Energy Services Network Association
NES User Group

A smart grid vision where everyone wins

How an interoperable, infrastructure approach benefits utilities and consumers alike

A smart grid is best built with an eye towards technologies, standards and services of the future. In order to ensure utilities and consumers both win in the smart grid game, it's essential that all players in the ecosystem consider the various moving parts involved as energy networks across the globe evolve. An interoperable infrastructure approach will lead to innovations and achievements at break neck speed, while limited, closed approaches will ultimately kill innovation and benefit very few. With these principles in mind, here, we take a look at many aspects of the smart grid today, from higher level benefits for all parties involved down to the inter-connecting details of metering, home area networking, Web, power line and RF technologies that are making the smart grid possible. We hope this article serves as a source for all leaders making major smart grid decisions that will serve many generations of people come after us.

It's not just about smart meters
Smart metering is an essential part and foundation of the smart grid itself – offering increased functionality for smart grid applications, built-in two-way communications to take advantage of that functionality, and support for new customer focused applications. The critical thing about defining smart metering is that it's not just about the meter. It is really about enabling the smart grid, which is an energy infrastructure that spans from generations through distribution to include thousands of power-based devices and systems that consume energy.

Therefore, we must look at smart meters as part of a "system" that delivers dramatic improvements in utility operations, reliability, and customer service capabilities by offering detailed usage information, demand metering, detailed power quality data, outage information, integrated disconnect switches, integrated customer premise interfaces and flexible billing options. Smart metering systems merely serve as the key information-gathering source and foundation for a smart grid that helps utilities' better manage their operations, and customers better manage their energy consumption; it's a win-win situation.

Smart meters are part of the solution to address one of the utility industry's biggest challenges; how to manage energy resources in the best way possible. They provide information and control energy in order to serve all stakeholders, although for different reasons.

Smart grid stakeholders – benefits to all
Consumers, distribution companies, and retailers all benefit from smart metering. A smart grid builds upon the information provided by the smart metering system (located at the low voltage network) to an information and control system to address the stability of entire energy networks.

A smart grid can improve management of the transmission and distribution assets as well as their generation portfolio in order to keep pace with their customers' increasing peak electricity demands. For the supplier and retailer, it makes possible and accelerates the adoption of new services to enable them to create unique market propositions, and differentiate their offerings in increasingly competitive energy markets. All of these great benefits to utilities also mean, of course, that the consumer wins.

There are many benefits associated with the smart grid and they should be viewed collectively and really as an aggregate of benefits to all parties. It is extremely difficult to build a compelling business case around just one set of benefits to a specific stakeholder. Of course, the consumer, and in general the society, will benefit from smart meters and the smart grid, since they provide a way to achieve a decrease in energy usage by raising consumer awareness of the cost and impact of electronic devices in our homes and offices, and the real "cost" of electricity. The most obvious direct benefit to consumers will be in the form of lower energy bills.

Energy empowerment, demand response and services beyond

Demand side management, or demand response, is becoming instrumental in managing the growing demand for energy, especially as it is combined with new and innovative pricing plans and consumer facing services, e.g., energy use portals. The combination of heightened awareness, an ability to track and manage energy use, and incentives will give consumers a sense of "energy empowerment" that they have never before experienced, and this will be huge.

For retailers, the marketer, it provides opportunities to add value beyond energy to a client. For instance, they can offer new products and services such as providing an in-home display, tariff schedules more focused to specific consumer groups, services such as energy advice offerings, a service to provide remote control of air conditioning or heating; and a web portal providing all kind of information about the energy usage with useful comparisons and advice.

By using smart meters, the Distribution Network Owner (DNO) will have ability to get more information from the low voltage network. For example, through information like phase detection the DNO will be able to extend lifetime of a substation; and by watching voltage, certain patterns the DNO can detect fraud and recover income. The best of the smart meters, those that provide grid intelligence like power quality data, power factor, Total Harmonic Distortion (THD), frequencies and other measurements, will give DNOs better insight into the grid.

The true smart grid creates an energy network that will detect and address emerging problems in the system before they negatively affect service. It will be able to respond to local and system-wide inputs, have much more information about broader system problems, and most importantly, be able to react to or resolve problems the moment they occur.

Coming full circle on the grid – work still to be done on the home-front

In order to best take advantage of all of the information and functionality of the smart grid, devices inside the customer premise must also be incorporated into the system in order to help create an energy-aware environment. Automatic demand response and the ability for a building to automatically shed energy loads in response to real-time supply/pricing conditions on the grid even within the commercial sector is still in its infancy.

However energy-aware products, particularly in the home will be the market driver for the Home Area Network (HAN). Once consumers have the ability to benefit in highly visible and tangible (e.g., monthly savings) ways from managing their energy use, they will naturally seek out products that help them increase their savings or make saving easier. This will also influence decision making across all consumer goods that use energy or impact one's personal environment (home, car, etc.).

As an example, electric vehicles (EVs) will need to communicate with the grid to understand when to charge at 100% and when to shift to trickle charge if the grid is under strain. The communications required for that is likely to need to interface with other smart HAN devices so that they too can tap into the same information and shift their consumption. So already, just with EVs or demand response functionality and their associated communications needs, there is a requirement for a HAN. It's a small step for a consumer but one that will allow them to really take advantage of the smart grid network.

The case for smart grid interoperability
In order to support the various networks and interfaces within the smart grid, one of the most important and basic requirements that is needed is interoperability. This is not only to support today's services and applications but also to support the provision of new services and/or meet new market demands in the future without replacing the core infrastructure and associated equipment.

Interoperability is too often used as an excuse to push a particular technology, regardless of its actual suitability for the application. Such agendas manifest themselves as a "choose one standard" technology approach; while in today's and tomorrow's world we know that technologies will continue to evolve. Therefore, instead of requiring a single standard, interoperability requires an open infrastructure, one that many companies have adopted and built custom solutions on top of. These solutions may be proprietary to each vendor, but since they're built upon a common, open infrastructure they can be mixed and matched, offering the utility competition, innovation, and choice.

Therefore to truly support interoperability, the smart grid system needs to be open at various key interfaces within the infrastructure; the head-end, the communications network and at the HAN or customer premise. To fully realize the benefits of a smart metering system, it must be able to exchange data between disparate utility systems. These systems often use a variety of data exchange formats and mechanisms that have historically prevented the systems from effectively communicating with each other. To address this, the Internet community has developed Web services (SOAP/XML), a standards-based way for applications to integrate with each other. Web services use ubiquitous protocols and the web infrastructure that exists in every organization, so they require little, if any, additional technology or training investment. The inherent interoperability that comes with using vendor-, platform-, and language-independent Web services technologies is vital in obtaining the maximum benefits from advanced metering systems for the least amount of integration costs.

The Netherlands – an interoperable case example
One of the best examples of this type of interoperability is to follow the NTA 8150 standard type of model, which defines interoperability at the web services, enterprise level and is already proving itself in The Netherlands. The NTA 8150 standard, an ESNA initiative, defines an API to a "virtual device or meter" that enables utilities to maintain and leverage their large investment in IT systems and applications and allows them the option to work with a variety of underlying metering systems.

This approach allows utilities to take advantage of the largest competitive market possible and also enables them to take advantage of new technologies as they emerge from any potential vendor. An additional benefit of standardizing at the enterprise level is that this will leverage and optimize the implementation of multiple smart grid applications rather than focus on a single application, such as metering. Put another way, it is a systems approach.

Limits on the grid are a death to innovation
By contrast, the implementation of a specific metering interoperability standard limits innovation and promotes the smart grid as a point solution rather than as an enterprise infrastructure for an entire corporate solution. Defining interoperability only at the meter with a single technical standard will only raise costs for utilities and decrease the benefits to their consumers. The logic for this is simple, setting a hardware standard locks the meter in time, ending innovation and technical progress, and decreasing the number of meter suppliers. In addition, like most such efforts, the vendors will create "open closed" products – ones that meet the letter of the law, but not the spirit. This has repeatedly occurred with these types of standards across multiple industries. These are just a few of the additional reasons that an approach similar the NTA 8150 model is preferred.

Another key interface within the smart grid that needs to be open is at the communications network. The WAN is designed to reliably and cost-effectively transport data utilizing two-way communications between meters and other devices in the field and the utility.

Rather than focus on the data application layer, it is essential that the communications 'plumbing' be built on proven IP networking technologies. Only in this way can utilities leverage the investment being made in new networking technologies such as BPL, WiMax, GPRS, and UMTS. This also gives utilities the flexibility to mix and match public and proprietary networking infrastructure to avoid vendor lock-in, reduce system cost, and guarantee flexibly, scalability, and security over the life of the system.

And finally, the third key interface is at the meter level. Smart metering systems are an investment in communications infrastructure as much as metering infrastructure. To fully benefit the utility and to support demand management, distributed generation, and other programs that may emerge over time, the infrastructure must be able to integrate devices other than electric meters into the system, including gas and water meters, EVs, streetlights, thermostats, and direct load control devices.

Communications standards to consider on the grid

Many smart metering systems support two-way communications, including messaging and control to HAN devices. However, most of these solutions are locked into a single HAN technology. To ensure reliable communications, multiple HAN technologies must be supported. This would let utilities deploy a variety of technologies and protocols to communicate to the vast amount of in-home devices without worrying about compatibility issues, technology limitations and technology obsolescence.

The most logical approach for enabling multiple HAN technologies is to move the HAN radio (such as Zigbee radio) outside of the meter. This solves a major problem — radios don't always communicate reliably from the meter location to devices inside the home — as well as lowers the lifecycle cost of the HAN solution.

The market for smart in-home devices is in its infancy, and RF control technologies — both the physical radio implementations and the software protocols on top of them — are extremely immature. Just as the cellular industry has moved from GSM to GPRS to EDGE to UMTS and the WiFi market has moved from 802.11A to 802.11G to 802.11N, utilities can expect to see dramatic changes in RF control technologies. Therefore, putting HAN radio technologies inside a meter will almost certainly shorten the technically useful life of the product.

The most logical HAN approach is to use a smart metering solution that provides a flexible and secure bi-directional interface into and beyond the meter that can be used over time with whatever in-home technology is appropriate. By moving the radio outside of the meter, utilities will be able to upgrade home communications infrastructure without having to replace the metering infrastructure.

Bridging power line and RF

One way to facilitate multiple HAN technologies is to use meters with built-in power line networking communications to interact with in-home devices. Once inside the home, other devices could be connected to the network and interact with the AMI system. For example, an in-home gateway could bridge the AMI solution's communications from the power line to a variety of RF technologies. Alternatively, the meter can have an external interface that allows external communication cards or modules to added and exchanged during the lifetime of the meter.

A number of organizations, including the Digital Home Alliance (http://www.digitalhome.com) and the ZigBee Alliance (http://www.zigbee.org), are working on standards and interoperability issues to facilitate HAN and intelligent in-home devices. Members of these Alliance are incorporating energy awareness into their products, as well as making them compatible with multiple HAN technologies. As these products emerge and consumers begin incorporating them into their home area networks, utilities will have a new type of customer to work with — ones who are willing and able to contribute to the smart grid and the environment.

The Digital Home Alliance approach enables new devices from multiple manufacturers to be added anywhere within the electricity network to provide competitive, value-added services at minimal cost. This extends the HAN to a variety of devices, including those manufactured by members of the Digital Home Alliance. For instance, products such as intelligent networked thermostats, boilers, appliances, air handlers, lights, and load control modules based on Echelon's LonWorks technology are already available worldwide from thousands of manufacturers. More devices that will enable a variety of HAN technologies, including power line (such as LonWorks) and RF (such as Zigbee, Z-Wave, WiFi, or 6LoWPAN), will continue to be developed by many companies and added to their HAN product portfolios.

HAN technologies provide utilities and their customers with effective tools to manage peak electricity demand, which lets customers shift their energy use (and demand) from peak periods to off-peak periods. Customers with smart meters that use in-home displays to monitor electricity use and pricing can more intelligently manage their usage. Utilities can also implement new pricing schemes that adjust the price of electricity based on consumption patterns. Utilities can use these tools to curb consumption during peak periods when electricity is most expensive, shifting consumption to those times when it's less costly. Consumers involved in these programs can either rely on in-home displays to track their energy use and manually change their consumption behavior, or use in-home devices that react automatically to the smart grid and time-of-use tariff in order to more effectively manage energy use.

As utilities face increasing pressure to reduce their costs and lower their environmental impact — by reducing emissions of greenhouse gases, for example — they must fundamentally shift their attitude toward power generation and resource planning. The smart grid and smart metering technologies will facilitate this strategic shift. More importantly, the smart grid and smart metering technologies will make power delivery more efficient, reliable, and safe, and will help customers better control their energy use.

An advanced metering infrastructure approach will allow utilities to deploy a solution that lets them extend the smart grid and communications infrastructure to intelligent devices inside customers' homes. The ideal smart metering solution will let utilities and their customers implement and access a truly intelligent smart grid — one that benefits both parties — through a variety of HAN and other technologies.

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