AMI and the smart grid: Key points for utility executives

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Overview

Whatever definition of "smart grid" you choose, as executives you are about to be inundated with the explosion of new applications and associated data that will be generated by the "smart grid," inevitably including advanced metering infrastructure, or AMI. AMI is not the smart grid, but rather an integral part of it, bringing terabytes of data of varying timeliness and value to the utility to enable more effective and intelligent operation of the grid in conjunction with the utility business strategy. In many ways, the smart grid and AMI applications and systems are new and their deployment and integration quite different than what utilities have ever had to deal with.

As a leader in AMI, and a long term supplier of revenue metering systems to gas, water and electrical utilities, Elster understands the smart grid. This paper will focus on how AMI systems are impacting utilities, some of the trends we see in the market place, as well as some of the concerns that we have as this aspect of the industry evolves.

Key facts about Elster Solutions:

1. Elster is one of the world's largest providers of electricity, gas and water meters and related communications, networking and software solutions to enable energy efficiency and conservation.
2. Elster has one of the most extensive installed meter bases in the world, with more than 200 million metering devices deployed over the course of the last 10 years.
3. Elster sells its products and services in more than 130 countries across electricity, gas, water and multi-utility applications for residential, commercial and industrial customers.
4. In 2008, Elster generated revenues of €1.3 billion, or $1.9 billion.

Solutions delivered

Elster is a firm believer in the need for two way communication in metering systems and was the first to introduce a comprehensive balanced two way network using managed mesh technologies. Since then, many companies have followed suit with similar architectures.

Since rolling out this technology in 2004, we have had the opportunity to work with hundreds of utilities as they tackle AMI rollouts. For the utility, there is only one chance at deploying an AMI technology to any sort of scale; most utilities expect to live with their decision for 10 to 15 years, the expected depreciation of the deployed assets.

Utility personnel performing technology evaluations face complex cross-area issues. Few if any have experience rolling out massive communication networks coupled with the required detailed understanding of metrology, security and system integration. Most systems are sold on the basis of what they are going to do and on the prospect of what they will be able to do when integrated with other "future" systems.

Through Elster's deployments of numerous fully functional systems and involvement in a multitude of system discussions with planning committees, we have noted that utilities struggle with the same types of issues over and over again due to misinformation and perceptions that are prevalent in the industry.

Key facts about Elster Solutions:

1. More than 60: Number of EnergyAxis systems deployed and integrated into the utility IT infrastructure (not vendor hosted systems)
2. More than 3 million*: Total number of deployed meters being read daily in deployments
3. More than 500,000* smart meters with disconnects deployed
4. Electric/gas/water AMI are all served by the EnergyAxis System

A new challenge

In the past, utilities may have had a few hundred or thousand communicating devices in the field, typically within or on utility assets.

With the advent of AMI, utilities are now deploying solutions requiring communication to and management of hundreds of thousands or millions of devices that can be physically accessed by the general public. In addition, the utilities face the challenge of managing and ensuring security, accuracy, consistency, timeliness, and reliable performance of these devices. Not only does this imply security challenges, but also large scale deployment of new IT and communication networks.

To make things more challenging, these systems are mission critical. Not only do they control the delivery of the utilities' prime revenue stream and hence business performance, but these systems also provide on a large scale other pertinent and timely information such as outage, demand response, and grid modernization—information that directly impacts customers and is a key part of daily operations.

AMI provides a new capability for utilities to overlay a ubiquitous two-way communication network across their utility, used to gather information about their network, and to implement control at a granularity previously considered impractical or uneconomical. While many vendors of AMI systems would have you believe that their technology is proven and mature, in reality one should argue that these systems are in fact in their infancy. Furthermore, the utility enterprise application required to leverage the AMI data, manage the AMI assets, and unify network management across the utility lags even further behind. The industry is just beginning to gain real world experience in deploying these networks and the required architectures. There is a lot of hype today in the market regarding smart grid and AMI. One needs to proceed with understanding and prudence in considering AMI options. We have observed that if a utility wants to leverage its AMI investment to the maximum extent that it should expect major changes to business processes throughout the utility.

A central point of integration for AMI systems within the utility enterprise is the meter data management system (MDMS/MDUS)

*As of first quarter 2010

Key facts for Elster Solutions

1. EnergyAxis systems have been or are in the process of being integrated with most major MDM suppliers:
   - eMeter
   - Oracle Utilities Meter Data Management
   - Aclara Software
   - EnergyICT
2. Elster acquired EnergyICT in 2009. The EnergyICT acquisition provides Elster with a world-proven MDM to complement its market-leading position in multi-utility solutions to customers across the globe, however, Elster continues to partner with the breadth of MDM, systems and service providers in the market to meet its customers' needs.

Hype verses reality

Utility committees and teams set up to evaluate AMI are easily enamored with new ideas and vendor excitement rather than some of the realities present in deploying such complex systems.

Smart grid and smart metering implies an expectation that hourly (or more granular) data is gathered from every endpoint every day at a 99%+ success rate. Careful investigation of systems is encouraged to understand the true level of performance that systems deployed today are actually delivering. For example, while some utilities declare millions of smart meters deployed, questions need to be asked about whether they are simply retrieving consumption data (kWh only), a far cry from the volume and data integrity challenges presented in retrieving true interval data.

Vendors claim the simplicity of scaling their networks to be able to handle terabytes of data, but the nature of AMI networks present unique issues that can only be proven by actual deployment. Simulating AMI networks in a lab environment can only approximate real world environments in which millions of end points need to communicate consistently, often across several communication mediums.

Careful scrutiny will reveal that few AMI systems deployed today are required to deliver billing quality data from hourly interval data on a scale beyond a few tens of thousands of points.

Key facts about Elster Solutions:

1. >1,000,000: number of smart meters that are read daily in one area
2. >98.0%: Daily read success rate is well above the government-mandated rate for the deployment in item 1.

Security considerations

As AMI systems by definition require two way communications, CIOs are faced with a situation where millions of unsupervised endpoints can ask for access to the utility network, through utility firewalls. These requests can be at any time, are often unpredictable, and can occur on a large scale when looking for real time information (outage information, tampering, restoration, etc.) Furthermore, these requests need to be handled automatically to be of value to the utility and may need to be handled by more than one application. This potentially presents an opportunity for malicious attacks.

AMI systems need to consider security measures from the ground up, and from a system approach. Security applications can require increased bandwidth and need to be considered at all levels of the system. Meters, communication, and head end systems all need to work in concert to maximize security strategies.

While there is some attraction to having mix and match components to build AMI networks, be cautious towards elements that do not optimize or consider the need for state of the art (rapidly changing) security design features. Ensure that security capabilities can be upgraded properly, right through to end points as the system evolves over what needs to be a 10-20 year life cycle.

Key facts about Elster Solutions:

1. Elster's EnergyAxis System security was enhanced in early 2010 with AES encryption for the mesh LAN
2. Elster's EnergyAxis System security was enhanced in early 2010 with AES encryption for the network WAN
3. Elster Solutions continues to work with our customers in security audits to make sure all security issues are addressed

Data integrity

After meter data is collected and recorded, serious consideration must be given to where it is stored in the system (meter, WAN/LAN/Head End) and the ability to audit the data. In the event of dispute, can the data in the meter actually be compared to the data used for billing?

Newcomers to AMI have failed to capture some of the fundamentals of revenue metering practices, well understood by established metering companies, about proper measurement and related data integrity and storage of consumption data in the metrological portion of the end point device. Some systems use "dumb meters" but smart communication modules in the meter, reducing meter cost but crippling the data integrity trail. Metering functions in these communications modules are often upgraded routinely as part of the network communication upgrade thus making difficult the audit and verification of the metering functions against what is actually measured by the meter

The lack of understanding of this principle poses risks to the integrity of the AMI system data. Elster believes that the current issues in the industry will result in the elimination of the "dumb meter," the use of which Elster has never embraced.

Key facts for Elster Solutions:

1. Every meter deployed in the EnergyAxis system is a true smart meter – all metering functions are performed in the meter, not the communications module
2. Meters in the EnergyAxis system meet Measurement Canada and ANSI C12.1 and C12.20 requirements

Communication options

There are two fundamental architectures in AMI and smart grid today: tower-based and distributed mesh based.

In the tower-based architecture, a single communication tower communicates with tens of thousands of end points (meters/and or smart devices) in the grid. The tower network offers the utility what would appear to be a simpler initial deployment, but locks the utility in to a single communication and proprietary solution over the life of the network. Tower-based networks tend to utilize narrow bands and must consider carefully interference into their own band.

In the mesh network architecture, a series of WAN connected gatekeepers or data collectors are used to manage distributed cells in mesh networks. Distributed mesh networks are used by most AMI vendors.

Typically these networks provide extensive multiple path capabilities and ample bandwidth. Most importantly, the networks offer the flexibility to adopt various communication technologies for the network WAN. As the WAN technology is rolled out across the distribution network, mission critical points can easily be set up over direct WAN connections to maximize bandwidth access, when and where required. This approach leverages the immense infrastructure investments being made by the telecommunication industry that bring promise to utilities such as public wireless (CDMA or GPRS), public or private WiMax, or SCADA RF systems.

Key facts about Elster Solutions:

1. Elster embraces integration of various WAN communications technologies to meet the individual utility's needs. Elster has integrated WAN networks utilizing public wireless networks, MDS SCADA radios, satellite technology, cable modem interfaces, fiber, and other utility WAN infrastructures
2. Elster offers meters with integrated WAN communications as an option when point-to-point communications are preferred or required

Standards

Elster has been a long-time supporter of standards—not just implementing them, but actively participating in their development. Standards have not yet been developed for every component of an AMI system; all systems currently in deployment depend to some degree on proprietary technology. What is required is interoperability between AMI components and between systems, both of which are available today, albeit to different extents in different systems.

Integration to other systems and components generally takes place at the head end (think of integration to CIS systems, outage systems, etc.) and at the end point – integration into the home area network (HAN). Elster approaches the head end integration by using a series of standard interfaces and standard protocols, such as XML. Standard web services APIs and XML schemas are published and available on request. Integration standards such as IEC CIM and MultiSpeak are the primary standards under development within the industry and the focus of Elster's software application (known as the EnergyAxis Management System, EA_MS).

Elster utilizes full TCP/IP stacks to all WAN endpoints, allowing the use of familiar IT management and security tools and techniques, right down to critical endpoints in the utility electrical network. Elster has led the implementation of many standards, including most recently ANSI C12.22, a standard geared at optimizing AMI data across wireless networks. This latest standard compliments the existing ANSI C12 family of standards that all manufacturers use in their meters to enable interoperability. Although most AMI system providers have incorporated C12.22 into their solutions, not all have. Failure to converge on a common set of protocols (that is, ANSI C12 suite, such as the C12.22) will only cause further delays in future integration goals.

Key facts about Elster Solutions:

1. Elster has implemented many standards including MultiSpeak, TCP/IP, UDP, C12.22, AES, SOAP, XML, and others in our solution
2. Elster has participated and continues to participate in the ANSI C12.21, C12.19, C12.22, IEEE 802.15.4g, CIM, SGIP, ZigBee, IETF, OpenSG and other industry standards meetings

Bandwidth is important

Today, a system may be seen to have adequate bandwidth to handle the transport of applications currently envisioned. Vendors may describe bandwidths in any number of ways. In some systems, the bandwidth capacity may actually vary for different applications.

In addition, the usable bandwidth for all systems is affected by the amount of overhead. As an example, take a look at how the system performs over the air (OTA) upgrades. If all of the OTA functions to each individual device are handled by the head-end, this operation will consume significant bandwidth. A more efficient approach is to transfer OTA data for batches of devices to an intelligent Gatekeeper which then manages the upgrade of multiple endpoints and reports results back to the head-end.

Key facts for Elster Solutions:

1. At 142 kbps Elster's mesh network offers the highest available bandwidth of any mesh network.
2. Elster's AMI network incorporates simple ways to increase bandwidth if required to WAN endpoints through the use of any technology supporting IP communications – while other solutions may require additional towers to increase bandwidth.

And what about the meter?

With the sudden shift in attention towards smart grid and from basic metering to smart metering, the meter itself seems to have been somewhat forgotten in all of this.

As the source of most of the data, and the measurement interface with the customer (and their money), the element making up the biggest overall cost of an AMI deployment, the meter, tends to be considered as a "given." The meter can also be the source of the biggest grief and risk. This asset sits in the field, hopefully untouched for years in typically harsh environments.

While similar in shape and appearance, their operating principles can vary widely, as can their design, construction and testing. Most electronic meter manufacturers will publish a failure rate of 0.5% - not bad. Elster publishes a failure rate of 0.3%, the lowest in the industry. Elster employs a multi-level verification strategy, which covers firmware verification, mesh network verification, element management verification and finally full system verification, to allow complete vetting of an integrated offering.

This could be fun

The introduction of the smart grid, and with it smart metering, introduces a wide range of possibilities and applications, most of which have yet to be proven on a large scale commercial basis or even developed yet. There are few rules and huge opportunities.

At first, smart metering may seem simple, merely adding communications to a well established field device. In fact, it is much more than that. Utilities that are most successful have quickly realized the immense impact these projects have on the IT infrastructure, in depth and breadth, and how business processes are affected across their organization. Those with strong IT involvement, procedures and knowledge have fared better than others.

We encourage sharing information and experiences with other utility executives that have lived through some of the early phases of these larger deployments (so far) and get actual field experience from those who have done it. An AMI deployment can be a fun and exciting endeavor!

About the author

Dr. David G. Hart, with over 18 years of design engineering and executive leadership, is a leading industry visionary in state-of-the-art advanced metering products and technologies in the electric utilities sector. Dr. Hart, Senior Vice President, Systems & Products, Elster Solutions, Raleigh, NC, is responsible for Elster product management, engineering, and quality. In 1992, Dr. Hart joined the ABB Transmission Technology Institute. Dr. Hart was responsible for R&D and held various engineering and managerial positions focusing on generator protection, transmission protection, distribution protection, as well as feeder automation. Dr. Hart has numerous patents in smart metering, power system protection and control, and in automation. Dr. Hart is a native of Union, SC and holds a Ph.D. in Electrical Engineering. Dr. Hart is a Senior Member of the IEEE.

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