PREMIUM CONTENT

"Treated produced water can be a source of alternative water in regions with limited resources"

U.S Department of Energy

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The Office of Fossil Energy and Carbon Management – U.S. Department of Energy – will make more than $18 million available in funding for research and development projects that focus on the **characterisation, treatment, and management of oil and gas-produced water and wastewater** associated with coal power plants.

The U.S. Department of Energy is funding R&D projects to help lower the cost of developing and demonstrating technologies to manage wastewater from the fossil fuel energy sector safely and effectively. The technologies, processes, and methods developed will not only mitigate the impacts of disposal of these waste streams, but also provide an alternative water source for other industries and users, and allow for the potential recovery of critical minerals, including rare earth elements. **Vanessa Nunez-Lopez, Director of Advanced Remediation Technologies** at the Office of Fossil Energy and Carbon Management discusses in this interview the expected economic and environmental benefits of the technologies to be developed.

Saur's bold vision: championing the water transition by 2030

Can you tell us briefly about your career path and your current role at the Office of Fossil Energy and Carbon Management?

I am a petroleum engineer by training and have spent most of my career on the research and development side of upstream oil and gas activities in industry, academia, and now government. For over 17 years, my research focused on developing economically viable approaches to geologic carbon storage, particularly in association with enhanced oil recovery. I conducted this work during my time at Chevron Energy Technology Company and as a research scientist associate at The University of Texas' Bureau of Economic Geology.

In my current role at the U.S. Department of Energy, I lead the Division of Advanced Remediation Technologies in the Office of Fossil Energy and Carbon Management. **Our mission is focused on reducing carbon emissions and other environmental and climate impacts from fossil fuels and energy production**.

> The Water Management programme focuses on research to fully treat oil and gas produced water so it can be beneficially reused

And in the Advanced Remediation Technologies Division, our Water Management programme is focused on **advancing research efforts to develop the capacity to fully treat oil and gas produced water so it can be beneficially reused** in areas where fresh water is scarce. We are also exploring the potential to **recover critical minerals** and other beneficial resources associated with these waste streams.

The DOE will fund R&D projects focused on oil and gas-produced water and coal combustion residual wastewater. What are the expected outcomes of this funding opportunity?

We want to advance research and development for the characterisation, treatment, and management of these wastewaters, not only for mitigation and remediation, but also for beneficial reuse outside fossil energy activities. From **providing an alternative source of water for other industries and users, especially in water-scarce regions**, or recovering critical minerals and rare earths, there are a lot of possibilities.

We will also be able to increase collaboration between universities and industry on research and development for managing these fossil energy wastewaters.

What type of technologies for wastewater treatment do you expect to fund?

Due to the stringent requirements for using water outside the oil field, such as for agriculture, **we expect to fund technologies that can not only remove total dissolved solids effectively and economically** (both in terms of costs and energy consumption), but that can **also remove emerging contaminants**.

We expect to fund technologies that can remove total dissolved solids effectively and economically and also remove emerging contaminants

We also expect to fund novel systems/processes and treatment trains. These can incorporate existing technologies but will be reconfigured and optimised for novel end-uses, primarily fit-for-purpose reuse and critical mineral recovery.

In addition, we are looking at characterisation methods, techniques, and technologies that can better detect contaminants of concern and "known unknown" contaminants that exist in the water but have not been identified.

What are the major challenges developers of these technologies face?

Many of the technologies for treatment and management are quite effective to meet current industry needs and comply with existing regulations, whether it's treating produced water for Class II injection or treating power plant effluent for disposal in ash ponds.

However, **new challenges are arising, such as emerging contaminants of concern and induced seismicity**, or minor earthquakes triggered by underground injection of produced water. **New regulations, such as limits on injection and effluent limitation guidelines**, require operators and water managers to develop alternative management strategies that may not be adequately addressed by state-of-the-art technologies.

Treating and managing these wastewaters for beneficial reuse outside of fossil energy activities is becoming an attractive alternative, especially for produced water operators. However, there are additional challenges, especially if reuse leads to direct/indirect exposure pathways to humans, animals, and the environment.

There will be several of these "known unknown" contaminants that will need to be identified, as well as contaminants of emerging concern. Analysing for these contaminants, understanding their toxicity and impacts on health and the environment, and developing standards may be a challenge. DOE can support this need by developing and optimising treatment trains/configurations to detect and treat these contaminants in a cost-effective and energy-efficient way. **Mitigating the risks of fit-for-purpose reuse while optimising cost and efficacy is a major priority**.

How is legacy wastewater associated with coal-based thermal electric power generation facilities currently managed, and how do you see this changing in the future?

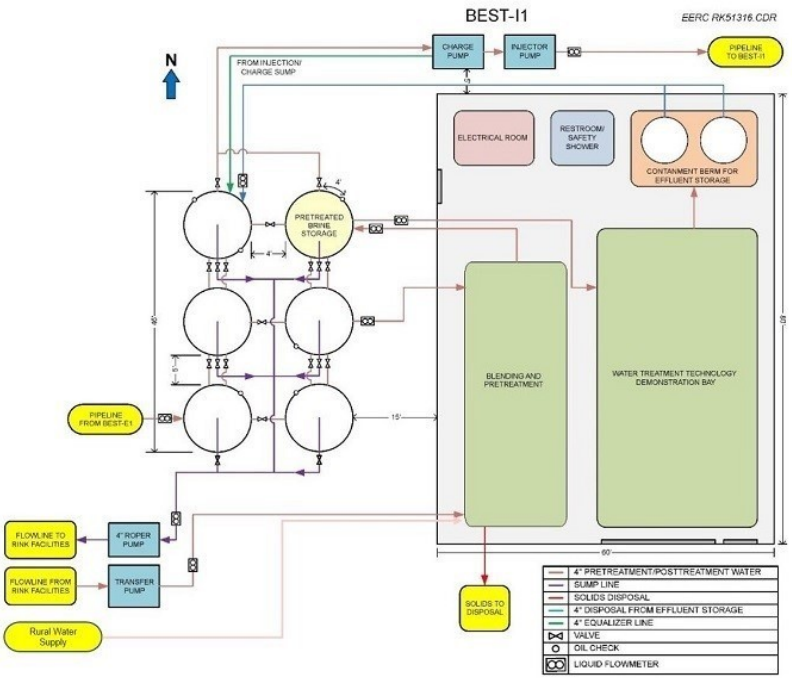
The current state-of-the-art includes physio-chemical and biological treatment systems and disposal in ash ponds. Many coal power plants were able to purchase such upgraded treatment systems to meet the requirement for the 2020 version of the U.S. Environmental Protection Agency (EPA) Effluent Limitation Guidelines (ELGs).

New EPA ELGs were released in January 2023, which will likely require more advanced treatment systems/treatment trains.

To what extent do you think there is a market for the recovery of rare earth elements, critical minerals, and elements of interest from these waste streams?

New challenges arising include emerging contaminants of concern and induced seismicity triggered by underground injection of produced water

There is renewed industry interest in critical mineral recovery from these waste streams, specially produced water. The scarcity of critical minerals and reliance on foreign supply means that domestic sources are in high demand. **Critical mineral recovery within existing produced operations can be a technologically and economically attractive option** for operators and will help offset the costs of treating produced water, depending on mineral composition. Currently, slip streams for recovering critical minerals are being incorporated into existing produced water management operations for development and testing.



Williston basin water treatment technology test bed. Conceptualized physical layout of the brine treatment test bed facility.

Do you think there is potential for using the wastewater treatment and resource recovery technologies developed in other applications outside the fossil fuel energy sector?

Yes, especially in desalination, industrial wastewater management, and recycling and reuse of municipal wastewater. Moreover, **these technologies can help facilitate decarbonisation, such as by providing an alternative source of water for hydrogen**, especially in drought-prone areas, or supporting brine management for carbon capture, utilization, and storage.

Information gleaned from research and development about emerging contaminants will be of high value to other wastewater sectors, both in terms of information on specific contaminants, as well as on the development of methods to identify new ones.

What would be the overall economic and environmental benefits of the technologies developed?

Improved characterisation and identification of safe, fit-for-purpose reuse applications will help mitigate impacts on water supply, especially in water-scarce parts of the nation that are seeing steady population and economic growth. Economic activities and population demands cannot be sustained in absence of available water. **Treated produced water can be a plentiful source of alternative water in regions with limited water resources.**

The technologies developed can help facilitate decarbonisation, such as by providing an alternative source of water for hydrogen

The technologies, processes, and methods developed will also mitigate the impacts of induced seismicity, as more produced water will be treated, and less produced water will be disposed of through injection into the deep subsurface. **Critical mineral recovery from produced water will help with the transition to a clean energy/decarbonised economy** and offset the costs of produced water treatment. Characterisation and optimised treatment will also help mitigate the effects of and prevent unintended consequences associated with emerging contaminants, especially with regard to health and the environment.

The technologies/processes will also help accelerate the transition to reuse and improve overall circularity and reduce greenhouse gas emissions and lessen our dependence on other countries for critical minerals production and processing.