

WATER-ENERGY NEXUS NEWS

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



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

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Message from the Director



After the successful launch of our quarterly Water-Energy Nexus e-Newsletter in 2021, I am pleased to announce the release of our Winter 2022 issue as part of our efforts to showcase the laboratory's research directed at the critical link between water and energy.

Water is required throughout the energy life cycle, and NETL has long been a leader in addressing the potential impacts of energy development on both water quality and water availability. Our talented team of scientists and engineers, along with exceptional facilities, allow the laboratory to deliver world-class technology solutions that enhance the nation's energy foundation while helping to protect our water resources for future generations. Needless to say, collaboration and partnership with the public and private

sector are fundamental to the success of our work, as is sharing our breakthroughs and successes with the energy community.

This year's issues of the Water-Energy Nexus e-Newsletter will continue to highlight our water-related research accomplishments and successes, partnering opportunities, patents and licenses, publications, and meetings and conferences, as well as feature our researchers working in the water-energy space.

Included in this Winter 2022 issue are updates on the laboratory's collaborative effort to develop an optimized framework for oil and gas produced water management, our partnership with the National Alliance for Water Innovation to advance a water treatment model, the University of North Dakota's Brine Extraction and Storage Test facility, and the recent Federal Energy Management Program's 2021 Federal Energy and Water Management awards. In addition, we highlight the accomplishments of our research staff.

I hope you enjoy the Winter 2022 issue of the Water-Energy Nexus e-Newsletter.

Sincerely,
Brian J. Anderson, Ph.D.
Director

Highlights: NETL Expands Its Water Treatment Modeling Tool

NETL is leading the development of ProteusLib, an open-source library of water treatment models built on NETL's Institute for the Design of Advanced Energy Systems (IDAES) platform. The work



NAWI

National Alliance
for Water Innovation

is part of a DOE National Alliance for Water Innovation (NAWI) funded project to create a common platform for the technoeconomic assessment of early-stage water treatment technologies. ProteusLib is being combined with a complementary NAWI modeling effort called the Water Technoeconomic Assessment Pipe-Parity Platform (WaterTAP3) to form a single comprehensive tool called the Water Technoeconomic Assessment Platform (WaterTAP).

In October 2021, DOE's Water Security Grand Challenge, the Office of Energy Efficiency and Renewable Energy's Advanced Manufacturing Office funded the further development of WaterTAP under Funding Opportunity Announcement (FOA) "Research and Development for Advanced Water Resource Recovery Systems." The objective of the project is to extend the capabilities of WaterTAP to cover technologies beyond NAWI's focus on desalination to wastewater treatment and resource recovery.

To access WaterTAP, visit <https://github.com/watertap-org/watertap>.

To learn more about NAWI, visit <https://www.nawihub.org/>.

For more information on the FOA, visit <https://eere-exchange.energy.gov/> or [click here](#).

Highlights: NETL and LBNL Collaborate with Olympus Energy on a Produced Water Optimization Initiative

NETL and Lawrence Berkeley National Laboratory (LBNL) are collaborating with Olympus Energy LLC (Olympus) on a project directed at managing produced water in the Appalachian Basin. The partnership with Olympus is part of a three-year, \$5 million Produced Water Application for Beneficial Reuse, Environmental Impact, and Treatment Optimization (PARETO) initiative to develop, demonstrate, and deploy an optimized framework for oil and gas produced water management.

DOE researchers have been working with the Olympus team since June 2021. The goal of the collaboration is to explore opportunities for leveraging cutting-edge mathematical optimization technology to (1) minimize community impacts of water management, (2) increase produced water reuse, (3) reduce trucking activity, and (4) decrease costs associated with produced water management.

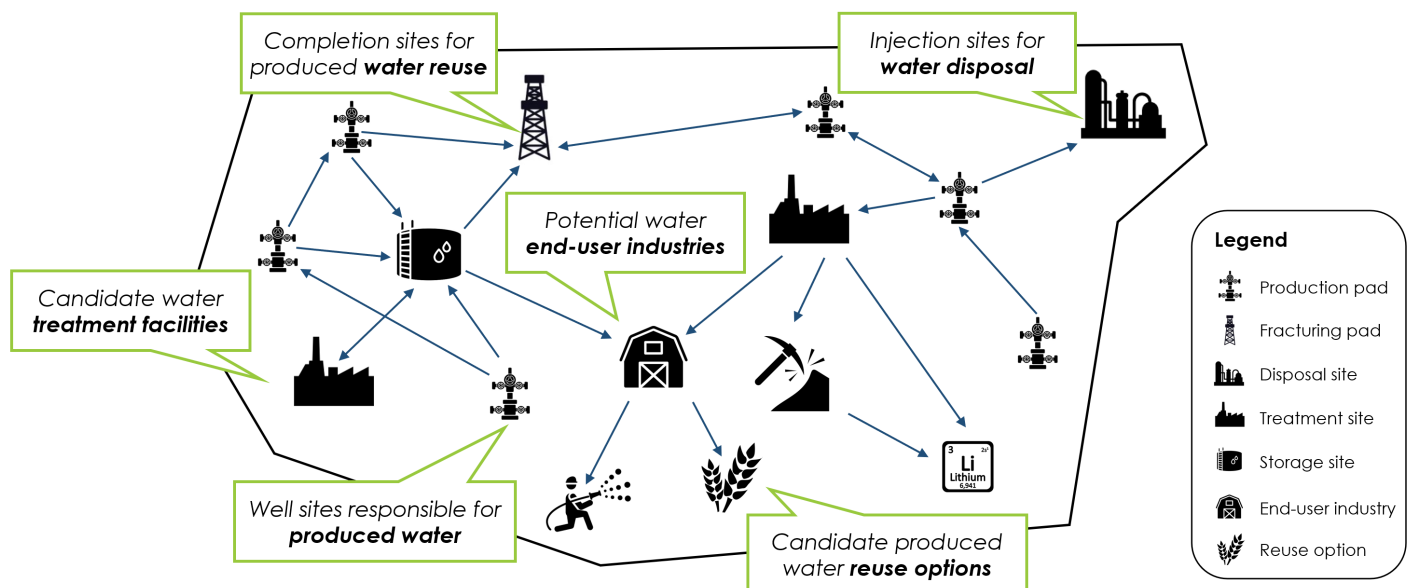
Using advanced optimization algorithms, the PARETO initiative will seek to coordinate important tasks such as finding the most efficient methods and routes to transport produced water from production areas to treatment facilities and examine the economic feasibility of supplying produced water to sites where it can be treated or repurposed.

The computational framework used by PARETO builds on foundational capabilities created through IDAES and NAWI. PARETO will leverage the IDAES integrated platform, an open-source modeling, simulation, and optimization framework, as well as the library of water treatment process models made available by NAWI to create a cutting-edge produced water optimization platform that supports better and faster decision-making.

Located in Canonsburg, Pennsylvania, Olympus is a privately-owned oil and gas company that specializes in upstream development of natural gas resources. Olympus is active in the core Marcellus, Utica, and Upper Devonian basins of southwestern Pennsylvania.

To watch a recorded webinar on the PARETO initiative, visit <https://www.nawihub.org/news-multimedia/videos/> or [click here](#).

For more information on the PARETO initiative, [click here](#).



Example of the scope of the PARETO initiative.

Highlights: DOE Announces 2021 Federal Energy and Water Management Award Winners



In November 2021, the U.S. DOE's Federal Energy Management Program announced 18 winners of the 2021 Federal Energy and Water Management Awards. These awards recognize individuals, teams, and organizations for outstanding efforts to cut energy waste, reduce costs, optimize performance, and advance America's progress toward net-zero carbon emissions by 2050.

The 2021 Federal Energy and Water Management Awards winners come from eight federal agencies, including one of DOE's national labs, the National Renewable Energy Laboratory (NREL). NREL partnered with the Marine Corps Air Station Miramar team to design and install a new efficient, resilient, and cost-effective data center. Completed in 2020, the project also leveraged the data center's backup diesel generator. The cooling towers were designed to use recycled water to provide additional savings. Overall, the project has resulted in a 35% drop in energy consumption.

Congratulations to all winners!

For more information on the 2021 Federal Energy and Water Management Award winners, visit <https://www.energy.gov/eere/femp/2021-federal-energy-and-water-management-award-winners>.

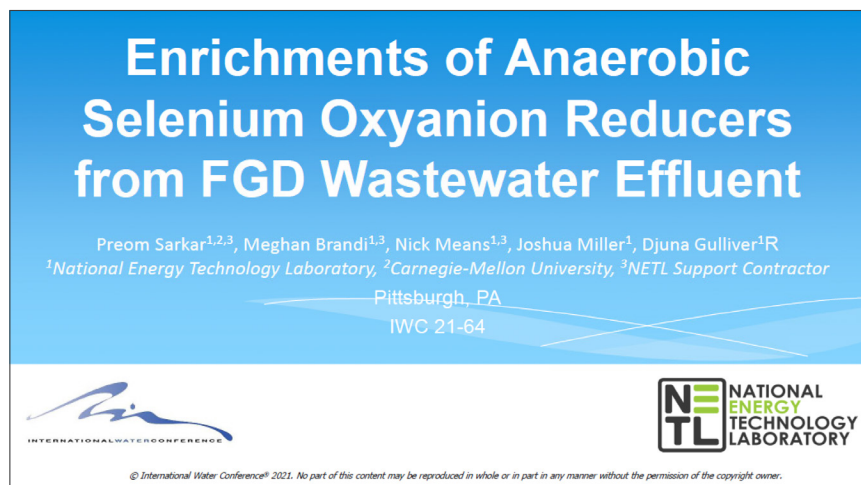
Highlights: NETL Presents Wastewater Research at the International Water Conference

In November 2021, representatives from NETL's Geomicrobiology and Geochemistry team participated in a technical session at the International Water Conference (IWC) on flue gas desulfurization (FGD) wastewater effluent. The presentation titled, "Enrichments of Anaerobic Selenium Oxyanion Reducers from FGD Wastewater Effluent" was given by Preom Sarkar and co-authored by Meghan Brandi, Nick Means, Joshua Miller, and Djuna Gulliver.

Sarkar discussed her research on the biological treatment of FGD wastewater with a specific aim to bioremediate (remove) soluble selenium species. FGD systems use an aqueous alkaline slurry to remove sulfur dioxide, mercury, and selenium from the stack gases of coal-fired power plants. As a result, a complex wastewater containing several contaminants is formed that must be managed to meet applicable state and federal water discharge standards. It is known that biological treatment can be used for this water, but not much is known about the microbial community that can treat this environment. Sarkar has been investigating the use of enriched microbial species native to FGD wastewater to biotransform soluble selenium species, such as selenate and selenite, into insoluble elemental selenium.

For more information on IWC, please visit <https://eswp.com/water/overview/>.

To learn more about the FGD systems, please [click here](#).



Water-Energy Project Highlights

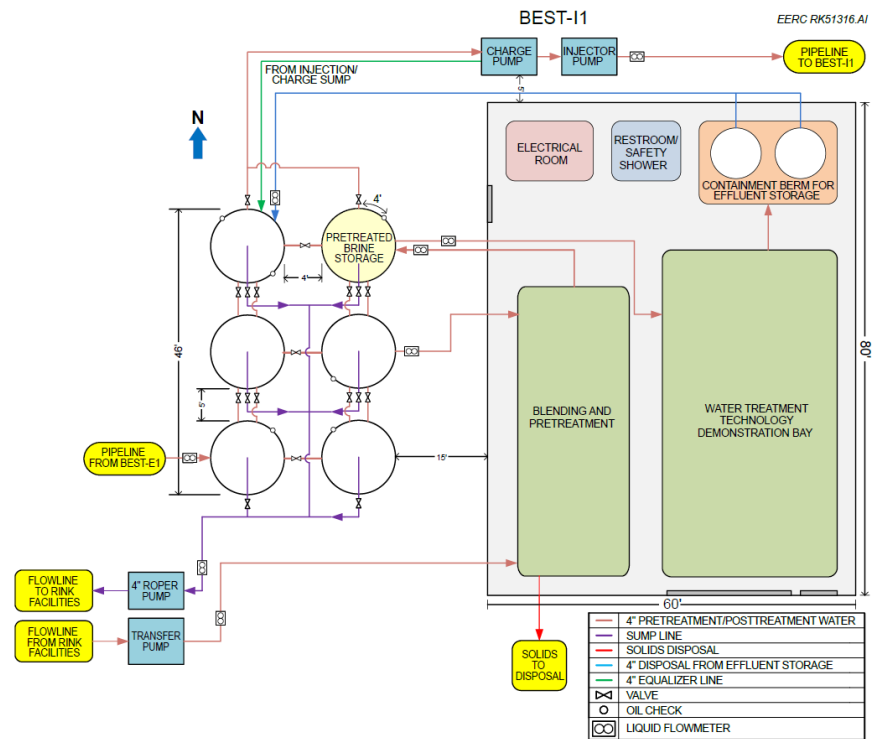
In 2015, DOE selected five projects under the “Fit-for-Purpose Field Project: Developing and Validating Pressure Management and Plume Control Strategies through a Brine Extraction Storage Test (BEST)” funding opportunity to investigate the use of active reservoir management (ARM) to ensure safe, geologic storage of carbon dioxide (CO₂). ARM is focused on capping fluid pressures in part or all of the storage reservoir and combines brine production with CO₂ injection to relieve pressure buildup, increase injectivity, manipulate CO₂ migration, or constrain brine leakage.

The BEST projects followed a two-phased research approach. Five Phase I projects carried out modeling and other analyses to support development of ARM strategies for potential field projects. Two projects advanced to Phase II field projects with the objective to develop and validate brine extraction strategies/approaches for managing changes in storage reservoir pressure while incorporating innovative treatment and re-use technologies for the extracted brines.

One of the two Phase II BEST field projects is with the University of North Dakota Energy and Environmental Research Center (UNDEERC). Under Phase I, UNDEERC worked with GE Global Research, Computer Modeling Group, and Schlumberger Carbon Services to utilize

existing geologic and site injection data to model multiple injection and extraction scenarios, design the field lab infrastructure, create operation and monitoring plans, and perform a thorough risk assessment. In Phase II, UNDEERC has validated efficacy of ARM applications to industrial CO₂ storage projects (through a field test) and demonstrated the steps necessary to design and implement ARM for industrial carbon capture and storage projects. In addition, the project has developed a water treatment test bed to test various technologies with application to treating high-total dissolved solids brines associated with geologic CO₂ storage targets. Furthermore, the treated brines could potentially serve as a source of water for agricultural, industrial, or domestic use.

For more information on the BEST project, visit <https://netl.doe.gov/node/2476> or [click here](#).



Conceptualized physical layout of the brine treatment test bed facility.

Conferences and Events

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

WEF/AWWA Utility Management Conference 2022

Description: The Water Environment Federation (WEF) and American Water Works Association (AWWA), in cooperation with the Florida Water Environment Association, are jointly hosting the WEF/AWWA Utility Management Conference. This leading and informative conference brings together water and wastewater managers and professionals from the water sector.

Date: Feb. 21–24, 2022

Locale: Orlando, Florida

Website: <https://www.wef.org/UtilityManagement>

World Water-Tech Innovation Summit

Description: Now in its 11th year, the World Water-Tech Innovation Summit has become a catalyst for innovation and an annual meeting place for the global water ecosystem. Utilities, regulators, engineering firms, technology giants, start-ups, and investors come together to share their experiences and identify future partners. The summit will combine a physical event in London with a smart virtual platform to connect in-person attendees with international participants joining online.

Date: Feb. 22–23, 2022

Locale: London, England + Virtual

Website: <https://worldwatertechinnovation.com>

2022 Permian Basin Water in Energy Conference

Description: The Permian Basin Water in Energy Conference connects industry leaders and researchers, sharing best practices and cutting-edge approaches to some of the oil and gas industry's most pressing issues.

Date: Feb. 22–24, 2022

Locale: Midland, Texas

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

2022 Ocean Sciences Meeting

Description: Co-sponsored by the American Geophysical Union (AGU), the Association for the Sciences of Limnology and Oceanography (ASLO), and The Oceanography Society (TOS), Ocean Sciences Meeting (OSM) is the global leader in ocean sciences conferences. OSM 22 aims to connect as many people as possible across media, while disseminating scientific knowledge, and creating personal connections.

Date: Feb. 27–March 4, 2022

Locale: Virtual

Website: <https://www.aslo.org/osm2022/>

Sustainable Water Management Conference

Description: The 2022 Sustainable Water Management Conference will bring together water sector organizations and professionals to discuss all aspects of resilient and efficient water management. Attendees will gain insights into best practices for managing water resources, source water protection, sustainable utility planning, analyzing the costs and benefits of water conservation, and exploring alternative water sources including stormwater and reuse.

Date: March 27–30, 2022

Locale: Denver, Colorado

Website: <https://www.awwa.org/Events-Education/Sustainable-Water-Management>

Researcher Spotlight



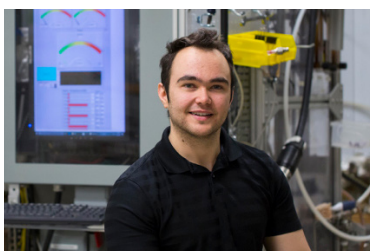
Chad Able

Senior Engineer

Chad.Able@netl.doe.gov

Chad Able, Ph.D. is a site-support contractor supporting the Research & Innovation Center's Energy Process Analysis Team. He earned a Ph.D. in Chemical Engineering from Ohio University and a bachelor's degree in Chemical Engineering from the University of Missouri – Columbia.

Able is supporting a partnership with Black & Veatch to determine the quantity, characteristics, and treatment of leachate produced from combustion residuals (coal ash) and a partnership with Stanford University to predict bromide emissions from coal-fired plants based on the type of coal burned and the bromide added to the plant. Previously, Able's support included evaluating the state of the art in FGD wastewater treatment in the Environmental Protection Agency's 2020 ruling and determining the effectiveness of treating coal- and natural-gas fired wastewater streams for generating hydrogen.



“I have a variety of interests in water remediation – I have historically worked on the treatment of water produced from hydraulic fracturing and the treatment of a variety of wastewater flows from coal- and natural gas-fired power plants.”

Able has co-authored ten scientific publications. His water-related publications include Sustainable Management of Hypersaline Brine Waste: Zero Liquid Discharge via Joule-Heating at Supercritical Condition; Advanced Supercritical Water-Based Process Concepts for Treatment and Beneficial Reuse of Brine in Oil/Gas Production; and The System $\text{CaCl}_2\text{--H}_2\text{O}$: Thermodynamic Modeling and Flow Calorimetry Experiments at Elevated Temperatures and Pressures. His water-related effort includes the Water Management for Power Systems (FWP 1022428).

Recent Water-Related Publications and Presentations

Below are several water-related journal articles authored or co-authored by NETL staff.

Critical Review of Functionalized Silica Sorbent Strategies for Selective Extraction of Rare Earth Elements from Acid Mine Drainage

Walter C. Wilfong, NETL; Tuo Ji, Oak Ridge Institute for Science and Education (ORISE)/NETL; Yuhua Duan, NETL; Fan Shi, NETL; Qiuming Wang, NETL; McMahan L. Gray, NETL (FEBRUARY 2022)

► <https://www.sciencedirect.com/science/article/abs/pii/S0304389421025930>

A Database and Framework for Carbon Ore Resources and Associated Supply Chain Data

Devin Justman, NETL; Michael Sabbatino, NETL; Scott Montross, NETL; Scott Pantaleone, NETL; Andrew Bean, NETL; Kelly Rose, NETL; Randal B. Thomas, NETL (FEBRUARY 2022)

► <https://www.sciencedirect.com/science/article/pii/S2352340921010350>

Heterogeneous Photo-Fenton-Like Degradation of Emerging Pharmaceutical Contaminants in Wastewater Using Cu-doped MgO Nanoparticles

Manoj Silva, Lehigh University; John P. Baltrus, NETL; Clinton Williams, U.S. Department of Agriculture (USDA); Allan Knopf, USDA; Lihua Zhang, Brookhaven National Laboratory; Jonas Baltrusaitis, Lehigh University (JANUARY 2022)

► <https://www.sciencedirect.com/science/article/abs/pii/S0926860X21004828>

High-Impact Innovations for High-Salinity Membrane Desalination

Alexander V. Dudchenko, SLAC National Accelerator Laboratory; Timothy V. Bartholomew, NETL; Meagan S. Mauter, Stanford University (SEPTEMBER 2021)

► <https://www.pnas.org/content/118/37/e2022196118>

Contact Us

NETL is part of DOE's national laboratory system. NETL is a government-owned, government-operated (GOGO) laboratory supporting DOE's mission to advance the national, economic, and energy security of the United States.

1450 Queen Avenue SW
Albany, OR 97321-2198
541-967-5892

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4764

626 Cochran's Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4687

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

CUSTOMER SERVICE: 1-800-553-7681

www.netl.doe.gov

Get Social with Us

There are several ways to join the conversation and connect with NETL's Water-Energy Research Program:



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 and into the marketplace.

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

Thomas J. Feeley, III

Research Partnerships & Tech Transfer

Thomas.Feeley@netl.doe.gov

412-386-6134

<https://netl.doe.gov/water-energy-research>



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