local government agencies, and other stakeholders to qualify field-ready prototype solutions that will be subjected to rigorous testing to demonstrate their potential. Submitted advanced treatment systems will need to have progressed to a point where they are ready to be tested and validated to a state of full, commercial-scale deployment (through TRL 8) – See Appendix A. Input from this RFI may be used to further develop the competition objectives, rules, metrics, and incentives. **Going forward within this RFI, the term “produced water” will refer to both flowback and produced water related to oilfield production activities**.

**BACKGROUND**: The [DOE-led Water Security Grand Challenge](https://www.energy.gov/water-security-grand-challenge/water-security-grand-challenge-0) (“the Challenge”) aims to advance technology and innovation to meet the global need for secure and affordable water using a coordinated suite of prizes, competitions, early- and late-stage research and development (R&D), and other programs.[[1]](#footnote-1) The Challenge consists of five goals; this RFI focuses on the goal of transforming the energy sector’s produced water from a waste to a resource.

The United States will, for the foreseeable future, continue to rely upon domestically produced oil and natural gas as the most significant contributor to our national energy supply. Given the increasing contributions from what have become known as unconventional oil and natural gas resources in the United States, primarily oil and natural gas produced from “tight” reservoirs, optimizing the continued development of the Nation’s conventional and unconventional oil and natural gas resources will require efficient and environmentally responsible produced water treatment and management technologies.

In many areas of the country, the oil and natural gas extraction processes require the simultaneous generation, handling, treatment, management, and disposal of large volumes of water produced along with hydrocarbon resources. According to the U.S. Environmental Protection Agency (EPA), produced water volumes in relation to generated oil and natural gas are highly variable, ranging between a 1:1 to 100:1 ratio (water: hydrocarbon)[[2]](#footnote-2). Portions of the Permian Basin are expected to have this ratio increase from approximately 4:1 to a 10:1 ratio.[[3]](#footnote-3) Oil and natural gas wells that have been hydraulically fractured will flow back a produced water loaded with dissolved solids, salts, and other constituents requiring it to be treated for recycling, beneficial use, or disposal. The EPA has identified up to 692 unique additives, proppants, and fluids that constitute produced water.2 Cost effective technologies for cleaning and managing produced water volumes to the degree necessary for their beneficial use are needed, particularly in those areas of the country where supplies of fresh water are reduced or decreasing.

Many companies and organizations, including DOE, have made significant R&D investments over the past decade or more in an attempt to lower the cost of treating produced and flowback water to a point where it can be economically reused within oilfield operations or sold for beneficial use by other industries. Previously, DOE has invested in multiple efforts to treat produced water, including, for example, the creation of the AltelaRain® system by partnering with Altela, Inc., BLX, Inc., CWM Environmental, Inc., and the Argonne National Laboratory. The produced water treatment system passed the Pennsylvania Department of Environmental Protection (PA DEP) regulations for water quality, proved that it could be placed at a wellhead, and provided treatment for less than conventional trucking and disposal in the Appalachian Basin.[[4]](#footnote-4)



However, costs rise rapidly with the level of treatment achieved, and often treatment technologies cannot compete with the option of salt water disposal wells or reuse as frac water. The fluctuation of oil and natural gas prices also affect the viability of produced water treatment as the total cost to treat the water starts to reduce the economic sustainability of production.

Advanced technologies or processes that can lower the cost or streamline the distribution of water treatment would be of significant value in reducing the volume of produced water that is disposed of in SWDs and the demand for freshwater by other industries in water stressed areas.

To build from prior work and make progress towards the goal of turning oilfield produced water from a waste to a resource, DOE is considering carrying out a prize competition that will seek demonstrations by participants of processes or technologies that will treat produced water for unwanted constituents thereby reducing disposal, the reliance on fresh water sources, and the economical impact of produced water management.

There are many commercialized produced water treatment processes available within the Permian Basin that include modular and scalable components that treat water volumes ranging from 1,000 to 250,000 barrels of water per day (bbls/d).[[5]](#footnote-5),[[6]](#footnote-6) These produced water treatment processes typically include treatment trains with prices that escalate as the complexity or volume of treatment increases.5 Costs to treat produced water for beneficial use **must be economical** to compete with the purchasing of fresh water and disposal within SWDs in order to establish a business case. Sourcing fresh water within the Permian Basin ranges from $0.15-0.60/bbl on average, while disposal costs typically range from $0.40-$1.00/bbl. 5 The volume of produced water that is treated has a direct effect on the economic viability of a treatment process or technology and can translate into cost savings of up to $0.60/bbl when applied to long-term water management strategies.[[7]](#footnote-7)

Any technology or process resulting from this potential prize competition should be lower in cost than SWDs at prescribed volumes or be scalable (based on participant’s treatment plan) as well as provide water management and cost saving benefits on a short-term and long-term basis while considering environmental impacts.

As currently envisioned, the contestants would provide a design with sufficient detail to confirm that the technology demonstrates that a step-change in performance and cost over existing state-of-the-art water treatments can be achieved. Included in the design details would be the source of the produced water, the expected influent constituent concentrations, the expected effluent quality post-treatment, and all operational and maintenance costs. During the submission/acceptance phase, proposed technologies would be judged on their innovation, potential economic and environmental benefits, volumetric treatment capabilities, and energy efficiency. If accepted into the competition, participants/contestants would construct their water treatment process or technology for demonstration and have that process or technology be rigorously tested and validated at an appropriate field location representative of a full-scale, commercial process. All technology, equipment, or processes used for the demonstration will be subjected to the same testing protocol, and multiple metrics will be recorded to assess performance. The top performing processes would be eligible for prize amount(s), as well as public recognition with the goal of incentivizing deployment by the private sector. At the conclusion of the competition, DOE anticipates awarding a small number of prizes in the range of $1-5M determined by the number of contestants that achieved the goal set forth of transforming produced water from a waste to a resource. DOE expects to provide participants approximately two years to construct, operate, and qualify the system.

Quantitative metrics would play a critical role in the judging process of the competition. DOE envisions applicants will need to demonstrate economical, environmental, and operational benefits as compared with existing technology in the Permian Basin. Additional metrics or guidance would be developed to assess submissions on other criteria, including energy efficiency, innovation, replicability, mobility, adaptability, and technical and engineering rigor.

**REQUEST FOR INFORMATION CATEGORIES AND QUESTIONS:**

**Group 1: Technical Aspects and Challenges**

1. Does produced water treatment approach vary within the Permian Basin? If so, how do the treatment approaches differ and what are the main drivers for the differences in the approaches? How do treatment approaches vary for reuse in other industries?
2. What effluent water quality is necessary for produced water to be effectively and efficiently supplied commercially to other industries/uses? Can the appropriate water quality standards be achieved by mixing with fresh water?
3. How much produced water is currently recycled by operators in the Permian Basin?
4. What entities currently supply fresh water in the Permian Basin? How would those businesses be impacted if produced water could be recycled and beneficially used in other industries throughout the Permian Basin?
5. In relative order, what are the main produced water constituents of concern that must be treated for the water to be supplied commercially to other industries and how do they differ, if What is a typical produced water decline curve for conventional and unconventional wells within the Permian Basin?
6. What waste streams are typically generated from the treatment of produced water within the Permian Basin? How much waste is generated per waste stream and per barrel of produced water that is treated within the Permian Basin?
7. If applicable, what are the implications for the disposal of normally occurring radioactive material (NORM) removed by water treatment within the Permian Basin?
8. What system integration advances are needed to most effectively employ new breakthrough technology/systems (including sensors, controls, and computation/data capabilities), specifically in the Permian Basin to enable economic reuse of produced water outside the oil and gas industry?
9. What is the ideal size of a treatment system that would make the largest volumetric impact for the beneficial use of produced water?

**Group 2: Economic and Supply/Demand Considerations**

1. Have existing customers, end users, or consumers of treated produced water been identified other than parties within the oil and natural gas industry within the Permian Basin? If so, what are they, how much water do they require, what is their required water quality, and does demand fluctuate within their respective industry?
2. What percentage of the total production cost of a barrel of oil (MMCF for natural gas) is typically allocated for the treatment of produced water and water management operations within the Permian Basin? Same for transport and disposal in SWD wells.
3. What is the average distance traveled for produced water to reach disposal or treatment facilities within the Permian Basin? What is the cost (barrel/mile) for transportation to an SWD?
4. How much does it cost for each waste stream, from production operations, to be disposed of within the Permian Basin? Do any waste streams need to be disposed of outside of the Permian Basin? If so, which waste streams, how much in terms of respective volume, and at what typical cost?
5. Are solid waste disposal costs included within produced water treatment costs within the Permian Basin?
6. What volumes of produced water treatment provide optimal cost-effective circumstances for the varying treatment methods? How could treatment methods be scalable to achieve cost-effectiveness more efficiently?
7. DOE internal assessment indicates that the average cost of municipal fresh water to residents and businesses in Permian Basin communities is on the order of 20 cents per barrel (plus or minus 10 cents depending on volume purchased and municipality), and that the wholesale price charged to municipalities for untreated fresh water by the Colorado River Municipal Water District (CRMWD) is on the order of 5 cents per barrel or less. Given these low prices, will it be economically feasible to deliver desalinated oilfield produced water at a quality level suitable for treatment by local water treatment plants and at a competitive price?
8. DOE internal assessment indicates that planned and potential future municipal water supply projects in the Permian Basin over the next several decades are expected to supply water suitable for treatment in municipal water treatment plants at a cost of 20 to 25 cents per barrel. Water volumes produced from brackish water aquifers and subsequently treated to potable water standards are expected to be available at a cost of less than 50 cents per barrel or less over the life of the supply. Given these low prices, will it be economically feasible to deliver desalinated oilfield produced water at competitive prices?

**Group 3: Environmental and Operational Considerations**

1. What produced water quality and volumes are shared within the industry, neighboring operators, or intra-basinally to support recycling or beneficial use within the Permian Basin?
2. What other options are available within the Permian Basin, besides SWD, for disposing of produced water or utilizing produced water outside of the oil and gas industry?

**SUPPLEMENTARY INFORMATION:**

**Request for Information Response Guidelines:**

Responses to this RFI must be submitted electronically to **WSGC-ProducedWater@netl.doe.gov** with the subject line “Water Security Grand Challenge Produced Water Treatment RFI” no later than 8:00pm (ET) on December 9, 2020. ***Responses must be provided as attachments to an email. It is recommended that attachments with file sizes exceeding 25MB be compressed (i.e., zipped) to ensure message delivery. Responses must be provided as an Adobe Acrobat PDF (.PDF) attachment to the email, and no more than 20 pages in length, 21-point font, 1- inch margins. Only electronic responses will be accepted.***

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

Respondents are requested to provide the following information at the start of their response to this RFI:

* Company / institution name;
* Company / institution contact;
* Contact’s address, phone number, and e-mail address.

The RFI document is located [here](https://netl.doe.gov/challenges/produced-water-rfi). On behalf of DOE, thank you in advance for providing your input on this important topic and contributing to DOE’s success in achieving its objectives.

**Confidential Business Information:**

Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email two well marked copies: one copy of the document marked “confidential” including all the information believed to be confidential, and one copy of the document marked “non-confidential” with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination. See 10 CFR 1004.11 for the criteria to be applied in determining whether information is exempt from mandatory disclosure.

**Disclaimer and Important Notes:**

DOE will not respond to individual submissions or publish publicly a compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed. **This is solely a request for information and not an announcement for a prize competition.** DOE is not accepting applications or submissions for a potential prize competition. If DOE pursues the potential prize competition, it will be announced through a separate announcement.

**Appendix A**

The following is a description of the NETL Technology Readiness Levels

| **TRL** | **Definition** | **Description** |
| --- | --- | --- |
| **1** | Basic principles observed and reported | Core Technology Identified. Scientific research and/or principles exist and have been assessed. Translation into a new idea, concept, and/or application has begun. |
| **2** | Technology concept and/or application formulated | Invention Initiated. Analysis has been conducted on the core technology for practical use. Detailed analysis to support the assumptions has been initiated. Initial performance attributes have been established. |
| **3** | Analytical and experimental critical function and/or characteristic proof-of-concept validated | Proof-of-Concept Validated. Performance requirements that can be tested in the laboratory environment have been analytically and physically validated. The core technology should not fundamentally change beyond this point. Performance attributes have been updated and initial performance requirements have been established. |
| **4** | Basic technology components integrated and validated in a laboratory environment | Technology Validated in a Laboratory Environment. The basic technology components have been integrated to the extent practical (a relatively low-fidelity integration) to establish that key pieces will work together, and validated in a laboratory environment. Performance attributes and requirements have been updated. |
| **5** | Basic technology components integrated and validated in a relevant environment | Technology Validated in a Relevant Environment. Basic technology component configurations have been validated in a relevant environment. Component integration is similar to the final application in many respects. Data sufficient to support planning and design of the next TRL test phase have been obtained. Performance attributes and requirements have been updated. |
| **6** | Prototype validated in a relevant environment | Prototype Validated in Relevant Environment. A prototype has been validated in a relevant environment. Component integration is similar to the final application in most respects and input and output parameters resemble the target commercial application to the extent practical. Data sufficient to support planning and design of the next TRL test phase have been obtained. Performance attributes and requirements have been updated. |
| **7** | System prototype validated in an operational system | System Prototype Validated in Operational Environment. A high-fidelity prototype, which addresses all scaling issues practical at pre-demonstration scale, has been built and tested in an operational environment. All necessary development work has been completed to support Actual Technology testing. Performance attributes and requirements have been updated.  |
| **8** | Actual technology successfully commissioned in an operational system | Actual Technology Commissioned. The actual technology has been successfully commissioned for its target commercial application, at full commercial scale. In almost all cases, this TRL represents the end of true system development. |
| **9** | Actual technology operated over the full range of expected operational conditions | Commercially Operated. The actual technology has been successfully operated long-term and has been demonstrated in an operational system, including (as applicable) shutdowns, startups, system upsets, weather ranges, and turndown conditions. Technology risk has been reduced so that it is similar to the risk of a commercial technology if used in another identical plant. |

**Appendix B**

**Questions for Consideration**

**Prize Design**

1. Is a prize incentive adequate to garner participation in a demonstration of produced water treatment technology or process to reduce disposal or eliminate disposal in SWDs?
2. Is the proposed timeline (i.e., about two years) sufficient to respond, plan, construct, and demonstrate/quality a produced water treatment system?
3. In regard to the Permian Basin, what scale (barrels or gallons per minute, hour, or day) is appropriate for demonstrations to provide sufficient assurance that the results would translate to deployment on a larger scale?
4. Please share any other perspectives on details of the prize design and specifically how it can affect the Permian Basin.
5. Can a prize-based approach contribute to achieving the goal of moving oilfield produced water from a waste to a resource? If so, what aspects of a prize in particular can help achieve this goal? If not, what other approaches could be considered? Are there other complementary activities that can be pursued to increase the impact of the prize?

**Criteria and Metrics**

1. What metrics are appropriate to assess the financial viability of a submission as part of judging?
2. Are there significant differences in the scalability or mobility of systems and how they affect produced water treatment within the Permian Basin?
3. What is the typical range of temperatures relevant for qualifying a water treatment system.
1. <https://www.energy.gov/eere/water-security-grand-challenge> [↑](#footnote-ref-1)
2. Summary of Input on Oil and Gas Extraction Wastewater Management Practices Under the Clean Water Act, Final Report, EPA-821-S19-001, US EPA, May 2020, <https://www.epa.gov/sites/production/files/2020-05/documents/oil-gas-final-report-2020.pdf> [↑](#footnote-ref-2)
3. Bridget R. Scanlon\*, Svetlana Ikonnikova, Qian Yang, and Robert C. Reedy, “Will Water Issues Constrain Oil and Gas Production in the U.S.?”, Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin, February 16th, 2020. [↑](#footnote-ref-3)
4. An Integrated Water Treatment Technology Solution for Sustainable Water Resource Management in the Marcellus Shale, NETL, <https://netl.doe.gov/node/2931> [↑](#footnote-ref-4)
5. The role of produced water treatment in shale plays, Water Standard, <https://waterstandard.com/> [↑](#footnote-ref-5)
6. Breakwater Energy Partners Constructs Largest Produced Water Recycling Facility in the Permian Basin, October 5, 2020, Breakwater Energy Partners, https://www.breakwaterenergy.com/news/breakwater-energy-partners-constructs-largest-produced-water-recycling-facility-in-the-permian-basin [↑](#footnote-ref-6)
7. Capper, L., Determining the True Cost of Water, Hart Energy, <https://www.hartenergy.com/exclusives/determining-true-cost-water-177877> [↑](#footnote-ref-7)