Hybrid Performance Project

Research programs initiated by the U.S. Department of Energy (DOE) to achieve increased efficiency and reduced emissions are expected to result in the development of highly integrated power generation technologies that are clean and use far less fuel to produce the same power as technologies used today. This highly efficient technology would extend our natural resources and reduce the dependence of the United States on foreign sources of oil and other energy feedstocks. No single technology is capable of meeting the aggressive efficiency targets proposed by DOE programs, emphasizing 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 the Office of Research and Development at 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 which could improve the performance of existing power plants.

Capabilities

Developing an understanding of dynamic issues related to the coupling of several novel power generation and thermal processing technologies is critical to the design of commercial equipment. Likewise, evaluation and testing of control strategies is critical to the implementation of commercial equipment. An experimental test facility was designed and built at NETL's Morgantown site as a resource to researchers and industrial developers of hybrid power systems. The facility is the only one of its kind anywhere in the world.

The experimental facility simulates more expensive and developing technology, such as a fuel cell and gasifier or even thermal energy storage, through a combination of hardware and software. This hardware used for simulating the developing technology (pressure vessels, piping, and a burner) is coupled to heat exchangers and a turbine in order to evaluate the dynamics of a fully integrated system.

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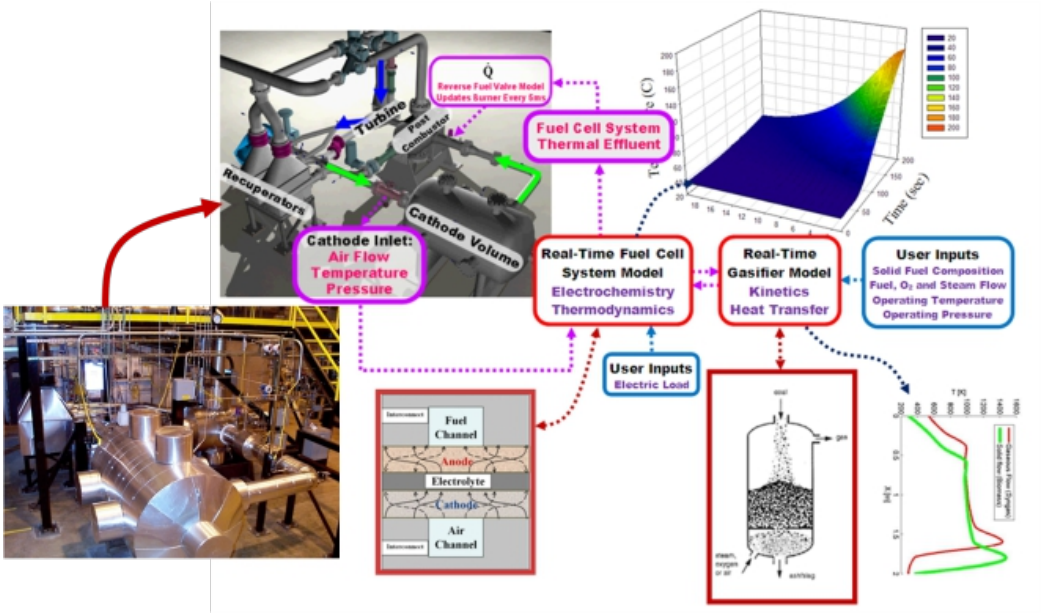
This allows control strategies to be developed and tested before actual implementation of the technology, reducing risk. For example, a variety of fuel cell types and geometries can be tested without risk to such an expensive component of the system. In determining the operating boundaries of a fuel cell turbine hybrid system, preliminary tests would have resulted in the destruction of many fuel cells. A diagram of the Hyper hardware-in-the-loop concept is shown in the following figure.



The test facility was designed to isolate and independently instrument each component of the system and is capable of simulations for systems up to 1MW. Recently, a variable load bank was added to the facility to control turbine speed independently from the fuel input. This allows researchers to conduct a wider range of transient simulations and to impose a load profile on the turbine in the system. The addition of a dSpace simulator 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 three international and several domestic academic collaborations underway, as well as two industrial collaborations.