

Whitepaper

The Smart Grid...

Where are we now? What's next? How can Telecommunication Providers participate?

Executive Summary

In the midst of rising energy costs and increased consumer interest in conservation and sustainability, the smart grid is poised to deliver a safer, more efficient, and more resilient energy system for the 21st century. The smart grid empowers consumers to actively participate in their energy usage, energy costs, and energy sources.

For broadband and telecommunications service providers, the smart grid represents a compelling **opportunity to differentiate their service packages and create new revenue streams with home automation and energy management services.** With the smart grid, broadband providers can further extend their reach inside the home with innovative, practical applications that improve everyday life by enabling homeowners to monitor and control their home appliances.

This whitepaper educates telecommunications and broadband service providers on the concepts and latest developments in the smart grid, with particular focus on the Home Area Network (HAN), and the technologies used to communicate among the utility, smart meter, smart appliances, and homeowner. This is a critical time to keep an eye on developments in the smart grid, and service providers should be well prepared to take advantage of smart grid applications in the near future.

Part 1: Background

Composition of U.S. Electric Utilities

In 2007, there were **3,273 traditional electric utilities** operating in the United States, including investor-owned, publicly-owned, cooperatives and Federal utilities.¹ State public service commissions have jurisdiction over the large, investor-owned electric utilities that own more than 38% of the country's generating capacity and serve approximately 71% of the nation's consumers. According to the U.S. Energy Information Administration (EIA), there were 210 investor owned electric utilities, 2009 publicly-owned electric utilities, 883 consumer-owned rural electric cooperatives and 9 Federal electric utilities in 2007.²

Rising Costs of Energy

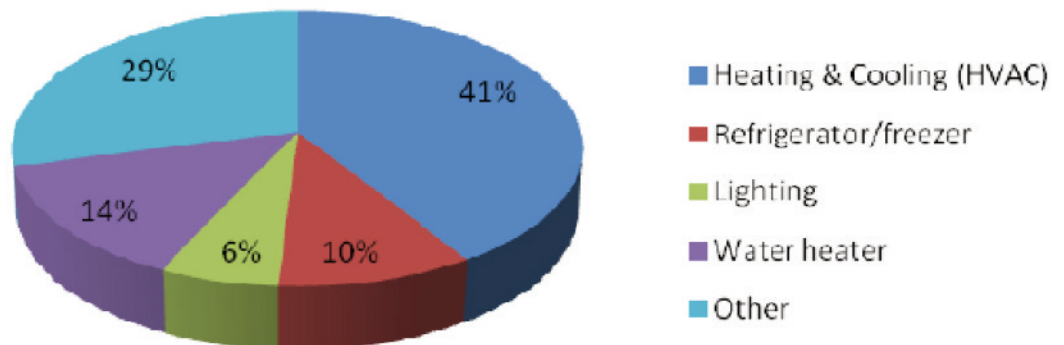
The **average price of electricity has been increasing** due to a wide range of factors — including rising fuel costs for natural gas, coal, and oil; infrastructure investments; environmental regulations; expiring price caps; and increased demand. Between 2004 and 2007, the National average price of electricity increased 19.7% from 7.6 cents per kilowatt-hour (kWh) in 2004 to 9.1 cents per kWh in 2007.³

Demand for electricity is only expected to grow in the foreseeable future.

According to the U.S. EIA, electricity consumption is projected to increase 45% by 2030, even after accounting for substantial savings (possibly more than 200 gigawatts) from energy efficiency and conservation.⁴

As shown in the following chart from the U.S. Department of Energy, **over half of the energy consumed in the U.S. is used for heating, cooling, and refrigeration/freezing.**

Home Energy Use by System, United States



(Sources: U.S. Department of Energy)

The smart grid represents the modernization of our electrical network, encompassing both transmission and distribution grids in order to support the energy needs of the 21st century. Through real-time knowledge and information sharing, the smart grid empowers consumers to actively participate in energy demand and cost control — by managing their energy usage and optimizing the integration of cleaner energy sources when available. Energy suppliers will be better equipped to reduce the frequency of power outages, as well as prepare for the future of renewable generation sources, distributed energy generation, and energy storage options.

In short, the smart grid is a vision for a safer, more efficient, and more resilient energy system.

Part 2: The Evolution of the Smart Grid

The progression of the smart grid will come in gradual stages, propelled by advancements in technology, infrastructure, products, and consumer awareness and adoption. In particular, its evolution will be pass through three key stages:

- Stage 1:** Energy efficient home (*our present stage*)
- Stage 2:** Energy managed home
- Stage 3:** Energy integrated home

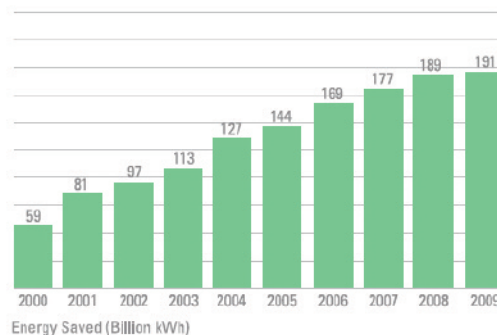
Stage 1: The Energy Efficient Home

In the first stage, there's a reduction in the overall demand on the energy grid by encouraging consumers to lower their own energy consumption. By making their homes more energy efficient through the installation of energy efficient products and appliances, improving sealing and insulation and option for high-efficiency heating and cooling systems, consumers can reduce energy bills and help protect the environment.

Based on current ENERGY STAR (a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy) guidelines, an Energy Efficient Home must be at least 15% more energy efficient than homes built to the 2004 International Residential Code (IRC) and include additional energy-saving features that typically make it 20-30% more efficient than standard homes. And new guidelines that will take effect in January 2011 further strengthen the certification, requiring new homes to be 20% more efficient than those built to the 2009 International Energy Conservation Code.

According to the EPA, more than 1 million ENERGY STAR homes have been built in the U.S. It estimates that families living in these homes **saved more than \$270 million on their utility bills**, while reducing greenhouse gas emissions equivalent to those from 370,000 vehicles.⁵ And according to the Harvard Joint Center for Housing Studies, "If homes built before 2000 used as little energy per square foot (adjusted by region) as those built since then, residential energy consumption would drop by fully 22.5 percent."⁶

Fig. 1. ENERGY STAR Benefits Continue To Grow



It's clear that there is an enormous opportunity to lower energy consumption through efficiency.

Stage 2: The Energy Managed Home

In the next stage of smart grid evolution, the energy managed home empowers consumers to play an active role in managing their energy usage and costs. Consumers are given **real-time visibility into their energy use** (whether for the whole home or individual appliances), so they can better understand how much, when, and where energy is consumed in their home. As a result of this visibility, consumers can modify their behavior to reduce their consumption, lower costs, and optimize their usage based on availability and peak/off peak rates and times. And in some cases, homeowners will even be able to select the source of their energy — for example, they can choose to run the clothes dryer only when wind power is available.

The energy managed home is comprised of several devices and products — including smart meters, smart appliances, personal energy management systems, and complete home automation systems.

Smart Meters

While conventional meters are only capable of sending data (i.e. sending consumption data to the utility for billing), **a smart meter supports two-way communications capability** — opening up a wide range of potential applications. For example, smart meters are capable of receiving real-time pricing information from the utility based on time of day and demand load, in order to give homeowners the option to defer usage until an off-peak, and less expensive, time.



Smart meters can also track consumption in more detail than a conventional meter. For example, while conventional meters track cumulative energy consumption, **a smart meter has the capacity to store data on a daily, even hourly, basis**. The smart meter communicates that data to the utility for monitoring and billing purposes; and the utility can also make granular consumption information available to consumers via a web interface or email/text alerts. Through this technology, consumers are able to find out exactly how much energy they use over the day, week, or month to make smarter, more energy efficient usage choices.

PG&E has installed 5.6 million smart gas and electric meters so far and plans for all its 10 million customers to have them by 2012. SoCal Edison has deployed 750,000 smart meters and plans to deploy 5 million in total.

Smart Appliances

A smart appliance has the ability to receive communications from local utilities over the smart grid and **dynamically adjust electricity usage to save homeowners energy and money**. For example, a smart dishwasher can receive information that a higher-tier pricing period is in effect and delay its start until an off-peak time. Such programs are always opt-in and homeowners have full control over setting their preferences and have the ability to override settings/commands at any point.



From 2011 to 2015, the U.S. household smart appliance market is projected to grow from \$1.42 billion to \$5.46 billion, respectively.⁷ Consumers will initially aim to purchase larger appliances such as refrigerators, dishwashers, clothes washers and dryers, and stoves/ovens.



Whirlpool announced that its **Energy Smart water heater**, which will have an external hookup for connection to a smart meter, will be available **by the end of 2010**. The company has committed to making all of its appliances “smart” by 2015. These appliances will be able to turn on, off or delay a cycle

based on information received from a utility via the smart grid. As a result, electric utilities can request to turn off or turn down home appliances to avoid brownouts during peak periods (again, if the homeowner chooses to participate in the program).

Do-it-Yourself Energy Management Systems

Several products are currently available that allow homeowners to monitor their home energy use. These 'personal' or 'DIY' energy management systems are purchased by consumers in the retail market, outside of the local utility provider. While they do not connect to the smart grid or receive communications from the utility, they provide visibility into home energy consumption to help homeowners eliminate energy waste in their home for lower energy bills.

For example, a product from Blue Line Innovations features a clamp-on transformer that measures electricity from the meter and then wirelessly sends this information to a reader. The company claims a 6-18% energy savings by using their product. Another product is TED® (The Energy Detective™). Here a Measuring Transmitting Unit (MTU) measures current by the meter, and then transmits that data via Powerline to a gateway.

The gateway can then send the information wirelessly (via ZigBee) to a TED display, as well as to the Internet so users can view their energy consumption on their computer or mobile device.



Home Automation Systems and the Home Area Network

Home automation systems take the concept of the smart appliance to the next level — enabling the monitoring and management of energy consumption of the whole home. Essential to this system is the **Home Area Network (HAN)**. Similar in concept to a Local Area Network (LAN), the HAN **connects consumer products together on a network** — including appliances, light switches, electrical outlets, thermostats, pools/spas, and any other energy consuming device.

The Home Area Network brings the smart grid infrastructure into the home, empowering homeowners to proactively participate in energy consumption programs. Electric utilities can inform and motivate homeowners to shape their consumption behavior based on tiered rate structures and load demands. Cost savings are passed onto the consumer and the utility is better able to address peak energy demands.

Signals are transmitted from the utility (or third party energy management service provider) to the smart meter and from the smart meter to the HAN, and all connected products and appliances. The **HAN can also connect to the home LAN or computer network**, to enable consumers to monitor their energy consumption, manage schedules, receive energy-related alerts from the utility, and even remotely access the home. Alternatively, consumers can access the HAN via dedicated in-home display units.

In the above scenario, the home automation system is a managed service delivered by the utility, either directly or indirectly via a third party service provider in partnership with the utility. Stand-alone home automation systems can also be installed by custom installers, typically in high-end homes, as well as in mid-range homes. These systems may not necessarily receive communications from the utility via the smart meter, but still enable homeowners to monitor their energy consumption throughout the home in real-time and manage/schedule energy consumption — for example homeowners can turn up/down the thermostat remotely from a mobile device or computer.

According to Pike Research, a cleantech market intelligence firm, **HAN capabilities will be included in 49% of all smart meters shipped worldwide by 2013.**

And in North America, HAN-enabled meter penetration will reach a staggering 81% by the same year.⁸

Said Bob Gohn, senior analyst at Pike Research, "HAN connectivity is a key enabler of a whole host of new consumer smart grid applications. Over the next few years, the technology will be in place for widespread adoption of smart thermostats, energy information displays, smart appliances, and other key tools for home energy management."

There is not yet one standard for HAN networks and products. ZigBee Smart Energy from the non-profit ZigBee Alliance is one of the leading wireless HAN standards. According to the alliance, more than 40 million smart meters are being installed around the world supporting ZigBee. And Pike Research believes that ZigBee will lead the HAN technology race with approximately 87% market share. Other HAN technologies include Wi-Fi, Z-Wave, 6LoWPAN, FlexNet, HomePlug, LonWorks, and Radio Data Systems (RDS).

Stage 3: The Energy Integrated Home

In the third stage, homeowners are not only able to monitor and proactively manage their energy consumption, but the **home is now capable of storing and distributing energy** based on availability and needs. Some examples of storage and redistribution in the smart grid include:

- Battery packs located in the garage or storage room can collect solar energy from solar panels on the roof, store this backup power, and then distribute it to key appliances in the case of a power outage or energy overload.
- Fixed electricity batteries can also store power during off-peak times to be used during peak periods.
- A plug-in hybrid vehicle in the garage draws energy from the house when it needs charging (or draws energy from another plug-in location). It also stores energy, which can then be distributed throughout the home when needed, or even be sent back to the utility when the grid is strained. Additionally, plug-in vehicles can draw power from the home's solar panels, store it, and send it back to the grid on demand.

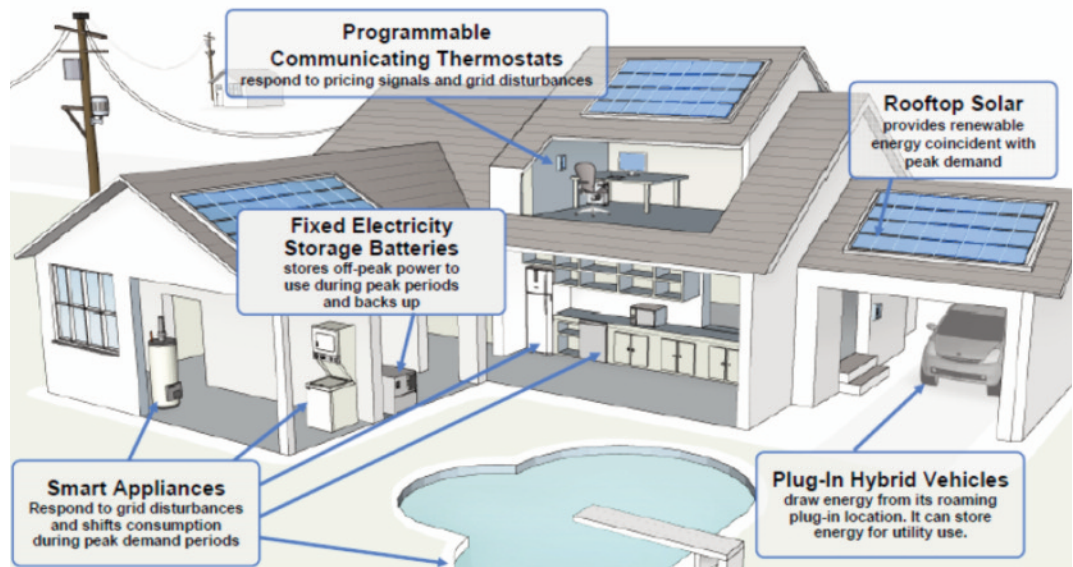


Figure 1

Source: The Wall Street Journal

Part 3: The push for a standard protocol inside the HAN

While there may not be a clear cut winner among the various technologies in play to link the smart meter to smart appliances, it is clear that a single common HAN communication standard is needed. The Association of Home Appliance Manufacturers (AHAM) has been a leading proponent of adopting a unified approach. AHAM is the U.S. based trade association of home appliance manufacturing industry.

In a whitepaper published in December 2009⁹, AHAM expressed their concerns regarding



the lack of a common standard inside the home. Considering the fact that appliance manufacturing requires standardized products for national distribution, customizing products for every proprietary or deployed HAN protocol would be impractical for appliance

manufacturers. In addition, the lack of a universally accepted standard would force consumers to have to replace their smart appliances every time they relocated to another utility service area in order to accommodate the specific technology used by that utility.

AHAM concluded: **Standards and protocols** for communications with Smart Appliances **must be open and limited in number** across all utility districts. This will allow appliance manufacturers to produce for a national marketplace so the same Smart Appliance can contribute to the Smart Grid whether in a home in Florida or in Oregon.

There must be a rapid drive towards open standards, with specific attention to the interface between the Smart Grid and the consumer.

The utility industry and state regulatory bodies are encouraged to work with product manufacturers and consumers to establish a common nationwide communication standard that impacts the area between the smart meters or home energy management system and appliances in the home.

The National Institute of Standards and Technology (NIST) has warned that they might need to mandate a solution as part of a national effort to draft smart grid standards if the industry doesn't pick a standard in a timely manner. And AHAM has asked the consulting firm EnerNex Corp. to draft a **detailed review of all home network technologies** in order to help determine how to advise its members. The report and AHAM's recommendations are **expected summer 2010**.



Part 4: Implications for the Broadband Service Provider

Broadband service providers and telecom operators can look to home automation and smart grid applications as a way to differentiate and enhance their service packages. As a key provider for a household's entertainment and communication services, operators can further extend their reach inside the home through innovative, practical applications that improve everyday life by enabling homeowners to monitor and control their home appliances (whether at home or remotely).

In this case, the broadband home router or modem becomes the focal point of whole-home management — with integrated applications and services for home security, communications, networking, entertainment, and home/appliance control.

Through home automation applications, consumers can use their TV, computer or mobile device to log into the home network, set their energy usage profiles and preferences, turn on/off and schedule appliances, and monitor their energy use in real time. The broadband home router serves as an easy-to-use bridge between the utility (smart meter) and smart appliances in the home.

Consumer-facing applications and energy management technology will be a key aspect of smart grid initiatives, presenting a strong opportunity for broadband service providers. According to a consumer survey conducted by Pike Research, over half of the respondents were very or **extremely interested in having a device in their home to monitor and adjust their energy usage**. The research firm projects that there will be more 28.1 million users of home energy management systems worldwide by 2015, including over 11.1 million users of web dashboards worldwide and 2.6 million users of energy management applications on mobile devices.¹⁰

Practical Considerations for the Service Provider:

This is an important time to keep an eye on developments in the smart grid, particularly in the home network. While there is a strong case for the smart grid and a compelling opportunity exists for telecommunications and broadband service providers, a few points should be considered:

- **Large number of electric utilities:** There are thousands of electric utilities, each with their pricing model. Therefore, **creating a common energy usage application (including relevant pricing) that can be deployed nationally is next to impossible**. Without relevant pricing, homeowners cannot calculate the potential savings from each of their usage decisions — resulting in a less than optimal application.

Note: In rural service territories, there may be only one or a handful of energy providers in the market. In this case, it is feasible for broadband service providers to collaborate with the utilities and develop a smart grid application that incorporates relevant utility pricing and data.

- **Slow consumer adoption of smart grid and smart appliances:** Throughout the industry, there is some concern that the projected increase in energy prices may offset any savings from ENERGY STAR products and energy saving practices. As a consequence, consumers may grow dissatisfied with the smart grid as their efforts to reduce electric bills fail.
- **Lack of in home standard:** Smart grid technology is rapidly evolving and still in a state of flux. This is particularly evident in the Home Area Network, where home appliance manufacturers have yet to reach a consensus on which communication standard should be used.

In order to position themselves for future smart grid applications, broadband service providers should be advised to:

- Wait for AHAM to release their findings and recommendations on the technology options.
- Keep a close eye on the few key appliances in the home that are responsible for the majority of energy consumption in the home. Over half of energy used in homes in the U.S. is for heating, cooling, refrigeration/freezing. It would be wise to monitor what manufacturers of these appliances do from a technology and communication standard perspective.
- **Keep your home gateway platform flexible**, so it can be upgraded down the road. By incorporating a USB port in the home gateway/router, it's easy to keep up with industry and technology developments. For example, a plug-in USB technology stick can add support for ZigBee, Zwave, or any other smart grid technology.

Heavy regulations in utilities present a strong opportunity for telecom providers.

While interest is high and the number of smart grids in the electrical networks is growing quickly, the number activated will be relatively small. "At this time, Parks Associates estimates that **fewer than 7% of AMI-capable meters will be HAN-activated by 2014**," said Bill Ablondi, Director Home Systems Research at Park Associates. Given the high level of regulation in the industry, electric utilities move at an inherently slower pace. This fact, along with the current lack of standards in the smart grid, presents telecom providers with a sizable window of opportunity to become a dominant player in the energy conscious home, and connect their brand with the leading edge of smart grid and energy management applications.

Conclusion

For the telecommunication and broadband service provider, the smart grid presents a significant opportunity to differentiate their service offerings, create new revenue streams, and excite customers through innovative smart grid/home automation/energy management applications. Broadband service providers should keep a close eye on smart grid developments – including consumer sentiment, the status of industry standards and regulations. It is critical to begin preparations for future smart grid and home automation services, with particular focus on keeping the home gateway flexible and powerful to be adapted for these future applications.

About Actiontec

Actiontec Electronics develops broadband connectivity and broadband-powered solutions that simplify and enrich the digital life – delivering a unified experience that encompasses communications, entertainment, home management, and more. Actiontec offerings range from the market's broadest selection of IPTV-capable broadband home gateways for bringing IP-based video services into the home, to DSL modems, wireless networking devices, routers and digital entertainment devices. The company's carrier-class products are easy to install, manage, and use, and are sold through retail channels and broadband service providers. The company is committed to protecting the environment through energy efficient products and other green-friendly practices. Founded in 1993, Actiontec is headquartered in Sunnyvale, CA, and maintains branch offices in Colorado Springs, CO; Shanghai, China; and Taipei, Taiwan.

Appendix: Value of Energy Star

What is ENERGY STAR?

ENERGY STAR is a joint program of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy designed to help consumers save money and lower their carbon footprint through energy efficient products and practices. Americans purchased over 300 million ENERGY STAR qualified products in 2009, and a cumulative total of about 3 billion products since 2000. The ENERGY STAR program encompasses more than 60 product categories, including external power adapters.



The Importance of ENERGY STAR Certification for Small Electronic Devices

The ENERGY STAR program and need for energy conservation is not limited to large appliances like washers and dryers. According to EPA statistics, there are as many as 1.5 billion small electronic devices with external power adapters in the U.S. and they account for approximately 11.5% of the national electric bill. ENERGY STAR ratings for these products signify they use at least 30% less energy than devices with conventional power adapters.

Recent research¹¹ from the EPA highlights the importance of ENERGY STAR-labeled products in today's households. Key findings from this report include:

- 76% of households recognize the ENERGY STAR label when shown the label
- 78% of households had a high or general understanding of the label's purpose
- Of households that recognized the ENERGY STAR label and purchased a product in a relevant product category within the past 12 months, 73% purchased an ENERGY STAR-labeled product
- For 76% of the households that recognized the ENERGY STAR label and knowingly purchased an ENERGY STAR-labeled product, the label influenced at least one of their purchase decisions "very much" (68%) or "somewhat likely" (22%)

Actiontec's Commitment to ENERGY STAR Products

Actiontec is dedicated to helping households choose 'green' by improving the energy efficiency of our product portfolio. Approximately 95% of our modems and routers shipped include an ENERGY STAR approved power supply. With superior energy efficiency, these devices enable broadband users to use approximately a third less energy compared with a regular modem or router. And most importantly, Actiontec modem and routers include industry-leading technological capabilities, so consumers do not need to sacrifice performance or features in order to satisfy their desire to help protect the environment and save money.

Sources

¹U.S. Department of Energy, Energy Information Administration. Independent Statistics and Analysis. Electric Power Industry Overview 2007.

<http://www.eia.doe.gov/electricity/page/prim2/toc2.html>

²IBID

³IBID

⁴U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2006, February 2006.

⁵http://www.energystar.gov/index.cfm?fuseaction=mil_homes.showSplash

⁶The State of the Nation's Housing 2009, Harvard Joint Center for Housing Studies

⁷2010 Zpryme Research & Consulting

⁸Press Release: "49% of Smart Meters to Include Home Area Networking Connectivity by 2013." Pike Research. April 23, 2010.

⁹Smart Grid White Paper: The Home Appliance Industry's Principles & Requirements for Achieving a Widely Accepted Smart Grid. Association of Home Appliance Manufacturers, December 2009.

¹⁰Press Release: Home Energy Management to be a Critical Element of the Smart Grid User Experience. Pike Research. May 27, 2010

¹¹National Awareness of ENERGY STAR for 2008: Analysis of CEE Household Survey. U.S. EPA, 20