NATIONAL ENERGY TECHNOLOGY LABORATORY

OCTOBER 2021

WATER-ENERGY NEXUS NEWS

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

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

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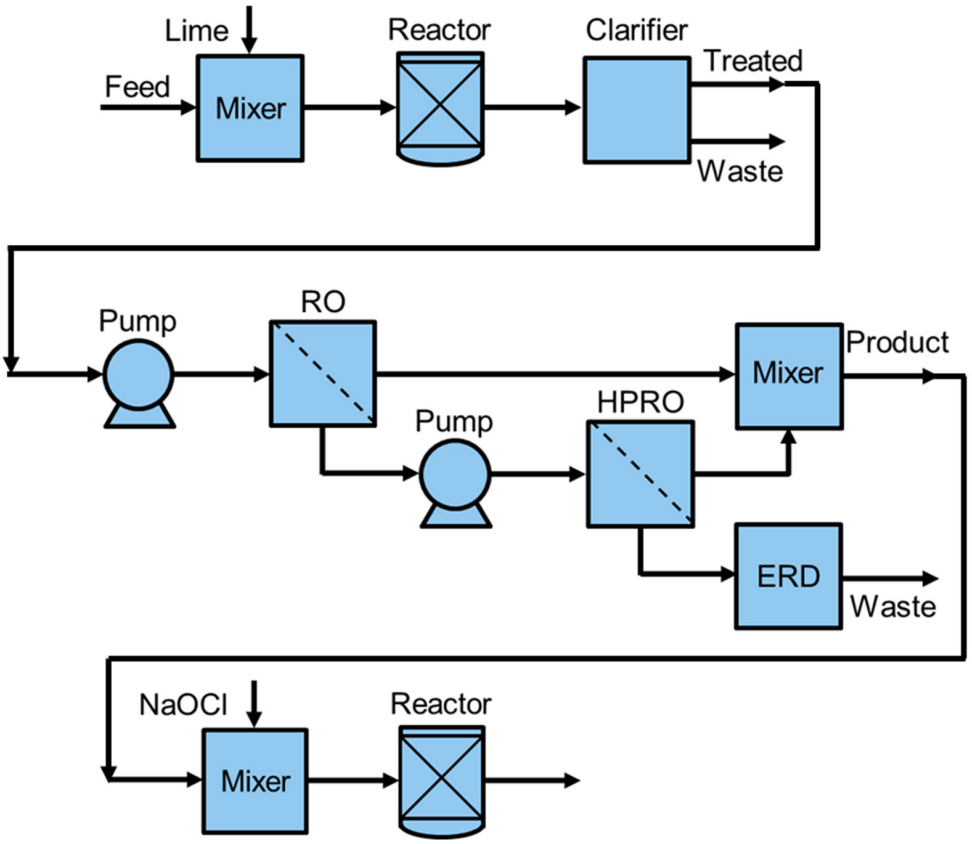
NETL's ProteusLib is Now Available to the Public

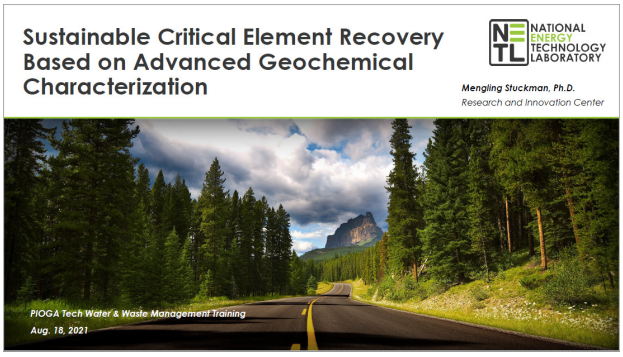
NETL continues to lead the development of NAWI's modeling and simulation tool, ProteusLib. ProteusLib is an open-source library of water treatment models built on NETL's Institute for the Design of Advanced Energy Systems (IDAES), an advanced process systems engineering platform for flowsheet-based analysis. ProteusLib is being combined with a complementary NAWI modeling project to form a single comprehensive tool coined the Water Technoeconomic Assessment Platform (Water-TAP). NETL is leading the integration and future development of the tools. ProteusLib was released to the public on Sept. 30, 2021.

To access ProteusLib, visit https://github.com/nawi-hub/proteuslib.



Example flowsheet of a full water treatment train that has been assessed using ProteusLib models and the IDAES Platform.

Highlights: NETL Presents at PIOGA's Water & Waste Management Seminar



NETL researcher Mengling Stuckman, Ph.D., presented NETL's recent critical minerals (CM) recovery research at the Pennsylvania Independent Oil and Gas Association (PIOGA) Water and Waste Management seminar Wednesday, Aug. 18, 2021 in Wexford, Pennsylvania.

Stuckman highlighted NETL's efforts to perform advanced geochemical characterization of U.S. energy production waste streams to support sustainable, domestic CM recovery. The U.S. satisfies much of its annual CM consumption by importing these materials, which are used in the manufacture of high-tech devices such as cell phones, rechargeable batteries, camera lenses, and computer hard drives. In addition, CMs are used in green energy technology and medical devices such as portable x-ray machines, nuclear medicine imaging, wind turbines, and hybrid automobiles. By creating a sustainable domestic CM supply chain, the nation could reduce its risk of supply disruption for essential domestic industries, while producing needed materials for the emerging clean energy technology market.

At NETL's Research Innovation Center (RIC), the geochemistry group performs advanced characterization including sequential extraction and elemental mapping to identify hosting phases of CM of solid wastes and waste waters from energy industries. Such information will inform the innovative and sustainable recovery of CM from the energy wastes. Examples include elemental mapping and sequential extraction enabled the targeted recovery of rare earth elements (REE) and other CM from coal by-products such as coal ash and acid mine drainage (AMD) treatment solids using significantly reduced chemicals, sequential extractions demonstrated the possibility of converting drill cuttings from shale gas extractions to soil carbon amendments and the potential as mining sources for CM, and produced water geochemical analysis revealed the potential to recover lithium and other CM from produced water in selected oil and gas extractions.

PIOGA Pennsylvania Independent Oil & Gas Association PIOGATech PIOGA's Technical Seminar Series

PIOGA, historically the principal nonprofit trade association representing Pennsylvania's independent crude oil and natural gas producers, marketers, service companies, and related businesses, continues to expand its focus as it embraces the entire oil and gas spectrum, from upstream through midstream and downstream entities. The PIOGATech Water and Waste Management seminar offers NETL the opportunity to present a technical presentation, regulatory update, academia, legal, and/or other water and wastewater updates that impact the conventional and unconventional natural gas industry.

For an overview presentation on NETL's CM recovery research, click here.

For more information on PIOGA, visit https://pioga.org.

Highlights: NETL's Sorbent Technology Wins a 2021 R&D 100 Award

The NETL research team behind the development of multi-functional sorbent technology (MUST) was awarded a prestigious 2021 R&D 100 Award in the Mechanical/Materials category. MUST is a low-cost revolutionary sorbent innovation that can successfully remove difficult to extract heavy metals and CM from wastewater, contaminated waterways, and electronic and pharmaceutical production processes.

The development of MUST stems from an earlier research completed at NETL. Patented in 2014, NETL championed the development of basic immobilized amine silica formations to sort gases and capture carbon dioxide (CO_2) from power plant emissions. Recognizing the implications for other essential functions, the team adapted the technology to create a product that can remove heavy metals and REE from water. The technology was also adapted to treat municipal drinking water and industrial wastewater on a large scale.

Unlike other technologies, MUST does not require water or other solvents to remove metals. MUST is proficient at removing toxic heavy metals classified by the U.S. Resource Conservation and Recovery Act such as arsenic, cadmium, chromium, lead, mercury, and selenium simultaneously from industrial wastewater streams.

NETL researchers have partnered with Dow Chemical Company to use MUST to remove trace metal ions that can negatively impact the performance and quality of electronic products and others that can lead to potential toxicity issues. Under a licensing agreement with Somerset International Inc., MUST will be developed to adsorb some or all of the contaminants from AMD that flows from abandoned and working mining operations.

For more information on the 2021 R&D 100 Award winners, visit https://www.rdworldonline.com/2021-rd-100-award-winners-announced-in-mechanical-materials-category.

Highlights: DOE Announces $5 million Federal Funding in Desalination Technologies

In July 2021, DOE and NAWI announced $5 million in federal funding to develop desalination technologies that will help bring freshwater supplies to communities across the nation. The funding will support early stage applied research on state-of-the-art, next generation technology desalination systems collaborative teams of industry, labs, and universities that treat non-traditional water sources.

Six projects were selected to address the challenges of managing concentrated brine waste streams that are a by-product of the desalination process. Led by the SLAC National Accelerator Laboratory, NETL is one of the team members selected to participate in a project to create a software program to better predict kinetic induction times which may improve capability of brine concentrators to operate at the edge of scale formation. Other industry team members include Veolia Water Technologies and OLI Systems, Inc.

The other five winning projects include:

- Stanford University (lead), SLAC National Accelerator Laboratory, Aqua membranes, Inc., and Cascade Technologies, Inc: This project will improve energy efficiency and reduce the risk of mineral scaling on membrane surfaces.
- Vanderbilt University (lead), Colorado State University, and Black & Veatch: This project will investigate a new brine crystallization process that will improve energy efficiency and reduce the total cost of crystallization.
- Idaho National Laboratory (lead), Massachusetts Institute of Technology, Trevi Systems, and USG Corporation: This project will use of dimethyl ether (DME)-Driven Zero Liquid Discharge (ZLD) desalination potentially reducing ZLD costs 50% relative to state-of-the-art crystallizers.
- The University of Connecticut (lead), Sandia National Laboratories, and Modelon, Inc.: This project will develop a new software toolset for the design and optimization of brine treatment processes.
- Yale University (lead), Oak Ridge National Laboratory, Electric Power Research Institute, and Saltworks Technologies: This project will develop new and improved antiscalants to prevent equipment scaling and improve the efficiency of brine concentrators.

Following the project selection announcement, OLI Systems, Inc., in collaboration with NETL, SLAC National Accelerator Laboratory, and Veolia Water Technologies hosted a webinar on their electrolyte model and its application to mineral scaling in complex systems titled “Rigorous and Accurate Electrolyte Simulation for Industrial Water and Wastewater Treatment” in September 2021. Practical applications of the OLI software to simulate water and wastewater applications were demonstrated and case studies for mineral scaling were reviewed.

For more information on the DOE announcement, visit https://www.energy.gov/eere/articles/department-energy-invests-5-million-desalination-technology-deliver-freshwater.

For more information on NAWI, visit https://www.nawihub.org.

Highlights: ORISE Fellow Participates in NETL's FWP to Study Wastewater Treatments

Flue gas desulfurization (FGD) systems play an important role in mitigating air pollution caused by coal-fired power plants. These systems are used to scrub the gas released during coal combustion to mitigate the release of pollutants such as sulfur oxide gasses and mercury into the atmosphere. As a result of scrubbing, a complex wastewater containing a number of contaminants is formed that must be managed.

Preom Sarkar, an Oak Ridge Institute for Science and Education (ORISE) fellow, was part of the geomicrobiology and geochemistry group at NETL in Pittsburgh, PA. Under the guidance of her mentor, Djuna Gulliver, Ph.D., Sarkar conducted research on water management of power systems, with a specific focus on biological treatment of FGD systems.

The study was part of a Field Work Proposal (FWP) through NETL's Water Management Program, titled Water Management for Power Systems (FWP-1022428). The work proposed aligns with the Office of Fossil Energy and Carbon Management's (FECM) Water Management program goals, with particular emphasis on addressing water issues faced by the existing fleet of coal-fired power plants.

Sarkar was specifically supporting Gulliver's research on Biological Treatment of FGD Effluent Streams (FWP-1022428 Task 6), where Gulliver is listed as the task Principal Investigator. The research goals of this project were to enrich, identify, and characterize the anaerobic microorganisms native to FGD wastewater with the ability to utilize soluble selenium species and bio-transform to insoluble elemental selenium. Knowing more about these organisms can lead to an optimization of biological treatment systems for selenium contamination removal.

Sarkar is currently pursuing her doctoral degree in environmental engineering at Carnegie Mellon University. After graduation, she hopes to either continue doing meaningful and impactful work for the government or pursue an industry career that allows her to make a positive difference in the world.

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Shaping the Future of Science

Administered by ORISE, the NETL Internship Programs offer opportunities to participate in energy-related research through three competitive internships and research fellowship programs. These programs include the Professional Internship Program (PIP), the Post Graduate Research Program (PGRP), and the Faculty Research Program (FRP). To complement NETL's mission, these educational programs ensure that future energy challenges can be overcome, and energy opportunities are realized.

To learn more about Sarkar's research, click here.

For more information on NETL's Internship Programs, visit https://netl.doe.gov/education/internships.

Conferences and Events

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

International Water Conference (IWC)

Description: The IWC presents the latest in scientific advances and practical applications in this field, cutting across a wide range of industries, technologies and functional areas. IWC is dedicated to advancing new developments in the treatment, use and reuse of water for industrial and other engineering purposes. Attendees come to learn unbiased details about the latest applications available in the industry, get educated on current technology and hold wide ranging discussions with their peers active in water treatment.

Date: Nov. 7–11, 2021

Locale: Scottsdale, AZ

Website: https://eswp.com/water/overview

2021 Virtual Annual Water Resources Conference

Description: One of the most diverse and inclusive conferences in water resources management, Annual Water Resources Association provides you with innovative, practical, and applied water resource management solutions, management techniques, and current research. Attendees can expect to hear lessons learned from the implementation of multidisciplinary projects, best practices discovered in the design and application of water resource management, implications of water policy decisions, and research into current and emerging issues.

Date: Nov. 8–10, 2021

Locale: Virtual

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

Massachusetts Institute of Technology (MIT) Water Summit

Description: This year's MIT Water Summit will focus on the role of water in building resilient systems for the future as we face a changing climate and an increasing population. With an emphasis on the water lens, it will examine the systemic problems exposed by the COVID-19 pandemic and explore approaches to creating more robust and sustainable technology, infrastructure, and policy to solve these issues. The MIT Water Summit is a three-day conference hosted annually by the MIT Water Club, bringing together global leaders and professionals.

Date: Nov. 15–16, 2021

Locale: Cambridge, MA

Website: http://www.mitwatersummit.com

Association of California Water Agencies (ACWA) 2021 Fall Conference & Exhibition

Description: ACWA conferences are the premier destination for water industry professionals to learn and connect. Program offerings include statewide issue forums, roundtable talks, and region discussions along with sessions covering a wide range of topics including water management, crisis communications, affordable drinking water issues, energy, finance, federal forum, and more!

Date: Nov. 30–Dec. 2, 2021

Locale: Pasadena, CA + Virtual

Website: https://www.acwa.com/events/2021-fall-conference-exhibition

Water-Energy Project Highlights

The U.S. DOE's FECM announced $5 million in federal funding to investigate hydrogen production, water-energy nexus, materials supply chain, and 5G wireless technologies. The three areas of interest (AOI) selected for the funding are AOI 1A: Energy-Water Nexus Implications and Opportunities of a Hydrogen Economy, AOI 1B: Electromagnetic Energy-Assisted Approaches to Convert Fossil Fuels to Low-Cost Hydrogen, AOI 2: Addressing High-Temperature Materials Supply Chain Challenges, and AOI 3: 5G for Fossil-Fired Power Generation.

Among 13 total projects, one water-energy nexus project was selected to receive the funding. This project is managed through the NETL's University Training and Research (UTR) program.

The project is described below:

Fossil Energy in the Hydrogen Economy - A Carbon-Water-Energy Nexus Adaptive Evaluation Platform — Florida A&M University (Tallahassee, FL)

Agreement Number: FE0032084

Project Duration: July 2021–July 2023

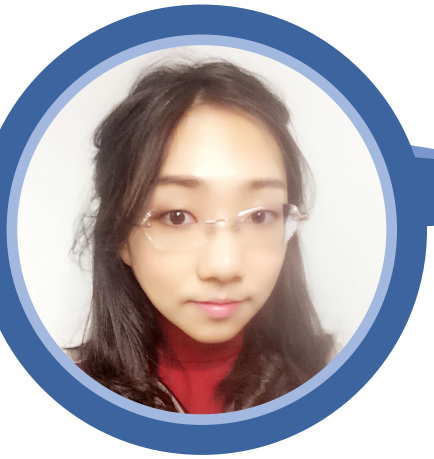
Overview: This project aims to support the efficient and environmentally sound integration of fossil fuels into the hydrogen economy as a complement to renewable energy resources penetration.

Objective: The primary objectives of the proposed work are to: 1) survey and document the current technologies that enable the integration of fossil fuels into the hydrogen economy, including hydrogen production, transportation, storage and use, with an emphasis on tracking their potential for carbon neutrality, the intensity of water usage, and strategies to mitigate the energy-water-CO_2 nexus; and 2) to develop tools to assist the planning and decision making process at regional and national levels regarding the insertion and adoption of technologies for fossil energy-derived hydrogen with reference to their water intensity, life-cycle cost, greenhouse gases, and energy efficiency.

To learn more about NETL's University Training and Research program, visit https://netl.doe.gov/coal/university-training.

For more information on the FOA, visit https://www.energy.gov/fe/office-fossil-energy or click here.

Researcher Spotlight



Mengling Stuckman

Environmental Scientist/Geochemist
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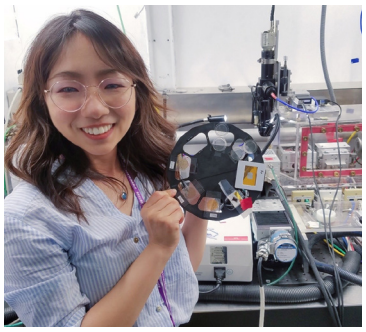
Mengling Stuckman, Ph.D. is a site-support contractor supporting the Research & Innovation Center's Geological and Environmental Systems Team. She has more than 15 years of experience in providing interdisciplinary scientific insights and eco-friendly cost-saving solutions to emerging problems impacting the sustainability of energy and environmental systems. With eight years of experience at DOE-NETL, Stuckman is an expert in innovating sustainable rare earth elements and critical mineral (REE/CM) extractions from domestic sources and in initiating and implementing challenging environmental and geochemical studies for complex energy systems such as coal, oil and gas, and carbon storage.



Stuckman completed her Ph.D. in Environmental Science and dual M.S. in Environmental Science and Civil Engineering from the Ohio State University (OSU). She attended the Wuhan University for her B.S. in Environmental Science. She is an active member of PIOGA and has recently been invited to give a talk in PIOGA water and waste seminar in August 2021. Stuckman used to be an active student member of the American Water Works Association (AWWA) and the Water Environment Federation (WEF) as secretary of their student chapter at OSU, and as several-time winners of student competitions and student scholarships.

> *"My research will fill an important gap in providing sustainable domestic supply of critical minerals that are essential for national economy and security. The innovations we are developing will also provide a potential revenue stream to offset the cost of wastewater treatments while reducing the environmental footprint of critical mineral extraction."*

Stuckman has co-authored and published 21 publications, one patent, and two in-application patents. Her publications include: Utilization of Produced Water Baseline as a Groundwater Monitoring Tool at a CO_2-EOR Site in the Permian Basin, Texas, USA; Geochemistry and Microbiology Predict Environmental Niches with Conditions Favoring Potential Microbial Activity in the Bakken Shale; The Evaluation of Critical Rare Earth Element (REE) Enriched Treatment Solids From Coal Mine Drainage Passive Treatment Systems; Effect of Maturity and Mineralogy on Fluid-Rock Reactions in the Marcellus Shale; and Biotic Arsenic Release from Spent Adsorbents Under Anaerobic Landfill Conditions.

Recent Water-Related Publications and Presentations

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

Effect of Thickness on Degradation of Austenitic 347H Steel by Direct-Fired Supercritical CO_2 Power Cycle Environment

Sajedur R. Akanda, ORISE/NETL; Richard P. Oleksak, Leidos/NETL; Reyixiati Repukaiti, ORISE/NETL; Kyle A. Rozman, Leidos/NETL; Ömer N. Doğan, NETL (NOVEMBER 2021)

▸ https://www.sciencedirect.com/science/article/abs/pii/S0010938X21005618

Creep of MARBN-type 9Cr Martensitic Steel in Gaseous CO_2 Environment

Kyle A. Rozman, Leidos/NETL; Richard P. Oleksak Leidos/NETL; Ömer N. Doğan, NETL; Martin Detrois, NETL; Paul D. Jablonski, NETL; Jeffrey A. Hawk, NETL (OCTOBER 2021)

▸ https://www.sciencedirect.com/science/article/abs/pii/S0921509321012612

Baseline Data for Spill Assessments: Ambient Conditions, Socioeconomic Data, Sensitivity Maps

Lucy Romeo, Leidos/NETL; Patrick Wingo, Leidos/NETL; Michael Sabbatino, Leidos/NETL; Jennifer Bauer, NETL (SEPTEMBER 2021)

▸ https://www.sciencedirect.com/science/article/pii/B9780128193549000077

Hydraulic Fracturing Geochemical Impact on Fluid Chemistry: Comparing Wolfcamp Shale and Marcellus Shale

Wei Xiong, NETL; Johnathan Moore, NETL; Dustin Crandall, NETL; Christina Lopano, NETL; Alexandra Hakala, NETL (JULY 2021)

▸ https://onepetro.org/URTECONF/proceedings-abstract/21URTC/1-21URTC/D011S011R002/465399

Investigation of Reactivities of Bimetallic Cu-Fe Oxygen Carriers with Coal in High Temperature In-Situ Gasification Chemical-Looping Combustion (iG-CLC) and Chemical-Looping with Oxygen Uncoupling (CLOU) Using a Fixed Bed Reactor

Ping Wang, NETL; Bret Howard, NETL; Nicholas Means, Leidos/NETL (FEBRUARY 2021)

▸ https://www.sciencedirect.com/science/article/abs/pii/S0016236120320081

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.

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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:

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

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