

WATER-ENERGY NEXUS NEWS

U.S. DEPARTMENT OF ENERGY | OFFICE OF FOSSIL ENERGY AND CARBON MANAGEMENT | NATIONAL ENERGY TECHNOLOGY LABORATORY



IN THIS ISSUE

- 3** Project Highlights
- 8** In The News
- 9** Conferences and Events
- 10** Researcher Spotlight
- 11** Publications

*An Update on the
National Energy Technology
Laboratory's Water-Energy
Research and Related Activities*

Welcoming the New Director

In February of this year, the U.S. Department of Energy (DOE)/Office of Fossil Energy and Carbon Management (FECM) announced the hiring of Dr. Marianne Walck as Director of the National Energy Technology Laboratory (NETL). Dr. Walck will manage the delivery and execution of FECM's mission and national programs to ensure the availability of affordable, abundant and reliable domestic energy while developing technologies to manage carbon and maintain environmental sustainability. Dr. Walck will also be responsible for NETL's program support to DOE's Office of Energy Efficiency and Renewable Energy, Office of Electricity and Office of Cybersecurity, Energy Security and Emergency Response. As director, Dr. Walck fosters strategic relationships with utility and academic institutions, state and local governments, and important carbon management stakeholders.

Prior to joining NETL, Dr. Walck was Deputy Director for Science and Technology and Chief Research Officer at Idaho National Laboratory. Dr. Walck also previously served in several positions at Sandia National Laboratories over 33 years, including as Vice President of the California Laboratory, Energy Division and Energy Climate Programs; Director of the Geoscience, Climate, and Consequence Effects Center; and Director of the Nuclear Energy and Global Security Technology Center.



For more about Dr. Walck, please [click here](#).

Project Highlights

Highlights: Conference Proceedings Now Available from the 2024 NETL Resource Sustainability Project Review Meeting

NETL recently showcased ongoing work by researchers from the public and private sectors to identify and address the nation's greatest energy, environmental and economic challenges during the NETL Resource Sustainability Project Review Meeting, held Apr. 2–4, 2024, in Pittsburgh, Pennsylvania.

Full proceedings from the conference are available on NETL's website at <https://netl.doe.gov/events/conference-proceedings>.

Some highlights of key presented work at NETL connected to water-energy include the following:

Critical Minerals & Materials

- [R&D Enabling Domestic Critical Mineral Abundance \(FWP-1022420\)](#), Burt Thomas, NETL
- [Critical Minerals: Systems Analysis Tasks \(FWP-1022420\)](#), Alison Fritz, NETL
- [Predicting Lithium Fluxes from a Heterogenous Brine Source: Marcellus Shale \(FWP-1022420\)](#), Justin Mackey, NETL Site Support Contractor

Water Management

- [NETL/RIC Water Management FWP \(FWP-1022428\)](#), Nicholas Siefert, NETL
- [Project PARETO – DOE's Produced Water Optimization Initiative \(FWP-1022477\)](#), Elmira Shamlou, NETL
- [NETL/RIC Produced Water Research Partnership \(FWP-1025012\)](#), Nicholas Siefert, NETL
- [Produced Water Characterization and Treatment: Task 3.0: Organics, Inorganics and Critical Minerals Characterization \(FWP-1025013\)](#), Lauren Burrows, NETL
- [Microbial DNA Database and Demonstration \(FWP-1025013\)](#), Djuna Gulliver, NETL



Dr. Marianne Walck providing opening remarks at the 2024 NETL Resource Sustainability Project Review Meeting.

Highlights: NETL to Manage Second Round of Funding Selections Announced for Water R&D Focused on Reuse and Resource Recovery

In April 2024, DOE/FECM announced a second round award selections of nearly \$10 million for Funding Opportunity Announcement (FOA) 2796: Water Research and Development for Oil and Gas Produced Water and Coal Combustion Residuals Wastewater Associated with Coal Power Plants. The **first round of award selections** was announced in December 2023.

The funding opportunity focuses on developing improved wastewater characterization to better understand how to process oilfield water for reuse and resource recovery, improving technologies for the effective management and treatment of wastewaters and leveraging systems engineering for oil and natural gas produced water management operations, including field implementation, operation and validation.

NETL will manage the following selected research and development (R&D) projects:

Characterization and Recovery of Rare Earth Elements/Elements of Interest in Coal Combustion Residual Wastewater and Solid Wastes Associated with Coal Power Generation intends to revise and streamline conventional procedures used to analyze rare earth elements (REEs) and other elements of interest from power plant target sources, with plans to demonstrate one electrodialytic technology for potential recovery of REEs and other elements of interest for helping enable beneficial use of coal combustion residuals wastewater and solid waste.

Scalable and Efficient Membrane Distillation and Adsorption Process for High-Purity Water and Lithium Recovery from Produced Water in New Mexico plans to comprehensively characterize produced water from the Permian and San Juan Basins in New Mexico and develop a scalable and highly efficient membrane distillation-crystallization and adsorption process for simultaneous water and critical elements recovery from produced water.

Strategic Management and Resource Recovery Transformation (SMAR2T): Recovery of Water and Elements of Interest from Produced Water Using Intensified Membrane Distillation and Metal Extraction intends to develop and optimize system engineering approach for produced water resource extraction and management in oil and gas operations.

Characterizing and Recovering Valuable Elements and Minerals from Produced Water in Oklahoma (OK-CARVER) intends to promoting sustainable resource utilization through sample and analysis of produced waters, with plans to develop geoscience and engineering solutions for the recovery of valuable elements and minerals from produced water.

Valuable mineral recovery and alternative utilization of produced water through a novel process plans to develop a process for achieving beneficial uses of produced water, including valuable mineral recovery, carbon fixation, and irrigation water production—ultimately, the project intends to establish a pre-pilot circuit to continuously test the process and collect critical information for testing at larger scales.

Further details on the selected projects are available [here](#).

Highlights: WaterTAP to Develop Capabilities in Support of NAWI, as Focus Shifts to Accelerate R&D

The National Alliance for Water Innovation (NAWI), led by DOE's **Lawrence Berkeley National Laboratory**, has been extended for five more years with \$75 million in funding from DOE.

NAWI shared **new directions** that will enable the program to continue to accelerate breakthroughs toward a circular water economy, where water is treated to fit-for-purpose standards and reused locally. Shifts in focus over the next five years will include regional water systems planning—in partnership with state and regional level water planners to develop and use new tools for water portfolio optimization and forecasting water supply and demand. NAWI also plans to spearhead water resilience pilot projects and implement regional water system workshops.

NETL will continue its role in leading the multi-lab effort in developing Water treatment Technoeconomic Assessment Platform (WaterTAP) capabilities to support these pilot projects, in collaboration with other national laboratories including Lawrence Berkeley National Laboratory, National Renewable Energy Laboratory, and Oak Ridge National Laboratory. The WaterTAP team will leverage capabilities already demonstrated at the pilot scale by other NETL projects such as the Institute for Design of Advanced Energy Systems (**IDAES**) and Carbon Capture Simulation for Industry Impact (**CCSI²**).

WaterTAP is an open-source Python-based software tool for assessing the performance and economic viability of water treatment trains. To learn more about WaterTAP, please visit <https://www.nawihub.org/knowledge/watertap/>.

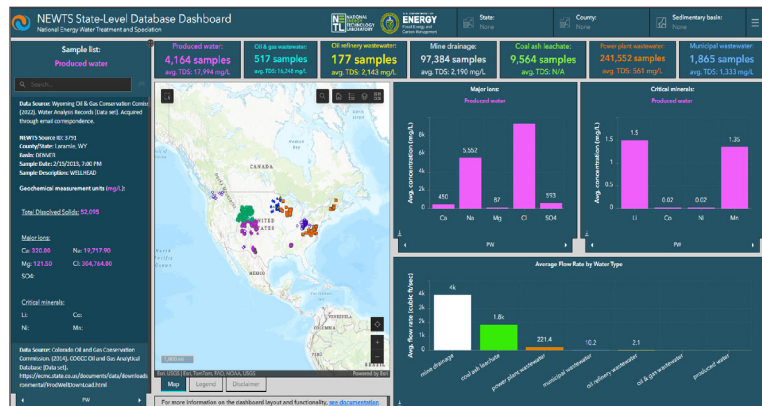
NAWI is a research program and public-private partnership supported by DOE in partnership with the California Department of Water Resources and the California State Water Resources Control Board. To learn more about NAWI, please visit <https://www.nawihub.org>.



Waste Not, Want Not: NEWTS Team Makes New and Historical Wastewater Data Available to the Public

In summer, there is a good chance you are relying on the fossil energy sector for the coal, oil or natural gas to fuel your seasonal fun—whether connecting a propane tank to the backyard grill, getting a slice of watermelon from the fridge, or curating a road-trip playlist before heading to the beach. But the fossil energy sector doesn't just produce fuel. It also produces wastewater, which must be sampled and analyzed to ensure its safe release or reuse.

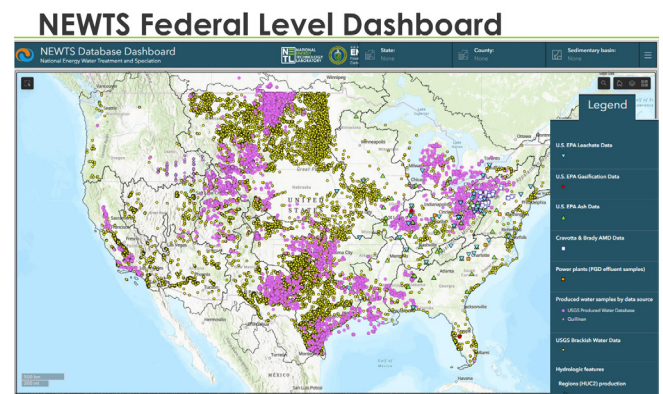
NETL's National Energy Water Treatment and Speciation (NEWTS) team has added more than 360,000 water samples to the new NEWTS **State-Level Database Dashboard**. These samples span a range of wastewater types, including produced water, mine drainage, coal ash leachate, and wastewater streams from other sources. The samples also span the nation—from creeks in Washington State and oil wells in Texas, to lakes in Ohio and rivers in Maine. What they all have in common is their origin in the fossil energy sector.



By providing these samples for visualization and consumption in the NEWTS State-Level Database Dashboard, NETL has made the data publicly available in one intuitive and integrated resource. The dashboard presents data-driven insights and valuable information to empower researchers, communities and stakeholders. For example, an engineer may want to determine how prevalent lithium, manganese and other critical minerals are in oil-and-gas wastewater. *Their* ultimate goal may be to capture these minerals for use in battery manufacturing. Meanwhile, a congressional

representative may want to know which minerals typify mine drainage in their district. Their ultimate goal may be to preserve waterways for the citizens they represent. In either case, the dashboard makes it easy to access useful, trustworthy information that was once challenging to find.




NETL's Research and Innovation Center (RIC) acquired data through publicly available and credible resources by contacting state-level environmental protection agencies. The resulting dataset provides detailed concentrations and speciation of major and minor aqueous compounds in energy-related wastewater streams. That means it contains 10 times the amount of data in the original NEWTS Dashboard, which features datasets obtained from federal agencies (namely, the U.S. Geological Survey and the U.S. Environmental Protection Agency). The original dashboard is also active, under a new name—the **NEWTS Federal Database Dashboard**.



Waste Not, Want Not: NEWTS Team Makes New and Historical Wastewater Data Available to the Public (*Continued*)

In spring 2023, NETL/RIC published approximately 850 historical samples of produced water in NETL's **Energy Data eXchange®** (EDX). Currently, these samples are housed at the University of Texas (UT) at Austin, but about six decades ago, they were collected from more than 800 oil fields in the United States and Canada. The archived data from that period (circa 1960) is now available via EDX, which includes "minor elements"¹ such as antimony, germanium, iridium and zinc. These elements (and others included in the 1960s assessment) now appear on DOE's critical materials list.² In addition, researchers with UT Austin recently analyzed about 80 of these historical samples as part of the NETL/RIC Produced Water Research Partnership.


UT Austin Archived Historical Produced Water Samples



- ~850 Historical Produced Water samples from across the U.S.
- Cation compositions analyzed in 1960s are available at the NETL NEWTS group site on EDX
 - Rittenhouse *et al.* Historical Archived Data
- UT Austin and UTEP have analyzed ~80 samples for training AI/ML networks

Samples stored at UT Austin, originally sampled around 1960

Examples of intact samples with minimal or no water loss

 [Rittenhouse et al. 1960s Historical Archived Produced Water Dataset - Submissions - EDX \(due soon\)](https://edx.netl.doe.gov/dataset/d0199726-61b8-4aa5-ad28-aff21ca91792/resource/2b90f43d-426e-4754-80b2-1d890c9605e2) 7

All of these datasets will inform a machine-learning tool that NETL researchers Dr. Chad Able and Dr. Alison Fritz are developing. Using the programming language Python, Able, Fritz and colleagues are developing the Constituent Data Replacement Tool (CoDaRT) to algorithmically estimate missing data including the quantity of REEs and other critical minerals in wastewaters including coal ash leachate and produced water. The models on which CoDaRT bases its estimates will reflect the state-level, federal-level and historical data that the NEWTS team made available this year.

- 1 Gordon Rittenhouse et al., "Minor elements in Oil-Field Waters," *Chemical Geology* 4 (1969), 189–209, <https://edx.netl.doe.gov/dataset/d0199726-61b8-4aa5-ad28-aff21ca91792/resource/2b90f43d-426e-4754-80b2-1d890c9605e2>, accessed April 30, 2024.
- 2 U.S. Department of Energy, Notice of Final Determination on 2023 DOE Critical Materials List, July 28, 2023, <https://www.energy.gov/sites/default/files/2023-07/preprint-frn-2023-critical-materials-list.pdf>, accessed April 30, 2024.

In the News

NETL Launches EDX Spatial to Bring Energy Research Data and Interactive Maps to Decision Makers

To help commercial, regulatory, and energy research professionals more effectively explore and interact with complex and evolving data, and glean insights through interactive maps, NETL developed EDX Spatial—a game-changing platform that empowers users to visualize data seamlessly through online mapping. The new EDX Spatial feature hosts thousands of earth-energy data files from public and DOE/FECM-related sources, as individual spatial data layers, as well as collated [Data Collections](#) that align to DOE FECM/NETL-funded research. The current inventory of EDX Spatial Data Collections includes the Carbon Storage Open Database, NATCARB Viewer 2.0, Offshore Gulf of Mexico Collection, Rare Earth Elements and Coal Open Database, and Global Oil and Gas Infrastructure Database.

Patent Issued for Laser Technology that More Efficiently Detects Leaks from Underground CO₂ Storage Sites

NETL's Dustin McIntyre and Daniel Hartzler were recently awarded the fifth in a series of technology patents that cover aspects of a laser induced breakdown spectroscopy (LIBS) probe for more efficient underground carbon storage site monitoring. Leakage can be detected by monitoring groundwater composition around underground storage sites known as geologic carbon sequestration sites. A variety of analysis techniques are currently used to measure trace elements in groundwater. However, many of them have high equipment costs, operator training requirements, and lack portability, requiring samples to be collected in the field and transported to a laboratory for analysis. Major advantages of LIBS include little to no sample preparation; a sensitivity to both light and heavy elements; durability for continuous, in situ measurements in hostile environments; and potential for miniaturization.

NETL's MUST Technology for Removing Heavy Metals from Water Nets Patent

NETL's award winning multi-functional sorbent technology (MUST), initially developed for use in carbon capture applications, was issued a U.S. patent for Multi-functional Basic Immobilized Amine Sorbents for Removal of Metal Contaminants from Wastewater in December 2023. After working on carbon capture applications, NETL developers McMahan L. Gray, Fan Shi, Walter C. Wilfong, Qiuming Wang, and Brian W. Kail discovered that MUST can play a significant role in removing toxic metals that flow from thousands of abandoned and active mines across the nation that pollute streams, destroy aquatic life and contaminate water supplies.

NETL Software Tools Contribute to First-of-Its-Kind Publication on Water Treatment

By using software tools developed at the laboratory ([WaterTAP](#) and [IDAES](#)), NETL helped co-author "[Modeling Framework for Cost Optimization of Process-Scale Desalination Systems with Mineral Scaling and Precipitation](#)," which was recently published in ACS ES&T Engineering. This work was the product of a collaboration between NETL researchers and OLI Systems, a water chemistry software company, which was funded by [NAWI](#).

NETL Report: Produced Water from Appalachian Hydraulic Fracturing Can Be Source for Lithium Used in Battery Production

Produced water that returns to the surface as wastewater after oil and gas hydraulic fracturing processes in parts of Appalachia can be a source of lithium, a valuable chemical element used in consumer products, according to an important new [report](#) from NETL. The NETL research suggests that Marcellus Shale production wastewater from the two Pennsylvania regions could meet 38–40% of current domestic lithium consumption. The research shows that Marcellus Shale produced water has the capacity to provide significant lithium yields for the foreseeable future.

Conferences and Events

Listed below are upcoming conferences and events that align with the NETL's water-energy research efforts.

Clearwater Clean Energy Conference

(48th International Technical Conference on Clean Energy)

Description: The Clearwater Clean Energy Conference offers participants approximately 200 technical presentations in four days. Topics are highly relevant and advanced, science and technology driven, and aimed at clean energy supply. The program presents an extensive overview of emerging, evolving, and innovative technologies, fuels and/or equipment in the power generation industry.

Date: Jun. 17–20, 2024

Location: Clearwater, Florida

Website: <https://clearwatercleanenergyconference.com/>

LET 2024: Achieving Sustainability Through Water Technology

Description: The International Water Association's (IWA) 19th Leading Edge Conference on Water and Wastewater Technologies (LET 2024) is designed to be the place for sharing the latest insights into how pioneering science, technological innovation, and leading practices will shape the major transformation in water management that is underway. The wastewater treatment track energy positive wastewater technologies session focuses on energy generation, recovery and balances from heat, electricity, hydrogen, ammonia, sludge and using innovative technologies in wastewater treatment plants.

Date: Jun. 24–28, 2024

Location: Essen, Germany

Website: <https://iwa-let.org/>

2023 FECM/NETL Carbon Management Research Project Review Meeting

Description: This meeting will provide attendees with a chance to share in the knowledge and insights gained by more than 150 DOE-sponsored R&D projects from the following FECM R&D programs: Point Source Carbon Capture, Carbon Dioxide Removal, Carbon Conversion and Carbon Transport & Storage.

Date: Aug. 5–9, 2024

Location: Pittsburgh, Pennsylvania

Website: <https://netl.doe.gov/events/24CM>

Permian Basin Conference 2024

Description: This regionally focused technical and business conference brings together 300 water-treatment experts from around the world with regional and global expertise to solve the toughest problems in the produced water field.

Date: Aug. 12–24, 2024

Location: Midland, Texas

Website: <https://producedwatersociety.com/event-permian/>

The Water Expo 2024

Description: The Water Expo tradeshow is an effective commercial hub to connect manufacturers and distributors with buyers, professionals, dealers, municipalities, contractors and potential representatives from various industries, including wastewater, environmental services, water quality and high pressure and stormwater industries.

Date: Aug. 21–22, 2024

Location: Miami, Florida

Website: <https://www.thewaterexpo.com/>

Researcher Spotlight

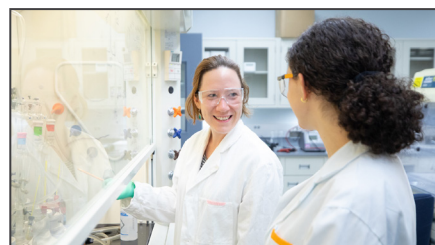


Lauren Burrows
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Dr. Lauren Burrows is a Research Scientist on NETL's Geochemistry Team under the Geological and Environmental Systems directorate. She received her Ph.D. in Organic Chemistry from the University of Pittsburgh in 2018 and earned her bachelor's degree in chemistry from Colgate University in 2012. Burrows has worked at NETL for over five years, first as an Oak Ridge Institute for Science and Education (ORISE) research associate in 2018, then as a research scientist through Leidos starting in 2021, before joining the federal team in August 2023.

Burrows currently is Principal Investigator for the Produced Water Characterization Field Work Proposal studying subsurface reactions of chemicals in fracturing fluids and the effect of these processes on wastewater contamination. She is also working on developing a mobile laboratory to monitor gas-phase emissions of nitrosamines and other pollutants from point source capture pilots and demonstrations under the Point Source Capture Multiyear Research Plan. As the nitrosamines emitted into the atmosphere could potentially accumulate in nearby water sources and present a public health concern, the project aims to monitor—and if needed, prevent—any emissions of nitrosamine compounds into the environment.

Burrows has also mentored as part of NETL's **Internship** program in summer 2022. She and Remy Goldberg, a Mickey Leland Energy Fellowship (MLEF) student, worked on a laboratory simulation of halogenation reactions occurring in produced water. Their experiments were published in 2023 in *ACS Earth and Space Chemistry*, **The Role of Iron in Oxidant-Initiated Halogenation Reactions of Hydraulic Fracturing Additives**.



Recent publications Burrows has co-authored include journal articles, **CO₂-Soluble Nonionic Surfactants for Enhanced CO₂ Storage via In Situ Foam Generation**, **Dissolving Nonionic Surfactants in CO₂ to Improve Oil Recovery in Unconventional Reservoirs via Wettability Alteration**, **Reactivity of CO₂ with Utica, Marcellus, Barnett, and Eagle Ford Shales and Impact on Permeability**, **A Literature Review of CO₂, Natural Gas, and Water-Based Fluids for Enhanced Oil Recovery in Unconventional Reservoirs**, and presentations, **Predicting Pollutant Generation in the Subsurface to Inform Produced Wastewater Remediation and Reuse** and **Produced Water Characterization and Treatment: Task 3.0: Organics, Inorganics and Critical Minerals Characterization**.

Publications and Presentations

LIBS sensing for in-situ iron detection and quantification in wastewater outfall

Chet Raj Bhatt, NETL Site Support Contractor; Daniel Hartzler, NETL Site Support Contractor; Dustin McIntyre, NETL. (DECEMBER 2023)

► <https://doi.org/10.1007/s00340-023-08156-y>

Fractionation of critical metals from authentic acid mine drainage using a multi-bed immobilized amine sorbent setup: A field site study

Walter Wilfong, NETL Site Support Contractor; Qiuming Wang, NETL Site Support Contractor; Bret Howard, NETL Site Support Contractor; Phillip Tinker, NETL Site Support Contractor; Karen Johnson, NETL Site Support Contractor; William Garber, NETL Site Support Contractor; Fan Shi, NETL; McMahan L. Gray, NETL. (FEBRUARY 2023)

► <https://doi.org/10.1016/j.jwpe.2024.104788>

Assessment of combustion residual leachate: Local treatment needs and critical mineral recovery

Chad Able, NETL Support Contractor; Alison Fritz, NETL; Eric Grol, NETL. (MARCH 2024)

► <https://doi.org/10.1016/j.resconrec.2024.107535>

Modeling framework for cost optimization of process-scale desalination systems with mineral scaling and precipitation

Oluwamayowa Amusat, Lawrence Berkley Nation Laboratory; Adam A. Atia, NETL; Alexander Dudchenko, SLAC National Accelerator Laboratory; Timothy Bartholomew, NETL. (MARCH 2024)

► <https://doi.org/10.1021/acsestengg.3c00537>

Posters & Presentations

National Energy Water Treatment & Speciation (NEWTS): A Water & Critical Minerals Database and Dashboard

Madison Wenzlick, NETL Site Support Contractor; Nicholas Siefert, NETL; Sophia Bauer, NETL Site Support Contractor; Zineb Belarbi, NETL Site Support Contractor; Devin Justman, NETL Site Support Contractor; Justin Mackey, NETL Site Support Contractor; Isabelle Pfander, NETL Site Support Contractor; Lucy Romeo, NETL Site Support Contractor; Michael Sabbatino, NETL Site Support Contractor; Kathryn Smith, Carbon Capture Scientific, LLC; Rachel Yesenchak, NETL Site Support Contractor; Randal B. Thomas, NETL. (DECEMBER 2023)

► <https://netl.doe.gov/energy-analysis/details?id=b946777d-0be0-42c9-8448-8e84dee35030>

Project PARETO – DOE’s Produced Water Optimization Initiative: Advancing Strategic Pathways for Produced Water Reuse Beyond Injection

Miguel Zamarripa, NETL Site Support Contractor; Elmira Shamlou, NETL Site Support Contractor; Travis Arnold, NETL Site Support Contractor; Philip Tominac, NETL Site Support Contractor; Melody Shellman, NETL Site Support Contractor; Markus Drouven, NETL. (FEBRUARY 2024)

► <https://netl.doe.gov/energy-analysis/details?id=14fa9fca-7b0a-46ae-b65a-8ea9fbf935e9>

Creating Markets for Produced Water

Markus Drouven, NETL; Miguel Zamarripa, NETL Site Support Contractor; Philip Tominac, NETL Site Support Contractor. (FEBRUARY 2024)

► <https://netl.doe.gov/energy-analysis/details?id=ac5f3d5e-7618-4de8-95c1-639a8e3919e2>

Investigation of Scale Deposition and Wellbore Corrosion in Carbonated Brine Injection: A Simulation Study

Zineb Belarbi, NETL Site Support Contractor; Merry Tesfu, University of North Dakota; Meghan Taunton, University of North Dakota Energy and Environmental Research Center (UNDEERC); Ryan Klapperich, UNDEERC; Marc Kurz, UNDEERC; Ryan Hall, NGL Energy Partners, LP; Randal B. Thomas, NETL; Wei Xiong, NETL Site Support Contractor. (MARCH 2024)

► <https://netl.doe.gov/energy-analysis/details?id=c294596d-0b3a-49f3-90ff-9c361b448d7d>

Partnering with NETL

NETL's partnership activities are central to DOE's core mission. NETL utilizes a complete suite of contractual vehicles, as well as its inherent authority as a GOGO laboratory, to pursue technology development and eventual transfer of technology to the marketplace. NETL's success in developing technology solutions that can be applied to the intersection of water and energy depends upon strong relationships with both public and private entities. From targeted competitive announcements to cooperative research and development agreements, NETL offers a variety of cost-shared funding and partnership arrangements to help move technology and intellectual property through the maturation cycle into the marketplace.

For more information on partnering with NETL in the water-energy space, contact:

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Contact Us

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Program staff are also located in **Houston, Texas**, and **Anchorage, Alaska**.

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