NATIONAL ENERGY TECHNOLOGY LABORATORY

JANUARY 2021

WATER-ENERGY NEXUS NEWS

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

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

IN THIS ISSUE

Welcome Message from the Director

Welcome to the inaugural edition of the U.S. Department of Energy National Energy Technology Laboratory's Energy-Water Nexus Newsletter.

Water is essential to life. We need it for drinking and other domestic uses. We need it to grow our food supplies. We need it for manufacturing and industry. And we need it for energy. In the United States, water withdrawals for the energy sector are second only to the water used for agricultural. Water is required throughout the energy life cycle, from the mining and extraction and processing of fuels to the recovery of valuable byproducts, such as rare earth elements (REEs), to the operation and cooling of thermoelectric power plants.

For more than 100 years, NETL has helped develop advanced technologies that provide affordable, reliable, domestic energy to the American people. With our exceptional facilities and skilled in-house research teams, NETL has earned a reputation for delivering world-class technology solutions that enhance the nation's energy foundation and protect the environment for future generations. Today, NETL is applying these capabilities and competencies to develop the advanced tools and technologies needed to address the critical link between sustainable fossil energy and water.

The Water-Energy Nexus Newsletter is intended to showcase the Laboratory's water-energy activities by highlighting our research accomplishments and successes, providing updates on water-related partnering opportunities, patents and licenses, publications, and meetings and conferences, and presenting features spotlighting on our researchers working in the water-energy space.

I hope you enjoy this inaugural issue of the Water-Energy Nexus Newsletter.

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

NETL Launches Water-Energy Nexus Website

NETL has long recognized the critical link between sustainable water and energy. Since 2002, NETL has been engaged in integrated, comprehensive RD&D to advance our understanding of fossil energy exploration, extraction, development, and use on freshwater availability and quality with the goal of improving the security and resiliency of our fossil-energy investments. Research on water is being carried out in a synergistic manner across the Laboratory's programs in thermoelectric power generation, unconventional oil and gas development, carbon capture and storage, critical minerals and REE recovery, coal combustion residuals, university coal research, and systems modeling and analysis. Future activities may include the application of machine learning and artificial intelligence to critical water-energy challenges. Collectively, these projects support DOE's Water Security Grand Challenge, a White House initiated, DOE-led effort to advance transformational technology and innovation to meet the global need for safe, secure, and affordable water.

You can explore specific areas of NETL's water-energy research, learn more about our water program, and sign up for the Water-Energy Nexus Newsletter by visiting our new Water-Energy Nexus website at https://netl.doe.gov/water-energy-research.

Highlights: National Alliance for Water Innovation

NETL is part of the winning team under the DOE Advanced Manufacturing Office's $100 million Desalination Hub solicitation. Led by the Lawrence Berkeley National Laboratory, the National Alliance for Water Innovation (NAWI) focuses on desalination and related-water treatment R&D to allow for non-traditional water sources to be used to replace or supplement freshwater in various municipal, industrial, and agricultural applications. The overall goal of NAWI is to achieve "pipe parity" between non-traditional or impaired waters and freshwater on a levelized cost of water basis.

NETL's Research and Innovation Center (RIC) is responsible for coordinating the Laboratory's participation in the Desalination Hub. RIC's efforts will be directed at modeling and simulation tools development and will focus on water treatment systems using the Laboratory's Institute for the Design of Advanced Energy Systems (IDAES) framework. IDAES is a next-generation modeling and optimization platform used to develop multiscale, simulation-based computational tools and models in support of the Laboratory's efforts in advanced technologies. The outcome of NETL's support of NAWI will be an open-source, predictive suite of models for steady-state and dynamic optimization of integrated water systems and treatment trains called Proteus.

NAWI
National Alliance for Water Innovation

The initial implementation of Proteus will focus on building the steady-state unit and property models and system-level capabilities to provide a water desalination system simulator. The developed suite of models will incorporate those unit operations needed to fully represent a desalination process and track ions, mass, and energy flows throughout the system.

NETL staff have also participated on various non-traditional water technical road mapping teams to help define and focus the research to be conducted under the NAWI program.

For more information on IDAES, visit https://idaes.org.

Highlights: NETL Announces Further Development of Advanced Water Management Projects for Thermal Power Generation

In December 2020, NETL's Cross-cutting R&D Program announced that $3.3 million in Federal funding will be issued for cost-shared research and development projects under the DE-FOA-002399, Water Management for Thermal Power Generation. This effort will identify and treat alternative sources of water and will support the DOE's Water Security Grand Challenge Goal 3: "Achieve near-zero water impact for new thermoelectric power plants, and significantly lower freshwater use intensity within the existing fleet."

Water scarcity is a key consideration for managing current systems and planning for future investments. Efforts to decarbonize fossil fuel-based power plants may also contribute to water scarcity. Carbon capture and storage (CCS), fuel switching to biomass or hydrogen, and the integration of intermittent renewables onto the electricity grid will be accompanied by increases in water intensity. Treating water inside a power plant can give the asset a zero-liquid discharge (ZLD) footprint and provide the asset owner with flexibility when water is scarce.

The Funding Opportunity Announcement seeks to advance near-term solutions to reduce the impact of traditional and non-traditional water uses associated with coal, gas, and hydrogen-based power plants. These include plant-effluent streams and brines associated with CCS. Some of the plant effluents that might be treated consistent with the ZLD objective, as well as the environmental compliance include flue gas desulfurization wastewater, ash pond, and landfill leachate. Integrating treatment of non-traditional source waters such as brackish groundwater and water generated by municipal, mining, or agriculture operations with thermal power plants can provide additional synergies.

To learn more about NETL's Crosscutting Water Research, visit https://netl.doe.gov/coal/water-management.

Water-Energy Project Highlights

As part of its Unconventional Oil and Gas Program water activities, NETL recently awarded four research projects directed at developing efficient, low-cost treatment technologies for produced waters. These projects are highlighted below:

A New Membrane Based Treatment Process for Reclaiming and Reutilization of Produced Water – TDA Research, Inc.

The objective of this two-year project is to develop a new membrane-based filtration system for removing organic compounds from produced water. The proposed membrane treatment process integrates the new filter with a series of well-established water treatment technologies to remove all suspended and dissolved solids, organic molecules, bacteria, and radioactive particles from the produced water generated in oil and natural gas production.

Fouling-Resistant, Chlorine-Tolerant Zwitterionic Membranes for Treatment of Produced Water in the Permian Basin – ZwitterCo, Inc.

This two-year effort is directed at the development of a novel membrane technology based on zwitterionic copolymers that can provide cost-effective pretreatment for produced water and maintain immunity to detrimental and irreversible membrane fouling.

Non-Fouling, Low-Cost Electrolytic Coagulation & Disinfection for Treating Flowback and Produced Water for Reuse – University of Arizona

This two-year effort is focused on developing and testing a new method for delivering a Fe^{3+} coagulant and disinfectant for treating flowback and produced water (FPW) so that it can be reused for fracking and water-flooding at a cost savings of at least 50% compared to current practices. The treatment system will remove suspended solids, dispersed oil, H_2S, microorganisms, and scale-forming cations from FPW.

Resource Recovery and Environmental Protection in Wyoming's Greater Green River Basin Using Selective Nanostructured Membranes – University of Wyoming

This two-year project will develop a working prototype of a two-part affinity-based membrane separation process for recovering hydrocarbons and separating organics from produced water. This research effort focuses on using nanostructured membranes that take advantage of interfacial chemistry principles to reduce fouling during water filtration and selectively permeate benzene, toluene, ethylbenzene, and xylenes and oil during resource recovery.

Conferences and Events

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

AWWA Virtual Summit: Sustainable Water, PFAS, Waterborne Pathogens

Description: Explore cutting-edge ideas related to the critical water sector topics of sustainable water, PFAS, and waterborne pathogens at the American Water Works Association (AWWA) Virtual Summit. Topics will include Water Resources Planning and Management, Treatment Challenges and Solutions, and Detection and Surveillance of SARs-CoV-2.

Date: February 10–11, 2021

Locale: Virtual

Website: https://www.awwa.org/Events-Education/AWWA-Virtual-Summits/Sustainable-Water-PFAS-Waterborne-Pathogens

World Water Tech-Innovation Summit

Description: By sharing best practices from around the globe and facilitating new connection and collaborations, the World Water Tech-Innovation Summit offers an invaluable platform to accelerate the transition to a digital future for the water and wastewater sectors.

Date: February 23–24, 2021

Locale: Virtual

Website: https://worldwatertechinnovation.com

AWWA Virtual Summit: Lead & Water Quality

Description: Lead and Copper Rule requirements prompt continued action from the water sector to reduce lead exposure through drinking water. This AWWA Virtual Summit provides a holistic perspective on lead reduction actions and impacts through engaging presentation of the most relevant technical content and total water solutions.

Date: April 7–8, 2021

Locale: Virtual

Website: https://www.awwa.org/Events-Education/AWWA-Virtual-Summits/Lead-Water-Quality-Summit

2021 Virtual Joint AWRA & National Capital Annual Water Symposium

Description: TThe 2021 Virtual Joint American Water Resources Association (AWRA) and National Capital Annual Water Symposium is a two-day conference engaging cross-disciplinary interactions; all focused around the next phase of water sustainability. Special sessions will focus on the idea of circular economies, managing for the unknown such as the COVID-19 pandemic, social hydrology, environmental justice, and innovations in water resource management.

Date: April 15–16, 2021

Locale: Virtual

Website: https://www.awra.org/Members/Events_and_Education/Events/2021_Spring_NCR_Conference

Researcher Spotlight

Nicholas Siefert

Mechanical Engineer

nicholas.siefert@netl.doe.gov

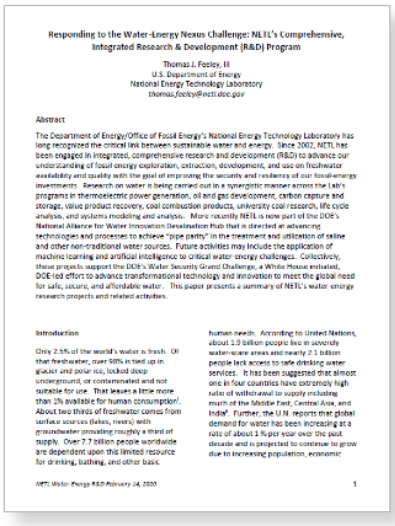
Nicholas Siefert, Ph.D. is a mechanical engineer on the Innovative Energy & Water Processes Team. He earned his doctorate in mechanical engineering from Carnegie Mellon University, master's in applied physics from Air Force Institute of Technology, and bachelor's in mechanical and aerospace engineering from Princeton University. His research interests include waste-to-energy, coal gasification with carbon capture, plasma physics, solid oxide fuel cells, and water treatment.

> *"I want to take waste streams and convert them into valuable products for other users, particularly in the water treatment areas, where eluent streams at power plants and produced water from oil and gas wells can be co-treated and converted into valuable products..."*

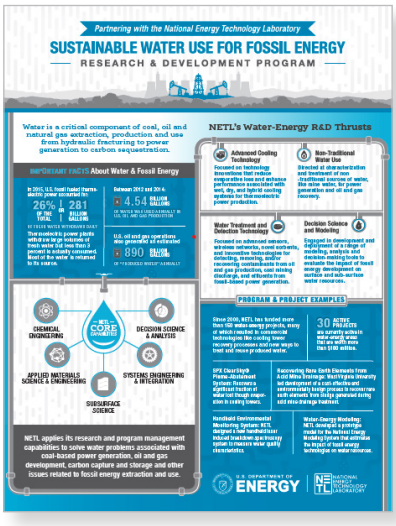
Siefert serves as an advisory for the Power Committee within NAWI's road mapping effort to determine the best ways to decrease the cost of water treatment. He also leads the in-house research at NETL in the area of water treatment at fossil power plants, which includes conducting experiment baseline testing for the FWP-1022428 Task 4 and developing novel processes for increasing the water recovery rate using reverse osmosis membranes.

Siefert has co-authored more than 35 scientific publications and holds four patents. His research includes a patent for Hydrophobic Carbon Capture Solvent (https://netl.doe.gov/node/5706), a patent for Allyl-Containing Ionic Liquid Solvents for CO_2 Capture (https://netl.doe.gov/node/386), FWP-1022428 Task 4 Concentrating Wastewater Effluent Streams (https://www.netl.doe.gov/node/9024), and Treating Effluent Streams at Coal Power Plants Using Membranes.

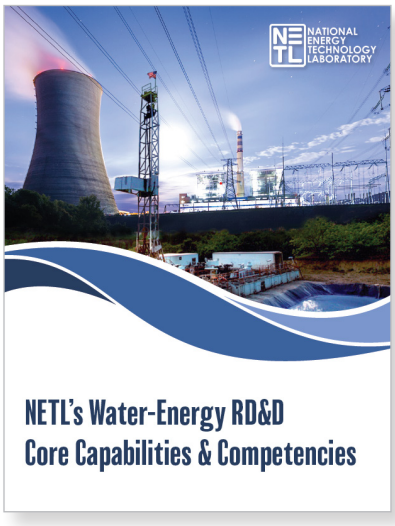
Recent Water-Related Publications and Presentations



Responding to the Water-Energy Nexus Challenge: NETL's Comprehensive, Integrated R&D Program



Sustainable Water Use for Fossil Energy: NETL's Research and Development Program (Infographic)



NETL's Water-Energy RD&D Core Capabilities & Competencies

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

Regional and Seasonal Water Stress Analysis of United States Thermoelectricity

Uisung Lee, Argonne National Laboratory (ANL); Joseph Chou, NETL; Hui Xu, ANL; Derrick Carlson, NETL; Aranya Venkatesh, NETL; Erik Shuster, Timothy J. Skone, NETL, Michael Wang, ANL. (OCTOBER 2020)

▸https://www.sciencedirect.com/science/article/pii/S0959652620322812

Utilization of Produced Water Baseline as a Groundwater Monitoring Tool at a CO_2-EOR Site in the Permian Basin, Texas, USA

James Gardiner, NETL, R. Burt Thomas, NETL Thai T. Phan, University of Waterloo, Mengling Stuckman, NETL, Jiaan Wang, Carnegie Mellon University, Mitchell Small, Carnegie Mellon University, Christina Lopano, NETL, J. Alexandra Hakala, NETL. (OCTOBER 2020)

▸https://www.sciencedirect.com/science/article/abs/pii/S0883292720301803

Techno-Economic Analysis of Converting Oil & Gas Produced Water into Valuable Resources

Madison Wenzlick and Nicholas Siefert, NETL. (MAY 2020)

▸https://www.sciencedirect.com/science/article/abs/pii/S0011916419320235

Contact Us

NETL is part of DOE's national laboratory system. NETL is a government-owned, government-operated laboratory (GOGO) 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 Cochrans 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 into the marketplace.

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

Thomas J. Feeley, III
Strategic Partnerships
Thomas.Feeley@netl.doe.gov
412-386-6134

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

U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY