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Hydrogen Fuel Station to Open in Seoul



Hyundai to unveil new fuel cell vehicle at IAA 2007 in Frankfurt



FuelCell Energy Sells Megawatt Power Plant to Turlock Irrigation District in California



Germany- Joint Commitment to Fuel Cells

Special Industry Story/Headlines



Industrial Fuel Cell Car Wash

“Inside The Industry” Sponsored by



1.) Hydrogen Fuel Station to Open in Seoul

Seoul is about to turn a new chapter in clean energy with the opening of the city's first hydrogen fueling station.

According to the Ministry of Commerce, Industry and Energy and the National RD&D Organization for Hydrogen & Fuel Cell on Tuesday, GS Caltex Corporation got approval from Seodaemun-gu Office earlier this year and has been constructing since March a hydrogen fueling station at Yonsei University in Seoul.



An artist's rendering of the GS Caltex hydrogen fueling station in Seoul.

The station is currently being tested ahead of its completion date scheduled for the middle of next month.

The country's first hydrogen fueling station opened in August last year at the Korea Institute of Energy Research in Daejeon. The station at Yonsei University will be the first located in the center of the city.

The opening of the Seoul hydrogen station should provide momentum for Hyundai Motor and local researchers that are developing cars designed to run on hydrogen fuel cells.

The refilling station is being built with support from MOCIE, the Korea Energy Management Corporation and the National RD&D Organization for Hydrogen & Fuel Cell.

At the station, hydrogen is produced from naphtha and stored in a high-pressure chamber that can dispense it into cars. Currently, there are 26 hydrogen fuel stations for research and everyday use in the U.S., 11 each in Germany and Japan, and six in Canada.

2.) Hyundai to unveil new fuel cell vehicle at IAA 2007 in Frankfurt



Hyundai Motor Corporation will unveil the i-Blue Fuel Cell Electric Vehicle at the 2007 Frankfurt International Motor Show which opens on September 13. The i-Blue demonstrates the company's commitment to developing environmentally responsible transportation.

Hyundai's new hydrogen-powered, zero-emission concept, the i-Blue Fuel Cell Electric Vehicle was developed at Hyundai's Design and Technical Center in Chiba, Japan. The all-new i-Blue platform is tailored to incorporate

Hyundai's third-generation fuel cell technology, currently being developed at Hyundai's Eco-Technology Research Institute in Mabuk, Korea.

In keeping with this year's show theme, "See What's Driving the Future," which focuses on sustainability and climate protection, the i-Blue signifies a major step towards the commercialization of Hyundai fuel cell vehicles. Unlike its predecessors which were built on SUV platforms, the i-Blue features a new 2+2 crossover utility vehicle (CUV) body type.

"The i-Blue is Hyundai's first-ever model designed from the ground up to incorporate fuel cell technology, marking a tremendous leap forward for our R&D program," said Dr. Hyun-Soon Lee, president of research and development. "Our engineering team has successfully designed a more compact fuel cell vehicle, while still realizing the safety, comfort, convenience and driving range of a traditional internal combustion engine vehicle."

Hyundai is making tremendous efforts to reach mass production of hydrogen-powered fuel cell vehicles a reality in the next decade.

3.) FuelCell Energy Sells Megawatt Power Plant to Turlock Irrigation District in California

FuelCell Energy, Inc. (Nasdaq:FCEL), a leading manufacturer of ultra-clean power plants using renewable fuels for commercial, industrial, utility and government customers, announced the sale of a 1.2 megawatt (MW) power plant to the Turlock Irrigation District (TID) to help meet its growing energy needs and improving air quality in the San Joaquin's Valley Air Basin.

The Direct FuelCell(r) (DFC(r)) power plant will be located at the city of Turlock's Regional Water Quality Control Facility, in California's Central Valley. By running the plant on a renewable fuel -- methane gas generated from its treatment of wastewater -- TID will reduce its carbon footprint by 5,200 tons annually compared to a typical power plant and saves on the cost of fuel.

DFC power plants have a system efficiency of 47 percent -- significantly better than traditional power plants which means they use less fuel to produce a MW of electricity. By using waste heat, these power plants can achieve up to 80 percent efficiency -- providing substantial improvement in fuel costs, air quality and reducing California's reliance on fuels like coal.

Located about 75 miles east of San Jose, the TID was California's very first publicly owned irrigation district. It is the electric service provider for approximately 220,000 people and 97,000 retail establishments in a 662-square-mile region that encompasses northern Merced County and Southern Stanislaus County, as well as small sections of Tuolumne and Mariposa counties. Electricity generated by its DFC1500(tm) unit will provide energy for approximately 1,000 homes and businesses in the area.

"We researched multiple solutions, including engines, turbines and other fuel cell manufacturers, to address our need to use a valuable renewable resource in the cleanest and most efficient way possible," said Larry W. Weiss, TID's General Manager. "We selected the DFC product as the best way to generate the maximum amount of electricity while negating the harmful impact on the air quality of our community and air basin."

TID is headquartered within the city of Turlock, a city of 69,000. The City's award-winning water Regional Water Quality Control Facility is responsible for wastewater treatment for Turlock and the community service districts of Denair, Keyes and a portion of the city of Ceres. As the principal provider of methane gas for the fuel cell power plant, the city views the fuel cell project as a benefit to the environment as well as the region's residents.

"Our partnership with TID for this project will provide an additional beneficial use of a valuable byproduct of the wastewater treatment process -- methane," said Dan Madden, the city's Municipal Services Director. "A further reduction in air emissions, as well as the efficient production of energy utilizing the Direct FuelCell process, only makes sense."

"Wastewater treatment facilities are the perfect application for our fuel cells in the state of California," said William Karambelas, Vice President of Business Development for FuelCell Energy. "By their nature, wastewater treatment facilities are located near population centers, many of which are growing fast, so there is a critical need for added power generation to be not only highly efficient but also ultra-clean."

FuelCell Energy currently has over 14 MW of power plants installed or on order for California customers, of which 4.85 MW are for wastewater applications.

California's Self Generation Program (SGIP), which was developed to foster the installation of clean and renewable generation sources throughout the state, contributed \$4.5 million toward this project. The power plant will be installed in the summer of 2008 by TID and once operational will be serviced by FuelCell Energy.

4.) Joint Commitment to Fuel Cells -Companies and Federal Minister of Transport Emphasize the Potential of this Future Technology

"**H**ydrogen and fuel cell technology is a critical building block when it comes to climate protection and our future energy supply." Federal Minister Wolfgang Tiefensee emphasized this point today during a visit to EWE AG in Oldenburg. The minister of transport, construction and urban development obtained more information about the current state of development of stationary fuel cells for single-family and multi-family houses at the EWE educational center.

The company's cooperative partners – manufacturers Baxi Innotech, CFCL, Hexis, Vaillant and Viessmann – presented their fuel cell devices in Oldenburg. The presentation triggered a detailed exchange of information among Tiefensee, the manufacturers and EWE.



Federal Minister Wolfgang Tiefensee, Dr. Werner Brinker, CEO of EWE AG, and the CEOs of Baxi Innotech, CFCL, Hexis, Vaillant and Viessmann met to discuss about the current state of development of stationary fuel cells for single-family and multi-family houses.

The minister was visibly impressed by the potential of the stationary application. "I expect stationary fuel cells to play a highly significant role in the efficient and environmentally compatible provision of heat and electricity to our buildings for a long time to come," stated Tiefensee. EWE and the manufacturers made great strides toward a market launch of this technology through their field tests.

EWE is already one of the leaders in the testing of fuel cells and intends to further intensify this commitment. As Dr. Werner Brinker, CEO of EWE AG, underlined, "Intelligent solutions are the key to the energy supply of the future. We are delighted to have the federal government support us in this project." It is now only a matter of time until fuel cells become established in the market.

Fuel cell technology is undisputedly regarded as the most efficient form of combined heat and power generation among experts. As part of the ten-year "National Innovation Program for Hydrogen and Fuel Cell Technology," government and industry are promoting the further development of this technology for mobile and stationary applications. Government and industry are each providing about 500 million euros in funding. The goal of the program is to make fuel cells marketable

through joint demonstration projects known as "lighthouse" projects.

The scheduled lighthouse project in domestic energy supply is a joint project of EWE, Baxi Innotech, MVV, Vaillant and Viessmann. Other companies also have the option to participate.

5.) Ford to Turn Paint Solvent From Auto Manufacturing Facility Into Green Energy With Ultra-Clean Power Plant From FuelCell Energy

300 Kilowatt Direct FuelCell Unit Will Operate On Paint Fumes That Were Previously Vented Into the Atmosphere



FuelCell Energy, Inc. a leading manufacturer of ultra-clean power plants using a variety of fuels for commercial, industrial and utility customers, announced that Ford Motor Co. will purchase a DFC300MA(tm) fuel cell for its Oakville, Ontario, facility to reduce paint solvent emanating from automotive painting operations by turning fumes from those compounds into 300 kilowatts (kW) of green electricity.

The Direct FuelCell(r) (DFC(r)) unit can transform into fuel the Volatile Organic Compounds (VOCs) that emanate from enamel base paints and clear coat finishes used in manufacturing.

The DFC power plant is being funded by Industry Canada, and the Ontario Ministry of Economic Development and Trade to assist in deploying alternative energy sources. The unit deployment in Oakville will be supported through the combined efforts of FuelCell Energy and its distribution partner, Enbridge, Inc. (NYSE:ENB - News). Installation and integration of the power plant with Ford's manufacturing facility will be managed by Arencibia Associates of Coopersburg, PA.

``By using the end-products of enamel and clear coat operations, we are eliminating the exhaust of thousands of tons of nitrous and sulfur oxides as well as CO2 -- a major greenhouse gas," said Andrew Skok, Executive Director, Strategic Marketing for FuelCell Energy. ``As this application shows, the fuel flexibility of our DFC300MA opens up an entirely new, very large market for us."

The DFC300MA unit is expected to be started up early in 2008 and over time, Ford and Detroit Edison, which jointly own the rights to the paint fume clean up and separation technology, could roll the system out to Ford's other plants, or license it to other manufacturers whose operations include similar uses of paint compounds.

6.) Plug Power Fuel Cells Provide Clean, Reliable Backup Power for New York State Fair



Plug Power Inc. (Nasdaq: PLUG), a leader in providing clean, reliable on-site energy products, has installed four GenCore® fuel cell systems at the New York State Fairgrounds to provide backup power for key communications infrastructure, including a public address (PA) system that is critical in emergency response situations.

The system providing backup power for the PA system is installed at the Coliseum, a sporting arena that includes an ice skating rink. The other three stationary GenCore systems are installed at three separate buildings, providing backup power for telecommunications systems, fiber optics and computer networks.

"It's critical that we're prepared in the event of a power outage or other emergency, especially with respect to our ability to communicate with people throughout the fairgrounds, which spans nearly 400 acres," said Dan O'Hara, the Director of the New York State Fair, a division of the New York State Department of Agriculture.

Currently, the New York State Fairgrounds is hosting the 161st Annual New York State Fair, which will continue through Labor Day on Sept. 3. The New York State Fairgrounds host statewide events throughout the year that can benefit from the reliable backup power provided by GenCore. "About one million people visit the fair each year. The enhanced reliability offered by the GenCore fuel cell systems will help ensure the safety of visitors as well as the continuity of our

operations," noted O'Hara.

"Because of their proven reliability and effectiveness, fuel cells are gaining traction with New York State in a variety of backup power applications," said Mark Sperry, Plug Power's Chief Marketing Officer. "And as state agencies across the country upgrade their systems with new equipment and technology, we expect that fuel cells will become the preferred backup power source for mission critical applications."

The New York Power Authority (NYPA) provided the funding for the four installations as part of a program to deploy fuel cells that will provide backup power at 22 public safety communications facilities across New York State.

7.) Politecnico of Turin Researchers to carry out tests on hydrogen in flight

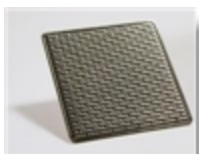
Used in the development of "Ecological" AAPU for aeronautics (WAPA) - "The expedition of researchers from Environment Park and Politecnico of Turin will leave tomorrow, Tuesday August 28th from Gressoney la Trinité (Aosta) to the 4556 mt. of Punta Gnifetti, on Monte Rose, for carrying out a series of tests on hydrogen in the labs of Capanna Margherita, the highest shelter in Europe.

An experiment at over 4,000 meters to appraise the performances of a hydrogen electric generator realized by Environment Park and reshaped by the Departments of Aeronautical and Space Engineering and Energetics of Turin's Politecnico, to be used as power generation unit (Auxiliary Power Unit - APU) on the ultralight aircraft Pelican, provided by Digisky. The APU will be installed on board the Pelican, equipped with a data acquisition system, and will be directly connected to the aircraft's electric system; at last, Digisky's pilots will try it in flight to study its performances and reliability.

The generator can supply a maximum power of 1,500 Watts and will power the tools, avionics and all on-board systems of the aircraft. It's a hydrogen generation unit similar to that installed on Easyriders, the ecological mopeds realized by Environment Park, properly readapted for aeronautical needs by the research staff of the Politecnico. The different parts of the generation unit will be transported to the various route stopovers and on the top of Capanna Margherita by a helicopter.

The tests target is to classify the behaviour of the combustible cell in altitude, where air pressure is a little more than half the pressure at sea level and temperature and humidity are rather low. Researchers observed that rarefied air, like it happens over 3,500 meters of altitude, causes a general decrease of the electric generator's performances. The mission target's is to identify ideal conditions for the working of the generation unit in an extreme environment".

8.) Morphic Technologies AB Receives Volume Order for Fuel Cell Plates



Morphic's subsidiary, Cell Impact, has received its first volume order to supply serial production volumes of fuel cell plates intended for consumer electronics from a US customer. The order represents a commercial breakthrough for Cell Impact. The agreement is valued at SEK 60 million, over a two-year period.

The flow plates will be produced using Morphic's patented high impact technology and offers a superior efficiency rate at an unbeatable price per unit. The manufacturing will initially take place in Cell Impact's production facility in Karlskoga, Sweden. Initial deliveries are scheduled for January 2008.

"It's no coincidence that the order stems from the consumer electronics industry. We have seen significant interest from that sector. This is a small order but it's indicative for the fuel-cell industry. It illustrates that our offer is heading the market and proves that we can deliver on price and performance," says Martin Valfridsson, President for Cell Impact.

There is a sizeable market potential within the sector. The main advantages are that fuel cells have considerably longer operating time and can be recharged extremely quickly. Contrary to today's batteries, the time it takes to restore maximum capacity is negligible.

About fuel cells and flow plates

The electricity in a fuel cell is produced by hydrogen dissolving in a controlled manner and reacting with oxygen. This reaction produces electricity with heat and water being the only residue. With a long life-span and next to no negative environmental impact, fuel cells represent a real alternative to most of today's energy converters when it comes to producing electricity for societal, industrial and residential needs, as well as for vehicle and portable electronics.

Simply put, a fuel cell consists of an electrolyte with two electrodes on each side. So-called 'flow plates' reside outside the electrodes, between which the injected fuel, for example hydrogen or methanol, react with oxygen. The plates represent a big part of the cost and its ability to effectively navigate hydrogen gas is essential for the fuel cell's ability to generate electricity. Morphic's patented technology makes it possible to manufacture the plates quicker, cheaper and of better quality than ever before.

9.) ARSC's American Hydrogen Corp and Ohio University Researchers to Develop Ammonia-to-Hydrogen Technology

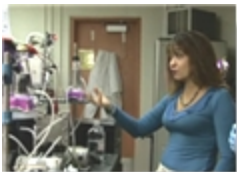


American Security Resources Corp. (OTCBB:ARSC) announced that its subsidiary, American Hydrogen Corp., and Ohio University (www.ohio.edu) have defined the goals for the Sponsored Research that ARSC is funding as part of its worldwide exclusive license to commercialize the patent-pending catalytic electrolyzer technology developed by Ohio University's Dr. Gerardine Botte.

Botte, associate professor of Chemical and Bio-Molecular Engineering at the Russ College of Engineering and Technology, who developed a method for producing hydrogen from ammonia for a fraction of the current commercial cost, will direct the research. The goals are to integrate an ammonia-catalytic-electrolyzer (ACE) with a HydraStax® fuel cell from ARSC's Hydra Fuel Cell Corp., upscale current electrode design to large commercial size and demonstrate the ACE technology to power a fuel cell car.

Benjamin Schafer, president of American Hydrogen and CTO of Hydra Fuel Cell, said, "Since we executed the License with Ohio University, we have been presented numerous opportunities to apply the ACE in a number of commercial applications which we're pursuing. Dr. Botte's team of researchers is creating the tools we need to capture these potential customers."

To View Video Interview of a **A fuel of the future** from the Ohio University Labs click [here](#) 📺



In a time when gas prices are topping the three-dollar-a-gallon mark, it's refreshing to know that researchers at Ohio University are contributing to the progress in developing more cost-efficient, environmentally friendly fuels. One such alternative fuel showing a great deal of promise is ammonia, and in Gerardine Botte's lab, that technology is already working.

10.) Linde's CEO Wolfgang Reitzle to drive hydrogen-powered BMW Hydrogen 7 from now on



For Professor Dr. Wolfgang Reitzle, the objective is clear: "Hydrogen-powered cars should become an everyday sight on our streets."

Today in Munich, the Chairman of the Executive Board of Linde AG is practicing what he preaches by collecting a BMW Hydrogen 7 at the Linde Hydrogen Center.

A brand new model of the first top-end saloon in the world with a bivalent hydrogen-powered combustion engine was handed over by Professor Dr. Joachim Milberg, Chairman of the Supervisory Board of the BMW Group.

11.) Branford High School First School in Connecticut to Install a Clean UTC Power On-site Tri-generation Power System



UTC Power, a United Technologies (NYSE: UTX) company, announced that Branford High School in Branford, Connecticut, has selected a UTC Power PureComfort(R) tri-generation system to provide on-site power, cooling and heating at the 1,200-student facility.

This ultra clean combined cooling, heating and power system also will enable the high school to double as an emergency shelter by having an on-site power source capable of grid-independent operation.

UTC Power PureComfort(R) systems are extremely energy efficient. They can achieve an overall energy utilization of up to 90 percent -- far greater than the 33 percent typical of the electrical grid. These systems also reduce a customer's carbon footprint because of their higher fuel utilizations and the use of natural gas to generate electricity, rather than coal or oil.

The system's design also ensures a reduction in pollutant emissions such as smog-forming nitrogen oxides, and there are no ozone-depleting refrigerants. Compared with generating power from the grid, the system will save more than 2.5 million gallons of water annually, nearly enough water to fill four Olympic-sized swimming pools.

According to Mark Deming, director of Facilities for the Branford School District, "The UTC Power system was the sensible choice for us; it can provide power, cooling and heating simultaneously in a clean, green, efficient manner. Plus, we know we can count on having backup power if there's a grid failure."

The UTC Power system will be the first in the state to provide simultaneous heating and cooling, with no seasonal changeover required, using the hot exhaust from its natural gas-fired microturbines to drive a double-effect absorption chiller. The system will lower the high school's energy bills and provide positive cash flow for the school district.

United Technologies Corp., based in Hartford, Conn., provides high-technology products and services to the building and aerospace industries. Its UTC Power unit in South Windsor, Conn., is a full-service provider of environmentally advanced power solutions. UTC Power is a world leader with nearly 50 years experience in developing and producing fuel cells for on-site power, transportation, space and defense applications, as well as a leader in innovative renewable energy solutions and combined cooling, heating and power solutions for the distributed energy market.

The mission of the Branford Public Schools is to develop life-long learners who are capable and confident, who contribute to their community, and who succeed in a changing global society.

12.) Air Products to Lead DLA Hydrogen Powered Forklift Demonstration Program



Air Products (NYSE: APD) announced it has signed an agreement with the Defense Logistics Agency's (DLA) Research and Development Program as lead contractor for a two-year demonstration program to develop an indoor hydrogen fueling station technology infrastructure to fuel 20 hydrogen fuel cell-powered forklifts for daily warehouse operations at the Defense Distribution Depot Susquehanna Pennsylvania (DDSP).

Air Products will collaborate with General Hydrogen, a wholly-owned subsidiary of Plug Power Inc. (Nasdaq: PLUG), to retrofit 20 battery-powered Class 1 forklifts with General Hydrogen's fuel cell power packs and provide Air Products' hydrogen fueling station technology infrastructure for the pilot program. DDSP personnel will operate the fuel cell-powered forklifts alongside lead-acid battery forklifts in daily operations. Data to compare costs and operational characteristics will be collected and analyzed to support the development and commercialization of hydrogen fuel cell technologies for Department of Defense (DoD) operations.

"The DLA is to be commended for commencing this demonstration program. Hydrogen-powered forklifts provide an excellent opportunity to continue to grow the potential applications for the use of hydrogen as an energy carrier. We believe the program will demonstrate that hydrogen-powered forklifts will show productivity improvements during active

warehouse operations, and also show economic and environmental benefits at the same time," said Tom Joseph, business development manager for Hydrogen Energy Systems at Air Products.

Hydrogen fuel cell-powered forklifts need refueling, which typically can be completed in less than five minutes, only once or twice daily, depending on use. In contrast, traditional battery-powered forklifts must be placed temporarily out of operation for battery replacement and required battery recharging usually every four to six hours. Hydrogen fuel cell-powered forklifts provide consistent power strength during use and do not have decreased performance or wear down as required battery changeout and recharge time nears. Further, hydrogen-powered fuel cell forklifts are more environmentally friendly, without associated lead-acid battery storage and disposal issues.

This demonstration program is a continuation of Air Products' work in the hydrogen-powered forklift market. Air Products has been participating in similar work at a manufacturing and assembly plant in Tennessee since January 2006 and a grocery chain warehouse in Texas since March 2007. The projects include providing indoor hydrogen fueling station infrastructure for fueling hydrogen-powered forklifts and automated guided vehicles powered by hydrogen.

13.) Japan's Samtech unveils new hydrogen cylinder for fuel cells



SAMTECH CO., a maker of forged auto parts, has developed a hydrogen storage cylinder for fuel cell cars that will let them travel longer distances without having to refuel. The storage container can hold 1.5 kilograms of hydrogen in a 40.8-litre cylinder.

* Since fuel cell cars can travel around 100 kilometers on 1 kilogram of hydrogen, a car equipped with four of these cylinders could travel 600 kilometers on a full load.

* The device is a high-pressure aluminum cylinder integrated with an alloy capable of absorbing and releasing hydrogen. The cylinder is pressurized to 350 atmospheres, but use of the alloy allows more hydrogen to be filled in the tank than is possible from high pressure alone.

13.) Rotterdam Climate Initiative Sponsors Formula Zero



The progressive city of Rotterdam has become Formula Zero's first Championship sponsor! The city will get to host the World Premiere **Formula Zero Championship**, Student Edition, and will provide the teams with fuel cells. Formula Zero looks forward to this exciting partnership and thanks all those involved in the process of making this happen.

Formula Zero will attempt to break FIA record in Rotterdam

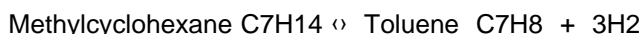
The 16th September 2007 will be an (ICE) car-free Sunday in Rotterdam to mark the beginning of the European Mobility Week. On this day Formula Zero will attempt to break the official FIA record on the Coolsingel in the heart of the city. The record attempt will take place at 13:30. For more details please visit our website. The current International 1/8 mile official FIA record for fuel cell vehicles, stands at 11,896 seconds and was set by Formula Zero last year. Come and see if we can break this record on the 16th September!

14.) Researchers Test On-Board System for Hydrogen Storage in Organic Hydride Liquids

Hrein Energy Inc., a Japan-based developer of hydrogen storage systems based on organic hydrides, has successfully field-tested an on-board version of its storage system to produce a hydrogen stream for use with gasoline in an automobile combustion engine. Hrein is targeting its system for eventual use with fuel-cell vehicles, among other applications.

The cooperative research project included Professor Emeritus Masaru Ichikawa of Hokkaido University, the developer of the organic hydride system, along with Futaba Industrial Co. and Ito Racing Service Co.

Organic hydrides are liquids under atmospheric temperature and pressure, yet offer relatively high hydrogen content: between 6-8 wt.%. An example of the reaction is:



Because the organic hydrides are liquids (not to be confused with liquefied hydrogen), the existing fuel storage, transportation and refueling infrastructure could basically be maintained were the liquids applied to transportation.

Organic chemical hydrides can freely produce and absorb H_2 gas by catalytic reaction under mild conditions. Hrein developed a spray pulse reactor that feeds the reactant (the organic hydride liquid) to the hot catalyst surface as atomized liquid.

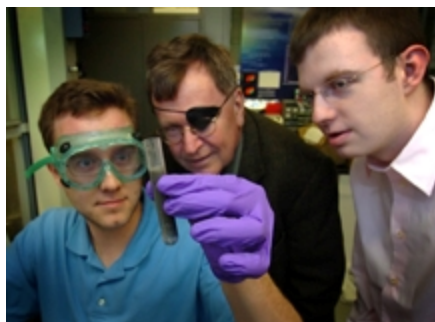
The company obtained its highest hydrogen production rate by using highly heat conducting supporting materials (thin Al_2O_3 layer on aluminum plate). Hrein Energy and the others packaged this system in the form of a small cylindrical reactor for recovering hydrogen from the organic hydride. Made of aluminum, the reactor is 45cm tall and 15cm in diameter and is heated by the engine's exhaust.

Hrein Energy plans to test the system on a compact car within the year.

Separately, at the recent 234th meeting of the American Chemical Society, Robert Crabtree from Yale presented his work on developing catalysts that could enable the use of hydrogen carried in a liquid fuel for transportation use.

Research News

Purdue Engineers continue to perfect hydrogen-generating technology



Researchers at Purdue University have further developed a technology that could represent a pollution-free energy source for a range of potential applications, from golf carts to submarines and cars to emergency portable generators.

The technology produces hydrogen by adding water to an alloy of aluminum and gallium. When water is added to the alloy, the aluminum splits water by attracting oxygen, liberating hydrogen in the process. The Purdue researchers are developing a method to create particles of the alloy that could be placed in a tank to react with water and produce hydrogen on demand.

The gallium is a critical component because it hinders the formation of an aluminum oxide skin normally created on aluminum's surface after bonding with oxygen, a process called oxidation. This skin usually acts as a barrier and prevents oxygen from reacting with aluminum. Reducing the skin's protective properties allows the reaction to continue until all of the aluminum is used to generate hydrogen, said Jerry Woodall, a distinguished professor of electrical and computer engineering at Purdue who invented the process.

Since the technology was first announced in May, researchers have developed an improved form of the alloy that contains a higher concentration of aluminum.

Recent findings are detailed in the first research paper about the work, which will be presented on Sept. 7 during the 2nd Energy Nanotechnology International Conference in Santa Clara, Calif. The paper was written by Woodall, Charles Allen and Jeffrey Ziebarth, both doctoral students in Purdue's School of Electrical and Computer Engineering.

Because the technology could be used to generate hydrogen on demand, the method makes it unnecessary to store or

transport hydrogen - two major obstacles in creating a hydrogen economy, Woodall said.

The gallium component is inert, which means it can be recovered and reused.

"This is especially important because of the currently much higher cost of gallium compared with aluminum," Woodall said. "Because gallium can be recovered, this makes the process economically viable and more attractive for large-scale use. Also, since the gallium can be of low purity, the cost of impure gallium is ultimately expected to be many times lower than the high-purity gallium used in the electronics industry."

As the alloy reacts with water, the aluminum turns into aluminum oxide, also called alumina, which can be recycled back into aluminum. The recycled aluminum would be less expensive than mining the metal, making the technology more competitive with other forms of energy production, Woodall said.

In recent research, the engineers rapidly cooled the molten alloy to make particles that were 28 percent aluminum by weight and 72 percent gallium by weight. The result was a "metastable solid alloy" that also readily reacted with water to form hydrogen, alumina and heat, Woodall said.

Following up on that work, the researchers discovered that slowly cooling the molten alloy produced particles that contain 80 percent aluminum and 20 percent gallium.

"Particles made with this 80-20 alloy have good stability in dry air and react rapidly with water to form hydrogen," Woodall said. "This alloy is under intense investigation, and, in our opinion, it can be developed into a commercially viable material for splitting water."

The technology has numerous potential applications. Because the method makes it possible to use hydrogen instead of gasoline to run internal combustion engines, it could be used for cars and trucks. Combusting hydrogen in an engine or using hydrogen to drive a fuel cell produces only water as waste.

"It's a simple matter to convert ordinary internal combustion engines to run on hydrogen. All you have to do is replace the gasoline fuel injector with a hydrogen injector," Woodall said.

The U.S. Department of Energy has set a goal of developing alternative fuels that possess a "hydrogen mass density" of 6 percent by the year 2010 and 9 percent by 2015. The percent mass density of hydrogen is the mass of hydrogen contained in the fuel divided by the total mass of the fuel multiplied by 100. Assuming 50 percent of the water produced as waste is recovered and cycled back into the reaction, the new 80-20 alloy has a hydrogen mass density greater than 6 percent, which meets the DOE's 2010 goal.

Aluminum is refined from the raw mineral bauxite, which also contains gallium. Producing aluminum from bauxite results in waste gallium.

"This technology is feasible for commercial use," Woodall said. "The waste alumina can be recycled back into aluminum, and low-cost gallium is available as a waste product from companies that produce aluminum from the raw mineral bauxite. Enough aluminum exists in the United States to produce 100 trillion kilowatt hours of energy. That's enough energy to meet all the U.S. electric needs for 35 years. If impure gallium can be made for less than \$10 a pound and used in an onboard system, there are enough known gallium reserves to run 1 billion cars."

The researchers note in the paper that for the technology to be used to operate cars and trucks, a large-scale recycling program would be required to turn the alumina back into aluminum and to recover the gallium.

"In the meantime, there are other promising potential markets, including lawn mowers and personal motor vehicles such as golf carts and wheelchairs," Woodall said. "The golf cart of the future, three or four years from now, will have an aluminum-gallium alloy. You will add water to generate hydrogen either for an internal combustion engine or to operate a fuel cell that recharges a battery. The battery will then power an electric motor to drive the golf cart."

Another application that is rapidly being developed is for emergency portable generators that will use hydrogen to run a small internal combustion engine. The generators are likely to be on the market within a year, Woodall said.

The technology also could make it possible to introduce a non-polluting way to idle diesel trucks. Truck drivers idle their engines to keep power flowing to appliances and the heating and air conditioning systems while they are making

deliveries or parked, but such idling causes air pollution, which has prompted several states to restrict the practice.

The new hydrogen technology could solve the truck-idling dilemma.

"What we are proposing is that the truck would run on either hydrogen or diesel fuel," Woodall said. "While you are on the road you are using the diesel, but while the truck is idling, it's running on hydrogen."

The new hydrogen technology also would be well-suited for submarines because it does not emit toxic fumes and could be used in confined spaces without harming crew members, Woodall said.

"You could replace nuclear submarines with this technology," he said.

Other types of boats, including pleasure craft, also could be equipped with such a technology.

"One reason maritime applications are especially appealing is that you don't have to haul water," Woodall said.

The Purdue researchers had thought that making the process competitive with conventional energy sources would require that the alumina be recycled back into aluminum using a dedicated infrastructure, such as a nuclear power plant or wind generators. However, the researchers now know that recycling the alumina would cost far less than they originally estimated, using standard processing already available.

"Since standard industrial technology could be used to recycle our nearly pure alumina back to aluminum at 20 cents per pound, this technology would be competitive with gasoline," Woodall said. "Using aluminum, it would cost \$70 at wholesale prices to take a 350-mile trip with a mid-size car equipped with a standard internal combustion engine. That compares with \$66 for gasoline at \$3.30 per gallon. If we used a 50 percent efficient fuel cell, taking the same trip using aluminum would cost \$28."

The Purdue Research Foundation holds title to the primary patent, which has been filed with the U.S. Patent and Trademark Office and is pending. An Indiana startup company, AlGalCo LLC., has received a license for the exclusive right to commercialize the process.

In 1967, while working as a researcher at IBM, Woodall discovered that liquid alloys of aluminum and gallium spontaneously produce hydrogen if mixed with water. The research, which focused on developing new semiconductors for computers and electronics, led to advances in optical-fiber communications and light-emitting diodes, making them practical for everything from DVD players to television remote controls and new types of lighting displays. That work also led to development of advanced transistors for cell phones and components in solar cells powering space modules like those used on the Mars rover, earning Woodall the 2001 National Medal of Technology from President George W. Bush.

Also while at IBM, Woodall and research engineer Jerome Cuomo were issued a U.S. patent in 1982 for a "solid state, renewable energy supply." The patent described their discovery that when aluminum is dissolved in liquid gallium just above room temperature, the liquid alloy readily reacts with water to form hydrogen, alumina and heat.

Future research will include work to further perfect the solid alloy and develop systems for the controlled delivery of hydrogen.

The 2nd Energy Nanotechnology International Conference is sponsored by the American Society of Mechanical Engineers and ASME Nanotechnology Institute.

Properties of hydrogen storage materials in automotive system the focus of new DOE-funded project at Sandia



Sandia researchers have spent a good deal of time in recent years examining the viability of hydrogen storage materials through the Department of Energy (DOE) Metal Hydride Center of Excellence (which it leads), as well as a work for others (WFO) partnership with General Motors, and other related materials science projects. The storage of hydrogen on board automobiles is a challenging issue, and hydrogen storage materials continue to be one of the more promising solutions under consideration.

In addition to developing materials that can store sufficient densities of hydrogen, an important area of research is the reactivity and durability of materials. How exactly do these storage materials behave under various conditions, including exposure to water and other compounds? What are the best methods to produce and handle hydrogen storage materials?

By addressing these questions now, researchers aim to ensure that such research and development issues are exhaustively examined and resolved for consumers prior to the commercialization and deployment of new storage technologies. Now, thanks to a new DOE-funded project at Sandia led by principal investigator Daniel Dedrick, the material properties of advanced metal hydrides within the context of an automotive fuel tank system are being quantified.

Sandia is a National Nuclear Security Administration laboratory.

Dedrick, a mechanical engineer, has worked on the Sandia/GM work-for-others project for several years, participates in the International Energy Agency's task on hydrogen storage, and has become an expert on metal hydride-based hydrogen storage systems. Consequently, he was well positioned to lead a proposal when the DOE decided to select six new competitively awarded projects in applied hydrogen storage research at more than \$8 million. Daniel's proposal, developed with colleagues Rich Behrens, Bob Bradshaw, Rich Larson, and Michael Kanouff, was selected for a 3-year, \$2 million effort (other storage projects were awarded to Argonne National Laboratory, Miami University, United Technologies Research Center, and the University of Hawaii).

"I realized when we all got together for the first time that there was some 167 years of Sandia service represented around the table," says Dedrick, who has been with Sandia for some seven years. "It was exhilarating." Dedrick says the mix of talent and experience on his team, which also includes Ken Stewart, Greg Evans, and Aaron Highley, will make it a success.

Although researchers, including those at Sandia, have been studying hydrides for years, the reaction processes between hydrogen storage materials (such as metal hydrides) and other materials, such as water, need to be better understood. This new project will aim to develop generalized methods and procedures required to quantify the reactivity properties of hydrogen storage materials to enable the optimal design, handling, and operation of hydride-based hydrogen storage systems for automotive applications. Through experiments and by building and validating models, the team is expected to develop computational tools that can predict the reaction processes.

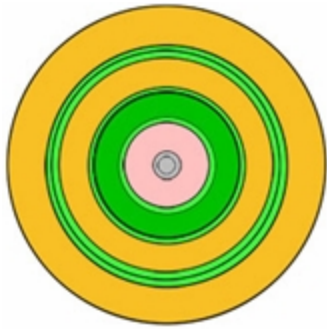
The first task, Dedrick says, will be to create a reaction model on a very small scale that begins to reveal how a hydride sample will behave under specific conditions. Eventually, the work will reach larger scales, but only after researchers have made educated conclusions based on experimental validation of the initial models.

In addition to the Sandia team members, the lab is coordinating with two other DOE-funded efforts – Savannah River National Laboratory and United Technologies Research Center. The three are active participants in the International Partnership for the Hydrogen Economy (IPHE), a global consortium established in 2003 to accelerate the transition to a hydrogen economy.

Dedrick says the project's research will eventually be transitioned to DOE's and Sandia's codes and standards work. "Eventually, when there is a comprehensive guide on how to operate a hydrogen filling station, there will need to be a chapter on dealing with hydrogen storage materials. This work will provide a scientific basis for the optimal operation of systems containing hydrogen storage materials."

Practical Fuel Cells for Electronics

A novel design could allow laptops to run 5 to 10 times longer.-By Kevin Bullis



Fuel Cell Fuel Processor



Integrated Unit

Hot design: A new plan for a fuel processor (top) that could be used in fuel cells calls for arranging a series of reactors in concentric tubes. At the center is a combustor, surrounded by chambers for heating methanol and water, stripping hydrogen from methanol, and removing carbon monoxide. The bottom image shows one option for integrating the fuel processor with a hydrogen fuel cell. Credit: Ronald Besser, Stevens Institute of Technology

A new scheme for creating a compact device that efficiently converts methanol into hydrogen could make it practical to incorporate fuel cells into laptop computers and other portable electronics. Such a device could allow a laptop to run for 50 hours and be recharged instantly by swapping in a small fuel pack.

Fuel cells powered by methanol or another liquid fuel have long been held up as a solution to the ever-growing energy demands of portable electronics. But fuel cells that convert methanol directly into electricity are bulky. Fuel cells that run on hydrogen gas are much more compact, but the hydrogen, unlike liquid fuel, takes up too much space.

An ideal compromise would be a system that uses a hydrogen fuel cell but stores the hydrogen in liquid form as methanol until just before it's needed. The hydrogen would be freed in a series of steps in a fuel processor that include heating the fuel to vaporize it, heating water for steam reforming, and further reactions for removing carbon monoxide. But the challenge has been to make them both small and efficient.

At last week's American Chemical Society (ACS) meeting in Boston, Ronald Besser, a professor of chemical engineering at Stevens Institute of Technology, in Hoboken, NJ, described a new system that could solve the problem.

Unlike in previous designs, in which the different processing steps are built into successive flat layers, Besser proposes a cylindrical design in which the layers form concentric tubes. In such a design, heat spreads in all directions from a combustor at the center, facilitating the necessary reactions. To keep each layer at the optimal temperature, he would incorporate aerogels, a relatively new type of insulation. To decrease costs, he's proposing to use advanced plastics for several of the layers.

The fuel processor for generating the 20 watts of power needed for a laptop or a large radio would be 4.8 centimeters in diameter and 10 centimeters long. Adding the fuel cell and fuel storage could mean another 20 centimeters of length, Besser estimates, but the processor would still be small enough to fit in a laptop. Considering the whole package, the system would store about 1,000 watt hours per kilogram; the very best batteries reach only

300 watt hours per kilogram, and laptop batteries can be about half of this. Besser says that such a system could potentially provide 5 to 10 times the amount of energy as a battery.

Jamie Holladay, a session chair at the ACS conference, is optimistic that the system can work. However, he says that his own research suggests that incorporating a plastic layer may not be possible, since it could deteriorate over time. Instead, it might be possible to use a metal or ceramic outer layer.

A number of research groups at companies and in academic and government labs have developed components for fuel cells that could soon be ready to incorporate into products, although Holladay doesn't expect to see them on the market for at least another two years. (See "Better Fuel Cells for Laptops.") There are still issues to be resolved with the hydrogen fuel cells. For example, such fuel cells produce water as they make electricity, and finding a way to get rid of that water without affecting the surrounding electronics in a laptop is a challenge, he says. What's more, the fuel cells are still expensive. If a fuel-cell system costs three or four times more than a battery, Holladay asks, why not just buy extra batteries for long trips?

And many experts believe that fuel cells will never appear widely in consumer electronics. They doubt that regulators, for instance, will allow passengers to bring flammable liquids on an airplane, even in small amounts and carefully packaged inside the system.

Still, advocates of the technology point to numerous practical applications. Emergency workers with powerful 20-watt radios need energy sources that can work for days or weeks on end without ready access to grid electricity. (See "Printing Fuel Cells.") The military could also be a major customer, using the technology replace batteries.

Quick Notes

Dayton's UltraCell set to ship fuel cells

UltraCell Corp. is ramping up production at its new Dayton plant and expects to begin shipping operating fuel cells to its Livermore, Calif., headquarters operation by year's end, a company executive said Thursday.

The company began producing fuel cell components in May and has been shipping fuel cell components and subassemblies to Livermore for final assembly, said Frank Beafore, UltraCell's vice president of manufacturing.

By year's end, he expects to start shipping to Livermore the so-called "engine blocks" _ the fuel cell and fuel processor, which make up the electricity-generating cell's active unit. Livermore will test the products and ship them to customers.

Livermore, where UltraCell began four years ago, handles research and development for new products. The company hopes to eventually bring all of that to its Dayton plant, which is its first-large scale manufacturing operation.

Fuel cells run on hydrogen and generate electricity, water and heat. UltraCell is among a growing number of companies making and assembling fuel cell components in Ohio.

UltraCell is leasing its space at Dayton International Airport in a building at 3250 Old Springfield Road from Miller-Valentine Group, landlord for the city-owned space. The company plans a dedication ceremony there on Sept. 11 and has invited state and local officials, customers and vendors.

The company makes 25-watt micro fuel cells, not much bigger than a book, that it sells to the Army and Air Force for use as portable power sources in the field. UltraCell eventually hopes to market the products to emergency responders, such as police and fire departments, and later for general use to power laptops and two-way radios.

The company has nearly 60 employees in California and 10 in Dayton, Beafore said. He projects employment of 16 to 20 people in Dayton by year's end and, depending on business, 30 to 60 in 2008 and 60 to 120 the following year. UltraCell has promised the state it expects to employ 360 people by January 2012.

Dr. Kunal Karan receives funding of \$100,000 from the Ontario Early Researcher Award program

Dr. Kunal Karan has received funding of \$100,000 from the Ontario Early Researcher Award program, to develop low-cost polymer electrolyte membrane fuel cells.

Dr. Karan's research will help maintain the leadership of Ontario fuel cell companies in this emerging technological field.

The Early Researcher Award program is a \$51 million, five-year initiative. It is a component of the province's research and innovation strategy, which aims to strengthen Ontario's economic advantage by helping to attract, retain and develop promising researchers.

Mahindra & Mahindra Tests Hydrogen Options

Mahindra & Mahindra (M&M) and Shell have successfully completed Phase I of their joint study titled Pre-feasibility Study on Hydrogen-based Transportation in India.

The scope of the study includes hydrogen supply, infrastructure, and the timing of introduction of various hydrogen vehicle platforms, such as hydrogen internal combustion engines and fuel cells, in India.

The project will also explore local fuel supply options, fuel distribution and storage options, automobile technology, safety,

commercial viability, environmental benefits, and public/private partnerships.

Hydrogen-Paving the Way for the Cars of Tomorrow

MUNICH Germany--Invitation for IAA: Come and Experience a Hydrogen Refueling Demonstration

With our Mobile Hydrogen Refueling Unit trailH2TM and a BMW Hydrogen 7 or a DaimlerChrysler F-Cell

It is increasingly important, thanks to global warming, to monitor the potential of alternative energy carriers, such as hydrogen. As leading experts in hydrogen technology, The Linde Group can provide you with the best information on the energy carrier of the future, as well as inspiring ideas.

At 11th and 12th of September, we cordially invite you to experience a hydrogen refueling demonstration at the International Motor Show IAA in Frankfurt/Main - with our mobile hydrogen refueling unit trailH2TM. The timings are:

11th of September: 11.00 - 11.30 a.m. Hydrogen refueling demonstration with a DaimlerChrysler

F-Cell (refueling compressed gaseous hydrogen/fuel cell)

2.45 - 3.15 p.m. Hydrogen refueling demonstration with a BMW hydrogen 7 (refueling liquid hydrogen/combustion engine)

12th of September

11.00 - 11.30 a.m. Hydrogen refueling demonstration with a DaimlerChrysler F-Cell (refueling compressed gaseous hydrogen/fuel cell) The demonstrations will take place at our booth, F337 in the agora, the open-air area next to the forum and festival hall. There, you will also find a wide variety of interesting, interactive exhibits - and our hydrogen experts will be on hand to answer any questions you might have.

COMPANY / INDUSTRY FEATURES AND HIGHLIGHTS

Industrial Fuel Cell Car Wash



One sunny day in the spring of 2002, the founders of Easywash Geoff Baker & Laura-Lee Normandeau were on the search for a good carwash. But not just any carwash; one that wouldn't scratch the paint but would remove the weeks of dirt and grime that had accumulated on their truck.

As it turns out, finding a good carwash was more challenging than originally anticipated.

After numerous unsuccessful trials, it became clear that a new type of carwash was needed for the marketplace and the seed for Easywash was germinated.

After visiting literally hundreds of carwashes in places as far away as Texas and New York, the founders analyzed the deficiencies they saw in the industry. A vision, that would both correct the problems as well as incorporate the ever increasing world need to pursue environmental sustainability, began to develop: Create the cleanest, easy to use, eco-friendly carwash chain in Canada.

Easywash was born.

In February 2004, the Greater Vancouver Water District implemented its Water Shortage Response Plan (WSRP) which targeted car washing as a major user of treated drinking water. The Greater Vancouver Regional District (GVRD) has now proposed stringent water restrictions on all treated water use, with a 25%

summer surcharge for water consumption being considered.

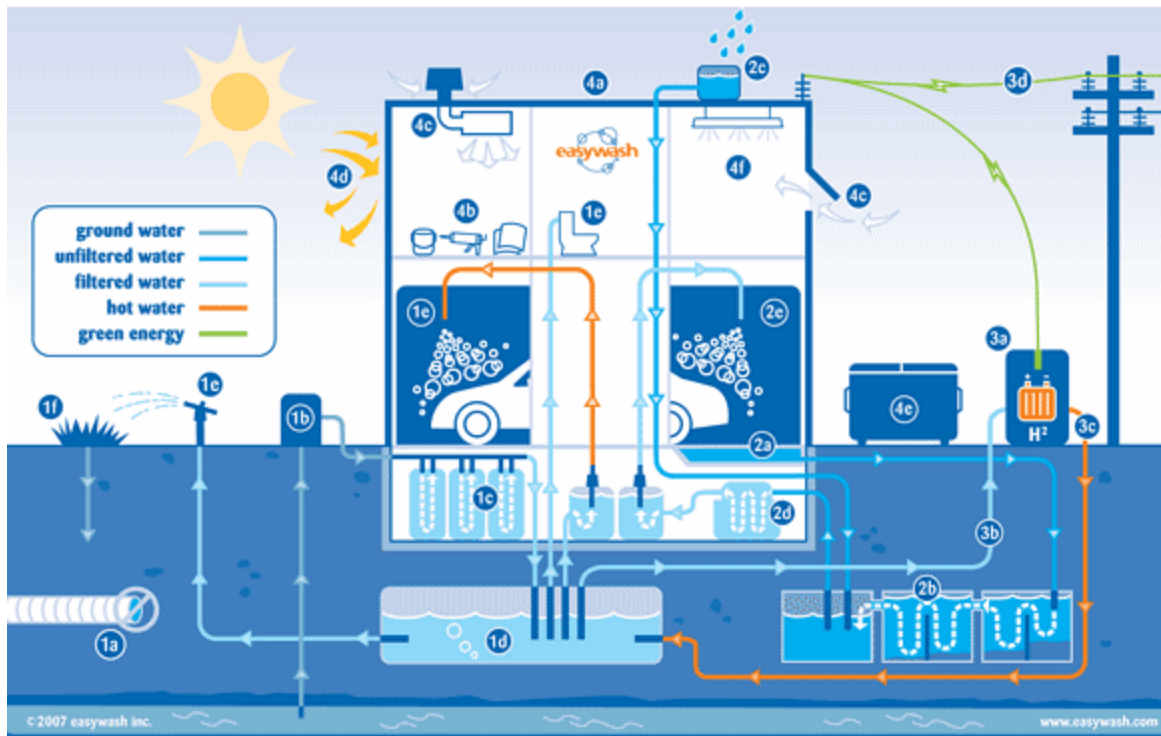
With all this attention on water consumption, it begs the question:

How can a carwash be Eco-Friendly?

- Easywash does not use treated drinking water to wash cars.
- Easywash instead uses well water to wash cars, dogs, bikes, flush toilets and irrigate the site.
- Easywash will save 24,000,000 liters of treated drinking water every year using and recycling well water.
- Easywash will be built to the exacting LEED rating system for Green building construction.
- Easywash will be powered by a state-of-the-art Hydrogen Fuel Cell.

Easywash is setting the standard for sustainable development in our industry:

- World's First LEED Certified Carwash
- World's First Hydrogen Fuel Cell Powered Carwash
- World's Most Eco-Friendly Carwash



The Integrated Waste Hydrogen Utilization Project (IWHUP).



Sacré-Davey Innovations, with consortia partner Sacré-Davey Engineering and contributing members Nuvera and Easywash, is integrating a fuel cell into a Combined Heat & Power (CHP) system for Easywash's new environmentally friendly carwash in North Vancouver.

The resulting 150 kW fuel cell system, using purified waste stream hydrogen, will provide electrical power for three carwash bays, pumps and dryers.

In addition, heat produced as a byproduct from the fuel cell will be captured to preheat the wash water, further reducing the car wash's power requirements. Power from the fuel cell will also be made available to BC Hydro's power grid when it is not needed for the carwash.

This is the seventh sub-project in the Integrated Waste Hydrogen Utilization Project (IWHUP).

Reading / Video / Audio Room

- [2007 Congressional Expo Highlights Fuel Cell's Promise](#) 
- [Green racing cars debut in London](#) 
- [Carbonate fuel cells: milliwatts to megawatts](#)
- [Student project drives fuel cell development](#)
- [Fuel cell companies plotting shake-up of auto, electricity industries](#)

Investor Update

- [CMR Fuel Cells CTO Resigns](#)
- [CMR Fuel Cells Posts Interim Results for the six-month period ended 30th June 2007](#)
- [Dutton Associates Announces Investment Opinion: HydroGen Speculative Buy Rating Maintained by Dutton Associates](#)
- [Distributed Energy nails down financing deal](#)
- [VIASPACE Executing on Clean Energy Product Strategy](#)
- [Dynetek announces changes to the Board of Directors](#)
- [Neah Power Systems Appoints Internationally Renowned Futurist Peter Schwartz to Strategic Advisory Board](#)
- [VIASPACE Energy Builds Global Distribution With Agreements in Japan, Korea and China](#)
- [FuelCell Energy Reports Third Quarter 2007 Results and Latest Accomplishments](#)
- [Intelligent Energy invited to World Economic Forum's New Champions meeting](#)
- [Ceramic Fuel Cells selects Gledhill as UK appliance partner](#)
- [Carl Kukkonen, CEO of VIASPACE Inc., Provides Company Progress Report in a New Audio Interview at SmallCapVoice.com](#) 
- [Fund Manager Champions Firm Under Cloud](#)
- [Wall Street upbeat on new breed of fuel cells](#)

Fuel Cell Job Listings This Week

[Design Engineer - Stationary Fuel Cells](#)

Arnold-hanafin Corporation - South Windsor, CT

Job Responsibilities: Provide technical leadership to the stationary power development group for the development of stationary power solutions. Activities include the ...

[Research Scientist - Fuel Cells](#)

Arkema Inc - King Of Prussia, PA

... this fast moving technology. Ph.D. in Electrochemistry 5 years industrial experience in fuel cells or MEA development Ability to develop and conduct experimental research plans ...

[Fuel Cell Technician](#)

Allegis Group Inc - Everett, WA

... Location: Everett, Washington Duration: Contract to Hire Wage: \$12-\$17 / Hour A leading fuel cell maintenance company is looking for a fuel cell technician for its operations in ...

[Fuel Cell Development Engineer](#)

Footbridge Engineering - Marlborough, MA

... or related discipline with greater than 4 years experience in systems development for fuel cell, fuel reforming or other thermomechanical systems. The engineer will have ...

[Fuel Cell Technician](#)

Modine Manufacturing Company Inc - Racine, WI

Bring your talents to this excellent opportunity at Modine responsible for consistently performing high quality welds on steel, stainless steel, aluminum and nickel alloys while ...

[Fuel Cell Engineer](#)

Diversity - Top Management Careers - Palo Alto, CA

... The focus will be on the design and fabrication of MEAs and portable cells. A minimum of 5 years of experience in MEA and potable fuel cell design and fabrication is required.

[2008 Product Development - Ford College Graduate Program, Research & Advanced Engineering](#)

Ford Motor Company - Michigan

... for Ford Motor Company vehicle program applications and conducts research on hybrid and fuel cell technologies to support future program needs. MVDRS develops and incorporates ...

[Executive Director](#)

South Carolina Hydrogen AND Fuel Cell Alliance - Columbia, SC

... of hydrogen technology across the state. Job Requirements: Knowledge of hydrogen and fuel cell technology and/or economic development is highly desired as well as excellent ...

[Fuel Cell Development Engineer](#)

Footbridge Engineering - Marlborough, MA

... or related discipline with greater than 4 years experience in systems development for fuel cell, fuel reforming or other thermomechanical systems. The engineer will have ...

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