FUEL CELL SUMMIT

Volume 1, Issue 3

A quarterly newsletter published by the U.S. Department of Energy for the U.S. fuel cell industry to foster development and adoption of codes and standards

Workshops Target Actions for Accelerating DG in U.S. Cities

Distributed generation (DG) must become part of cities' master plans, and cities need to start planning now for the 21st century. With 44,000 state and local code jurisdictions in the United States, a lack of national codes and standards to regulate the safe performance of DG units in or near buildings may ultimately prevent widespread DG implementation. This was the message delivered in the workshop, The Role of Distributed Generation in Municipal Government, held in October in Austin, Texas.

Sponsored by the City of Austin/Austin Energy, the Distributed Power Coalition of America (DPCA), and the U.S. Department of Energy (DOE), the workshop was a forum for city officials and city managers to meet with DG practitioners and share perspectives on DG implementation problems and solutions. Approximately 25 representatives from U.S. cities, the federal government, and other organizations participated.

Chuck Manning of Austin Energy emphasized the increasing importance of the role of DG in municipal governments. Jay Corn of DPCA explained that the DPCA is an advocacy organization with a goal of removing federal, state, and local regulatory and legislative impediments to the siting of DG units. Joseph Galdo, Program Manager, DOE Office of Power Technologies, offered some background on DOE's Distributed Energy Resources (DER) Taskforce, which was launched by Dan Reicher, Assistant Secretary for Energy Efficiency and Renewable Energy, in March 2000. It combines DER-related programs of the Office of Energy Efficiency and Renewable Energy into one office to enhance the effectiveness of research, development, demonstration, education, and implementation activities (see http://www.eren.doe.gov/der).

One barrier to DG discussed extensively during the workshop was building codes and standards. Technologies will need to be mentioned by name in the model codes, beginning with a manufacturing or system integration standard. The National Electric Code, Mechanical Code, International Fuel Gas Code, Life Safety Code, and International Building Code must all be modified to reference onsite power generation systems. Workshop participants suggested that industry and code compliance agencies work together in the process, when appropriate, to establish codes that bridge national acceptance.

Workshop participants also suggested that it is critical that DG technologies have performance and reporting standards that can be referenced by federal, state, and local authorities for operation permits, emissions evaluation and credits, and energy-efficiency initiatives. Suggestions for accomplishing this task include working with the federal government to create these standards or encouraging manufacturers to develop voluntary standards of their own.

Participants felt that a general lack of knowledge among code officials about DG technologies is hindering their widespread deployment. They felt that education programs to provide code officials with an opportunity to explore DG technologies would be beneficial to all stakeholders in the industry.

Participants felt that communication and "information sharing" are vitally important to the future of DG and that websites should be used as much as possible to communicate the benefits of DG to city planners and managers. Training programs should be planned and begun as soon as possible. They felt that no true "champion" of DG exists in the marketplace today; a true leader needs to emerge. DG is indeed "real" and it holds great promise for municipal governments in the very near future.

Roger Duncan, of Public Technology Inc.'s Urban Consortium Energy Task Force concluded the meeting and suggested that cities focus on building codes and standards since they are likely to be the greatest barrier to future DG implementation in cities. He stressed that translating the national codes to the local level is an enormous task that must begin immediately. Duncan encouraged participants to go back to their cities, site and implement a DG project, and then document and report what difficulties they encountered (e.g., building codes, fire codes, etc.).

A follow-on workshop in Philadelphia in November identified target actions that included a national education campaign for code inspectors and a website for DG codes and standards installation information.

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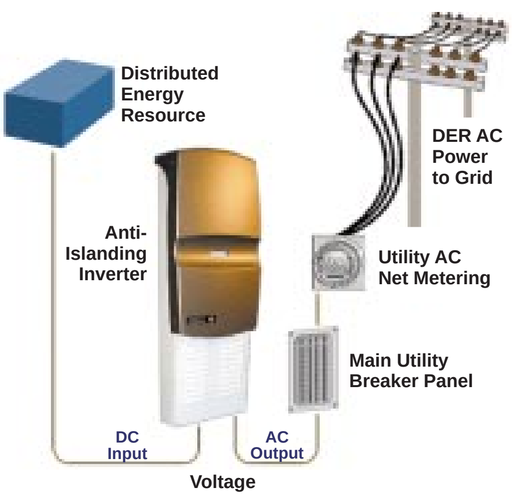
PV Anti-Islanding Technologies Hold Promise for Fuel Cell Systems

by John Stevens, Sandia National Laboratories

This article reports on anti-islanding work recently performed at Sandia National Laboratories for photovoltaic systems. The same techniques can be extended easily to any distributed resource, such as a fuel cell, that is interconnected to the electric utility through an inverter.

"Islanding" of photovoltaic (PV) systems or of any generating system not controlled by a utility is a concern of both utilities and generating equipment owners because of the potential for safety hazards and equipment damage. Islanding is a condition in which a portion of the utility system that contains both load and operating generation remains energized when utility operational procedures require that it be de-energized. If the generating sources that supply the loads within the island are not controlled directly by the power system operator, there is concern for several reasons. (If the utility controls generation directly, it is not a concern in the context of this article because the utility can turn the resource on or off at will.)



Perhaps the most significant concern is the potential safety hazard to a lineworker or a passerby coming in contact with a line presumed to be de-energized. If the line is actually energized because a home or business has a grid-tied resource left energized and tied into the grid, the results could be deadly.

Recent development of two standards, an IEEE standard on utility interconnection of PV systems (IEEE Standard 929-2000) and the Underwriters Laboratories safety standard for photovoltaic inverters (UL 1741) required an improved understanding of islanding. Because of the renewed interest in islanding and the need for test data to confirm the anti-islanding capabilities of modern inverters (see box on page 5), Sandia National Laboratories initiated a test program to investigate their propensity for islanding. Sandia tested several inverters from different manufacturers. One important finding was that the various approaches for preventing islanding used by different manufacturers interfered with each other and allowed islanding to occur.

Another finding was that even single inverters did not respond fast enough to meet the newly proposed IEEE Standard 929-2000 requirements. As a result of these findings, Sandia undertook an anti-islanding development program in cooperation with U.S. PV inverter manufacturers.

Sandia National Laboratories obtained significant input from the PV inverter industry and set out to develop an anti-islanding technique that could be incorporated into any manufacturer's inverter to make it a non-islanding inverter. Note: a non-islanding inverter cannot provide anti-islanding protection for other distributed generators on the same circuit that do not incorporate adequate islanding protection measures. That is, if another distributed generator on the same circuit as the non-islanding inverter regulates voltage and frequency inside of the non-islanding inverter's trip limits during islanding, then the non-islanding inverter has no means to distinguish whether the voltage and frequency are being maintained by the utility or by a non-utility generator.

Implementation of the techniques developed by Sandia and industry has proven to achieve a non-islanding inverter as defined in IEEE Standard 929-2000 (see box on page 5). These techniques are likely to work with high penetrations of distributed generators. They do not require synchronization between inverters to operate. Other active methods that perturb the utility and measure a coincident change in voltage or frequency will not work in high penetrations unless the perturbations are synchronized. Such synchronized perturbations can be undesirable for the interconnected utility.

The anti-islanding techniques were fairly easy to implement. The only modifications necessary to implement them in the inverters used for testing were changes in firmware. No changes to the hardware were required. This may not be true for all inverter designs.

Test results have been far superior to those of other anti-islanding tests conducted over the last 18 months at Sandia and elsewhere. A significant product of this work was the establishment of a test procedure that can be used to distinguish between inverters that have satisfactory anti-islanding techniques and those that do not. This procedure is included in IEEE Standard 929-2000 and in UL 1741.

This work was supported by a consensus of U.S. inverter manufacturers. Although not guaranteed, it is likely that these results will support a move toward a defacto standard for anti-islanding in the United States. It is hoped that by sharing these results, similar methods will be considered in the international community.

A more detailed discussion of anti-islanding can be found at http://www.sandia.gov/pv/0800steve.pdf.

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2001

Calendar of Events

JAN

16-19 **DOE Distributed Power Program Review Meeting**, second annual program review; Washington, D.C. Additional information at http://www.eren.doe.gov/distributedpower/. Contact: Megan Maguire (303) 275-4321; email: megan_meguire@nrel.gov.

28-1 **IEEE Power Engineering Society (PES) Winter Meeting 2001**, Columbus, OH. Contact: (614) 883-7235; fax (614) 883-7222; email: t.c.wong@ieee.org.

29-31 **1st IEC Joint Coordination Group (JGC TC82/TC21/TC88) Meeting**: **Decentralized Renewable Energy Systems**, Golden, CO. Hosted by NREL. Contact: Kathy Shropshire, (303) 384-6459; email: kathy_shropshire@nrel.gov.

31-1 **F-Cells: Fueling the Stationary Power Revolution**. San Diego, CA. Email: stationaryfcells@iqpc.co.uk.

FEB

18-20 **6th Annual National Ethanol Conference: Policy and Marketing**, Renewable Fuels Association. Las Vegas, NV. Contact: (800) 567-6411.

19-22 **4th Industrial Energy Efficiency Symposium and Exposition**, Washington, D.C. Meeting Management Services, OIT Expo Office (877) OIT-SYMP; fax (703) 486-0618.

25-28 **Energy Outlook Conference**, Washington, D.C. Organized by the National Association of State Energy Officials (NASEO). Contact: Melanie Minesinger (703) 299-8800 ext.14; http://www.naseo.org/events/outlook/default.htm.

MAR

6-8 **Hydrogen: The Common Thread**. U.S. Hydrogen meeting and EXPO, Washington, D.C. Contact: National Hydrogen Association, (202) 223-5547; fax: (202) 223-5537; email: nha@ttcorp.com.

20-24 **Distributed Generation Conference**, San Diego, CA. Contact: (503) 231-1994; fax (503) 231-2595; www.powerin.org.

22-24 **Building Energy 2001 Conference**, Boston, MA. Sustainable economic growth; speakers address issues ranging from fuel cells to offshore wind to greening institutional buildings. Contact: Jonathan Tauer, (413) 774-6051, ext. 20.

25-27 **EGSA's 2001 Spring Conference**, Albuquerque, NM. Contact: (561) 750-5575; fax (561) 395-8557; email: egsa.org; http://www.egsa.org.

29-31 **Globalcon**, Atlantic City, NJ. Organized by the Association of Energy Engineers (www.aeeecenter.org). Contact: Debbie Hannaman (920) 338-0950; fax: (920) 338-0951.

APR

9-11 **22nd International Power Sources Symposium: Research & Development of Batteries & Fuel Cells**, Manchester, U.K. Contact: Bob Baily, +44.1892.652.881; fax: +44.1892.653.459; email: ipss@marketdevelopco.demon.co.uk.

17-19 **The U.S. Department of Energy Hydrogen Program Annual Review**, Baltimore Hilton & Tower, 20 West Baltimore Street, Baltimore, MD. Contact: Cathy Gregoire; email: cathy_gregoire@nrel.gov.

23-28 **Hannover Fair 2001: The World Fair for Energy Management and Technology**, Hanover, Germany, +49-(0)8151-99892-3; fax: +49-(0)8151-99892-43; email: arno@fair-pr.com.

29-1 **AGA Operations Conference and Biennial Exhibition**. Dallas, TX. Contact: email: l.ingels@aga.org.

MAY

6-9 **23rd Symposium on Biotechnology for Fuels and Chemicals**. Breckenridge, CO. Contact: Megan Maguire, (303) 275-4321; fax: (303) 275-4320; email: megan_maguire@nrel.gov.

9-10 **West Coast Energy Management Conference**, San Diego, CA. Organized by the Association of Energy Engineers (AEE). Contact: Brian Douglas, (770) 279-4386; fax (770) 381-9865.

30-31 **Fuel Cell Summit V**. College Park, MD. Supported by the U.S. Department of Energy, Office of Power Technologies. Contact: Maude Wickline, (703) 617-4254 or visit www.pnl.gov/fuelcells.

JUNE

3-6 **Energy 2001**, Kansas City, MO. National energy management workshop and trade show for federal, state, local, and private sector energy managers, ESCos, utilities, procurement officials, and engineers. Contact: JoAnn Stirling, (800) 395-8574; fax (321) 638-1010.

4-6 **4th Annual Energy 2001**. Kansas City, MO. Sponsored by the U.S. Department of Energy, U.S. Department of Defense, and General Services Administration. Contact: (410) 997-0763; fax (410) 997-0764; email: energy@epponline.com.

25-27 **Electric 2001**. Orlando, FL. Contact: (212) 370-5005; fax (212) 370-5699; email: info@electricshow.com.

Standards Committee Activities Updates

ANSI - Z21.83 - 1998/CSA, Fuel Cell Power Systems

Work continues on proposed changes from the Fuel Cell Technical Working Group. The next meeting will be scheduled for late February or early March. Contact: Steven E. Kazubski (CSA International), (216) 524-4990 ext. 8303; email: steve.kazubski@csa-international.org.

ASME PTC 50, Performance Test Code for Fuel Cell Power Systems

This code will apply to all fuel cell power systems regardless of the electrical power output, thermal output, fuel cell type, fuel type, or system application and applies to the performance of overall fuel cell power systems. It will provide test procedures, methods, and definitions for performance characterization and address combined heat and power systems. It does not address the performance of specific subsystems, energy storage systems, emissions, reliability, safety issues, or endurance. Work on the draft continues; 2002 is the target date for completion and publication. The next meeting will be January 24-26, 2001, at Singer Island, FL. Contact: Tony Leo (Fuel Cell Energy), (203) 792-1460 or Jack Karian (ASME), (212) 591-8552; email: karianj@asme.org.

IEC TC 105, Fuel Cell Technologies

New Work Item proposals include three from the United States: Definitions and Terminology: Stationary FC Systems –Safety: Stationary FC Systems–Installation: Stationary FC Systems–Performance. Japan has proposed Stationary FC Systems–Performance, and Germany has proposed FC Modules (stacks)–Construction Safety Standards. The next meeting of the U.S. TAG will be scheduled for late February or early March. The next IEC TC 105 meeting will be in summer 2001; locations being considered are Florence, Italy, and Vancouver, B.C., Canada. Contact: Steven E. Kazubski (CSA International), (216) 524-4990 ext. 8303; email: steve.kazubski@csa-international.org.

IEEE P1547, Distributed Resources Interconnected With Electric Power Systems

The working group expects to incorporate comments from the October meeting in California and complete Draft 6 of the standard in time for presentation at the January 16-19 meeting in Washington, D.C. The meeting will be in conjunction with DOE's Distributed Power Program Review Meeting. Contact: Richard DeBlasio (NREL), (303) 384-6452; email: dick_deblasio@tcplink.nrel.gov; or Tom Basso (NREL), (303) 384-6765; email: thomas_basso@nrel.gov.

ISO TC 197, Hydrogen Technologies

Target dates set by ISO/TC include: October 2000 for the availability of the Draft Publicly Available Specification for WI 15916 Basic Considerations for the Safety of Hydrogen Systems; November 2000 for the availability of the Draft International Standard for WI 15869 Gaseous Hydrogen and Hydrogen Blends-Land Vehicle Fuel Tanks; December 2000 for the availability of the proposed Final Draft International Standard for WI 13985 Liquid Hydrogen-Land Vehicle Fuel Tanks; September 2001 for the availability of the first committee draft for WI 17268 Gaseous Hydrogen-Land Vehicle Filling Connectors; and December 2001 for the availability of the first committee draft for WI 15866 Gaseous Hydrogen Blends and Hydrogen Fuel-Service Stations.

The 10th plenary meeting will be in October 2001 in Paris. The 11th plenary meeting will be in conjunction with the 14th World Hydrogen Energy Conference in June 2002 in Montreal. Contact: Karen Miller (NHA), (202) 223-5547; email: kmiller@ttcorp.com.

National Evaluation Service (NES) Protocol, Fuel Cell Installations

The NES continues development of an evaluation protocol by which stationary fuel cell power plants can be evaluated and a National Evaluation Report can be issued on a subject technology. A National Evaluation Report verifies and supports compliance with adopted codes and standards and is used by state and local code officials to enforce building regulations. Contact: Darren Myers (BOCA), (708) 799-2300; email: dmeyers@bocai.org.

NFPA 70–Article 691/692, Fuel Cell Systems

Code-Making Panel 3 met December 7-9, 2000, in Phoenix, to address the Report on Proposals and public comments to the proposed new Article 691 including the proposed new title, "Fuel Cell Systems," and renumbering as Article 692. The panel's actions will be reviewed at the TCCD meeting March 5-9, 2001, and a Report on Comments will be available in April. NFPA members will vote on the standard May 13-17 in Anaheim, CA. The NFPA Standards Council will issue the 2002 NEC on July 20, 2001, and make it available in September 2001. Contact: Jean O'Connor (NFPA), (617) 984-7421.

NFPA 853, Installing Fuel Cells

NFPA 853 has been accepted by the National Fire Prevention Association and is available to the public by calling (617) 770-3000 or online at www.nfpa.org. Contact: Don Drewry (Hartford Steam Boiler); email: Don_Drewry@hsb.com or Richard Bielen (NFPA), (617) 770-3000; email: rbielen@nfpa.org.

UL1741, Standard for Inverters Converters and Controllers for Use in Independent Power Systems

This standard has been harmonized with IEEE 929. Utility interactive product Listed to the published UL 1741 are being accepted by many utilities across the nation for utility grid interconnection. UL 1741 is slated for harmonization with IEEE P1547, Distributed Resources Interconnected with Electric Power Systems, once IEEE 1547 is published. This harmonization will allow manufacturers to have their products evaluated once, to comply with the necessary national electrical safety and utility interconnection performance requirements. Contact: Tim Zgonena (UL), (847) 272-8800 ext. 43051; email: Timothy.P.Zgonena@us.ul.com.

For additional information, contact:

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What is a Non-Islanding Inverter?

A non-islanding inverter is defined in IEEE Standard 929-2000 as:

- An inverter that will cease to energize the utility line in 10 cycles or less when subjected to a typical islanded load in which either of the following is true:
    1. There is at least a 50% mismatch in real power load to inverter output (that is, real power load is less than 50% or greater than 150% of inverter power output) or,
    2. The islanded-load power factor is less than 95% (lead or lag).
- If the real-power-generation-to-load match is within 50% AND the islanded-load power factor is greater than 95%, then a non-islanding inverter will cease to energize the utility line within 2 seconds whenever the islanded load has a quality factor of 2.5 or less.

How an Island Might Occur

If a segment of a utility system is established as a PV-powered island, then there is no utility control over the voltage and frequency of that island. This situation could occur:

- As a result of a fault detected by the utility protection equipment resulting in the opening of a fault-interrupting device that is not detected by the PV inverter
- As a result of accidental opening of the normal utility supply by equipment failure
- As a result of utility switching of the distribution system and loads such as for maintenance operations
- As a result of human error or malicious mischief.

Why Islands are Undesirable

Non-utility-controlled generation islanding should be avoided because:

- The utility cannot control voltage and frequency in the island. Voltage or frequency excursions can cause damage to customer equipment. Utilities can be liable for electrical damage to customer equipment connected to their lines that results from voltage or frequency excursions outside of the acceptable ranges.
- Islanding may interfere with the restoration of normal service by the utility.
- Reclosing into an island may result in re-tripping the line or damaging the dispersed generation equipment, or other connected equipment, because of out-of-phase closure.
- Islanding may create a hazard for utility line-workers by causing a line to remain energized when it is assumed to be disconnected from all energy sources.

Most islands can be avoided easily by monitoring AC voltage and frequency at the inverter output terminals and allowing only inverter operation when these parameters are within acceptable limits. When an island is created, imbalance between islanded load and islanded generation will result in either frequency or voltage (or both) drifting outside of their normal operating range, causing the PV inverter to disconnect. It is possible, however, that the power requirements of the load match the instantaneous output of the distributed generation system so closely that voltage and frequency limits would not be exceeded if the system were islanded.

Residential Fuel Cells Plug Into the Grid

A new power conversion system allows fuel cells to operate just like “plug-in” appliances and enables them to operate seamlessly in a grid-independent or grid-parallel mode. SatCon Technologies recently announced a power conversion system with a new utility grid interface for fuel cell distributed power generation systems. The new GridLink™ interface will be part of the PowerGate™ Power Conversion Systems, which are designed to handle load requirements of up to 50 kW. The system, including the grid interface and a controller, convert low-voltage DC power from fuel cells into usable AC power. Multiple units of the modular system can be “stacked” to handle higher loads. The system can also operate with microturbines, generators, and other distributed power generation systems.

According to David Eisenhaure, SatCon President and CFO, the new interface solves several problems for fuel cell power generation systems. First, the new interface may eliminate future regulatory issues with tying into the utility grid. The interface is designed to pull power from the grid like any simple plug-in appliance. Since it does not pump electricity back into the grid, there may be no need for regulatory approval for its use. Second, it allows the fuel cell to operate both grid-parallel and grid-independent, a combination that increases the effectiveness of a fuel cell system. Third, since power can be pulled from the grid to meet peak loads that might otherwise be met by batteries, it eliminates many of the discharge cycles, extends the life of the battery back-up system, and allows the back-up system to be saved for grid outages.

The overall system is designed for 50 kW with an average operating range of 3 kW to 10 kW. This allows the fuel cell to accommodate a wide range of installation requirements and to operate during such occurrences as an over-loaded circuit breaker without losing power to the entire house. SatCon is working with several manufacturers including Plug Power, H Power, IdaTech, Nuvera, and Fuel Cell Energy to incorporate the technology into their fuel cell power generation systems. Grid interconnection can be a key component to the successful market introduction of residential-sized fuel cell power generation systems.

DOE Publicaton RL-P00-006

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Underwriters Laboratories Expands DG Program

by Tim Zgonena, Underwriters Laboratories

Underwriters Laboratories (UL) is an independent and not-for-profit organization that acts as a third party to evaluate thousands of products, components, materials, and systems for compliance with recognized safety requirements. These include electrical and electronic equipment, mechanical products, building materials, construction systems, fire protection equipment, alarm systems, and chemicals. Once compliance is demonstrated, manufacturers are authorized to apply the appropriate UL mark to their products. Continued compliance is verified through unannounced factory visits.

UL has been involved in the distributed generation (DG) arena since the early 1980s. UL participates in IEEE, IEC, NFPA, ANSI, and utility working groups and technical committees to establish and maintain the requirements for many DG products as well as the utility interconnection of these products.

UL 1741, The Standard for Inverters Converters and Controllers for Use in Independent Power Systems (formerly the Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems), has been harmonized with IEEE 929 the Recommended Practice for Utility Interface of Photovoltaic (PV) Systems. Utility interactive products listed to published UL 1741 are being accepted by many utilities across the nation for utility grid interconnection. Although established for PV systems, UL 1741 is being used to evaluate the output power inverters, converters, and power controllers for all types of DG power sources.

UL 1741 is slated for harmonization with IEEE P1547, Distributed Resources Interconnected with Electric Power Systems, once IEEE 1547 is published. This will allow manufacturers to have their products evaluated once to comply with the necessary national electrical safety and utility interconnection performance requirements.

UL has performed product evaluations in the following DG categories: photovoltaics, fuel cells, microturbines, wind turbines, engine generators sets, and hybrid combinations of the above. UL can evaluate other DG products as well.

The public is highly aware of PV systems as an environmentally friendly solution to niche power demands. PV modules and panels are evaluated to UL 1703. UL has evaluated microturbines to the basic requirements in UL 2200, augmented by UL 50, UL 1741, and/or UL 508C for enclosure and interconnection requirements, respectively.

There are very few codes or standards for lower power fuel cell products. UL is investigating several designs primarily planned for marketing to the residential or light commercial sector and rated less than 10 kW output. They are fueled by either an external source of hydrogen or an onboard reformer to process hydrogen from natural gas fuel. These designs vary as to how electric power is utilized. Some are designed as an un-interruptable power supply, while others are designed to operate independent of or interactive with the electric grid. It is clear that fuel cell power plant designers can address a variety of system applications.

Lower power fuel cell products have features or components that often exceed the scope of ANSI/Z21.83, Stationary Fuel Cell Power Plants. Therefore, UL is devising additional requirements to cover these new classes of equipment, such as leakage of flammable gases both outdoors and indoors, computer control of power plant safety functions, and the use of UL 1741 to evaluate onboard inverters, controllers, and battery chargers.

UL is also considering the work done by the technical committee that developed requirements for NFPA 853-Standard for the Installation of Stationary Fuel Cell Power Plants, and the National Evaluation Service proposed protocol for Stationary Fuel Cell Power Plants.

Bridging the gap between emerging new equipment and the codes and standards community will result in better codes and standards and permit manufacturers to have easier entry into their target markets.

For information about specific DG requirements or a particular area of DG, please contact the appropriate person in the table below. For more information, visit the UL website: www.ul.com.

Inverters, Converters, Charge Controllers and Utility Interconnect Requirements UL 1741, IEEE 929 and IEEE P1547		
Tim Zgonena	(847) 272-8800 ext. 43051	Tim.P.Zgonena@us.ul.com
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Engine Generators, Microturbines, UL 2200		
Harry Ruetschlin	(847) 272-8800 ext. 42938	Harry.M.Ruetschlin@us.ul.com
Booster Compressors		
Larry Kettwich	(847) 272-8800 ext. 42484	Larry.D.Kettwich@us.ul.com
Windpower Generators, IEC 61400		
Bill Colavecchio	(919) 549-1400 ext. 11534	William.A.Colavecchio@us.ul.com
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