GREEN OVATIONS

Innovations in Green Technologies

Smart Home Energy Management with or without the Smart Meter

By Louis Szablya, VP of Marketing and Product Management at Energate

A recent report by The Edison Foundation's Institute for Electric Efficiency estimated that about 27 million smart meters had been installed in the U.S. as of September 2011, representing approximately 22 percent of U.S. households. The report also estimates that just over half of all U.S. households (54 percent) will have a smart meter by the end of 2015. Given the growing desire by utilities to reduce peak demand, and by consumers to save money by controlling energy utilization more effectively, is there anything that can be done for today's underserved and unserved majority of residential customers now?

Long before the advent of the smart grid and smart meters, electric utilities used a variety of demand-side management programs to reduce peak demand. These programs initially focused on commercial and industrial customers as the major users of electrical energy. More recently, residential demand-side management programs have been implemented using direct load control (DLC) for air conditioner compressors, pool pumps, and electric water heaters. The network infrastructure requirements for residential DLC are fairly modest, and can often be satisfied by an existing pager or other one-way broadcast network.

While a residential DLC program may be necessary to achieve meaningful reductions in peak demand, they are not sufficient. Demand response (DR) programs are therefore, also needed, but these have more demanding infrastructure requirements. For the relatively small number of relatively large commercial and industrial customers, the investment in the requisite infrastructure is fairly easy to justify. For the relatively large number of relatively small residential customers, however, the fairly high investment in infrastructure and equipment required remains an impediment to some much-needed progress.

This article explores what electric utilities can do to implement smart home energy management programs cost-effectively in the absence of a fully-functional and service area-wide advanced metering infrastructure. Before exploring the two options available, it is useful to characterize the ideal arrangement, or "best case" use case for smart home energy management.

'Best Case' Use Case for Smart Home Energy Management

Demand response has been identified as a 'killer application' for the smart grid, and an effective residential DR program requires a smart yet simple home energy management system (HEMS). Indeed, it is the 'smart' part of the smart thermostat or home energy gateway that is critical to encouraging consumer acceptance and adoption by making the HEMS simple enough for the average person to use. Consumers want savings of course, but they also want convenience and comfort without complexity.

To be truly smart (and therefore 'set-and-forget' simple), the utility must be able to communicate with the home energy management system—and vice versa. This two-way, end-to-end communications capability requires two separate networks. One is the so-called neighborhood area network (NAN) that is part of the advanced metering infrastructure (AMI) needed for reading the interval data from the smart meters. The other is the home area network (HAN) that enables the smart meter, and therefore the utility, to communicate with the HEMS.

Ideally the HAN is sufficiently robust that, in addition to its primary task of reading meter interval data, it can also accommodate residential DR and other smart grid applications, such as distribution and substation automation, outage management, volt/VAR optimization, etc. To handle all of these applications well, the NAN must have an adequate amount of both upstream and downstream bandwidth, and provide acceptable levels or quality of service, especially for protocols requiring near real-time communications.

For its role in residential DR, the NAN would need to be able to send dynamic pricing signals (whether time-of-use, real-time or critical peak) via the smart meter's HAN to the home energy management system. The smart thermostat or home energy gateway in the HEMS would receive and then respond to the changing prices based on (easily set) customer preferences, and communicate the results back to the utility via the HAN and NAN.

In the U.S. the HAN used for DR is likely based on the ZigBee wireless networking protocol, along with its companion Smart Energy Profile (SEP), which specifies the home energy management protocols and applications, including for demand response, receipt of pricing signals, load control commands and text messages from the utility, time synchronization, security, etc. Based on these comprehensive capabilities, SEP version 2.0 has been selected by the U.S. National Institute of Standards and Technology for residential demand response in the Smart Grid Interoperability Standards Framework. Because SEP 2.0, while still supporting ZigBee, is also network-agnostic, it has now earned additional support from the HomePlug Powerline Alliance, HomeGrid Forum, SunSpec Alliance, Wi-Fi Alliance, IPSO Alliance and International Society of Automotive Engineers.

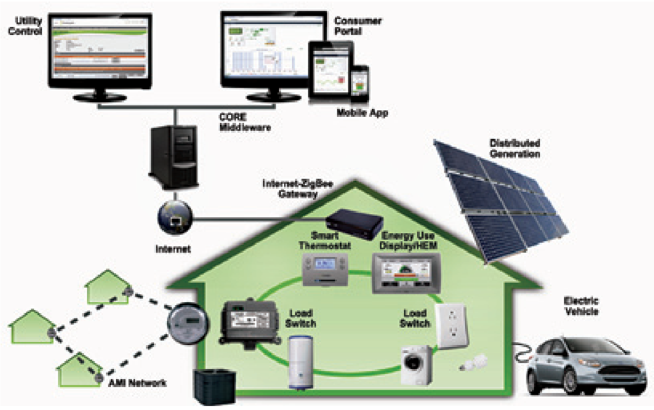
The 'HAN-less Smart Meter' Use Case

For some utilities that have deployed an AMI network, the smart meters can lack the end-to-end communications needed for residential DR for two reasons:

1. Either the meters are not equipped with a HAN
2. The AMI network is insufficient to handle the information exchanges required.

It is entirely possible that if the latter is the case, the former is also true as there is really no need to support a HAN in the smart meters. According to Parks Associates, as few as 10 percent of the smart meters currently installed are equipped with two-way communications between the home and the utility. Other analysts predict more or less HAN penetration, but the result is the same – another network is needed to facilitate residential DR.

Fortunately, there already exists a ubiquitous, reliable, secure and always-on two-way data communications network suitable for DR that is available in every utility's service area: the Internet. Broadband Internet access is now available to virtually every home in the industrialized world, and in the U.S. is already installed in 63 percent of them. The penetration in larger residences with the highest potential return on the DR investment is even greater. And the extent of broadband Internet access will only continue to increase as digital subscriber line (DSL), cable modem, third- or fourth-generation (3G/4G) cellular communications, and satellite services are expanded and competition among these alternatives lowers subscription rates. All that is needed for utilities to take advantage of the Internet is a dedicated gateway to connect the broadband Internet modem to the HAN, as shown in the figure. The gateway provides continuous two-way communications between the utility and the consumer's home energy management system devices, such as a smart thermostat or an energy use display shown. The gateway establishes a secure "service entrance" into the home by connecting both to the broadband modem (via Ethernet) and to the ZigBee, Wi-Fi or other HAN. The gateway is configured for secure, encrypted communications between the utility's DR application and the in-premises HEMS, and if the utility chooses, optional direct load control for other loads, enabling them to also receive dynamic pricing and/or direct control signals.



Wireless ZigBee HAN served by both a broadband Internet gateway and an AMI network. Note the ability to control other loads, including the charging of electric vehicles, which will be supported in future versions of the Smart Energy Profile.

It is important to note that this configuration is just as good as the 'Best Case' use case. It works with either dynamic pricing or published TOU rates, and because it provides even more capable communications into the home, the configuration affords an opportunity to implement home energy management applications that are even more sophisticated than most AMI networks are capable of supporting. For this reason, some utilities with an AMI network use Internet-HAN gateways for some or all residential DR programs, particularly for those requiring a higher bandwidth or lower latency than the AMI supports.

The 'Dumb Meter' Use Case

For homes that still have a 'dumb' electromechanical meter or even a 'semi-smart' meter incapable of capturing interval data (perhaps as part of an automated meter reading system), the 'HAN-less' configuration described above can be just as effective, but with one major difference: There is no way to use dynamic pricing. But this is not necessarily as big an impediment to residential DR as it might first appear to be.

There are many ways to provide incentives for consumers to reduce consumption during periods of peak demand other than higher 'punitive' rates that require interval data. Residential direct-load control programs have long used the one-time rebate as an incentive, but the availability of two-way communications via the Internet-HAN gateway gives utilities substantially more flexibility to craft more compelling incentives.

Some smart thermostats and home energy gateways enable the utility to capture the users' control settings to assess their impact on reducing peak demand. For example, the smart thermostat may be programmed to increase the temperature setting whenever it receives notification of a DR event from the utility or while TOU rates are in effect; the greater the increase in temperature (and therefore the greater the demand reduction), the larger the potential incentive. The home energy gateway might also be configured to temporarily shut off additional major loads, such as a water heater or pool pump. The utility could then provide a range of rebates (for a fixed rate structure) depending on how much each residence is curtailing its load.

Another option involves mounting a commercially available sensor to the 'dumb' electromechanical or digital meter to track consumption. These sensors attach to the outside of the meter to read current usage either from the spinning disc (analog) or LED port (digital), and then transmits the readings on a periodic basis to the smart thermostat or home energy gateway via the HAN. Some smart thermostats and home energy gateways are capable of storing these readings for an extended period of time, and transmitting the data to the utility via the Internet-HAN gateway. While such a configuration may not constitute official interval data for billing purposes, it could be used to calculate the level of rebate or adjustment based on actual usage, as well as to provide verification during periods of peak demand.

Of course, some consumers may not even need a financial incentive to do what is just the right thing to do for the benefit of society – and the planet. Several surveys have identified and characterized consumer segments whose members are quite willing to make changes to their energy consumption for the environment. These include the Anything Clean and Ultra Green segments identified in the 2011 Energy + Environment Study by Market Strategies International, and the Concerned Green and Young America segments identified in the 2011 Consumer Pulse and Market Segmentation Study conducted by the Smart Grid Consumer Collaborative (SGCC). The SGCC study also found that 78 percent of respondents strongly or somewhat agree that the smart grid and its energy-saving enhancements would better protect the environment and help make the U.S. more energy independent. And for many in these consumer segments, that may be incentive enough.

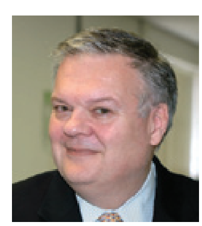
Astute readers may be wondering what happens when a home with an Internet-HAN gateway eventually gets a smart meter with a built-in HAN? The latest version of SEP 1.1 (technically version 1.1.1) includes a provision for more than one Energy Service Interface (ESI) into the home. Support for multiple ESIs enables a smart meter and an Internet-HAN gateway to coexist, thereby providing two-way communication via both the AMI and the Internet at the same time. This allows real-time meter information to be available not just to the utility and devices connected directly to the meter's HAN, but also to customer portals and mobile apps via the Internet-HAN gateway.

Conclusion

Advances in home energy management solutions, combined with the ubiquity of the Internet, mean that utilities no longer need to depend on the deployment of, or features in, smart meters and advanced metering infrastructure networks to implement residential demand response programs. These same alternative configurations could also be used with small businesses, which could control both the HVAC system and other loads with some of the more sophisticated smart thermostats or 'home' energy gateways available today.

So why not at least explore these alternatives with a trial or pilot program? The pilot could be used to reach those areas where the AMI has yet to (or may never) be deployed, such as in a sparsely populated area. Or, use the Internet-HAN gateway to read interval data via HAN-equipped smart meters to supplement or backup the AMI network. I, for one, would welcome hearing from anyone who is doing the latter, and I suspect others in the industry would be equally interested!

About the Author



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