

# Transforming Produced Water: From Waste to Resource

## U.S. Department of Energy Perspectives on Produced Water Management

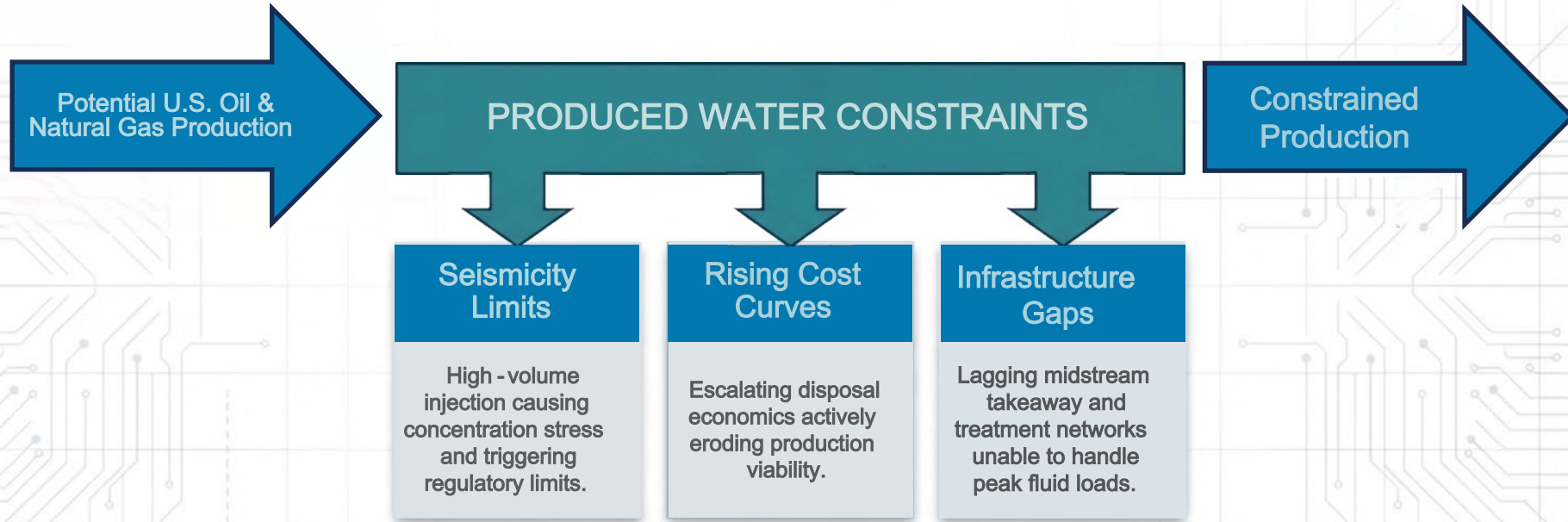
Hichem Hadjeres, Program Manager for Water Management R&D  
Permian Basin Water in Energy Conference, April 9, 2026



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# Escalating water volumes and disposal limits are shifting produced water from an operational byproduct to a barrier to production



**When disposal capacity tightens and infrastructure lags, water becomes the bottleneck. If water is constrained, energy production is constrained.**



# Resolving the produced water constraint requires a paradigm shift from local waste disposal to centralized treatment and beneficial reuse



## The Constraint

Escalating produced water volumes in regions like the Permian Basin and lagging disposal infrastructure act as a barrier to U.S. oil and natural gas production.



## The Vision

Changing produced water from a waste to a resource. From a problem to an opportunity. Supporting oil and natural gas production.



## The Enabler

De-risk commercial scaling and encourage private market investment, paving the way for a new approach.

# Securing long-term production requires a strategic pivot from minimizing waste to optimizing interconnected infrastructure

 Legacy Model

 Emerging Reality

Core Framing

Waste to dispose of.

Strategic **resource** to manage.

Primary Goal

Minimize disposal costs.

**Optimize** multi-pathway infrastructure

Asset View

Single-use operational liability.

**Scalable** treatment and beneficial reuse facility


End State

Lowest-cost local injection.

**Systems-level** optimization

**We cannot solve a 50-million-barrel-a-day challenge with a linear mindset. Basins require options beyond injection-only models.**

# System -level optimization unlocks six strategic opportunities spanning risk mitigation and new economic verticals



## Produced Water Infrastructure

### Category 1: Core Protection & Mitigation



#### Protecting Base Production

Removing the water bottleneck so infrastructure constraints never cap oil output.



#### Reducing Seismic Risk

Diversifying management pathways to reduce concentration stress in specific injection zones.

### Category 2: Resource Synergies



#### Stranded Gas Utilization

Co-locating power generation with treatment to bypass limited takeaway capacity.



#### Mineral Recovery

Extracting lithium and other high-value elements from concentrated brines.

### Category 3: Broad Economic Growth



#### Water Supply Augmentation

Supplementing water supply for municipal or agricultural needs in water-stressed regions.



#### Industrial Enablement

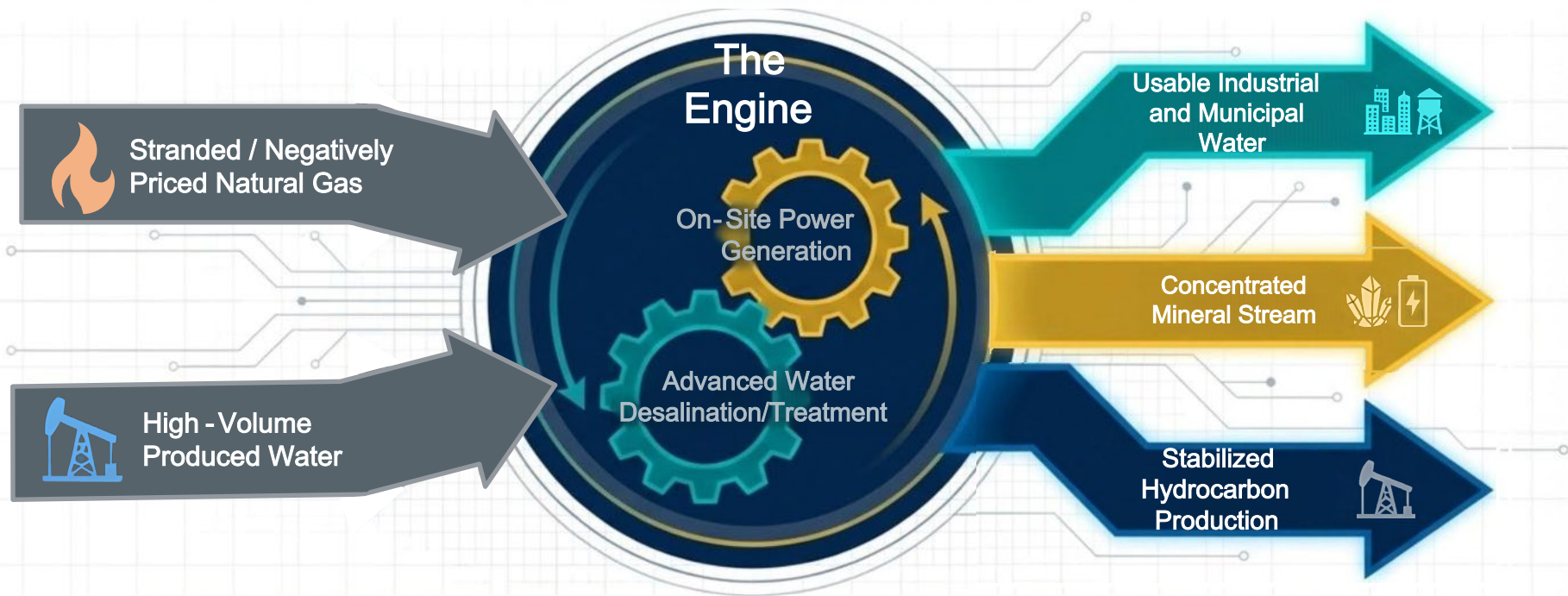
Providing reliable water and power required to support data centers and manufacturing.



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# Co-locating water treatment with stranded hydrocarbons transforms two regional liabilities into high-value productive assets



By leveraging excess gas to power desalination, operators eliminate flaring penalties, reduce injection volumes, and generate net-new resource streams

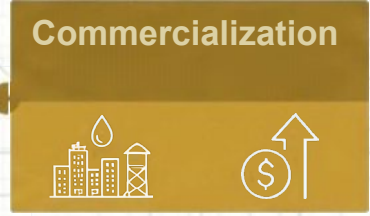


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# The DOE acts as an ecosystem enabler, deploying four strategic levers to bridge the gap between innovation and commercial scale



Innovation Valley of Death

**NETL O&G Center of Excellence**



Foundational lab research, geochemical analysis, and tech validation.

**2**  
**HGEO**

Advance, de-risk, and scale beneficial reuse technologies

**3**  
**NEDC**

Aligning federal frameworks (EPA, DOI, USDA) to reduce regulatory friction



**Implementation at Scale**

Enabling scalable regional water infrastructure

**We help reduce risk.**



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# Federal investments are already lowering costs & providing data to support decisions

## **Desalinated Produced Water as Irrigation Source for Non-Consumptive Agriculture and Adjacencies for Ammonia Mining and Carbon Sequestration Field Trials**

Advance the beneficial reuse of produced water for non-consumptive agriculture and industrial application.



## **Characterizing and Recovering Valuable Elements and Minerals from Produced Water in Oklahoma**

Sample produced waters; determine their chemistry; determine their concentrations in terms of rare earth elements, critical minerals, and/or elements of interest; and engineer their extraction technologies



## **Integration of Produced Water Thermal Desalination and Steam Methane Reforming for Efficient Hydrogen Production**

Conduct a pilot scale field-demonstration of hydrogen production (capacity of 1 ton/day) using produced water (generated during oil and gas extraction) at a cost~15% below existing methods (\$1.30 – \$2.10/kg of H<sub>2</sub>) and showing potential to reach DOE's goal of \$1 per 1 kg by 2030.



## **Valuable mineral recovery and alternative utilization of produced water through a novel process**

Develop a process for achieving three beneficial uses of produced water, including valuable mineral recovery, carbon fixation, and irrigation water production



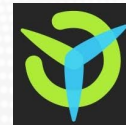
## **Scalable and Efficient Membrane Distillation and Adsorption Process for High-Purity Water and Lithium Recovery from Produced Water in New Mexico**

Comprehensively characterize produced water from the Permian and San Juan Basins in New Mexico



## **Strategic Management and Resource Recovery Transformation (SMAR2T): Recovery of Water and Elements of Interest from Produced Water Using Intensified Membrane Distillation and Metal Extraction**

Develop a system engineering approach for produced water resource extraction and management in oil and gas operations



## **Produced Water Consortium for Ultralightweight Composite Manufacturing by Accelerated Carbon Mineralization**

Form the Produced Water Consortium for Ultralightweight Composite Manufacturing to manage, treat, and/or beneficially reuse produced water from onshore oil & gas operations.



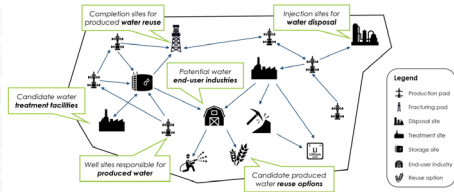
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# Federal investments are already lowering costs & providing data to support decisions

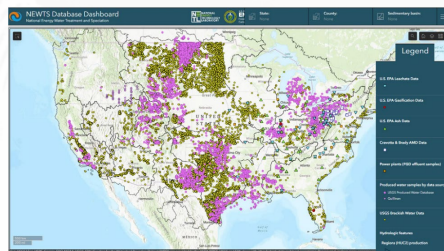
## An Optimization Framework for Produced Water Management and Beneficial Reuse



**Goal:** Develop a modeling and optimization application to identify cost-effective and environmentally sustainable produced water management, treatment, and reuse solutions.



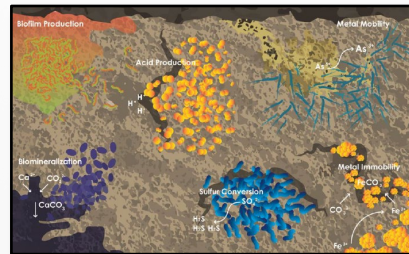
## National Energy Water Treatment & Speciation Database



**Goal:** Create publicly available online datasets curated and processed by NETL to better understand the composition of energy-related wastewater streams. The data will help identify possible sources of valuable critical minerals.



## Produced Water Characterization & Treatment



**Goal:** This work focuses on the critical national R&D effort directed at characterizing produced water associated with sustainable oil and gas development and reducing disposal volumes.

## Produced Water Research Partnership



**Goal:** Leveraging its core capabilities, competencies, and authorities, NETL will partner with universities and industry to develop and increase to commercial readiness the technology needed to treat and manage produced water from oil and natural gas operations.

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## System Optimization (PARETO)



### PARETO

The Produced Water  
Optimization Initiative

**Modeling cost-effective and environmentally sustainable reuse networks.**



**Projected 2,400% ROI** for taxpayer investment.



Downloaded **700+times**; utilized by **30+** industry members



Winner of the 2022 Meritorious Award for Engineering Innovation.

## Data & Mineral Discovery (NEWTS Database)



### NEWTS

DATABASE

**Identifying valuable rare earth elements in energy-related wastewater.**



Centralized database built with **>400,000** sample records



Downloaded **>13,000** times



Enables operators to map mineral recovery potential directly into their existing industry dashboards.

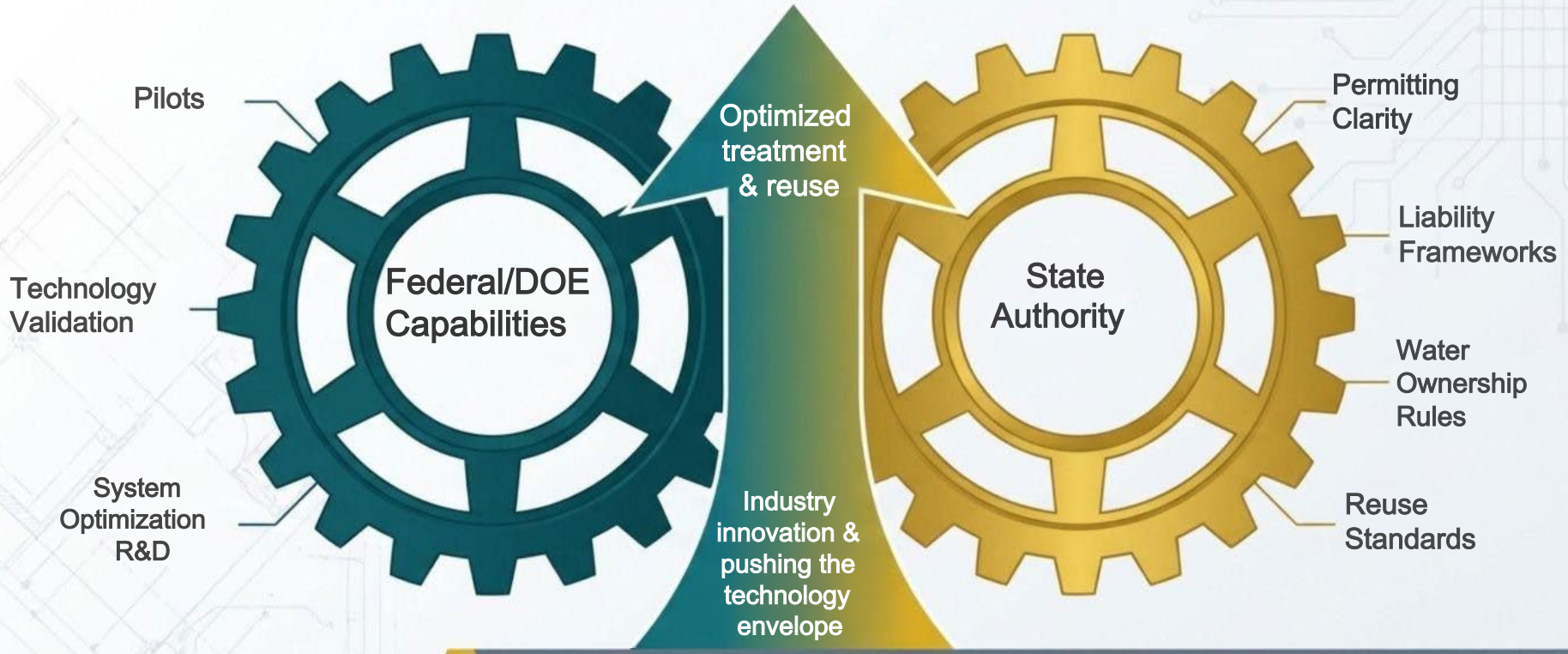


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# Federal technology validation must interlock tightly with state regulatory authority



DOE's role is not to replace state authority, but to align federal funding and tech validation with state priorities



# We are seeking partners to build scalable, replicable solutions. The door is open.

## The Mandate

Projects that scale to millions of barrels per day.

Technologies that drastically lower water management costs

Solutions replicable across major producing regions (Permian, Marcellus, DJ)

## Future R&D Direction

Expanded data collection and compilation through each stage of a treatment train.

De-risking the commercialization of highly scalable technologies for produced water treatment

Long-term testing of available near-commercial produced water technologies at scale and the development of testing scenarios for the future of produced water treatment.

Novel produced water treatment (optimization and demoing in the field) for burgeoning unconventional clean water supply chains to service regional supply chains (industry, agriculture, etc.).

Advanced real-time water quality sensors that can withstand the harsh conditions within a produced water treatment train.

## DOE Resources

Hydrocarbons and Geothermal Energy Office (HCEO)

NETL Oil & Gas Center of Excellence (COE)



# Questions?

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