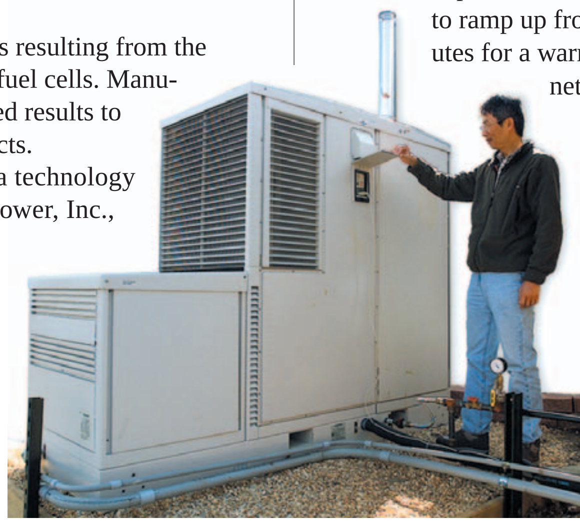
Coming soon to your home?
Performance Monitoring of Family-Size Fuel Cell

Although fuel cells for large buildings have been on the market for several years, units sized for residential use are still under development. Monitoring of a 5-kW fuel cell now under way by ORNL's Buildings Technology Center will provide data to help manufacturers refine the performance of home-size fuel cells.

DOE will use the data and insights resulting from the project to guide its R&D on residential fuel cells. Manufacturers will be able to use the published results to improve the performance of their products.

The fuel cell being monitored is a technology demonstration unit (TDU) from Plug Power, Inc., that is not yet on the market. For a fuel source, it uses natural gas, which is reformed to produce hydrogen. A chemical reaction inside a fuel cell acts upon the hydrogen and oxygen from air to produce a flow of free electrons (electricity) and water.

The Plug Power cell began operating in January. Characteristics such as power output; efficiency; ramp-up and ramp-down times; fuel, air, and water flow; and operating temperatures will be monitored. So far, the fuel cell has produced up to 5.2 kW net of electricity. It produces power continuously and has gone through several shutdown and start-up cycles.



Fang Chen and others are conducting studies on the first residential polymer electrolyte membrane fuel cell unit operating in the Southeast.

Performance characteristics tested to date include cold and warm start-up and load variations. The fuel cell requires an hour to ramp up from cold start to full power, 15 to 20 minutes for a warm restart, and 2 to 5 minutes to change net power output from 2 to 5 kW. The fuel cell stack is running at around 70°C.

BTC researchers hope to use waste heat produced by the fuel cell to regenerate an enthalpy wheel for air-conditioning, similar to the one being used in a geothermal heat pump project at a local school (see p. 3).

The manufacturer hopes to have its residential units ready for the consumer market in the near future.

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Designer Crops Shape Their Carbon Allocation

Meeting the projected demand for biomass-based products will not be a simple matter of planting garden-variety trees and grasses. It will require energy crops that store maximum amounts of carbon in desired configurations.

Plants "allocate" carbon between their above- and below-ground parts and "partition" it among three types of cell wall components — cellulose, hemicellulose, and lignin. The ideal biomass plant will have high-carbon stems, branches, and leaves that yield more fuel and/or chemicals when harvested and processed. It also will have a root system high in lignin, which will decay slowly and thus store carbon for longer times in the soil.

Plant scientists at ORNL are investigating the genomic-level processes that govern how plants allocate and partition carbon in hopes of developing the capability to customize biomass crops for specific purposes.

Two new techniques for characterizing wood chemistry (pyrolysis molecular beam mass spectrometry) and wood density (computer tomography X-ray densitometry) developed at National Renewable Energy Laboratory and ORNL, respectively, make it possible to examine large plant populations to determine the genetic basis for cell wall formation (partitioning). Using these techniques, researchers have identified two regions of the pine genome associated with cell wall composition. Based on this work, three hypotheses related to carbon allocation and partitioning have emerged: carbon allocation is controlled by a small number of genes; genes controlling partitioning operate independently above- and below-ground; and the genes that control allocation also affect partitioning.

To produce a hybrid poplar tree, flowers from the female are inoculated with pollen from the male. Hybrid progeny grow from the resulting seed.

The research team is studying wood tissue samples from 300 hybrid poplar trees, a promising biomass crop, to map the hybrid poplar genome. They hope within 2 years to identify the specific genes that control carbon allocation and partitioning in hybrid poplar.

Such a discovery would lead to a better understanding of the biological processes that underlie the production and use of biomass.

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