Research programs initiated by the U.S. Department of Energy (DOE) to achieve increased efficiency, improved flexibility, and reduced emissions are expected to result in the development of highly integrated or hybrid power generation technologies that are cleaner and use far less fuel than the technologies used today. This highly efficient and flexible technology would extend our natural resources, thus reducing the dependence of the United States on foreign sources of oil and other energy feedstocks. Furthermore, this will provide resiliency with respect to the continued penetration of intermittent renewable power resources such as wind and solar. We are therefore utilizing an integration of technologies to meet the aggressive efficiency and flexibility targets proposed by DOE programs, which emphasize the need for research in systems integration and controls.

As an example, one technology identified with the promise of meeting such a challenge is the combination of a high-temperature fuel cell and a gas turbine with a gasifier or reformer. This hybrid technology has been studied extensively through the use of numerical models and a limited number of demonstration projects. The Hybrid Performance Project (Hyper) was initiated by DOE's National Energy Technology Laboratory (NETL) to make this complex integration work. In subsequent years, the scope of the Hyper project was expanded to include support for other innovative energy technologies as a test bed for new sensors and advanced control methods that could improve the performance of existing power plants.
The test facility was designed to isolate and independently instrument each component of the system and is capable of simulations for systems up to approximately 1MW. Recently, an independent heat source was added for cyber-physical simulations to allow supplementary firing as a turbine speed control method. This additional capability enables the site to explore load-following for peaking demands, as well as distributed power applications. This will ultimately improve grid reliability during transient events amidst power demand fluctuations or generation intermittency from renewable assets. The addition of dSpace and OPAL RT simulators has expanded the capabilities of simulation to include spatial resolution of fuel cell and gasifier components in real time.

### OPPORTUNITIES

The Hyper experimental facility and modeling results are available for public research collaboration with universities, industry, and other research institutions. In addition to planned NETL studies, the Hyper facility is intended to provide a test platform for novel sense and control strategies that may emerge from university or small business research projects. Collaboration with academic, non-profit, or commercial research groups can be arranged under a variety of cooperative programs, such as a cooperative research and development agreement and student or visiting scholar programs. There are currently four international and many domestic academic collaborations underway, as well as three industrial collaborations.

NETL is a U.S. Department of Energy national laboratory that drives innovation and delivers technological solutions for an environmentally sustainable and prosperous energy future. Through its world-class scientists, engineers and research facilities, NETL is ensuring affordable, abundant and reliable energy that drives a robust economy and national security, while developing technologies to manage carbon across the full life cycle, enabling environmental sustainability for all Americans, advancing environmental justice and revitalizing the economies of disadvantaged communities.