

FUEL CELL QUARTERLY

Carmakers Step Up Fuel Cell Commitment

Volume 11, Issue 1
Fall/Winter 2007

A few weeks ago, I was fortunate enough to be able to attend a General Motors (GM) event comprised of several briefings about its Project Driveway program, GM's fuel cell strategy in general and the hydrogen infrastructure; and a ride and drive of its fuel cell-powered Chevy Equinox, the star of aforementioned Project Driveway. While the presentations were quite informative, I found that driving the fuel cell Equinox was incredible! A week later I lucked out again and was a passenger in BMW's Hydrogen 7 vehicle, which sports an internal combustion engine (see story on page 6), not a fuel cell, but is still equally incredible.



Chevy's Fuel Cell Equinox

These cars are not only eye-catching inside and out, they drive smoothly and quietly, have great pick up and braking, and emit nothing beyond water vapor. The BMW car even came with bottled water labeled "exhaust" – a great marketing idea. Both cars have on board, state-of-the-art

technology and all of the luxuries expected in high-end automobiles. Once people, and that includes policy makers, government employees, media and the general public, drive, ride in or even see these cars on the road or parked in the street, the case is pretty much closed as to why we should be invested in fuel cell vehicles and the hydrogen economy. As the old saying goes, seeing is believing, and luckily for the fuel cell industry, automakers are firming up their commitments to move their fuel cell vehicles out of the research labs and onto the streets so more people can feast their eyes upon them.

With its ground-breaking Project Driveway, GM plans to place 100 fuel cell-powered Chevy Equinoxes into the hands of celebrities as well as regular people for 3 month test periods in the California, New York and Washington, DC areas in early 2008. Both the car and hydrogen fuel are offered free in exchange for real world data on how the vehicles perform in everyday operation. Some drivers have already been selected for the project and beginning in January 2008, the Walt Disney Company will take delivery of 10 vehicles and use them to shuttle Disney employees, celebrity talent and others within Disney-owned facilities in Southern California..

The fuel cell Equinox reaches speeds of 100 miles per hour (mph) in 12 seconds and has gone through all the standard safety testing and requirements. The vehicle comes equipped with driver and front passenger air bags, Chevy's StabiliTrak Electronic Stability Control System, four-wheel antilock disc brakes with Traction Control, and OnStar. GM

Table of Contents

Car Commitment	1
Current Demonstrations	2
Fuel Cell Vehicle Records	3
Ballard Sells Auto Assets	3
Greenhouse Gas Study	3
Rochester Hydrogen Village	4
Fuel Cells on High Seas	4
New ICAO Rules	5
Celebrities Going Green	6
Stationary Roundup	6

Fuel Cell Quarterly is a publication of Fuel Cells 2000, a non-aligned, non-profit educational activity of the Breakthrough Technologies Institute, a 501(c)(3) organization. Contributions to Fuel Cells 2000 generally are tax deductible and are most welcome.

Initial support for Fuel Cell Quarterly has been provided by grants from Argonne National Laboratory and the W. Alton Jones Foundation.

Copyright 2007 by BTI. Reproduction in whole or in part prohibited except by permission. All rights reserved.

Jennifer Gangi, writer/editor
jennifer@fuelcells.org

Sandra Curtin, writer
sandra@fuelcells.org

To read complete newsletter,
please go to [www.fuelcells.org/
info/newsletter.html](http://www.fuelcells.org/info/newsletter.html)

To remove your name from our
mailing list, please [click here](#).
Questions or comments? E-mail us
at jennifer@fuelcells.org.

**What can YOU do to
support the fuel cell
industry?**

Go to
[http://www.fuelcells.org/
info/grassroots.html](http://www.fuelcells.org/info/grassroots.html)
to find out how to get
involved.

has also demonstrated the European Version of the fuel cell Equinox, the HydroGen4, of which ten will undergo day-to-day testing overseas beginning in the middle of 2008.



Honda's FCX Clarity

Honda's FCX Clarity recently made its debut at the Los Angeles Auto Show and plans are underway to lease a limited number in Southern California in the summer of 2008. The three-year lease will cost \$600 per month, which includes maintenance and collision insurance. Commercials for the FCX Clarity are running on television, too.

The FCX Clarity incorporates Honda's latest generation V Flow 100 kW fuel cell stack which is smaller, lighter and more efficient than previous systems. The vehicle achieves around 350 miles per tank of hydrogen and reaches a top speed of 100 mph. The Clarity is about three times more efficient than today's ICEs and twice as efficient as hybrid vehicles.

DaimlerChrysler's Mercedes-Benz announced that the company will begin limited serial production (think hundreds) of its new B-Class F-Cell fuel cell vehicle within the next three years. The range of the vehicle is around 250 miles.

Mercedes has also provided the Sacramento Metropolitan Fire Department with a fuel cell-powered fire response vehicle, the Fire Service Mercedes-Benz F-Cell. The vehicle, based on the A-Class, contains a Ballard Power Systems fuel cell, has a range of approximately 100 miles, a top speed of 85 mph, and can go from 0 to 60 in 16 seconds. The vehicle will be refueled at a BP Energy hydrogen fueling station located at the California Fuel Cell Partnership, also in Sacramento. The company also has another fuel cell emergency response vehicle on the road in Michigan.



Hyundai i-Blue

At the Frankfurt Motor Show, Hyundai Motor Company introduced its new i-Blue Fuel Cell Electric Vehicle concept. The i-Blue incorporates Hyundai's third-generation fuel cell technology, a 100 kW electrical engine and fuel cell stack, which is currently being developed in-house in Korea. The i-Blue's 115 liter tank allows the vehicle to achieve around 360 miles per fueling and can reach a maximum speed of 102 mph. Hyundai plans to begin mass production of its fuel cell car in 2012 at the earliest, or from 2015 at the latest.

A company that has been rather quiet on the fuel cell front has resurfaced at the recent Los Angeles Auto Show. Volkswagen just rolled out the Space Up Blue, a concept vehicle that features a Volkswagen-designed high-temperature fuel cell. While almost every fuel cell vehicle uses a proton exchange membrane that operates at around 80 degrees Celsius, Volkswagen's high temperature fuel cell runs higher at about 120 degrees Celsius, eliminating the need for on-board cooling systems. As a result, the car weighs less. The Space Up Blue gets about 155 miles range, with an additional 62 miles kicking in via a compact lithium-ion battery package. The cool thing about the Space Up Blue is that it can charge its battery by plugging it in or by the roof-mounted solar panels. The first prototypes are expected in 2010, with the first production models arriving in showrooms by 2020.



Volkswagen's Space Up Blue

All of the recent and upcoming demonstrations and firming up of production plans show a clear commitment by automakers to the fuel cell future and the hydrogen economy. They are all starting to offer firm dates for rollouts and early stage commercialization. With each demonstration, valuable data and information helps researchers improve upon the technology. Hopefully these vehicles will drive out on the road sooner rather than later because seeing (and driving) is really believing. (JG)

Current Vehicle Demonstrations

Right now, there are light duty vehicles on the road in several states and around the world. Some of the high profile car demonstration projects in the U.S. include:

Honda - leased FCX to Spallino family of Redondo Beach, CA and actress Q'orianka Kilcher of Los Angeles, CA.

GM - U.S. Postal Service in Irvine, CA using HydroGen 3 minivan.

DaimlerChrysler - UPS testing fuel cell Sprinter vans in Los Angeles and Sacramento, CA as well as Ann Arbor, MI.

To see more, go to Fuel Cells 2000's State Fuel Cell and Hydrogen Database at <http://www.fuelcells.org/info/statedatabase.html>.

Fuel Cell Vehicle Records

The Ford Fusion 999, a modified production-based fuel cell car, attained a record speed of 207.297 mph at Utah's Bonneville Salt Flats during August 2007. The vehicle uses three high pressure tanks – two filled with hydrogen and one with a mix of helium and oxygen – sending a blend of the three gases to feed the car's fuel cell. The power-dense helium/oxygen mixture negates the need of an air compressor, reducing the system's weight and aiding the vehicle in achieving speeds greater than 200 mph. The car was engineered through a partnership of Ford, Ballard Fuel Cells, Roush Racing and Ohio State University, where the idea to race the fuel cell car was first proposed by a group of engineering students.



The super-fast Ford Fusion 999



Buckeye Bullet

Ford, Ballard Fuel Cells, Roush Racing and Ohio State University students have also been working together on the Buckeye Bullet 2, the world's first hydrogen fuel cell streamliner racer. The vehicle, which is powered by a mixture of hydrogen and oxygen, was designed and built from scratch by Ohio State engineering students, with guidance from faculty and sponsors. The racer successfully attained a speed of 224.301 mph at the Bonneville Salt Flats in October 2007 – exceeding the Ford Fusion's record and making it world's fastest fuel cell-powered vehicle!

An improved version of the Toyota FCHV (fuel cell hybrid vehicle) successfully completed a 2,300 mile trek from Fairbanks, Alaska to Vancouver, British Columbia along the Alaska-Canadian (ALCAN) highway. This next generation of the FCHV is 25 percent more fuel-efficient than the previous model and can store twice the quantity of hydrogen in its 70 MPa high pressure storage tank. The trip showed progress in reliability and durability, cold-weather operation and extended range capability - more than 450 miles on a single fill-up of hydrogen. Prior to this journey, the FCHV completed a 350-mile road trip from Osaka to Tokyo using just a single tank of hydrogen.



Toyota FCHV

A fuel cell-powered Unmanned Aerial Vehicle (UAV) – the remotely or self-piloted small aircraft used primarily by the military for reconnaissance and intelligence-gathering and also for civil applications - recently set a world record by flying 78 miles on a quarter tank of hydrogen. Dubbed the Pterosoar because the nose of the aircraft resembles a Pterosaur dinosaur, the craft has potential range of 310 miles on a full tank of hydrogen. The aircraft was developed by principal investigators Oklahoma State University and California State University, in association with Temesak Polytechnic of Singapore, Horizon Fuel Cell Technologies, NASA, the Dryden Flight Research Center, the U.S. Air Force Office of Scientific Research and National Science Foundation. The Pterosoar will soon attempt another world record, flying for more than 15.5 hours to break the current UAV endurance record. (SC)

Ballard Selling Auto Assets to Daimler and Ford

Ballard Power Systems is selling its auto fuel cell assets to Daimler and Ford in order to focus on growth in profitable fuel cell applications in commercial fuel cell growth markets, including materials handling, backup power and residential cogeneration. Daimler and Ford will form a new private company, called the Automotive Fuel Cell Cooperation, which will be located at Ballard's facilities. Ballard will retain a 20% share.

Ballard and Plug Release Greenhouse Gas Study

Ballard Power Systems and Plug Power have been evaluating the impact of hydrogen and fuel cell technology on greenhouse gas (GHG) emissions and had the results independently verified by the Center for Energy Efficiency and Renewable Technologies (CEERT). The analysis focused on fuel cell applications most likely to achieve near-term commercialization, specifically residential cogeneration, distributed generation, backup power systems, materials handling and public transit buses. The results show that global GHG reductions through the year 2025 from these applications could be in the range of 30,000 to 115,000 kilotonnes, depending on assumptions made regarding production of hydrogen. The study results can be found at <http://www.fuelcells.org/fuelcellclimatechange.pdf>.

Rochester's Hydrogen Village Taking Shape

Rochester, New York is on the way to developing America's first Hydrogen Village, a large-scale demonstration project that will harness the energy of the city's downtown waterfall to produce hydrogen from electrolysis for mobile and stationary applications. The pressurized hydrogen will be stored in tanks at hydrogen fueling stations for use in fuel cell car and bus demonstrations, and delivered by underground pipeline to some downtown buildings to replace the use of natural gas. The Project will also feature other forms of renewable energy, such as solar and wind power, as well as cutting edge energy efficiency technologies. Community leaders hope the Hydrogen Village will attract other energy R&D companies, making Rochester a leader in clean energy research and development and using "sustainability as an engine for economic growth". The U.S. Green Building Council has certified the city's Greenprint action plan, the first such certification in the nation. A fuel cell demonstration is already underway at the East Rochester Schools Complex where the unit provides half of the school's electricity on weekdays and two-thirds of power needs during the summer. The city will also soon receive Chevy Equinox Fuel Cell Vehicles for trials under GM's Project Driveway. (SC)



Fuel Cells on the High Seas

While automakers are working hard to get fuel cell cars on the road, several other organizations are focusing their sights on the water. With more than 12 million marine engines operating in the United States alone, you can imagine the amount of hydrocarbons and other polluting emissions coming from the high seas.

An outboard motor produces 140 times the hydrocarbons for each liter of fuel than the average car and marine diesels account for 4.5% of NOx and 1% of particulates from all mobile sources. The Envi-

ronmental Protection Agency (EPA) and state organizations such as the California Air Resources Board (CARB) have started passing regulations to control engine cleanliness, the fuels ships are allowed to use, and also pollution emitted when entering or exiting ports. Using fuel cells for engine propulsion, or even as an auxiliary power unit (APU) to provide electricity to onboard electronics has become a beacon of hope to alleviate marine pollution.

Researchers and manufacturers have been looking at fuel cell and hydrogen-fueled boats

for some time now – in 2000, a passenger ship powered by a 6.5-kW alkaline fuel cell set sail in Bonn, Germany. Several others followed shortly after. The advantages of fuel cells not only include drastic reductions in emissions, but also in noise and weight, plus a much longer operating time and faster charging.



Iceland New Energy's Smart H2

Since that maiden fuel cell ship voyage, a lot of activity and research has been taking place all over the world. A Marine Hydrogen and Fuel Cell Association has even formed in Germany, focused on advancing the progress of fuel cell technology in marine applications.

In Iceland, roughly one-third of the country's emissions come from its large fishing fleet. Icelandic New Energy, one of the major players leading Iceland's transition to the hydrogen economy, is looking to remedy that number and has several hydrogen boat projects under its wing.

In 2007, they launched the SMART H2 boat demo, a three year project to design and test a hydrogen-powered auxiliary unit that will be installed in a whale watching boat. The hybrid system, which is comprised of a fuel cell and batteries, will replace the current diesel

Cont'd from page 4

engine and generate electricity for all the boat's onboard needs. This demo builds upon the previous projects completed several years ago, including the FC-Ship and NewH-Ship. The boat in the SMART H2 demo can hold 150 passengers.

The Norwegian shipping group Eidesvik Offshore ASA plans to install a 330-kW MTU CFC Solutions' fuel cell system on an oilfield supply vessel in 2008. It will be one of several engines on the ship, all powered by liquefied natural gas (LNG) stored in refrigerated tanks on board.



Voller fuel cell yacht

Voller Energy, based in the UK, is targeting the marine and recreational markets with their portable fuel cell products. The company has even collaborated with Ken Freivokh to design a 55-ft fuel cell-powered yacht. In the designs, the yacht incorporates Voller's VE100 portable fuel cell system.

Voller has also joined forces with the Unipart Leisure and Marine division of the Unipart Group of Companies to distribute its 1-kW Emerald fuel cell system. The Emerald unit is able to run off of liquefied petroleum gas (LPG, propane or Calor Gas), and can provide hot water and space heating with the ability to support air conditioning.

Also in the UK, at the University of Birmingham, engineers have unveiled The Ross Barlow, a retrofitted canal boat with a fuel cell replacing the diesel engine. The boat uses metal hydride hydrogen storage which allows for more storage at less pressure. The university worked with EMPA Laboratories from Switzerland.

The Cobalt 233ZET, a hybrid runabout (small motorboat) has been developed by the Swiss firm Brunnert-Grimm and German company zebotec for use on Lake Constance, Germany, which has strict emissions regulations. The boat integrates electric motors, fuel cells, hydrogen tanks and uses a battery only for peak power requirements and is slated to enter the market in 2008.

Tropical S.A., located in Greece, is currently offering a fuel cell engine for boats. The fuel cell powers the propellers mounted on the boat. Tropical S.A. also has two different hydrogen generation options – a renewable electrolyzer or a natural gas/LPG reformer and has already begun selling complete hydrogen boat packages to European universities. The package includes the boat, a 1-kW fuel cell, an electric propeller and a metal hydride storage tank.

In Canada, Jim Harrington, president of AGO Electronics, successfully installed a 300-watt Horizon fuel cell system into a 19-foot sailboat.

Back in the United States, the Naval Sea Systems Command (NAVSEA) not only maintains a force of 53,000 civilian, military and contract support personnel, but oversees the Navy's ships and submarines as well. About ten years ago, NAVSEA and the Office of Naval Research (ONR) began an advanced development program to develop shipboard fuel cell power systems for the Navy. The program, Ship Service Fuel Cell (SSFC) program, worked with several different fuel cell types and sizes through the years, and other programs focused on component development and fuel reforming and logistics challenges. NAVSEA currently has a High Performance Fuel Cell program (HPFC) focused on developing a 500 kW fuel cell that would be scaled to fit the ship's needs - 2,500 kW is a target. The fuel cell system will contain a fuel processor to reform diesel and other fuels that the Navy often utilizes.

The progress these groups are achieving with their fuel cell boats can translate into other transportation application advancements, and even move on to land, cleaning up busy ports and harbors by using stationary fuel cells. So regardless of what part of the globe and which lakes or oceans these fuel cell boats set sail in, the voyage will benefit both the industry and the environment, leading to much more peaceful energy waters. (JG)



Cobalt 233ZET

ICAO Rules Fuel Cells Can Be Carried On Board Airplanes

The International Civil Aviation Organization (ICAO) Dangerous Goods Panel (DGP) has decided that fuel cells and fuel cartridges for fuel cells of all types can be transported as cargo and as carry-on baggage on board both passenger and cargo aircraft. The decision is effective as of January 2009 with the adoption of the ICAO Technical Instructions by the various countries around the world. This decision builds upon approvals of methanol, formic acid and butane fuel cells that took effect in January of 2007.

Celebrities Going Green

Green is the new black for celebrities, and many are becoming high profile supporters of fuel cells and hydrogen.

Actor George Clooney has signed on as an executive board member, and the public face, of a new Swiss energy company that will develop fuel cells for vehicles. The company is being formed by the CEO of watchmaker company, Swatch Group.



Singer-songwriter and environmentalist Tracy Lyons' autumn concert tour will feature an off-grid powered stage that will use biodiesel and a fuel cell. Lyons' vision for the tour is to draw attention to global warming, alternative and clean energy solutions and the negative health effects of pollution.

The Clinton Climate Initiative (CCI), a project of former President Bill Clinton, has signed Memoranda of Understanding with fuel cell developer UTC Power, and fuel cell storage system developer Dynatek Industries, as official suppliers in the group's effort to help commercialize fuel cell buses. CCI is forming a purchasing consortium for volume sales that will help cities buy energy efficient technologies at lower prices.

BMW has begun delivering their BMW Hydrogen 7 vehicle - a 6.0 liter, V12 luxury performance sedan with a hydrogen drive - to entertainers, politicians and business leaders for long-term test drives. The car is fueled with up to 17.6



BMW Hydrogen 7

pounds of liquid hydrogen that is stored at -423° Fahrenheit in a cryogenic tank, giving the vehicle a range of around 125 miles. The Hydrogen 7 also carries a 19.5-gallon gas tank (310-mile range) and can switch from one fuel to the other at the touch of a button. Keys have already been turned over to comedian Will Ferrell, talk show host Jay Leno, opera singer Placido Domingo, Inconvenient Truth director Davis Guggenheim, and author and hydrogen advocate Terry Tamminem. The Hydrogen 7 has also chauffeured celebrities to high profile premieres and events, including actors Brad Pitt, Angelina Jolie, Gerard Depardieu, Jane Fonda, Greta Scacchi, Richard Gere, Monica Bellucci, Geoffrey Rush and Cate Blanchett, and film director Francis Ford Coppola. (SC)

Stationary Roundup

In the past few months, there have been several installations around the globe as well as numerous announcements of sales and upcoming locations for the siting of fuel cells.

IdaTech, plc installed and is currently operating its 3-kW Tactical Fuel Cell Generator (TFCG) at the Army Communications-Electronics Research Development and Engineering Center (CERDEC) in Ft. Belvoir, Virginia. IdaTech also installed a 5-kW ElectraGen™5XTR fuel cell backup system at Investec's security office in London.

Plug Power Inc. has installed two 5-kW GenCore® fuel cell systems to provide backup power for a New York State Police radio tower in eastern Rensselaer County. Each fuel cell system has enough stored hydrogen to provide backup power for 72 hours without refueling.

Acumentrics Corporation has completed the installation of a 5-kW solid oxide fuel cell (SOFC) system at the Cuyahoga Valley National Park in Ohio, its second installation at the Park. Acumentrics has also shipped a 5-kW SOFC to Hera Holdings in Barcelona, Spain, for a demonstration system using biogas from a Hera landfill site to generate heat and electricity.

Several fuel cell manufacturers made significant sales recently. FuelCell Energy, Inc. sold 3.9 megawatts (MW) of power plants to the Linde Group to install at various customer locations in the San Diego area and three DFC300 power plants to Eastern Municipal Water District (EMWD) in California. FuelCell Energy, Inc. also sold one of its DFC300 power plants to the Pacific Missile Range Facility (PMRF) on Kauai, Hawaii, scheduled for installation by September 2009.

UTC Power is providing its PureCell™ Model 200 fuel cell system to the new 283,000-square-foot Middletown High School and Vocational Agricultural Center in Connecticut which is due to open in September 2008.

To keep tabs on where fuel cells are located, check out Fuel Cells 2000's installation [data-base](#).