## NETL 25th Anniversary Celebration

Thursday, December 5, 2024, 1:00 pm – 2:40 pm
Morgantown, West Virginia

# LABORATORY TOUR AGENDA

| Time | Tour Stop | Speaker | Location |
|---|---|---|---|
| 1:00 pm | **Research & Innovation Center Safety Briefing** | | B26-G51 |
| 1:10 pm | **High Efficiency Hybrid Power Systems** | Dave Tucker | Hybrid Performance Project, B4 |
| 1:25 pm | **Gasification for Clean Power Generation and $H_2$ Production / Oxygen Carrier and Catalyst Development** | Justin Weber, Ranjani Siriwardane | Chemical Looping Reactor Project, B4 |
| 1:40 pm | **High-Temperature Fuel Cell and Electrolyzer Development** | Harry Abernathy | DOE Fuel Cell Test Facility, B4 |
| 1:55 pm | **CT Scanning Lab** *(includes presenting Joule on the way to lab)* | Dustin Crandall | Nondestructive CT Imaging Laboratory, B17 |
| 2:10 pm | **Reaction Analysis and Chemical Transformation (ReACT) Facility** | Christina Wildfire | ReACT Facility, B14 |
| 2:25 pm | **Innovative Energy Systems: High-Pressure, High-Temperature Combustion Systems** | Pete Strakey | Heat Exchange and Experimental Testing Laboratory, B6* |

**Controlled Lab*

# TOUR STOP DESCRIPTIONS

**High Efficiency Hybrid Power Systems**
The Hybrid Performance (Hyper) Facility features the only hardware-based cyber-physical simulation of an advanced hybrid power system anywhere in the world. This one-of-a-kind facility is currently being used to develop control strategies and explore operating flexibilities for the reliable coupling of fuel cell and gas turbine technologies. The Hyper facility is also used for controls research. Evaluation of complex, next-generation control algorithms on hardware with the potential for controlling highly coupled and even non-linear processes enables the realization of advanced power systems previously only considered in numeric models.

**Gasification for Clean Power Generation and $H_2$ Production**
Gasification processes can be used for production of power, hydrogen, and syngas from fuels such as biomass, waste plastics, municipal solid waste, and natural gas with inherent $CO_2$ capture. Formally known as NETL's chemical looping combustion (CLC) lab, the facility it currently being retrofitted to support a range of gasification and pyrolysis reactions in a fluidized bed configuration or a circulating fluidized bed configuration. The facility will consist of a lab scale reactor capable of reaching temperature of 1000°C and 11 bar as well as a matching cold flow unit operating at room temperature and constructed out of plastic. This facility will support lab scale development and demonstration of co-gasification technologies, processes, solid fuel feeding, flue gas analysis and cleanup, as well as refractory testing.

**Oxygen Carrier and Catalyst Development**
Development of efficient oxygen carriers is key to the success of chemical looping systems. The oxygen carrier, usually a metal oxide, transports oxygen to the fuel. An effective carrier will react readily with the fuel, oxidizing the fuel to carbon dioxide ($CO_2$) and water ($H_2O$) and the reduced oxygen carrier will fully re-oxidize upon contact with air. Reactivity and durability of oxygen carrier materials are significant issues that NETL is addressing. Researchers are striving to meet other criteria for oxygen carriers, including low cost and good availability. Carriers are tested in the NETL pilot-scale 50 kilowatt-thermal CL reactor. Future tests will include catalyst and oxygen carrier tests for H2 production with various fuels.

**High-Temperature Fuel Cell and Electrolyzer Development**
NETL is leading the development of solid oxide fuel cell and electrolyzer technology, which has the potential to be the most efficient hydrogen- and/or power-producing technology available and supports our nation's ambitious carbon management goals. These laboratories provide our world-class researchers access to facilities for generating practical data to validate and improve models the simulate the performance and degradation of electrolyzers and fuel cells. The laboratories are equipped to test fuel cells, electrolyzers, and component materials at temperatures up to 1000°C and under various gas atmospheres and operational conditions. The laboratories include conventional ceramic fabrication facilities, an automated electrode manufacturing device, and electrochemical characterization equipment.

**The NETL Supercomputer: Joule**
NETL is home to Joule, one of the world's fastest high-performance computers, along with advanced visualization centers that serve the Lab's research and development needs. As of June 2022, Joule ranks 45th in the nation and 139th in the world among supercomputers.

Supercomputing provides the foundation of NETL's research efforts, and NETL maintains supercomputing capabilities to effectively support its research to meet clean energy goals calling for net-zero carbon emissions in the electricity sector by 2035 and economy-wide net-zero emissions by 2050. Supercomputing allows NETL researchers to simulate phenomena that are difficult or impossible to otherwise measure and observe. This simulation-based engineering approach helps NETL to reduce the cost and time of technology development at every stage: speeding up the discovery of new materials, increasing the reliability and performance of novel devices, and reducing the risk inherent in scaling up processes. Ultimately, supercomputing gives NETL and its industry partners an innovation advantage, enabling the development of globally competitive technologies and a sustainable, affordable energy portfolio for the nation as we responsibly transition to greater reliance on renewable energy sources.

**CT Scanning Lab**
The lab's four CT scanners enable researchers to examine materials across a range of scales, probe different subsurface phenomena, and distribute detailed characterizations of rock cores. The lab is built to look at real rocks under real subsurface conditions. Most research is focused on enabling environmental sustainability of the nation's energy production by upscaling the physical phenomena that controls flow in the subsurface. The work has important implications for determining geologic carbon storage potential, wellbore integrity, and flows through fractured rock.

**Reaction Analysis and Chemical Transformation (ReACT) Facility**
NETL is pushing the boundaries of yet-to-be explored research in reaction science with its Reaction Analysis & Chemical Transformation (ReACT) facility. Here, researchers are advancing the science needed to optimize energy conversion and transforming how we think about and approach chemical reactions. The ReACT facility supports NETL's energy conversion engineering competency, which includes increasing power cycle efficiency and enabling more power generation with less fuel and fewer emissions — efforts that support net-zero carbon emission goals. The ReACT facility's capabilities enable researchers to work toward optimizing chemical reactor designs for specific chemical transformations. This includes investigating novel approaches, such as microwaves, to selectively energize chemical reactions.

**Innovative Energy Systems: High-Pressure, High-Temperature Combustion Systems**

NETL's High-Pressure Combustion Facility is a unique resource within the national laboratories system, providing the test capabilities needed to evaluate new combustion concepts for high-pressure, high-temperature hydrogen and natural gas turbines. The facility serves two key areas: studying fluid flow and combustion variability, and analyzing reaction behavior during high-pressure combustion. To model and study fluid flow and combustion variability, researchers use computational fluid dynamics and the Dynamic Gas Turbine Combustion test rig to gain insights into complex combustion processes. The Simulation Validation, or SimVal, unit is a unique optical combustor for analyzing high-pressure combustion and validating computational fluid dynamics models. Using information from this facility, researchers are developing alternative thermal management methods, sensors, and control capabilities necessary for advanced combustion systems that operate more efficiently and support decarbonization goals.