NATIONAL ENERGY TECHNOLOGY LABORATORY

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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

IN THIS ISSUE

NETL's NEWTS Launches Tool and Website for Data Sharing

The National Effluent for Water Treatment and Speciation (NEWTS) Database is housed under the National Energy Technology Laboratory (NETL) Water Management Program. The NEWTS team includes Nicholas Siefert, Randal "Burt" Thomas, Jen Bauer, Madison Wenzlick, Zineb Belarbi, Lucy Romeo, Justin Mackey, Izzy Pfander, Michael Sabbatino, Kathryn Smith, Sophia Bauer, and Devin Justman, and is funded by the Water Management for Power Systems field work proposal (FWP) with U.S. Department of Energy (DOE) Office of Fossil Energy and Carbon Management (FECM) Program Manager Hichem Hadjeres.

The overarching goal of the NEWTS Database effort is to help researchers and community members understand the composition and location of energy-related wastewater streams, including power plant leachate, acid mine drainage waste, brackish water, and oil and produced water, to ascertain where environmental risks may be, and to also understand the value in the water, such as the presence of critical minerals. Once communities have this information, they have opportunities to potentially leverage the value from the waste streams and to also treat water systems as needed. To that end, the NEWTS team has two main objectives: 1) release high-quality datasets of water compositions in formats easy to enter into software for modeling treatment, and 2) create a visualization tool for a large number of datasets. The NEWTS website is the first step in addressing a challenging data gap, and this work is part of NETL's larger effort to obtain datasets for quantifying water quality and volume data related to energy processes across the United States. Data in these streams are managed by state and federal regulators and are often difficult to find and analyze. Therefore, the NEWTS database will improve ease of access for understanding what is in these water streams and will ultimately enable improved water management decisions.

The NEWTS team released the first series of data on Sept. 30, 2022, which included three large datasets with flue gas desulfurization (FGD) power plant effluent, brackish water, and produced water compositions in formats that are easy to enter into commercial software such as OLI Studio and Geochemist Workbench. In the first data release, compositions from >4,000 FGD power plant effluent streams, >15,000 of the most complete and highest salinity brackish waters, and >15,000 of the most complete and high salinity produced water compositions were released in the format and speciation necessary for easy input into aqueous chemistry modeling software. Future releases will include additional datasets with large sets of energy-related water streams and accompanying compositions of all major and most minor species.

The datasets were released in spreadsheet (.xlsx/.csv) format on NETL's EDX website. Blank templates files (.oli and .gss) were also uploaded to the website. The NEWTS team released a video showing water researchers how to download the data and how to easily copy data into the .oli and .gss template files. The video highlights caveats and assumptions, such as how the team assigned species (e.g., SeO_4^{2-} when the original measurement might have been of the element, Se).

In the next steps of the project, the NEWTS team will continue to update the available datasets and will release data on its interactive ArcGIS-based web platform, which allows users to search through the data in the Excel files. For more information, please visit the NEWTS website here.

Highlights: WaterTAP Adds More Water Treatment Modeling Capabilities

NAWI National Alliance for Water Innovation

The Water treatment Technoeconomic Assessment Platform (WaterTAP) is an open-source Python-based software tool for assessing the performance and economic viability of water treatment trains. The tool development began in July 2020 and is led by researchers at NETL in collaboration with other national labs including Lawrence Berkeley National Laboratory (LBNL), National Renewable Energy Laboratory, and Oak Ridge National Laboratory. The work is funded under two sources: 1) DOE's desalination hub – the National Alliance for Water Innovation (NAWI), and 2) DOE FOA-0002336 – Research and Development for Advanced Water Resource Recovery Systems.

In addition to supporting the research and development (R&D) portfolios of the two funding sources, WaterTAP seeks to provide a unified, flexible, and powerful platform to the broader water research for modeling and simulating conventional and emerging water treatment technologies. WaterTAP comprises a modular model library that is based on NETL's Institute for the Design of Advanced Energy Systems (IDAES) platform. WaterTAP is updated and released quarterly; the most recent release in September 2022 included refined modeling capabilities for membrane, evaporative, adsorption, and electrochemical processes. The release also included a limited graphical user interface that was designed so that external collaborators without a background in Python coding could analyze systems built by the development team.

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

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

Highlights: Awards and Recognition

NETL's PARETO Wins 2022 Meritorious Award for Engineering Innovation

DOE's produced water optimization program—Produced Water Application for Beneficial Reuse, Environmental Impact and Treatment Optimization (PARETO)—developed by NETL and LBNL, was named a winner in Hart Energy's 2022 Special Meritorious Awards for Engineering Innovation for its water management capabilities. For more information, please click here.

TREE Process Named Finalist for 2022 R&D 100 Award

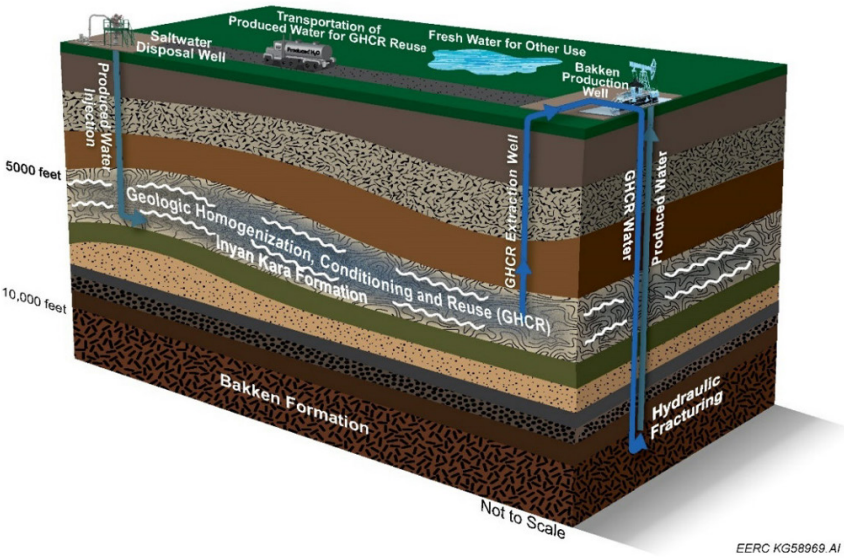
NETL's Targeted Rare Earth Extraction (TREE) process, an environmentally friendly and cost-effective technology to extract rare earth elements and critical minerals from a broad range of coal and coal-processing materials and waste streams, was named a finalist in the Process/Prototyping category. The TREE process was also nominated for the 2022 Carnegie Science Awards. For more information, please click here.

Highlights: NETL-Funded Project Among Finalists in 2022 IChemE Global Awards

The University of North Dakota's Energy & Environmental Research Center's (EERC) Produced Water Management Through Geologic Homogenization, Conditioning, and Reuse (GHCR) project—funded by NETL and developed in partnership with the North Dakota Industrial Commission Oil and Gas Research Program (OGRP) and Nuverra Environmental Solutions—is a finalist in the Oil and Gas category of the 2022 Institution of Chemical Engineers (IChemE) Global Awards.

The GHCR concept offers a novel approach to the recycling of produced water from oil and gas extraction, particularly in the Bakken region of North Dakota. With demand for water used by the energy industries expected to double in the coming years, its careful management is essential to ensuring that local communities have adequate clean water supplies. In the GHCR process, produced water is reinjected into the subsurface where it takes advantage of the natural filtration and biogenic activity of geological strata to remove contaminants including suspended solids and organics. Laboratory column testing and field sample collection indicate that North Dakota Inyan Kara sandstone and native formation fluid are capable of treating, stabilizing, and homogenizing produced water to a point where it can be recycled and reused.

The potential benefits of the GHCR process over conventional produced water management are many. Reusing the treated water relieves formation pressure, allowing for new Bakken oil wells to be drilled more economically. Further, GHCR fluid extraction extends the life of saltwater disposal (SWD) wells, which is the traditional approach of managing produced water and minimizes the need for new SWD wells. The GHCR concept eliminates the need for surface storage of produced water, while utilizing existing infrastructure (pipelines and wells). Moreover, the GHCR concept nearly eliminates the need to manage the highly concentrated brines and naturally occurring radioactive materials typically associated with produced water treatment and reuse. Finally, the recycled water can be reused in hydraulic fracturing completion operations to reduce the oil and gas industry's demand on freshwater.



GHCR concept involves adding an extraction well and utilizing that water as hydraulic fracturing makeup water for Bakken wells. Used with permission from EERC

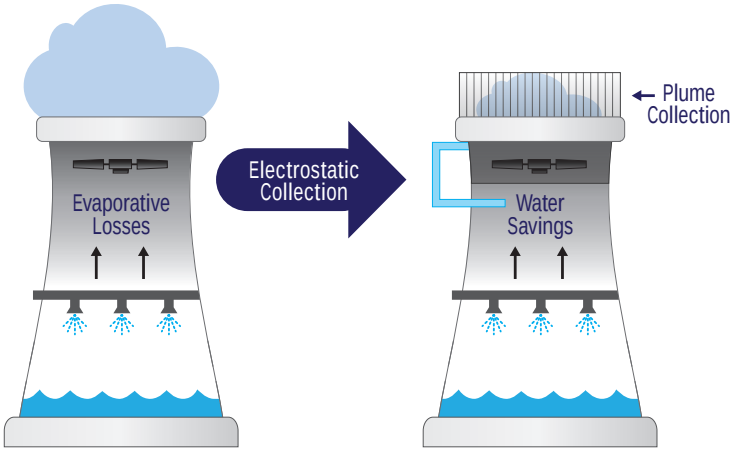
A field evaluation of the GHCR process was conducted at the Brine Extraction Storage Test (BEST) facility located in Waterford, North Dakota. The BEST facility is an NETL-funded testing site in the Bakken oil and gas fields managed and operated by EERC.

The NETL team that coordinated with EERC and OGRP includes Kyle Glazewski, Brent Brannon, Kirk Johnson, and NETL project manager Joseph Renk. The IChemE Global Awards 2022 winners will be announced in Manchester, United Kingdom, on Nov. 17, 2022. Congratulations to the team for the recognition of this nomination! For more information about the project, please click here.

Water-Energy Project Highlights

NETL Supports Startup Technology to Produce Clean Water from Cooling Tower Plumes as it Prepares for Pilot-Scale Testing

As part of NETL's continued efforts directed at the water-energy nexus, the laboratory is supporting an award-winning startup company to help develop a novel power plant technology that can produce clean water from cooling tower plumes. The technology could significantly reduce water consumption in evaporative cooling tower systems by capturing water from cooling tower plumes, which are formed when water vapor generated in cooling towers mixes with colder ambient air as it leaves the tower and condenses.



Infinite Cooling's WaterPanel technology produces clean water from cooling tower plumes. Image recreated with permission from Infinite Cooling

Power plants are particularly water intensive and cooling towers are the most common cooling system. Infinite Cooling, a Somerville, Massachusetts, startup company, proposed a novel technology that produces clean water from cooling tower recirculating water by using the evaporation/condensation cycle that naturally takes place in cooling towers.

This is one of several advanced cooling technologies that NETL has sponsored to reduce water demand from the power generation sector. For example, the ClearSky® Plume Abatement System developed by SPX Cooling Technologies in partnership with NETL is a commercial technology that minimizes cooling plumes and reduces evaporative water loss.

With a $1.1 million DOE cooperative agreement support from NETL, Infinite Cooling is set to accelerate the commercialization of the technology from its current lab-scale prototype status to a full-scale prototype on the Fox Energy Center, a large natural gas-fired power plant in Kaukauna, Wisconsin. Testing operations resulting from the project will quantify system performance for water production rates and water quality, assess system durability, and lead to next steps for technology maturation and commercialization.

As of October 2022, Infinite Cooling has selected contractors to perform evaluation and design of load transfer and structural connections necessary for pilot-scale installation of their plume capture technology, WaterPanel. They will also draft a request for proposal to select a potential partner to install the load transfer and structural connections. Fabrication of WaterPanel components will begin in February 2023. Infinite Cooling is ordering sub-assemblies that have longer lead-times in hopes they will be ready prior to the start of manufacturing in February 2023. The company is also finalizing an installation plan for electrical, communications, and data acquisitions components. The current pilot installation timeline at the partner plant is May/June 2023.

For more information about this project, please click here.

Conferences and Events

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

The International Water Conference® (IWC)

Description: The IWC is a yearly educational conference presenting the latest in scientific advances and practical applications in the water field, cutting across a wide range of industries, technologies, and functional areas. As the preeminent international technical forum in the field, the IWC brings together end users, researchers, practicing engineers, managers, educators, suppliers, and contractors. It is dedicated to advancing new developments in the treatment, use, and reuse of water for industrial and other engineering purposes.

Date: Nov. 6–10, 2022

Location: Orlando, Florida

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

Water-Energy-Food (WEF) Nexus Symposium

Description: The aim of the WEF symposium is to provide a comprehensive overview of state-of-the-art WEF research, along with gaps and advances in WEF research. Well-known keynotes and prominent early-career scientists have been invited to cover a wide range of topics including water and energy footprints, the role of forests and food waste, governance, and more.

Date: Nov. 7, 2022

Location: Virtual

Website: https://www.water-energy-food.org//events/symposium-water-energy-food-nexus-symposium-of-the-state-of-the-art-gaps-and-advances-in-wef-research

America Water Resources Association (AWRA) 2022 Annual Water Resources Conference

Description: AWRA's Annual Water Resources Conference provides 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. 7–9, 2022

Location: Seattle, Washington

Website: https://www.awra.org/Members/Events_and_Education/Events/2022_Annual_Conference/2022_AC.aspx

2022 Association of California Water Agencies (ACWA) Fall Conference and 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, innovation, public communication, affordable drinking water, energy, finance, federal forum, and more.

Date: Nov. 29–Dec. 1, 2022

Location: Indian Wells, California

Website: https://www.acwa.com/events/2022-fall-conference-exhibition/

Researcher Spotlight

Hichem Hadjeres

Program Manager

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Hichem Hadjeres is the program manager for Advanced Remediation Technologies Division (ART)-Water Management (WM). During the summer, DOE FECM integrated the produced water (PW) management R&D activities (originally housed within NETL Oil & Gas upstream research) with the Water Management for Power Systems Program (operated under NETL's Crosscutting Research Program). These joined programs are now based in ART. Hadjeres led the reorganization of the FECM water programs.

Throughout his career, Hadjeres has taken a multidimensional approach toward the water-energy nexus that lies at the intersection of scientific R&D, innovation and emerging technologies, business management and strategy, and public policy. Hadjeres brings these perspectives to ART-WM and is working with the ART-WM team to transfer best management practices and technological innovations from other industries and apply them to the ART-WM R&D portfolio. This has resulted in the development of several novel FWPs on advanced treatment processes, biological and chemical characterization, and advanced computing systems and big data. The program is also researching advanced machine-learning platforms that automate time-intensive tasks and perform high-computational analysis to assist on water effluent and water-energy infrastructure data.

Previously, Hadjeres was the project coordinator for the Water Management for Power Systems Program and served as the founder and project lead for several water-energy management projects at DOE. He is an active member in several DOE and federal agency-wide working groups, including the Nexus of Energy and Water for Sustainability Research, Development, and Demonstration (RD&D) Interagency Working Group, and was a founder of the FECM Artificial Intelligence Community of Interest. He is also a member of the New Mexico Produced Water Consortium and Texas Water Initiative.

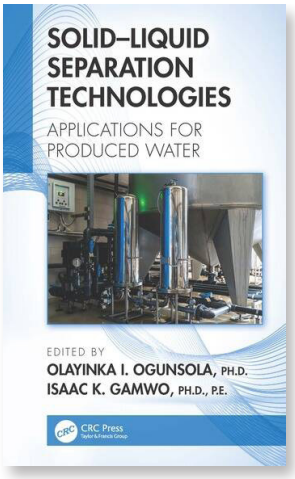
Before beginning his career at DOE, Hadjeres was active in the water innovation space in the Boston area as a research scientist and is a founder of the New England Water Environment Association's Innovation Committee. As an international clean-tech entrepreneur and company co-founder, he used his experience in business and water management to advise several water-tech startups on new product development and market entry and served as a lead mentor for the Massachusetts Institute of Technology Water Innovation Prize. He is equally passionate about youth development and served in various capacities as a youth mentor and program developer on the east coast and overseas.

Hadjeres holds a Master of Science degree in Hydrology from the University of Rhode Island, a Bachelor of Arts degree in Geosciences with a minor in economics from Wesleyan University, and a certificate in machine learning from Cornell University. His publications include Nitrosamines: A review of formation pathways, precursors, control, and occurrence in drinking water; The Case for LED-UVC as a Primary Disinfectant for Small Sustainable Drinking Water Systems; and Pulse UV light effect on microbial biomolecules and organic pollutants degradation in aqueous solutions.

Publications and Presentations

Below are several water-related publications and presentations authored or co-authored by NETL staff.

Solid–Liquid Separation Technologies: Applications for Produced Water



Edited By Olayinka I. Ogunsola, DOE; Isaac K. Gamwo, NETL (APRIL 2022)

https://www.routledge.com/SolidLiquid-Separation-Technologies-Applications-for-Produced-Water/Ogunsola-Gamwo/p/book/9780367893286

- Chapter 1: Produced Water Treatment Technologies: An Overview
- Chapter 3: Standard Water Treatment Techniques and their Applicability to Oil & Gas Produced Brines of Varied Compositions
- Chapter 6: Solid–Liquid Separation Technologies: Applications for Produced Water
- Chapter 11: Influence of Colloids on Mineralization in Unconventional Oil and Gas Reservoirs and Wellbores: A Case Study with the Marcellus Shale

Physical solvents and techno-economic analysis for pre-combustion CO_2 capture: A review

Kathryn H. Smith, NETL & Carbon Capture Scientific; Husain E. Ashkanani, University of Pittsburgh (Pitt) & Kuwait University; Badie I. Morsi, NETL & Pitt; Nicholas S. Siefert, NETL (JULY 2022)

- https://www.sciencedirect.com/science/article/abs/pii/S1750583622001128?via%3Dihub

Historic Submarine Landslides in the Northern Gulf of Mexico

Alec Dyer, NETL; Scott Pantaleone, NETL; MacKenzie Mark-Moser, NETL; Andrew Bean, NETL; Paige Morkner, NETL; Samuel Walker, Idaho National Laboratory; Jennifer Bauer, NETL (AUG. 2022)

- https://www.osti.gov/biblio/1879673

Multiphysics Simulation of Supercritical CO_2 Gasification for Hydrogen Production

Alexander Prlina, University of Utah; Eric Eddings, University of Utah; Ronald Breault, NETL, presented at the 46th International Technical Conference on Clean Energy (AUG. 2022)

- https://www.osti.gov/biblio/1877662

Publications and Presentations *(Continued)*

2022 Carbon Management Project Review Meeting

Aug. 15–19, 2022, Pittsburgh, Pennsylvania

A selection of water-energy presentations from approximatively 200 presentations given at NETL's 2022 Carbon Management Project Review Meeting. For the complete conference proceedings, please click here.

- **Developing and Validating Pressure Management and Plume Control Strategies in the Williston Basin Through a Brine Extraction and Storage Test (BEST) (FE0026160)**
  Ryan Klapperich and John Hamling, University of North Dakota EERC
  ▸ https://netl.doe.gov/sites/default/files/netl-file/22CM_CTS16_Hamling.pdf

- **Phase II Field Demonstration at Plant Smith Generating Station Assessment of Opportunities for Optimal Reservoir Pressure Control, Plume Management and Produced Water (FE0026140)**
  David Alumbaugh, LBNL; Robert Trautz, Electric Power Research Institute
  ▸ https://netl.doe.gov/sites/default/files/netl-file/22CM_CTS16_Trautz.pdf

- **A Combined Water and CO_2 Direct Air Capture System (FE0031970)**
  Will Kain, IWVC, LLC
  ▸ https://netl.doe.gov/sites/default/files/netl-file/22CM_CDR16_Kain.pdf

- **Numerical Simulation of Commercial-Scale CO_2 Storage in a Saline Formation Evaluating Basin-Scale Pressure Interference and CO_2 Plume Commingling (FWP-1022464)**
  Nur Wijaya, NETL; David Morgan, NETL; Derek Vikara, NETL; Timothy Grant, NETL
  ▸ https://netl.doe.gov/sites/default/files/netl-file/22CM_CTS17_Wijaya.pdf

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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:

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

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