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## FEATURES



## COLUMNS



## DEPARTMENTS

# The Smart Grid Impact on Homes

By Ken Wacks

The objective of a smart grid is to integrate the elements of an electric power system for enhanced reliability. These elements extend beyond the meter into buildings and homes. This paper examines the impact on homes by introducing the projects of the Home-to-Grid Domain Expert Working Group (DEWG).

The Home-to-Grid DEWG mission is to provide guidance for the U.S. National Institute of Standards and Technology (NIST), part of the Department of Commerce, and the Smart Grid Interoperability Panel (SGIP). The SGIP was established by NIST as a public/private partnership with the utility industry.

The Home-to-Grid DEWG maintains a Web site using a collaborative publishing tool called a TWiki. All the papers mentioned in this article are available at: http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/H2G

## Creation of the Domain Expert Working Groups

Under the *Energy Independence and Security Act (EISA)* passed by the U.S. Congress in 2007, NIST is required to examine standards that enable a smart grid. In 2008 NIST asked the GridWise Architecture Council (GWAC) for help in this mission. GWAC is a panel of 13 experts appointed by the U.S. Department of Energy to provide strategic guidance for the utility industry on smart grids. NIST and GWAC created DEWGs to focus on the business and policy of smart grids and the interfaces to transmission and distribution networks, homes, buildings, industry, and electric vehicles. Each DEWG was established with co-chairs from GWAC and NIST.

My role at GWAC is to focus on the grid-to-home interface. Therefore, I was asked to co-chair the Home-to-Grid DEWG with Tom Nelson, an engineer from NIST. NIST and the DEWG members select topics for us to investigate based on the needs of NIST and the expertise of our participants.

The Home-to-Grid DEWG is open to anyone, with membership currently standing at more than 100. I am especially pleased that we have a balance of utilities, utility equipment suppliers, and consumer product developers.

## Mission of the Home-to-Grid DEWG

Among the recommendations of the *Energy Independence and Security Act* is a request that the utility industry plan for the deployment of demand response systems rather than focusing exclusively on supply (generation). The need for demand response stems from:

- Electric supply limitations
- Public resistance to building large generating plants
- Concerns for environmental pollution, including greenhouse gases
- Opposition to "siting" transmission lines

- The anticipated demands for electricity by electric vehicles
- The introduction of distributed generators such as wind and solar panels
- The fluctuation in output with time and weather from distributed generation sources

The objective of demand response is to help match the demand for electricity with economical sources of supply. Electricity consumption patterns have peaks daily and seasonally. During weather extremes of heat and cold the demand for electricity rises sharply. To meet these occasional peak demands, some utilities need to keep relatively expensive generators running or must build new plants.

U.S. utilities are required to maintain the supply of electricity sufficient to meet any demand. However, this is becoming less practical because of the cost of new electricity plants, public resistance to new plants, and government rules controlling environmental pollution. The pressure for plants to meet peak demands could be reduced if customers evened out their power consumption so the peaks are flattened.

Utilities have developed specific programs to influence the customer demand for power in order to align with the available supply. Such utility programs have been called demand-side management (DSM). Since DSM programs may not involve explicit management by the utility, the term *demand response* is being widely used in the industry.

Demand response uses incentive-based and indirect methods for controlling how much electricity is consumed during a specified time interval by water heaters, air-conditioners, and industrial equipment. The more innovative methods of load control depend on market forces for exerting control by varying the price of electricity.

## Home-to-Grid Requirements

To assist NIST in evaluating standards for demand response, the Home-to-Grid DEWG started by preparing a list of home-to-grid requirements. NIST asked us to critique a set of requirements for interfacing home devices to a smart grid. These requirements were written by the Open Smart Grid (OpenSG) Technical Committee of the UCA® International Users Group (UCAIug), a trade organization of utilities and suppliers. OpenSG created a specification entitled "UCAIug 2008 Home Area Network System Requirements."

The Home-to-Grid DEWG delivered a report to NIST that begins with an overview of demand response based on a published international technical report (ISO/IEC 15067-3 "Model of an energy management system for the Home Electronic System"). Various methods for implementing demand response are described. The choices vary by utility to achieve the load shape that aligns with supply limitations, transmission and distribution capabilities, regulatory constraints, and business considerations.

The 178 requirements proposed in the UCAIug specification were analyzed and organized into the following categories. The number of requirements per category identified by the Home-to-Grid DEWG is shown. The total of all requirements is less than the 178 selected by UCAIug since some are specific to the demand response solution chosen and some were unnecessary according the Home-to-Grid DEWG.

- General requirements (8)
- Requirements based on features chosen by consumer (28)
- Payment options (2)
- Customer education application (21)
- Direct load control (34)
- Network configuration and management (12)
- Network security (4)

## Implementing interoperability

A smart grid enhances a conventional electric grid with the addition of sensors, actuators, and controllers. These devices are interconnected via communication networks that are interoperable across the entire utility network. At the home these networks may link to:

- Home networks that support demand response programs
- Local generation sources (wind, solar, etc.)
- Electric vehicles

Each segment of the electric network uses different communications methods and application models. It is not feasible to specify a uniform communications protocol for all aspects of utility operations because they have different requirements. However, for seamless operation of a smart grid, these differences must not impede the flow of data and control. This requires that the various protocols must interoperate, possibly via gateways that translate between protocols.

The Home-to-Grid DEWG issued a paper that defines

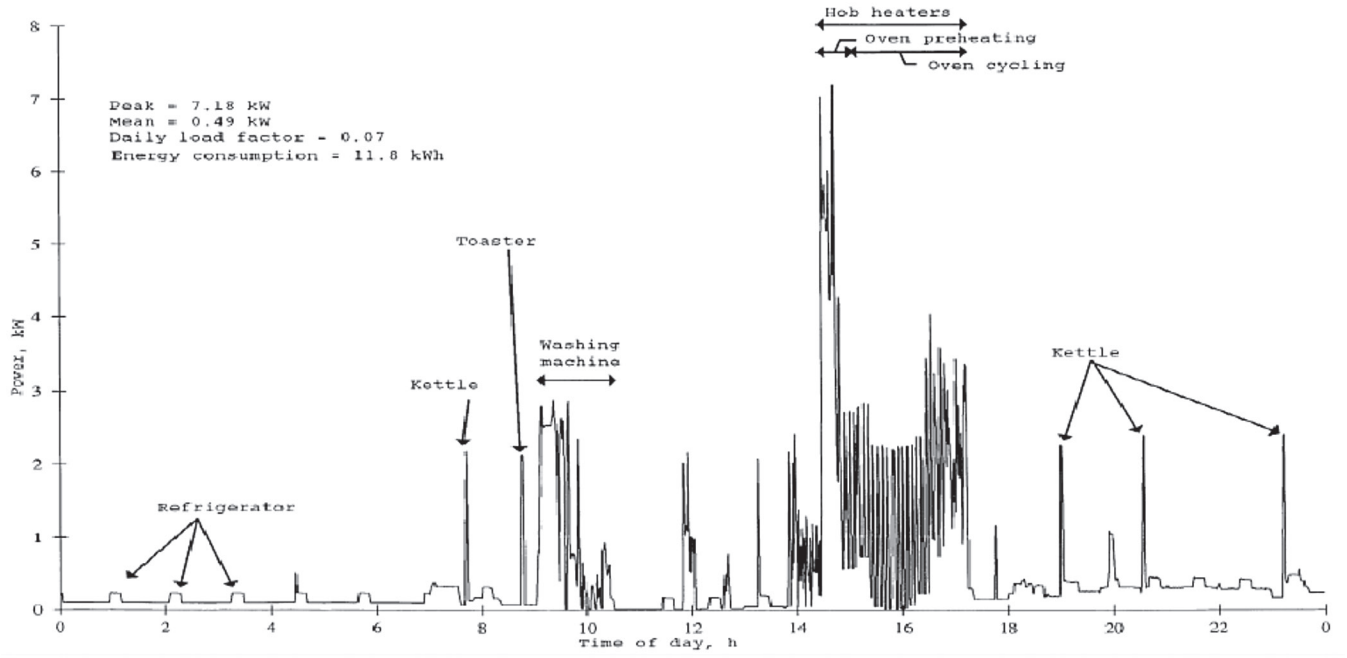


**Figure 1** - Information Derived from Meter Consumption Data

interoperability and explains how to achieve it within the smart grid. This paper presents guidelines for interoperability including a business and technical plan to build a successful interoperability-testing program regardless of the specific standards or profiles under test. The emphasis is on installation rollout with interoperability verification independent of any particular communication standards and interface technology.

## Protection of consumer privacy

The *Energy Independence and Security Act of 2007* mandated that NIST report to Congress on cyber security for the electricity grid. Privacy is an important adjunct to security and uses some of the same data tools. However, privacy goes beyond data tools and confidentiality. How personal information is collected, used, shared, stored, retained, and disposed of all impact privacy. Stringent and effective security can be in place and still result in egregious privacy breaches that fall outside of security controls.

Figure 1 illustrates information that can be inferred from frequently reading consumption at the electric meter. This illustration was on the cover of a report to the Colorado Public Utility Commission entitled *Smart Metering & Privacy: Existing Law and Competing Policies*. It was included in the NIST Interagency Report 7628, *Guidelines for Smart Grid Cyber Security* (section 5.3.6).

The Home-to-Grid DEWG issued a paper addressing consumer privacy and possible impacts on:

- Ownership and misuse of consumer data.
- Remote control of consumer premises devices and misuse of that control, and the related data.

The paper proposes policies for:

- Ownership of data
- Stewardship of data
- Types of data (appliance energy consumption)
- Use of data (intended and unintended)
- Sharing of data
- Retention of data
- Disposal of data

## Additional Home-to-Grid DEWG projects

The Home-to-Grid DEWG has completed the following additional projects:

- *Electromagnetic compatibility (EMC)*

We were asked by NIST to consider whether a reliable smart grid imposes extra requirements on EMC for consumer products

- *Appliance interface to a home area network*

We have been examining how to assist the appliance industry in adding energy management features to products. This investigation has resulted in the publication of three papers:

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- *Free Market Choice for Appliance Physical Layer Communications*
- *Appliance Socket Interface*
- *Modular Communications Interface Specification for Demand Response*

Work on the "Modular Communications Interface Specification for Demand Response" was completed in September 2011 and has been passed to the Consumer Electronics Association for development into an American national standard. These projects will be examined in a future article for *iHomes & Buildings*.

Dr. Kenneth Wacks has been a pioneer in establishing the home systems industry. He advises manufacturers and utilities worldwide on business opportunities, network alternatives, and product development in home and building systems. In 2008, the United States Department of Energy appointed him to the GridWise Architecture Council. For further information, please contact Dr. Wacks at 781.662.6211; kenn@alum.mit.edu; www.kenwacks.com.