OAK RIDGE NATIONAL LABORATORY FACT SHEET
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Unique Fuel Cell Installation Showcased at the National Transportation Research Center (NTRC)

Oak Ridge National Laboratory (ORNL), through funding sponsored by the U.S. Department of Energy's (DOE's) Office of Distributed Energy and Electric Reliability Program and a Department of Defense (DoD) National Energy Technology Laboratory (NETL) grant, has installed a United Technologies Company (UTC) phosphoric acid fuel cell at the National Transportation Research Center (NTRC) in Knoxville, TN. Installation of this fuel cell is unique for a DOE–leased building in a region with low electric rates, as well as for provision of thermal recovery for the building.

Background on Fuel Cells

A fuel cell is an electrochemical device that combines hydrogen fuel, such as natural gas and oxygen from the air to produce electricity and hot water (see Figure 1). Fuel cells operate without combustion, so they are virtually pollution free. Since the fuel is converted directly to electricity, a fuel cell can operate at much higher efficiencies than internal combustion engines, extracting more electricity from the same amount of fuel. The fuel cell itself has no moving parts, making it a quiet and reliable source of power.

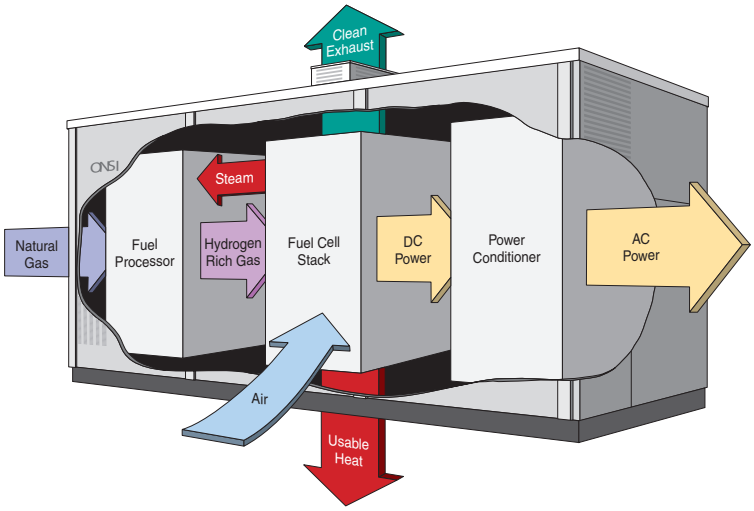

Figure 1. Fuel Cell uses Natural Gas to Produce Electricity.

Figure 2. The NTRC Fuel Cell.

The NTRC Fuel Cell

The NTRC fuel cell was purchased commercially from International Fuel Cells, which sells about 40 units per year, with the majority installed in the Western United States. The fuel cell (see Figure 2) consumes 2,050 cft/hr natural gas to generate 200 kW electricity while creating 900,000 Btu/hr hot water. The NTRC uses the electricity generated by the fuel cell to supply about one-third of the building's electricity. Thermal energy created by operation of the fuel cell is used to supplement the heating provided by seven gas-fired boilers. In the summer, the building is cooled using a 525-ton chiller that produces 55°F air. Hot water produced by the fuel cell will also be used in the summer to reheat this 55° air for temperature control.

Contribution to Operational Efficiency

In operation, this fuel cell combines heating, cooling and power generation to improve building efficiency. Efficiency is expected to increase from ~33% to 59% year round by using 250°F water for temperature control. Knoxville Utility Board (KUB) approved a lower gas rate to support favorable operating costs. The project is expected to reduce utility bills.

Independence from the Grid

Though the fuel cell normally operates connected to the electric grid, it is designed to automatically disconnect from the grid when either the grid fails or is out of tolerance. If out of tolerance, a fuel cell "grid enabled circuit" is opened. The local utility, Lenoir City Utilities Board (LCUB), required installation of a reverse power relay to prevent power from feeding the grid during grid outage. If the fuel cell fails to disconnect from the grid during a power outage, the reverse power relay disconnects the fuel cell from the grid.

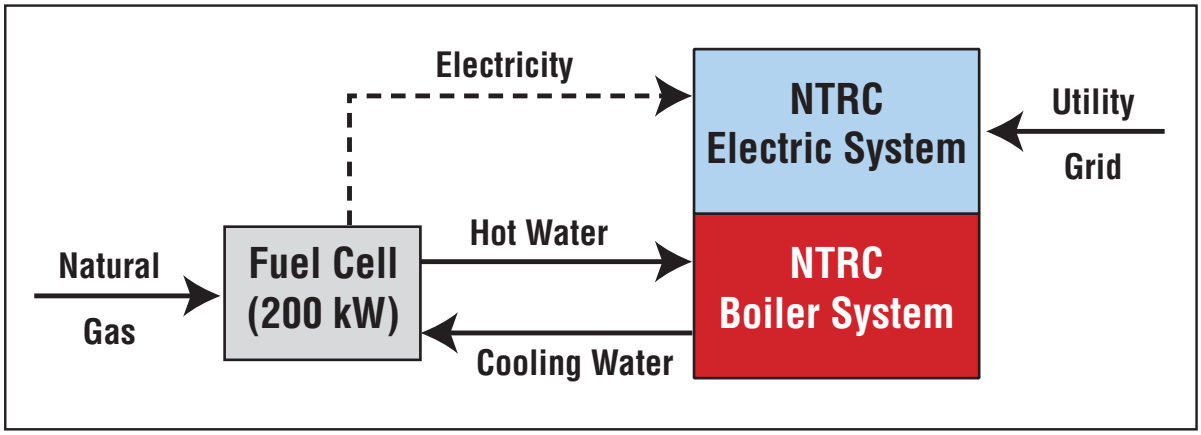

Figure 3. Fuel Cell Supplies Electricity and Heating.

Research on Advanced Relays

In addition to improving energy-efficient operation of the NTRC facility, the fuel cell is central to a research project on advanced relays. The grid disconnect relays of the LCUB substation are being compared with those of the UTC fuel cell. The "load tracking" control loop interaction is being evaluated in comparison with the reverse power relay. Research partners on this project include ORNL, EPRI Power Electronics Application Center (PEAC) Corporation, and Tennessee Valley Authority (TVA), with involvement from Construction Research Engineering Laboratory (CERL) and Institute of Electrical and Electronic Engineers, Inc. (IEEE).

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