Broadcast-based Energy Management

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Introduction

The Home-to-Grid Domain Expert Working Group (H2G DEWG) has developed a white paper entitled *Broadcast-based H2G Communication Solutions.* The H2G DEWG chair, Ken Wacks, explained that the development of this paper was motivated by a request from regulators and appliance makers for a simple method to deliver energy management data from a power utility or energy service provider to consumer products. These data may include electricity prices or event notices about energy shortages. The data transmission method uses an FM subchannel available to all FM radio stations. Digital data are broadcast to special receivers that may be embedded in appliances or in an energy management controller. There are provisions for authenticating that the data originated from the utility to ensure cyber security. The use of FM broadcasting provides universal real-time coverage throughout the country with messages that can be tailored to each geographic region.

The following smart applications are enhanced by the fast response time and full market coverage enabled by FM broadcast communications:

- Demand response
- Frequency regulation
- Integration of renewable generation
- Dynamic pricing schemes

Benefits of Broadcast Communications

Power utilities may significantly reduce operating costs and increase grid reliability if appropriate pricing signals or event notices are sent to assist the balancing of power supply and demand. By sending regional prices to energy-consuming devices in the home, it is possible to leverage and optimize the inherent energy storage and/or ability of appliances to modify consumption (with user cooperation) in real-time.

Feedback or confirmation of load-shed characteristics can be obtained by data mining at the feeder or substation level. These data are inherently aggregated so end-user privacy is maintained. The benefit of this approach is potentially influencing a greater volume of loads more quickly and cost effectively than any current alternative.

The broadcast method can potentially address some of the problems users may have with localized two-way transmitters, such as a lack of signal coverage in multiple occupancy homes or

small businesses. The broadcast solution can be complementary to optional home energy management or networking systems by providing an independent live input to the local network.

Broadcast communications is an economical method for reaching large numbers of end devices in the residential and small commercial markets. Energy management in these markets is becoming increasingly important since the growth of wind and solar resources in the supply-side mix has added significant complexity to load/resource balancing requirements. New control methods with loads such as electric vehicles or existing loads with inherent energy storage such as water heaters on the demand-side creates opportunities for simple low cost control optimization solutions.

Radio Broadcasting

FM radio broadcasters are authorized to carry digital data in addition to audio using the Radio Data System (RDS). Consumers use RDS for station, song, and artist displays on car radios. There is excess capacity in the RDS channel that station owners can rent. RDS distribution offers the benefit that the market coverage of an FM station is typically well matched to the service area of electric utilities in that market. RDS broadcast costs are shared with the primary business application of audio broadcast.

FM broadcasting offers considerable value for demand response applications with ubiquitous deployment, good building penetration, robust reliability, and low delivery and consumer-equipment cost. The infrastructure already exists as "low hanging fruit" – reducing time to implementation as well as overall capital expenditures. It also eliminates otherwise needed environmental assessments, reviews, and regulatory impact studies. Furthermore, broadcast solutions utilize the existing FM radio infrastructure while preserving customer privacy, without introducing new local radio frequency emissions.

FM broadcasting enables smart appliances by providing them with real time price information, vastly improving the efficiency of the way that an appliance buys the power it needs to serve the consumer. In addition to communicating price and event notices to appliances, a simple message display terminal can be addressed by utilities to alert and advise consumers regarding energy usage during critical periods and to provide an alternative messaging channel for other important information.

The smart grid is a complex system of electric supply and demand with increasing market penetration of renewable and bi-directional microgrids. It is therefore logical to assume that a myriad of communication solutions needs to be developed to accommodate this complexity. One of the key characteristics of broadcasting is the ability to expand without limiting the number of simultaneous listener devices. This alone is a strong case for the consideration of broadcasting as a primary tool for Smart Grid home-to-grid communication solutions. Other important traits of broadcasting include end-user privacy preservation and the ability of the broadcast system to complement Home Energy Management Systems (HEMS) and Advanced Metering Infrastructure (AMI) networks.

Applications of broadcast communications

Automated Demand Response

Most devices that use electricity either have thermal inertia (e.g., heating, cooling, water heating, and refrigeration) or potential flexibility as to when they take power from the grid (e.g., industrial pumping loads and batch processes, pool pumps, dishwashers, clothes dryers, and charging of electric vehicles and battery powered devices). While many of these end-use devices have built-in intelligent controls, they lack information about when it would be most economical to use power from the grid.

An inexpensive, standards-based approach for communicating present and near-term energy prices could rapidly lead to the deployment of millions of devices that would automatically and continually adjust the timing of their electricity use in response to grid conditions without materially impacting the consumer's experience. In the aggregate, such devices could provide a flexible resource. This response could help compensate for the output variation in large, renewable resources, improve utility asset utilization and lower costs, enhance reliability, facilitate demand response, and remove a key barrier to efficient retail pricing.

Home Energy Management System

A Home Energy Management System (HEMS) may be deployed as an agent for coordinating appliance energy consumption. An HEMS energy management controller may contain the FM RDS receiver. The real time pricing and other information received via broadcast signals can then be shared with the connected devices. The H2G DEWG developed a specification for an interface between an appliance and a home network that may be part of an HEMS. This interface is now an American National Standard called *Modular Communications Interface for Energy Management* (ANSI/CEA-2045).

Federal Energy Regulatory Commission (FERC) mandate

Broadcast communications could help FERC to fulfill a legal mandate from the Energy Policy Act of 2005 to "provide for the dissemination, on a timely basis, of information about the availability and prices of wholesale electric energy and transmission service to … the public." Thus, data about when it would be economical to use electricity should be available to any device, anywhere, at all times, as inexpensively as possible, and with little or no change in consumer behavior required. Broadcast communications are relatively low cost to deploy.

Transactive Energy

Transactive Energy is an automated strategy for balancing the supply and demand for electricity under development by the GridWise® Architecture Council. In a Transactive Energy environment, power-producing devices from utilities and from customers with local power generating capacity may offer excess power to the grid via a market bid-and-ask mechanism. The device or an aggregate of devices would propose power at a specified level and time, which could be a few minutes or hours later. Loads on the grid bid for this power, a price is agreed, and the power is delivered when promised to settle the trade. The price and power data are exchanged among the devices via a network using machine-to-machine (M2M) communications. The broadcast

mechanism can be a very useful tool for facilitating the Transactive Energy concept, especially if grid-specific information can be attached for optimizing feeder and substation capacity issues.

Winners with broadcast communications

The innovative use of FM broadcast RDS for utility load management in smart grids represents a win-win situation, wherein utilities can rebalance electrical loads with low cost optimization strategies and broadcasters can collect new non-traditional revenues by providing valuable energy management services to their communities. FM broadcasters have shown support for this utility endeavor and can provide additional value to the utilities by offering on-air timely public awareness of Smart Grid campaigns along with extraordinary grid service conditions and advisories to the local communities they currently serve.

About the Home-to-Grid Domain Expert Working Group

In 2008, the Home-to-Grid Domain Expert Working Group (H2G DEWG) was established by the National Institute of Standards and Technology (NIST), U.S. Department of Commerce, and the GridWise® Architecture Council (GWAC), an industry panel of 13 experts appointed by the U.S. Department of Energy. The H2G DEWG is now part of the Smart Grid Interoperability Panel (SGIP), a member-funded, non-profit association created with support from NIST to identify technical and interoperability standards harmonization that accelerates modernization of the grid.

The H2G DEWG scope includes applications and communications linking energy service providers (utilities and other third-party providers) with customer equipment in residential buildings via the electric grid and associated networks. Customer equipment may include home appliances, consumer electronics, plug-in electric vehicles (PEVs), plug-in hybrid electric vehicles (PHEVs), and local power sources (such as photovoltaics). See more at: http://www.sgip.org/home-to-grid-h2g-dewg.

H2G papers are written by volunteer subcommittees from the Smart Grid community including utilities, services providers, equipment vendors, and appliance manufacturers. This white paper on broadcast communications was proposed and developed by Jackson Wang of e-Radio with the support of a dedicated subcommittee of the H2G DEWG.

Dr. Kenneth Wacks serves as Chair of the SGIP H2G DEWG and has been a pioneer in establishing the home systems industry and a management advisor to clients worldwide, ranging from startups to large companies. His business focus includes home and building systems, energy management, and digital entertainment networks. The United States Department of Energy appointed him to the GridWise Architecture Council. For further information, please contact Ken at +1 781 662-6211, kenn@alum.mit.edu, or visit http://kenwacks.com.

About the Smart Grid Interoperability Panel

The Smart Grid Interoperability Panel (SGIP) orchestrates the work behind power grid modernization. SGIP was established to identify technical and interoperability standards harmonization that accelerates modernization of the grid. As a member-funded, non-profit organization, SGIP helps utilities, manufacturers, and regulators address standards globally: utilities gain improved regulatory treatment for investment recovery and manufacturers obtain enhanced commercial opportunities worldwide. SGIP members stay competitive, informed and well-connected. To learn more about SGIP, visit http://sgip.org.