Is There a Fuel Cell in Your Future?

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Fuel cells hold promise for U.S. Department of Agriculture (USDA) Forest Service use, especially in areas where commercial electric power is unavailable. Within a few years, fuel cells will provide a clean, quiet alternative supply of power in areas where it is impractical to use renewable energy sources such as solar, microhydroelectric, or wind power. Fuel cells can provide power for any size application from a single clock to an entire city. Possible future applications of fuel cells in the USDA Forest Service include providing power for lights, showers, cooking, and computers at remote fire camps; providing battery-type power for portable field equipment; powering water pumps at recreation sites; and even providing electric power for remote ranger stations.

Fuel cells are similar to large batteries with constant fuel input (figure 1). They are energy-conversion devices that electronically transform energy stored within hydrogen into electricity, heat, and water. Unless fuel cells use pure hydrogen for fuel, they produce small amounts of carbon dioxide. Fuel cells have no moving parts. Because they do not burn their fuel, they produce virtually no pollution. Fuel cells convert around 30 percent of the energy in their fuel to electricity, compared to 20 percent for a typical power plant. The heat produced by fuel cells can be used to provide domestic hot water and to heat or cool buildings, raising the total potential efficiency of fuel cells above 80 percent.

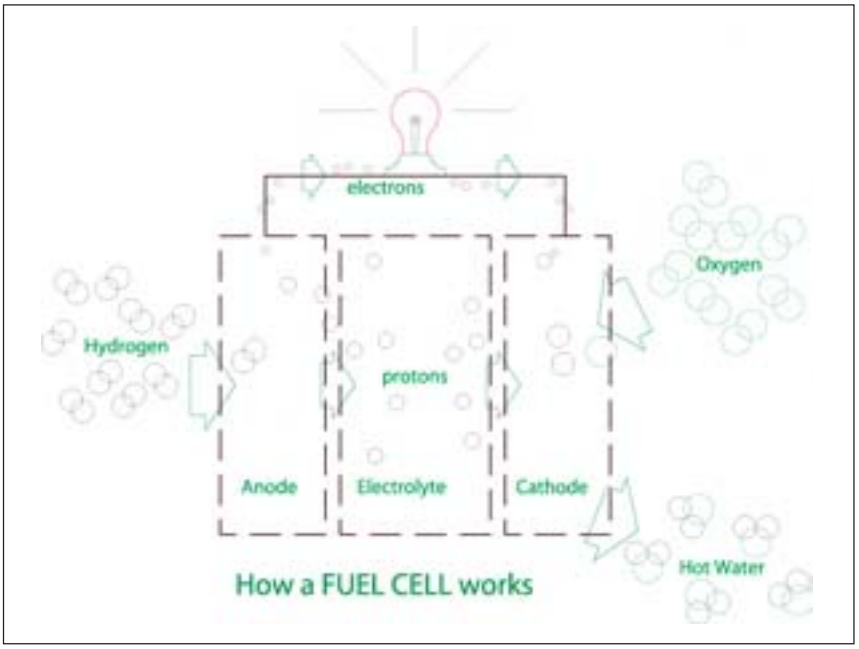

Figure 1. *This schematic drawing shows how fuel cells produce electricity.*

Fuel Cells are Coming (0371-2307-MTDC), a tech tip produced by the USDA Forest Service Technology and Development Program, explains how fuel cells work, the types and uses of fuel cells, and the current state of fuel cell development. The tech tip is available from Missoula Technology and Development Center (MTDC) either electronically (http://www.fs.fed.us/eng/t-d.php?link=pubs/htmlpubs/htm03712307/) or in print (call 406–329–3978).

Currently, most fuel cells are far more expensive to purchase and use than conventional power sources. Stationary fuel cells for domestic or light commercial use (figure 2) cost about $20,000 per kilowatt. Very large units (100 kilowatts or more) cost about a fourth to half as much per kilowatt. These units are cost effective only when electricity costs exceed 15 cents per kilowatt-hour or when electric power failure or fluctuations can cause expensive losses to businesses or government installations. Fuel cell manufacturers expect the medium-to-large units to become viable commercially when the cost drops below $1,000 per kilowatt. Major fuel cell manufacturers expect costs to reach that level between 2007 and 2010.

Figure 2. *This 5-kilowatt fuel cell manufactured by Plug Power is being tested by the U.S. Department of Defense at the Concurrent Technologies Corp. test facility. It is intended for residential use or small commercial installations. —Photo courtesy of Concurrent Technologies Corp., Johnstown, PA.*

Small fuel cell systems (under 100 watts) cost less than $100 per watt, a cost comparable to some battery systems. Portable battery replacement fuel cell units (figure 3) are much lighter and last longer than battery systems with similar power output. These systems are available from manufacturers, but they must be specially built for each application.

Figure 3. *The black box (foreground) attached to this commercial video camera is a fuel cell manufactured by Jadoo Power Systems. The fuel cell replaces much heavier batteries and is used whenever a portable power source is needed. —Photo courtesy of Jadoo Power Systems, Folsom, CA.*

Some vehicle manufacturers producing limited quantities of fuel-cell-powered vehicles have tested fuel cells under commercial conditions. In December 2002, Honda delivered the first commercial fuel cell automobiles to the United States for fleet use in Los Angeles (figure 4). Toyota delivered a fuel cell vehicle to the University of California at Irvine for use by employees. These vehicles are still extremely expensive to produce. They use compressed hydrogen fuel, which is also expensive.

Figure 4. *This Honda FCX is one of the first commercially available automobiles to be powered by fuel cells in the United States. —Photo courtesy of American Honda Motor Co., Torrance, CA.*

For the past 35 years, commercial fuel cell development has been characterized as "about 5 years away." It appears that the state of fuel cell development has finally caught up to the promises. In anticipation of commercial availability, the USDA Forest Service Technology and Development Program, along with other agencies and private industry groups, will install a fuel cell as a demonstration project at the Big Goose Ranger Station (figure 5) on the Tongue Ranger District of the Bighorn National Forest. The Big Goose Ranger Station is located at about 7,800 feet elevation, 7 miles from the nearest power line. The project's goal is to learn how fuel cells can be installed in the future and used effectively within the USDA Forest Service.

Figure 5. *Big Goose Ranger Station, Tongue Ranger District, Bighorn National Forest.*

The project, which began in late 2002, will replace an aging propane generator with a 10-kilowatt fuel-cell system in the summer of 2004. A core project team, which includes personnel from cooperating agencies and organizations as well as USDA Forest Service staff, has faced significant challenges in implementing the project. Besides funding from the USDA Forest Service, funding will come from diverse sources including the U.S. Department of Defense (DOD), the U.S. Department of Energy, and the Propane Education and Research Council. The design is a joint effort by the USDA Forest Service and an engineering and technology firm contracted by DOD. Because fuel cells of this size are still in the precommercial development stage, design parameters assure that the ranger district will have a functioning electrical system, even if the fuel cell system expires. A major challenge has been locating a fuel cell system that will operate efficiently on propane at high elevation without much operator attention and that will not be damaged during the station's winter shutdown.

Steady progress has been made on the fuel cell demonstration project as the project team has solved each new challenge. Installation is expected to occur on schedule next summer. Besides the tech tip, other reports will share what is learned as the project progresses and the fuel cell system begins operation. For more information about fuel cells or the fuel cell project, contact Kathie Snodgrass, project leader at the MTDC, or Anna Jones-Crabtree, forest engineer for the Bighorn National Forest.

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