FUEL CELL SUMMIT

Volume 5, Issue 2

A quarterly newsletter from the U.S. Department of Energy to supply information on U.S. regulation of hydrogen and fuel cells.

## Permitting Guides bring Hydrogen Codes and Standards to You

As hydrogen fuel cell projects are proposed, the building code and fire safety officials faced with issuing permits and inspecting and approving installations will need a good understanding of what fuel cells are, what issues need to be considered, and which codes and standards apply.

Two new guides were published this year to help code officials find out what is required. The guides help inspectors determine what codes are relevant for two types of fuel cell installations: stationary fuel cell plants installed to provide power for commercial buildings (Figure 1) and hydrogen fueling stations for hydrogen-powered cars (Figure 2). The guides are free and available on Pacific Northwest National Laboratory's Hydrogen and Fuel Cells website: http://www.pnl.gov/fuelcells/.

They were produced through a collaborative effort involving the National Fire Protection Association (NFPA), the International Code Council (ICC), PNNL, and the National Renewable Energy Laboratory (NREL).

The ASME International, the Compressed Gas Association, the ICC, the NFPA, and the U.S. Department of Transportation have all published codes or standards that include regulations pertaining to fuel cells. But for code officials and building owners just entering this brave new world, many questions loom – where do I find the specific regulations I need? What exactly do I need to be concerned about? And just what is a fuel cell anyway?

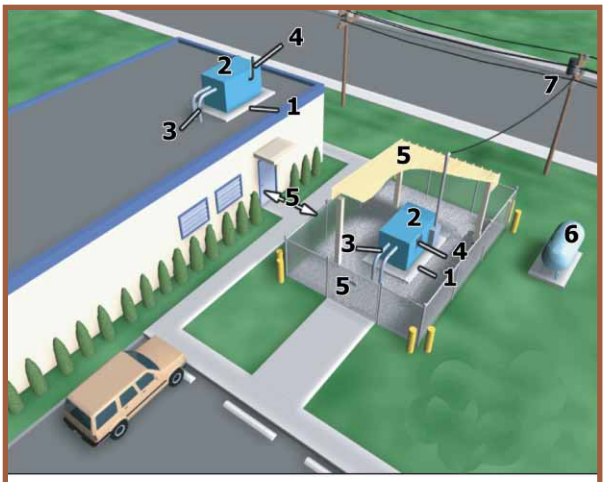


**Figure 1. (from *Permitting Stationary Fuel Cell Installations)* Components that are regulated by codes. Hydrogen fuel cells, installed to provide power for a commercial building, would typically be installed oustide, either on the roof or in an adjacent enclosure. The numbers indicate components covered by various regulations.**

1. **Foundation and protection**
2. **Fire protection systems**
3. **Piping components and connections**
4. **Ventilation, exhaust, and makeup air**
5. **Siting, installation, and protection**
6. **Fuel supply and storage**
7. **Interconnection**

*(cont'd on page 6)*

## DOE Moves Forward with National Training Facility for Hydrogen Safety

*Linda Fassbender, Pacific Northwest National Laboratory*

Hydrogen safety training will start in FY05 at HAMMER, DOE's Volpentest Hazardous Materials Management and Emergency Response Training Center in southeast Washington State. This training fills a critical need for the successful transition to the envisioned hydrogen economy. DOE is making a long-term commitment to the National Training Facility for Hydrogen Safety at HAMMER, which will support the FreedomCAR Partnership (a DOE initiative to develop petroleum- and emission-free cars).

In April, HAMMER staff met with representatives from DOE, DOT, and several national laboratories (Pacific Northwest, Sandia, Los Alamos, and the National Renewable Energy Laboratory) to discuss specific hydrogen safety training props that might be deployed at HAMMER. Meeting participants toured the facility and observed several propane burn props in action. This kickoff meeting was followed by video-conferences in May and June to continue discussions.

To meet the needs of first responders, training props must simulate actual situations and geometries that they might encounter. The props discussed included high-pressure storage tanks, pipeline systems, tank storage inside walls, liquid storage, and liquid hydrogen burn pads.

*(cont'd on page 5)*

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# DOE Developing Hydrogen Database

Many codes currently applied to hydrogen are based on natural gas because the corresponding data needed to make them specific to hydrogen do not exist or have not been properly considered. However hydrogen's properties vary considerably from those of natural gas. Solid, verifiable technical data for hydrogen is needed to develop credible codes and standards for hydrogen technologies, which DOE would like to see in place by 2015.

DOE's goal is to build a comprehensive database comprised of reproducible validated data on hydrogen behavior in engineered systems. Through a collaborative agency effort, DOE and its national laboratories have already begun developing just such a database in their efforts to facilitate implementation of the hydrogen economy. The FreedomCar and Fuel Partnership is very supportive of this effort and believes it to be a critical priority in the further development of codes and standards. Experimental testing, as described below, is underway to provide missing or incomplete data, assist in the verification of historical information, and clarify misinterpretations related to hydrogen behavior. Additionally, DOE is applying existing information on hydrogen combustion and fluid mechanics to quantify the hazards associated with hydrogen safety.

## Unintended Releases and Combustion

DOE is conducting several activities focused on determining the combustion and flammability characteristics of hydrogen and the fluid mechanics of unintended releases. Accurate heat transfer correlations are needed to model hydrogen flame impingement and thermal radiation heat fluxes from an ignited jet. Additionally, combustible cloud models are needed to determine placement of jet sources near air intakes and ignition sources. Lean flammability limit work is being conducted to establish mean ignition limits for turbulent flows. Understanding the behavior and impacts of hydrogen combustion events is essential for determining appropriate building and system designs, including set-back distances.

## Material Properties and Compatibility

The impact of hydrogen on metals' yield and tensile strength, fracture toughness and threshold stress-intensity factor, fatigue crack growth rates and fatigue thresholds, and impact energy needs to be understood. Creep rates and creep rupture strength at high temperatures, hydrogen permeation rates, and materials behavior at elevated pressure also need to be better understood. As new materials such as polymers and composites become available for use in hydrogen systems, we need to understand the effects of hydrogen on these materials to ensure safe operation.

DOE sponsored a materials compatibility workshop in 2003 to identify and prioritize materials compatibility data needs. Material compatibility information will be compiled in a *Technical Reference for Hydrogen Compatibility of Materials*. The higher priority materials are pressure vessel steels (stationary storage and transportation of hydrogen gas), pipeline steels (hydrogen gas transportation), and stainless steels (ancillary components in the storage, distribution, and consumption of hydrogen gas such as piping, pressure relief devices, and valves). Lower priority materials are aluminum alloys (hydrogen gas storage vessels on vehicles) and copper alloys (high-pressure hydrogen seals).

## Detection and Mitigation

With the wide variety of potential hydrogen applications, including buildings, vehicles, and personal (hand-held) devices, sensors are needed for detecting leaks. Wide-area, whole-system, hand-held, and built-in sensors need to be accurate, sensitive, selective, and reliable, with appropriate response times, sufficient range and scale, and recalibration frequency. A reliable interface to system shutdown is also required.

Sensor requirements and design options for innovative hydrogen sensor technologies are being evaluated, along with analytic techniques for remote sensing of hydrogen. Development of wide-area visible hydrogen sensors will be initiated, and low-cost sensor arrays, specifically addressing the transfer of instrument calibration between devices and the stability of devices over time will be assessed. The application of gettering (materials that gather or absorb hydrogen) polymer films for coating onto pipe and joined surfaces, gettering gasket materials based on Teflon composite materials, and the incorporation of sensor chemicals into the coating and gasket materials are also under exploration.

## Physical Characteristics

The National Institute of Standards and Technology (NIST) is developing standards for weights and measures for vehicle systems and refueling facilities, fuel cells, and on-site hydrogen generation. NIST is behind the effort to develop physical measurement standards for hydrogen flow rate, purity, and volume metering and to identify the requirements for commercial equipment for metering hydrogen at the point of sale.

This extensive and collaborative testing and verification program effort is expected to continue through at least 2010, as the Federal Government pursues its investigation of a safe and economically viable hydrogen economy.

For more information, contact Chris Moen at cmoen@sandia.gov or consult the DOE program website at http://www.eere.energy.gov/hydrogenandfuelcells/. ■

## Standards Committee Activity Updates

**ICC Ad Hoc Committee for Hydrogen Gas**. The Ad Hoc Committee (AHC) met May 3-4 in West Sacramento, CA, at the California Fuel Cell Partnership (CaFCP), following NHA's 15th Annual U.S. Hydrogen Conference in Los Angeles, CA. The next AHC meeting will be June 18-19, following the Hydrogen and Fuel Cells Summit VIII, in Coral Gables, FL. The Committee on Separation Distances continues its work. Contact: Darren Meyers (ICC), (800) 214-4321 ext. 307, dmeyers@iccsafe.org.

**NFPA 70, National Electrical Code - Article 692, Fuel Cell Plant**. The NEC Technical Correlating Committee met in February; no notes were added to comments received on Article 692 of the 2005 NEC. Any floor actions pertaining to the 2005 NEC will be presented at the Technical Committee Report Session May 26 in Salt Lake City. The TCC will meet with the NFPA Standards Council July 14, 2004, in San Francisco to review amendments. The Standards Council will vote on releasing the 2005 NEC at this meeting; it should be available in September 2004. Contact: Jean O'Connor (NFPA), (617) 984-7421, (617) 984-7070 (fax), joconnor@nfpa.org.

**IEEE 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems**. The Institute published IEEE 1547 in July 2003. Working groups met in San Francisco April 20-22, 2004, with 65 participants. The next meeting of P1547.1 thru P1547.4 will be early August 2004 in Chicago or LasVegas. Contact: Richard DeBlasio (NREL), (303) 275-4333, Dick_DeBlasio@nrel.gov or Tom Basso (NREL), (303) 275-3753, thomas_basso@nrel.gov.

**NFPA 52, Vehicular Fuel Systems Code**. The 2005 Edition will contain requirements for gaseous and liquid hydrogen refueling operations. A draft of this document will be available on the NFPA web site August 1, 2004, for public review and comment. Contact: Carl Rivkin (NFPA), (617) 984-7418, crivkin@nfpa.org.

**NFPA 55, Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks**. NFPA 50, 50A, and 50B will be incorporated into the 2004 Edition of NFPA 55 by June 2004. This 2004 Edition will also likely contain requirements for underground storage of hydrogen. Contact: Carl Rivkin (NFPA), (617) 984-7418, crivkin@nfpa.org.

**NFPA 853, Installation of Stationary Fuel Cell Power Plants**. The 2003 Edition of NFPA 853 has been expanded to stationary fuel cells below 50 kW. The new chapter, "Fuel Cell Power Systems 50 kW or Less," gives requirements for outdoor and indoor installations, ventilation, and fire protection. The 2003 Edition is available at (800) 344-3555 or www.nfpa.org. Contact: Carl Rivkin (NFPA), (617) 984-7418, crivkin@nfpa.org.

**UL1741, Standard for Inverters, Converters and Controllers for Use in Independent Power Systems**. Underwriters has delayed the next UL1741 draft to incorporate essential aspects of IEEE P1547.1. The next draft of UL1741 should be completed by the end of June. Contact: Tim Zgonena (UL), (847) 272-8800 ext. 43051, (847) 509-6298 (fax), timothy.p.zgonena@us.ul.com; or Susan Malohn (UL STP Secretary), (847) 664-1725, susan.p.malohn@us.ul.com.

**IEC TC 105, Fuel Cell Technologies.** The 2004 Plenary will be June 24-25 in Tokyo. WG#1 (Terminology) - The DTS (draft technical specification) on fuel cell terminology was approved and will be published. The next meeting is June 23 in Tokyo. WG#2 (FC Modules) - The FDIS (final draft international standard) will be circulated in June. If approved, expect publication by October 2004. The next meeting is June 23 in Tokyo. WG#3 (Stationary FC - Safety) - The next meeting is May 11-13 in Vancouver. A committee draft will be issued. WG#4 (Stationary FC - Performance) - The CDV (committee draft for vote) was approved and the FDIS (final draft international standard) will be circulated. The next meeting is June 21 in Tokyo. WG#5 (Stationary FC - Installation) - The next meeting is June 28-29 in Yokohama. WG#6 (FC Propulsion Systems) - Although activities were suspended June 2003, a meeting is scheduled for June 22 in Tokyo. WG#7 (Portable FC) - A CD (committee draft) is being circulated. The next meeting is June 23 in Tokyo. WG#8 (Micro FC-Safety) - The next meeting is June 28-29 in Yokohama. Two new TC 105 work item proposals–Performance and Interchangeability of Micro Fuel Cell Power Systems–are establishing working groups. Contact: Steve Kazubski (CSA America) (216) 524-4990 ext. 8303, or steve.kazubski@csa-america.org.

**ANSI/CSA America FC 1-2004, Stationary Fuel Cell Power Systems**. Published in April this is a revision and re-designation of ANSI Z21.83-1998. CSA America FC 3, Portable Fuel Cell Power Systems, will be published in June 2004 (pending ANSI approval). ANSI/CSA America FC 1-2004 available at www.shopCSA.com. Contact Steve Kazubski (CSA America), (216) 524-4990 ext. 8303, or steve.kazubski@csa-america.org.

# 2004 Calendar of Events

## JUN

1 - 4 **Advanced Automotive Battery Conference 2004**. San Francisco, CA. Sponsored by Advanced Automotive Batteries. Contact: info@advancedautobat or visit www.advancedautobat.com/AABC/

9 -10 **Fuel Cell 2004 Conference**. Marriott Tech Center, Denver, CO. Conference and Exhibit on Advancements in Fuel Cell Applications and Technology. Contact: www.fuelcell-magazine.com/fc_conf_index.htm.

10 **Pathways to the Hydrogen Economy**. Double Tree Post Oak Hotel, Houston, TX. Presented by the Economic Department of the Embassy of France. Contact: Coralie Loisel, (713) 985-3293 or visit www.dree.org/hydrogen.

14 - 16 **Fuel Cell Science, Engineering and Technology Conference**. R.I.T. Inn & Conference Center, Rochester, NY. Contact: fuelcell@asme.org or visit www.asme.org/events/fuelcell/.

14 - 17 **41st Power Sources Conference**. Adam's Mark Hotel, Philadelphia, PA. Sponsored by Power Sources Center of Excellence, U.S. Army Communications Electronics Command and Sensors and Electronics Devices Directorate, U.S. Army Research Laboratory. Contact: www.pcm411.com/powersources/program.pdf.

15 - 17 **Hydrogen and Fuel Cells Summit VIII**. University of Miami Convocation Center, Coral Gables, FL. Hosted by U.S. Department of Energy – Office of Hydrogen, Fuel Cells and Infrastructure. Status reports on: safety, codes and standards activities related to hydrogen fuels; RD&D in stationary, portable, and vehicular fuel cell technologies; and remaining institutional issues. Identification of action items and voluntary teams. Contact: Cecilia Mendoza (509) 372-4520, (509) 372-4990 (fax), cecilia.mendoza@pnl.gov, or visit www.pnl.gov/fuelcells.

16 - 17 **22nd West Coast Energy Management Congress**. Anaheim Convention Center, Anaheim, CA. Contact: (770) 279-4390 or visit www.aeecenter.org.

22 - 25 **20th Anniversary of the International Fuel Ethanol Workshop and Trade Show (FEW)**. Monona Terrace Convention Center, Madison, WI. Contact: (719) 942-4353 or visit www.bbibiofuels.com/few/.

27 **95th Annual IDEA Conference and Trade Show**. The Westin Seattle, Seattle, WA. Presented by International District Energy Association. Contact: (508) 366-9339 or visit www.districtenergy.org/conferences.htm.

## JUL

9 – 14 **2004 National Solar Energy Conference**. Doubletree Hotel Portland – Lloyd Center, Portland, OR. Presented by American Solar Energy Society. Contact: (303) 443-3130, ases@ases.org, or visit www.ases.org.

23 - 25 **SolWest Renewable Energy Fair**. Grant County Fairgrounds, John Day, OR. Presented by Eastern Oregon Renewable Energies. Contact: Jennifer Barker (541) 575-3633 or visit www.solwest.org.

25 - 30 **Sixth Gordon Conference on Fuel Cells - Understanding fuel cells and fuel cell components**. Roger Williams University, Bristol, RI. Contact: www.grc.uri.edu/programs/2004/fuelcell.htm.

## AUG

8 - 11 **Energy 2004 – The Solutions Network**. Rochester Riverside Convention Center, Rochester, NY. 7th Annual National Energy Efficiency Workshop and Exposition. Presented by U.S. Department of Energy, Federal Energy Management Program. Contact: Jane Vander Linden (703) 921-1719, (703) 921-1610 (fax), or visit www.energy2004.ee.doe.gov.

9 - 13 **Micro-Hydro Power**. Solar Energy International (SEI) Carbondale Facility, Carbondale, CO. Contact: (970) 963-8855 or www.solarenergy.org/workshops/workshop.php?id=10.

22 - 24 **Fuel Cell Chemistry and Operation Symposium**. Pennsylvania Convention Center, Philadelphia, PA. Sponsored by the Fuel Cell Chemistry Division. Contact: natlmtgs@acs.org.

22 - 26 **Advances in Hydrogen Energy Conference**. Pennsylvania Convention Center, Philadelphia, PA. Sponsored by MesoFuel, ChevronTexaco, and Colorado School of Mines. Contact: natlmtgs@acs.org.

28 - 3 **World Renewable Energy Congress**. Denver Marriott City Center, Denver, CO. Sponsored by the National Renewable Energy Laboratory (NREL). Contact: www.nrel.gov/wrec/contacts.html.

31 - 1 **Energy Technology Expo and Conference**. Colorado Convention Center, Denver, CO. Co-located with World Renewable Energy Congress and sponsored by U.S. DOE and NREL. Contact: Jennifer Vangele (203) 925-0004 ext. 106, (203) 925-0003 (fax), or visit www.energytechexpo.com.

## SEP

12 - 15 **Hydrogen and Fuel Cell Futures Conference**. Perth, Western Australia, Australia. Organized by Government of Western Australia, Dept. for Planning and Infrastructure. The first such event for the Southern Hemisphere. Contact: Congress West +61 8 9322 6906, +61 8 9322 1734 (fax), hydrogen@congresswest.com.au, or visit www.congresswest.com.au/hydrogen/.

14 - 16 **World Fuels Conference 2004**. Capital Hilton, Washington, DC. Refining and Automotive Policy. Contact: Paul Argyropoulos (301) 354-2025, (301) 738-8183 (fax), pargyropoulos@chemweek.com, or visit www.worldfuels.com.

21 - 23 **Electric Drive Transportation Association Conference and Exposition 2004: Mobilizing the Market**. Gaylord Palms Resort & Convention Center, Orlando, FL. Contact: Jennifer Watts (202) 408-0774, (202) 408-7610 (fax), jwatts@electricdrive.org, or visit www.edtaconference.com.

## EPRI Developing Universal Interconnection

Home owners who want to use fuel cells to meet their own home's power load need a means for selling surplus power back to the grid. And utilities want some assurance that the power transfer can be handled in a way that protects the integrity of the grid. The Electric Power Research Institute (EPRI) is working on a device that could make both sides of the meter happy. EPRI is developing a low-cost, universal interconnection device called the GridGateway that provides a safe and reliable means for two-way power flow.

The technology provides a "protective firewall" for the electric utility system while enabling two-way power flows for the benefit of the customer and the grid. The GridGateway will work with fuel cells and other environmentally friendly on-site generation systems like photovoltaics, as well as small gensets.

GridGateway will have communication links for setup and monitoring and programmable protective relay functions so the utility can download its own grid protection settings onto the device. According to Dan Rastler, technical leader of the EPRI Distributed Energy Resources (DER) program, the device will also permit the electric distribution company to periodically test the integrity of the interconnection function. The GridGateway ensures that even if the system settings in the fuel cell or other power generating equipment are changed, the utility will be protected by the settings that were originally downloaded into it.

"GridGateway will fulfill a huge need for a low-cost, universal interconnection solution that's plug and play compatible with low-power-level DR generation equipment in the range of one kilowatt to eventually up to 200 kilowatts," said Rastler. "It is also very cost effective; installed costs are estimated to be under $400 for mass markets."

The device builds upon a technology platform originally introduced by Pepco Technologies under the name GenerLink that was recently acquired by EPRI. The difference between the two devices is that GenerLink doesn't allow the home owner to operate their fuel cell or other generator unless the grid is down, while GridGateway allows the homeowner to produce power even when the grid is up. According to EPRI project manager Bill Steeley, "the GenerLink is a 'break-before-make' device. It disconnects you from the utility so there is no two-way power. It won't allow the generator to create power until the utility voltage goes to zero, in other words, when an outage occurs. Then you manually turn on the generator. GenerLink alerts you when the grid is back on, then you have to manually turn the generator off."

The GridGateway allows seamless operation back and forth, enabling the home owner to operate their fuel cell or other distributed generation around the clock even when the grid is operating.

*(cont'd on page 6)*

## DOE Moves Forward with National Training Facility for Hydrogen Safety *(cont'd from page 1)*

Based on these discussions, the following three integrated prop systems were proposed. Participants are working to determine which systems address the most urgent near-term training needs. Participants agreed that all training activities conducted with props should be captured on film or DVD for use in distance learning applications.

***High-Pressure Hydrogen Gas Storage Tank Prop System*** - This system includes a high-pressure hydrogen gas storage tank with a valve train and piping in an enclosed structure that can be vented or sealed. The prop would simulate both high-pressure and low-pressure hydrogen gas leaks, with and without ventilation. It would demonstrate the operation of a pressure relief device, hydrogen buoyancy properties, and hydrogen flame characteristics.

***Hydrogen Vehicle and Gasoline Vehicle Accident Prop System*** - This system simulates a hydrogen vehicle accidentally impacting a conventional fuel vehicle. It includes a hydrogen storage tank, valves, piping, and a conventional fuel storage tank. It simulates a release of hydrogen due to heat from a fire in the conventionally fueled vehicle.

***Bulk Liquid Hydrogen Storage Tank Prop System*** - This system includes a bulk liquid hydrogen storage tank with the ability to simulate variable leak rates.

DOE will ask for stakeholder feedback on these three conceptual prop systems and other hydrogen safety training needs at the Hydrogen and Fuel Cell Summit in June. Design and construction will begin in FY05 and will probably take 12 to 18 months, depending on the specific prop systems selected for deployment. Hydrogen training classes not requiring the use of props will also commence in FY05. ■

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## Permitting Guides bring Hydrogen Codes and Standards to You *(cont'd from page 1)*

That's where the Permitting Guides can help. Both documents start with a background on fuel cells describing the technology and defining terms. Both documents also provide a comprehensive listing of pertinent regulations a code official will have to know about in the form of an extensive table complete with concise descriptions and helpful hints on what to look for during inspections.

The table (4.2 Module 2) for the fueling stations permitting guide, *Permitting Hydrogen Motor Fuel Dispensing Facilities*, covers five main sections:

- Fuel Supply and Storage – Addresses both onsite storage in a storage vessel (e.g., hydrogen) and offsite storage and delivery of the fuel to the site.
- General Station Siting Issues – Addresses siting of the fuel dispensing station outdoors and indoors.
- Fueling Station Piping and Equipment – Provides codes and standards for the design of the piping and venting systems, compressors, pressure relief devices, shutoff valves, dispensing and electrical systems (e.g., those used for testing and listing the equipment).
- Fire Protection – Addresses fire protection issues as they relate to the fuel dispensing stations, including safety precautions, fire protection systems, and emergency shutdown equipment.
- Operation and Maintenance – Addresses operational permitting, training, fuel dispensing, tank filling and vehicle movement onsite, equipment maintenance, fire extinguishers and signage.

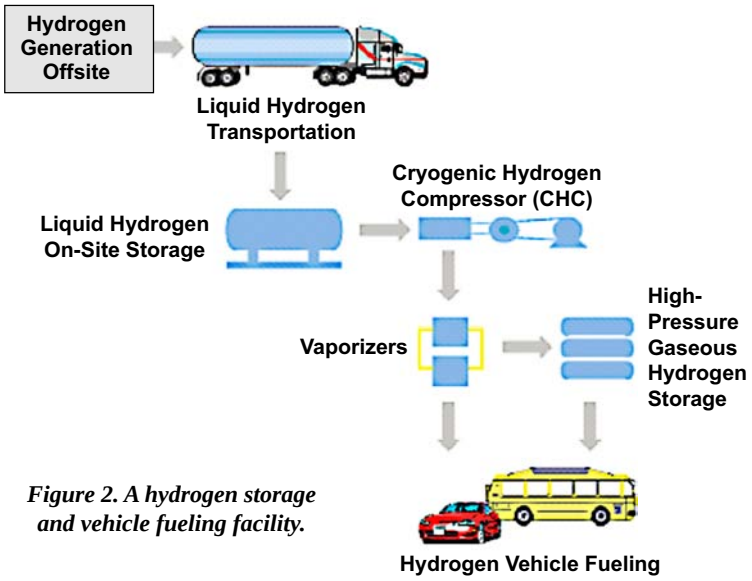


***Figure 2. A hydrogen storage and vehicle fueling facility.***

The fueling station guide will point you to the right code to find out exactly how far tank connections need to be from parked cars, how the signs should be worded, what kind of metal the pipes should be, and much, much more.

Additional topics for Permitting Guides are planned for future development. For more information about the Permitting Guides contact Heather Dillon (heather.dillon@pnl.gov) or see the PNNL Hydrogen and Fuel Cells Website, http://www.pnl.gov/fuelcells/permit_guide.stm. ■

## EPRI Developing Universal Interconnection Device *(cont'd from page 5)*

One advantage of GridGateway is that it will encourage home owners to get maximum benefit out of their distributed generation power resources so they can operate them whenever it is deemed economic to do so.

There are other connection devices out there but they can be more expensive and they often rely only on the protection settings built into the generation device. Those protection settings help but utilities are concerned that they may be intentionally or inadvertently changed after the equipment is installed. The protection settings in the GridGateway will ensure that power enters the grid within certain voltage, frequency, and current limits. In essence, the GridGateway provides a second layer of protection for the grid by allowing utilities to download their own protection settings.

EPRI has initiated a contract with several utility funders to create a beta prototype of the GridGateway. This prototype will be tested in the laboratory first and then at the partner utilities' sites. After testing, a decision will be made about going forward with commercialization and any needed changes will be incorporated into design specifications. Testing of the prototype should be completed in around 18 months, said Steeley. "If all goes well we hope to have a commercial product available soon, possibly within two years. Initial development will be on a device for residential use. Then we will move into commercial and industrial applications."

For more information, contact Bill Steeley, wsteeley@epri.com; (650) 855-2203. ■