

FUEL CELL QUARTERLY

All Aboard the Hydrogen Train

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The concept of hydrail, or hydrogen-powered rail, is generating international interest with its potential to provide clean and efficient power, independence from foreign oil, and freedom from expensive electric rail infrastructure. Driven, in part, by rising oil costs and a desire to mitigate harmful diesel engine pollutants, the concept has spurred several international conferences, as well as feasibility studies and technology demonstrations. Interested parties include rail companies, national governments, and transportation research institutes.

Limitations of current electric rail have also helped to spark interest in hydrail. Electric-powered rail requires capital investment in expensive electric power infrastructure that is typically only justified in areas of high rail traffic density. In contrast, hydrail is flexible and can be implemented regardless of rail traffic density and avoids costly infrastructure investment. A recent evaluation has found that capital costs for hydrail and electric rail are similar: a 1998 Caltrain study found the cost to electrify an existing commuter rail line would be \$376 million for a 124-km line (\$0.33 million/km), which compares favorably to the pro-rated cost of \$100 million to develop hydrail along North Carolina's 32-km Mooresville-Charlotte passenger line (\$0.32 million/km).

The largest hydrail project underway is a [1.2 MW prototype locomotive](#) - the world's largest fuel cell-powered vehicle -



Army fuel cell diesel locomotive

that is being developed under a U.S. Department of Defense-sponsored project for potential military and commercial applications. The locomotive will use eight Nuvera 150-kW Forza PEM fuel cell power modules with onboard metal-hydride hydrogen storage that will allow 30-40 hours of continuous operation. An international consortium is involved in the project, including rail operators BNSF Railway Company, New York City Transit, Regional Transportation District-Denver and Tube Lines/London Underground. The fuel cell locomotive should be ready for testing by March 2008.

Testing has already been completed on several smaller fuel cell-powered trains. One project, sponsored by the U.S. Department of Energy (DOE), demonstrated a [17-kW PEM fuel cell-powered, 3.6 ton mining locomotive](#) in 2002. Fuel cell technology is promising for mining vehicles since it would eliminate the expensive ventilation systems required to mitigate toxic emissions from underground diesel locomotives. Another short test, conducted in 2006 by Japan's Railway Technical Research Institute (RTRI), involved a single,

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New Budget Sees Increase for Hydrogen and Fuel Cells

After the new 110th Congress settled in, lawmakers and President Bush signed a "continuing resolution" bill to ensure funding for the federal government until September, when fiscal year (FY) 2007 ends.

This newly approved bill provides a significant funding increase for the Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) which includes the Hydrogen, Fuel Cells & Infrastructure Technologies Program. House Joint Resolution 20, also known as the "Revised Continuing Appropriations Resolution, 2007," continues funding at FY 2006 levels for much of the federal government, but in Section 20314, it is specified that nearly \$1.474 billion go to EERE, nearly a 27 percent increase. The bill also gives EERE more flexibility in directing the funds because most earmarks are eliminated.

A few years ago in his State of the Union Address, President Bush committed \$1.2 billion in research funding so that America can lead the world in developing clean, hydrogen-powered automobiles." The "Hydrogen Fuel Initiative" (HFI) is a 5-year plan to accelerate R&D to enable technology readiness in 2015 and industry commercialization of fuel cell vehicles by 2020.

For FY2008, keeping in line with the HFI, \$309 million has been requested for hydrogen and fuel cell programs. Another \$62 million has been requested for the Office of Fossil Energy's Solid-State Energy Conversion Alliance, known as the SECA program, which was formed to accelerate the commercial readiness of solid oxide fuel cells in the 3-kW to 10-kW range for use in stationary,

transportation, and military applications. The FutureGen program, also in the Office of Fossil Energy, has requested \$108 million to continue the initiative to build the world's first integrated sequestration and hydrogen production research power plant.

The FY2008 budget request for the HFI is a \$20 million increase from 2007. By reducing funding for fuel processor research and development (R&D), technology validation and generating hydrogen from coal, DOE was able to request increased funding to expand research in areas such as hydrogen storage materials and hydrogen production from renewables.

Within the HFI program, the money requested is allocated as follows:

Hydrogen and PEM Fuel Cell Program (Office of Energy Efficiency and Renewable Energy) - \$213 million

Basic Research (Office of Science) - \$59.5 million;

Coal-to-Hydrogen (Office of Fossil Energy) - \$12.5 million;

Hydrogen Production (Office of Nuclear Energy) - \$22.6 million

For a more in depth look at the FY2008 budget request, please go to <http://www.hydrogen.energy.gov/budget.html>.

The support for hydrogen and fuel cells doesn't end at DOE. Over at the Department of Transportation (DOT), the FY2008 budget request includes \$12 million for its Research and Innovative Technology Administration's (RITA) Research and Development program. This program focuses on innovative transpor-

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Chart courtesy of DOE

Hydrogen Fuel Initiative				
<i>BUDGET by Participant Organization</i>				
Activity	Funding (\$ in thousands)			
	FY2005 Approp	FY2006 Approp	FY2007 Request	FY2008 Request
Hydrogen Fuel Initiative				
EERE Hydrogen (HFCIT)	166,772	155,627	195,801	213,000
Fossil Energy (FE)	16,518	21,635	23,611	12,450
Nuclear Energy (NE)	8,929	24,750	18,665	22,600
Science (SC)	29,183	32,500	50,000	59,500
DOE Hydrogen TOTAL	221,402	234,512	288,077	307,550
Department of Transportation	549	1,411	1,420	1,425
Hydrogen Fuel Initiative TOTAL	221,951	235,923	289,497	308,975

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(cont'd from page 2)

tation technologies, including hydrogen fuel. RITA is working with DOE and other partners, to design safe handling, transport and storage guidelines for hydrogen fuels as well as the education of emergency responders for safe handling of hydrogen fuel incidents. The proposal includes \$0.5 million for that effort.

DOT has also requested \$49 million for its Clean Fuels Grant Program, which provides financing for the purchase or lease of clean fuel buses and facilities. Fuel cell buses are included in the program.

We see more and more states stepping up to the plate with financing and incentives, but funding and support from the federal government is crucial to moving the technology to commercialization. (JG)

(cont'd from page 1)

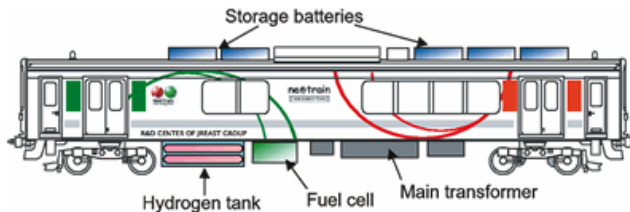
[120-kW Nuvera PEM fuel cell-powered rail car](#). RTRI has previously tested a 30-kW fuel cell rail car (2004) and a 1-kW fuel cell mini-train (2001), and plans to place a two-car, fuel cell powered train, capable of traveling 300-400 km (187-250 miles) at 120 km/h (75 mph) before refueling, into commercial service by 2010. In another 2006 demonstration, East Japan Railway Company ran its [130-kW fuel cell-battery hybrid train](#) back-and-forth along a short test track, attaining a speed of 30 mph (50 km/h) while carrying 30 passengers. The vehicle can reach a maximum speed of 100 km/h (60 mph) and travel for up to 100 km (62 miles) before refueling with hydrogen. The company anticipates deployment of the fuel cell hybrid train on its tracks in Nagano and Yamanashi prefectures during Summer 2007.

With all of these international projects under way, it is no wonder that hydrail is drawing so much attention. Its many attractive features – clean power, reduced dependence on increasingly expensive diesel oil, and freedom from complicated electric rail infrastructure – make the technology an attractive power alternative for rail. Further research, through locomotive demonstrations and early trials, will be able provide additional data on performance, reliability and maintenance costs. Together, this information could



JR East fuel cell hybrid train

Other potential hydrail deployments are anticipated in Denmark, the U.S. and Canada. The



JR East fuel cell hybrid rail car diagram

The Denmark project would place a fuel cell-powered passenger train in service along the 29-km (37-mi) Vemb-Lemvig-Thyborøn Jernbane railway line. The project is supported by [The Hydrogen Train](#) consortium, whose goal is to develop and launch Europe's first hydrogen powered train by 2010. In the U.S., the [Mooresville Hydrail Initiative](#) is working to place a hydrogen-powered commuter train along a 30-km (48-mi) rail corridor between Mooresville and Charlotte, North Carolina. Initially proposed by hydrail supporters in Mooresville, the project now has the backing of the Charlotte Area Transit System. A third project involves Canada's Fraser Valley Heritage Railway Society, which is working on a unique ["Heritage to Hydrogen"](#) project that would convert antique railcars to operate on fuel cell power. The group hopes to place the trains in service by 2009 along a revived passenger rail route between Surrey and Chilliwack, British Columbia, and the project is being supported by the city of Surrey.

help establish a business case that will convince rail operators that hydrail is the new future of rail. For more information on hydrail visit <http://www.hydrail.org>. (SC)

Connecticut Study to Examine Fuel Cell Power Along Rail Tracks

The Connecticut legislature is funding a study to determine if Metro-North Railroad's New Haven commuter train line could be powered by fuel cells. Metro-North is a major customer of Connecticut Light & Power, spending about \$50 million each year just to power its New Haven line alone. If feasible, fuel cell power stations could replace some electric substations located along the tracks, reducing demand on the power grid and saving money for the rail company.

Just a Day in the Park for Hydrogen

The Toro Company is providing three hydrogen-powered Toro® Workman® utility vehicles to New York's State Office of Parks, Recreation and Historic Preservation where they will be used to carry workers and grounds-keeping equipment, remove trash and snow, drag infields and haul turf materials. The vehicles are part of a green parks initiative and will also help to meet the state's mandate to place "Green and Clean" vehicles in the state's fleet. Fuel will be provided by a New York Power Authority (NYPA) project to generate hydrogen using Western New York's hydropower resources.

New Cars on the Block

As noted in our last issue, there has been a recent flurry of activity within the automotive fuel cell world. Since then, there have been several more major announcements from some of the big automakers and new vehicles wowing the audiences at auto shows.

Everyone remembers their first set of wheels, but imagine if your first car was a fuel cell vehicle. Honda Motor Co. has just leased its second FCX fuel cell vehicle to 17-year old actress Q'orianka Kilcher, who was featured in the 2005 film "The New World." This is the second vehicle to be leased to the general public – the first FCX went to the Spallino family of Redondo Beach, California, in 2005. Honda



Honda FCX

plans to expand its leasing program of a vehicle based on its FCX Concept in Japan and the United States in 2008 and Honda's president Takeo Fukui has made the claim that he thinks the company will be able to mass produce fuel cell vehicles for the general market by 2018.

Not quite the same, but 17-year olds in Japan could take a fuel cell car to the prom now that Nissan Motor Co., Ltd. has delivered the latest version of its X-TRAIL fuel cell vehicle to Kanagawa Toshi Kotsu Ltd. to be used as part of their chauffeur-driven fleet. This is the first time that a fuel cell vehicle has been made available for hired-car services.

DaimlerChrysler has introduced the first fuel cell-powered fire response vehicle, the Fire Service Mercedes-Benz F-Cell. The vehicle will be operated by the Sacramento Metropolitan Fire District in California and has a range of approximately 100 miles, a top speed of 85 mph, and can go from 0 to 60 in 16 seconds. The fuel cell stack has been developed by Ballard Power Systems. The vehicle will be refueled at a BP Energy hydrogen fueling station located at the California Fuel Cell Partnership, also in Sacramento.



Daimler's fuel cell fire vehicle

Hybrids and plug-in hybrids have gotten a lot of attention lately. One major problem with plug-in hybrids, besides some of the technical obstacles yet to be overcome, is the source of electricity where you plug the vehicle into. In the U.S., most of our electricity is produced by coal, not exactly the cleanest form of energy production. A



great solution that results in low to zero emissions is plugging the battery into a fuel cell. Along those lines, Ford recently unveiled its Airstream Concept vehicle (see picture), a plug-in hybrid electric vehicle that uses a hydrogen fuel cell to recharge the lithium-ion battery while the car is on the road. This helps greatly increase the range. Ford's HySeries Drive™ powertrain features a Ballard fuel cell that begins operating after 25 miles. The vehicle can then travel another 280 miles on the 4.5 kg of hydrogen stored for use in the fuel cell. Ford has incorporated the HySeries Drive™ powertrain into its Edge chassis and that prototype is already testing on the road, achieving a combined city/highway equivalent fuel economy of 41 miles per gallon.

Aside from their fuel cell vehicles, GM is working on extended-range electric vehicles and recently showcased the Chevrolet Volt concept powered by E-Flex - GM's new family of electrically driven propulsion systems specifically engineered for future small- and mid-sized vehicles. The E-Flex technology provides the flexibility to use electricity from a wide range of sources, including a hydrogen fuel cell.

At a recent sustainability event, Volkswagen showcased its Touran HyMotion hydrogen fuel cell vehicle with the company's breakthrough high-temperature fuel cell.

These new vehicles and announcements highlight the commitment that auto companies have to fuel cell and hydrogen technology. With R&D advances and support from the government and industry, hopefully we won't have to wait too much longer to get behind the wheel. (JG)

To see all the fuel cell vehicles ever demonstrated, go to <http://www.fuelcells.org/info/charts/carchart.pdf>

Conference Roundup

Here are some previews of upcoming fuel cell and hydrogen conferences - you can see a complete list of events around the world at <http://www.fuelcells.org/news/conf.html>.



NHA Annual Hydrogen Conference & Hydrogen Expo US 2007

Hydrogen Expo US, the NHA Annual Hydrogen Conference's trade show, has become the leading showcase for hydrogen and fuel cell technologies in North America. 90 exhibitors from nine countries are already signed up for the expo - and still counting. Attendees at this year's event, which takes place March 19-22 in San Antonio, Texas, will have the opportunity to see, test and feel near-to-market products, including hydrogen generation technology, fuel cell systems and vehicles.

Exhibits available today and on display at the Expo include:

Apollo Sensor Technology's H-II Sensor with a detection range of 50 ppm to 5%, and a response time of less than a second;

Hydrogenics' HyPX Power Pack, currently powering lift trucks through dealer, LiftOne;

HyRadix's Adeo on-site hydrogen generators (50- 100 Nm³/hr);

HyGear's HGS onsite hydrogen generators (5-50 Nm³/hr) and fuel cell reformers;

Lincoln Composites' TUFFSHELL fuel tanks, operating pressures of 248, 350, 500, and 700 bar;

Linde's mobile hydrogen fueler with dispensers for both liquid and gaseous hydrogen;

Pall's Gaskleen ST purifiers which clean gas streams of unwanted particles, moisture and gases;

Pdc Machines' diaphragm compressor (15,000 psi/103 MpA discharge pressures);

Proton Energy's HOGEN hydrogen generators, which produce hydrogen from electricity and water in a clean and efficient process;

Vibro-Meter's flame detectors, which are certified to see hydrogen fires; and many more.

The 2007 Hydrogen Expo US is the largest ever, with a 25% increase in exhibit space compared to the past event. Several state initiatives use the expo to present their activities, including Texas, Connecticut, South Carolina, and California. From Germany, the State of North-Rhine Westfalia is bringing eight exhibitors from one of leading regions in hydrogen and fuel cell commercialization in Europe. Two new feature areas put the spotlight on hydrogen production: the Hydrogen-from-Renewables- and the Hydrogen-from-Nuclear-Pavilion.

Clean mobility will again be a dominant theme at the trade show. Car manufacturers such as American Honda, BMW, DaimlerChrysler, GM and Toyota will bring vehicles for indoor and outdoor display. The California Fuel Cell Partnership will have a presence on the show floor and will orchestrate the "Ride and Drive", one of the NHA Annual Hydrogen Conference & Hydrogen Expo US's highlights. The European Initiative on Hydrogen for Transport, "H2moves.eu", presents the demonstration and outreach activities funded by the European Commission in it's Sixth Framework Programme.

Some of the exhibitors will present their projects and products in the Hydrogen Expo US Seminar Forum located inside the exhibit hall. On March 21, the expo offers free admission at the "Public Day" from 10.00am to 4.00pm.

For more information on Hydrogen Expo US visit: www.hydrogenexpo.com.

To register for the NHA Annual Hydrogen Conference visit: www.hydrogenconference.org.

Fuel Cell 2007

[Fuel Cell 2007](#) conference & expo, June 14-15 in Rochester, NY, is the fourth annual conference designed for organizations interested in learning more about and applying fuel cell technology. The conference provides an interactive forum for OEMs, designers, engineers and integrators to discuss the latest advances in the industry. This event will feature presentations from technology-leading companies discussing the innovations behind portable, stationary and automotive fuel cells.





Fuel Cell Early Markets 2007 : Policy, Finance, & Applications

IntertechPira is pleased to announce its partnership with Core Technology Ventures Services on a new event: Fuel Cell Early Markets 2007: Policy, Finance, & Applications, to be held 11-12 June, 2007.

Fuel Cell Early Markets 2007 will be held at the Brussels Marriott Hotel in Brussels, Belgium – the administrative center of the European Union and European Commission. The event will bring together government policy makers, representatives of fuel cell industry associations, financial fund managers, equity analysts, venture capitalists, fuel cell manufacturers, and end users in the stationary and transport markets, with an anticipated audience of over 100 key decision makers. The conference program will feature 15 presentations preceded by an intensive three-hour preconference seminar on the morning of 11 June. The seminar will be instructed by Dr. Christopher Hebling of Fraunhofer Institute and by Dr. Rupert Gammon of Bryte Energy Ltd and Loughborough University, and will address the role of hydrogen and fuel cells in future energy markets.

Co-chairing this year's event will be:

- **Tim Yeo MP** – Member of Parliament for South Suffolk in the UK since 1983. Since 2005 he has also served as Chair of the Environmental Audit Select Committee.
- **Dr. Alan Lloyd** – President of the International Council on Clean Transportation. Dr. Lloyd served as the Secretary of the California Environmental Protection Agency from 2004 through February 2006 and as the Chairman of the California Air Resources Board from 1999 to 2004.
- **Nick Owen** – Responsible for RTD planning and Technology Roadmaps at Ricardo and Coordinator of Roads2HyCom, a 4.5 million Euro three-year project funded by the EU to coordinate, assess, and monitor hydrogen and fuel cell technologies for stationary and mobile energy applications.
- **Phil Doran** – Partner and Co-Founder of Core Technology Ventures. An economist by training, he is also a founding member of Fuel Cell Europe, member of the UK Society of Investment Professionals, member of the EU Finance & Business Development Panel, and former Global Head of Fuel Cell research at UBS Warburg in Frankfurt.

There will also be a number of networking functions and an exhibit area for displaying new products and technologies. For more information about corporate or function sponsorships and exhibit opportunities, please contact Brian Santos at tel: +1 207-781-9618, fax: +1 207-781-2150, or email: bsantos@intertechusa.com.

For further program information or to register online, please visit the conference website: www.intertechusa.com/fuelcells.html. You may also contact Magda Dziembowski at tel: +1-207-781-9601, fax: +1-207-781-2150, or email: mdziembowski@intertechusa.com. Register by 18 May and SAVE \$100 with the Early Bird discount!

Congressional Fuel Cell Expo

The 2007 USFCC [Congressional Fuel Cell Expo](#) will be taking place on Tuesday, May 15, 2007, in the Cannon Caucus Room on Capitol Hill in Washington, D.C. For the 7th consecutive year, the event will be supported by the Department of Energy and sponsored by House Members and Senate Leaders. The event is free to the public and there will be a fuel cell vehicle Ride and Drive.



US Fuel Cell Council

Congressional Fuel Cell Expo 2007

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Fuel Cells in a Changing World

Powering the future: environmental challenges,
energy security and consumer needs

The [Tenth Grove Symposium: Fuel Cells in a Changing World](#), will be held at the QEII Conference Center in London, England, September 25-27, 2007.