BY DAVID LUSTIG

BNSF experiments with fuel cells

A hydrogen fuel cell locomotive may be coming to your town sometime in the future

BNSF Railway is developing an experimental hydrogen fuel cell powered switching locomotive. Working with Vehicle Projects LLC, a private engineering firm headquartered in Denver, the railway's mechanical department is assembling the locomotive (which started as an EMD GP9 and was later rebuilt into a RailPower Green Goat) in BNSF's Topeka, Kan., shops. The two say the fuel cell locomotive has the potential to reduce air pollution as well as prepare for locomotives that are not dependent on expensive oil for fuel.

Throughout its system, BNSF locomotives currently burn more than 4 million gallons of diesel fuel a day, about 2 percent of U.S. diesel fuel usage. The railroad in its third-quarter 2007 filings said diesel fuel costs represent 26 percent of its operating costs. Using fuel cells in vehicles such as buses and automobiles is not new, but its introduction into railroading by a Class I is.

So how does this technology work and is it really an innovative path to new methods of powering trains?

A fuel cell is an electrochemical device that combines hydrogen and oxygen to produce electricity, and produces water and heat as a byproduct. As long as fuel (hydrogen and oxygen) is available, the fuel cell continues to generate power.

BNSF says the oxygen used by a fuel cell comes from the air, while the hydrogen must be provided. Electricity needed to generate hydrogen can come from any number of available sources including nuclear, wind, and solar.

The experimental locomotive will carry compressed hydrogen on board in tanks similar to those used on fuel-cell-powered highway vehicles. Since fuel cells convert fuel to energy via an electrochemical process rather than combustion, the process is clean (meaning no emissions), quiet, and highly efficient.

How efficient? BNSF engineers say it can be two to three times more efficient than the standard diesel locomotive, although that calculation does not take into account the energy required to produce the hydrogen the fuel cell needs.

For something like a locomotive, fuel cell technology might provide much higher starting torque and overload capacity than battery power.

In locomotive applications, BNSF says, an onboard fuel cell power module uses the hydrogen and oxygen to produce electricity that is either stored in batteries or directly fed to the locomotive's high-voltage propulsion system, which uses DC choppers. The choppers are electrical devices that have the capability to control the power to each traction motor independently, providing substantially improved adhesion over a conventional locomotive wheel-slip system.

"While it's not a proven technology and the project is still in its infancy, we believe investments like the fuel cell switch locomotive are important for the advancement of new technology," says Craig Hill, BNSF's vice president of mechanical and value engineering.

"The world burns millions of barrels of oil for energy," adds Arnold Miller, president, Vehicle Projects, "and the waste carbon is then emitted to the atmosphere.

"Because they don't rely on oil as a fuel source, fuel cells solve these two issues," he says, adding that developing proof-of-concept hydrogen fuel cell locomotives is an important first step toward the use of fuel cells in future rail applications.

According to the railway, the RailPower locomotive, which had been reduced to a shell, was delivered to Topeka from Montreal and the various experimental components (the fuel cell power modules and hydrogen storage tanks) were integrated with an electrical transmission and control systems. BNSF and Vehicle Products expect to begin testing the unit sometime in mid- to late 2008.

Besides partnering with BNSF on its switcher project, Vehicle Projects also is working incorporating fuel cell technology into a road-switcher. Fuel-cell-powered locomotives also have been used in mining.

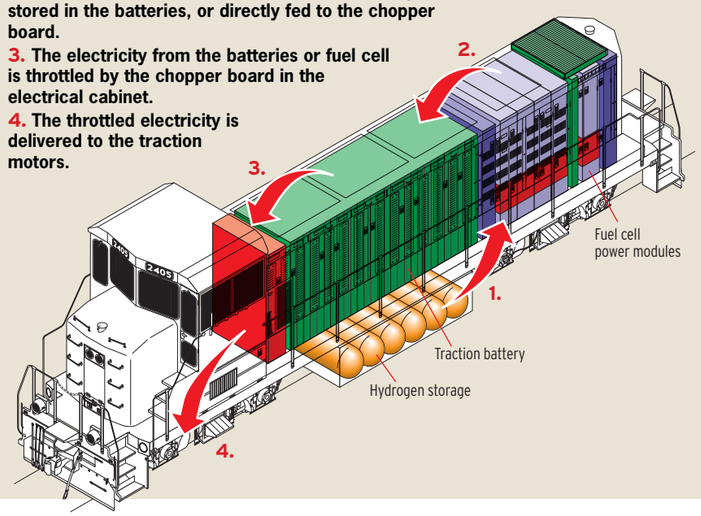
The Class I's current experimental locomotive should be viewed as concept vehicle to demonstrate that it is possible to adapt hydrogen fuel cell technology to a rail application, a BNSF spokesman says. Whether the technology will be commercially viable depends on a number of factors, including the need for production, storage, and distribution of hydrogen. That infrastructure does not currently exist, he says, and would require a substantial investment.

Will this technology ever be adopted across the rail industry? Time will tell. But in an era of decreasing oil supply, this hydrogen-powered hybrid could be the dawn of a new age in rail transportation.

How do fuel cells power a locomotive?

This diagram shows how fuel cells can power a locomotive using a hybrid battery storage system. Each step of the process is shown:

1. **Hydrogen is used by an onboard fuel cell power module.**
2. **The fuel cell power module produces electricity that is either stored in the batteries, or directly fed to the chopper board.**
3. **The electricity from the batteries or fuel cell is throttled by the chopper board in the electrical cabinet.**
4. **The throttled electricity is delivered to the traction motors.**



Help wanted, training needed

Universities, industry try to forestall engineering shortage

U.S. railroads have been investing big bucks in capacity improvements for several years. And, if a recent Association of American Railroads report [see pages 48-49] is any indication, the industry's growth spurt won't be ending anytime soon. But who will build them?

About half of all railroad engineering professionals are within five years of retiring, says University of Illinois Associate Professor Christopher Barkan, director of its railroad engineering program. The lack of college-level training for tomorrow's engineers concerns him and others in the industry.

University of Illinois has the oldest program at 100-plus years and recently expanded its program by hiring J. Riley Edwards as lecturer in railroad engineering; Michigan Technological University established its program in February. University of Kentucky, North Dakota State University, and West Virginia University offer courses in railroad engineering, while other schools conduct research in railroad engineering, including University of Kentucky, University of Nebraska, Massachusetts Institute of Technology, Texas A&M University, and Virginia Tech. That might sound like decent representation, except that nearly every other university transportation engineering program focuses almost entirely on highway transport.

"If all one's been trained in is highway, then there's a tendency to solve transportation problems by building more roads," Barkan says. "Instead, we'd like to see 10-12 universities offering a curriculum in railroad engineering." Now Barkan and Edwards are working with the American Railway Engineering and Maintenance-of-Way Association's Committee 24 (education and training), to make this happen.

Committee 24 will hold a Railroad Engineering Education Symposium June 8-11 at University of Illinois at Urbana-Champaign to help professors interested in incorporating railroad-related material into their curricula understand the basic concepts and provide them teaching materials to take back to their respective universities.

"Our goal is a new generation of transportation engineers better schooled in all the different ways we can move people and goods in an economical, efficient, and environmentally sustainable manner," Barkan says. — *Kathi Kube*