ADVANCED METERING

Connectivity for the Modern Grid

A 21st Century Electricity System Issue Brief

By Advanced Energy Economy

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ADVANCED ENERGY ECONOMY

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ABOUT ADVANCED ENERGY ECONOMY

Advanced Energy Economy (AEE) is a national association of businesses and business leaders who are making the global energy system more secure, clean and affordable. Advanced energy encompasses a broad range of products and services that constitute the best available technologies for meeting energy needs today and tomorrow. AEE's mission is to transform public policy to enable rapid growth of advanced energy businesses. AEE and its State Partner organizations are active in 26 states across the country, representing roughly 1,000 companies and organizations in the advanced energy industry. Visit www.aee.net for more information.

ABOUT THIS ISSUE BRIEF

The U.S. utility sector has entered a period of foundational change not seen since the restructuring of the late 1990s. Change is being driven by new technologies, evolving customer needs and desires, environmental imperatives, and an increased focus on grid resiliency. With these developments come challenges, but also new opportunities to create an energy system that meets the changing expectations of consumers and society for the coming decades. We call this the *21st Century Electricity System:* a high-performing, customer-focused electricity system that is efficient, flexible, resilient, reliable, affordable, safe, secure, and clean. A successful transition to a 21st Century Electricity System requires careful consideration of a range of interrelated issues that will ultimately redefine the regulatory framework and utility business model while creating new opportunities for third-party providers and customers to contribute to the operation of the electricity system.

To support this transition, Advanced Energy Economy (AEE) has prepared several issue briefs that are intended to be a resource for regulators, policymakers, and other interested parties as they tackle issues arising in the rapidly evolving electric power regulatory and business landscape.[1] This issue brief on **Advanced Metering** lays out the concepts of advanced metering infrastructure (AMI) and advanced metering functionality (AMF) and how they can provide benefits to our electricity grid, describes potential challenges and barriers that utilities and regulators will have to grapple with in implementation, and makes recommendations on how to move forward to meet the emerging and varying needs of utilities and their customers.[2]

SUMMARY

Advanced metering infrastructure (AMI) is defined as an integrated network of smart meters, communication networks, and data management systems, which has the potential to transform how utilities, customers, and third-party providers manage electricity generation, delivery, and use. AEE also uses the concept of Advanced Metering Functionality (AMF). Whereas AMI typically refers to a specific technology solution deployed directly by utilities, AMF is a broader term that refers to the capabilities that the technology provides, leaving the door open for a wider range of technologies and solutions to provide the same or similar capabilities.

At a minimum, AMF should include the following:[3]

1. Collection of customers' usage data, in near real-time, usable for settlement in relevant retail and wholesale markets for energy and ancillary services
2. Automated outage and restoration notification
3. Two-way communication between customers and the electric distribution company
4. With customer's permission, communication with and control of smart devices
5. Large-scale conservation voltage reduction (CVR) programs, also called Volt-VAR optimization (VVO)
6. Remote connection and disconnection of a customer's electric service (while maintaining consumer protections)
7. Measurement of customers' power quality and voltage

AEE believes AMF is a foundational component of a 21st Century Electricity System, and as such supports timely and rapid deployment of AMF as part of an enabling platform for other technologies and to allow for the adoption of programs and services that will transform how customers, utilities, and third-party service providers interact with a modern grid.

INTRODUCTION

According to the Energy Information Administration's (EIA) most recent data (January 2015), there are over 58 million AMI meters (also called "smart meters") installed in the United States, representing about 41% of all meters. This level of deployment is noteworthy, considering that, in 2009, there were only 9 million AMI meters.[4]

AEE views the deployment of smart meters as a foundational step towards enabling a smart grid and animating a market in distributed energy resources (DER).[5] The result will be to provide customers with access to a range of technologies and services that can help them better control their energy use and costs. However, advanced meters must be coupled with other technologies, functionalities, and services, such as time varying rates (TVR),[6] for their benefits to be fully realized. On that basis, most of the AMI meters installed in the United States are not yet being utilized to their full potential. For example, only 1% of meters in the United States are AMI-connected to a home area network (HAN) gateway (see box below), which allows the meter to communicate with devices in a customer's home.[7] Similarly, not all smart meters are connected to a meter data management (MDM) system, which provides information to the customer and uses interval data for billing.

The key to getting more out of past and future AMI investments is not simply deploying more meters, but rather creating an integrated network of meters, communication networks, and data management systems, then using that network to improve operations, system planning, and engage customers in new ways.

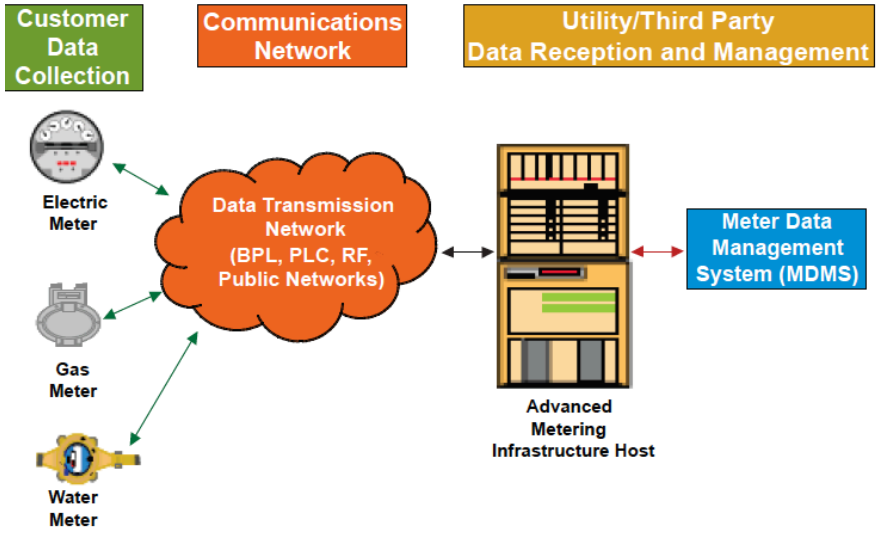
HAN/BAN Gateways

A home/business area network (HAN/BAN) gateway allows smart meters to communicate and transfer information between electronic devices in a customer's home or business. These devices may include in-home displays, smart appliances, computers, smart phones, energy management devices, and distributed energy resources.

AMI connects a home or business to the electric grid through a two-way communication system capable of recording and transmitting data in near-real time between the meter and the utility. This data can also be shared with authorized third-party providers of energy products and services.[8] In some cases, these third parties act as contracted agents of the utility, working seamlessly with the utility on programs such as energy efficiency and demand response. In other cases, the third party is designated by customers and works on their behalf. Regardless, AMI opens the door to a world of possibilities, including digital customer engagement, real-time energy tracking, improved load forecasting, implementation of time varying rates, demand response, real-time outage detection and restoration, dynamic voltage control, and enhanced customer service.

THE CONCEPT

AMI typically refers to the full measurement and collection system, which includes three major components, shown in the figure below: smart meters with integrated communications at the customer site; a two-way communications network between the customer and a service provider, such as an electric, natural gas, or water utility; and data reception and management IT systems that collect, store, and make the information available to the service provider.



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Since AMI represents a specific set of technologies, AEE also uses the concept of Advanced Metering Functionality (AMF). More precisely, AMI is typically understood as the utility-owned[10] complete technology solution that has been the primary means to date by which AMF has been provided, in both vertically integrated and restructured markets. As technology evolves, there may be additional options for achieving the same functionality and for adding new functionality as well. For example, third-party solar companies already provide web-based and mobile tools that allow customers to view their historical and near real-time consumption as well as track their solar PV output, and demand response companies operate their own networks and control centers. These and other providers continue to develop and offer new energy management options.[11]

AMF, whether provided by AMI or some other means, provides a platform for utilities and third-party service providers to offer highly granular data on individual customers' energy usage, in some cases with near real-time access. These data are essential building blocks for customized load management programs and other services that can empower customers to effectively and simply

control their energy usage and costs. AMF can also improve system-wide efficiency by enabling utilities to develop more precise real-time load monitoring and forecasting capabilities. These capabilities, when combined with DER scheduling, can reduce reliance on expensive and inefficient peaking power plants to meet peak demand. AMF also provides benefits in the areas of utility planning, asset management, reliability, power quality, dynamic Volt/VAR optimization (including in combination with smart inverter capabilities), and reduced system losses.

The individualized, granular, and timely data provided by AMF is indispensable for customer engagement efforts. For example, with AMF, DER providers can analyze customer usage patterns and develop tailored recommendations for DER offerings or rates that will produce the greatest savings for each customer's circumstances. AMF can also empower customers to take control of their energy bills through timely, individualized insights such as high bill alerts.[12] Of equal importance, AMF allows for the measurement and verification of changes in consumption of individual customers so that they can be accurately accounted for and valued, for example, in peak-time rebate programs.[13] The use of AMF data is also beneficial for achieving savings through behavioral energy efficiency, and is essential for enabling mass-market demand response (DR) delivered through targeted communications, and the use of time-varying rates (TVR). These enable customers to become much more engaged with their energy usage and to manage their own energy costs while also helping to optimize performance of the grid.

AMF Enables Time Varying Rates

While AMF provides a number of benefits by itself, many of its potential benefits are realized by enabling other technologies and services, such as time-varying rates. Examples of AMF-enabled time-varying rates at work include a Sacramento Municipal Utility District critical peak pricing pilot, which achieved a 26% savings at peak hours, and a Baltimore Gas and Electric (BGE) peak time rebate program that saved consumers in BGE's capacity zone $162 million in capacity charges and $7 million in avoided transmission and distribution infrastructure costs. Non-BGE customers in adjacent zones saved an additional $126 million due to the program, illustrating how benefits extend to the system at large, including non-participants. Elsewhere, customers in Vermont and California reduced their peak demand by up to 3.5% in response to targeted behavioral messaging made possible by AMF.

QUESTIONS TO CONSIDER

There are a variety of questions involved in an AMF deployment: Who will own and maintain the infrastructure? Which customers should receive AMF? What is the most cost-effective deployment strategy? Who will pay for deployment? How will privacy concerns with regard to customer and third-party access to data be handled? What standards and oversight is required if third parties provide AMF (e.g., billing accuracy, data access, privacy)?

Regulators and policymakers must decide which AMF components should be owned and maintained by the utility, by customers, or by third parties. Utility ownership has been the most common option to date, but ultimately ownership of AMF components should depend on several criteria:

- Overall total cost of ownership
- Regulatory incentives (e.g., utilities earn returns on capital investment, while third-party ownership of specific components may be mandated)
- Capabilities (e.g., third parties may have greater expertise or scale to own and operate)
- Risk (e.g., shifting ownership to another party may lower overall implementation risk for the utility)

The selection of an AMF solution is unique to each utility's circumstances and is dependent on a number of factors, including geography, customer density, scalability and growth, and use cases.

Before undertaking the investment, the benefit-cost ratio for AMF should also be considered. A comprehensive benefit-cost analysis should be used to build a business case for AMF deployment that includes the full range of use cases, including the benefits of timely access to granular data; operational and customer benefits, including access to enhanced energy efficiency, demand response, and customer engagement programs; as well as how AMF can contribute to meeting state policy goals. By planning comprehensively, regulators can ensure that consumers receive a strong return on their investment.

Finally, customer and third-party data access is a topic that will become increasingly important once AMF is widely deployed. We support efforts to provide customers with more data and to make it easy for those customers to share such data with authorized third parties. The available data – such as daily, hourly, sub-hourly and near real-time usage information – will enable new DER-related products and services to be developed and offered to more customers. Although increased access to data raises privacy concerns, those concerns can be addressed and mitigated by establishing data access standards, customer authorization procedures, and potential data exchanges.[14]

CONCLUSIONS AND RECOMMENDATIONS

There is no one-size-fits-all solution for a successful AMF deployment. Nevertheless, past experience suggests that the following basic framework can be used to help policymakers, regulators, and utilities design and implement a program for deployment that best fits their specific needs and circumstances.

LAYING THE FOUNDATION

For timely and effective AMF deployment, policymakers should begin a dialogue among utilities, third party providers, customers, and other stakeholders. The stakeholders involved must educate themselves on the concept of advanced metering, consider all possible barriers to adoption and the unique challenges in their service territories, and establish a practical framework to achieve a successful deployment.

DEVELOPING A PLAN

Experience globally (about 500 million AMI meters) and in the United States (approximately 60 million AMI meters) has shown utility ownership to be the most cost-effective in the vast majority of cases. However, third-party providers can help with customer engagement and DER deployment, either on behalf of the utility or on their own, enabled by AMF.

Next, utilities and regulators must decide upon the most cost-effective deployment strategy. As a general rule, the benefits[15] of AMF – both operational and direct customer benefits – are best achieved through universal deployment rather than on a customer-by-customer basis. Full-scale deployment enables both the framework for DER and customer facing solutions that provide immediate benefits of AMF. Evidence from large-scale AMI deployments has shown that wide deployments generate more robust benefit-cost results due to capturing economies of scale, enabling more customer benefits, and maximizing operational efficiencies. The cost for installing each meter increases when deployment is targeted at only some of the customers in a designated area, and some of the benefits of AMF cannot be fully realized unless all customers have the technology.

In addition, AMF deployment must include back office and data management systems to allow a customer full access to their data in a form they can benefit from. An AMF deployment without this capability is likely to be less expensive but also far less beneficial to customers relative to the costs they are to bear.

ENABLING THE FULL SUITE OF BENEFITS

While there are immediate operations and maintenance (O&M) and service quality

benefits associated with the deployment of AMF itself, most customer benefits are contingent on further actions by utility regulators that enable options such as time-varying rates, integration of plug-in electric vehicles, Volt-VAR optimization, distribution automation, demand response, and behavioral energy efficiency. In order for regulators to make fully informed decisions, they should require that utilities explore AMF deployment through business cases that capitalize on the full functionality available. This would include evaluation of O&M savings and benefits, and also provide estimated customer benefits for a range of other technologies and solutions enabled by AMF, such as energy efficiency and demand response. Immediate customer benefits can be delivered through engagement applications such as web portals, personalized energy management tools, rate analysis, and usage alerts.

Furthermore, the benefits of AMF will not be fully realized unless policies are instituted *before* AMF is deployed, rather than after, so that customers and their designated third parties gain access to data in a timely fashion. This information should be provided through the utility provider's website (e.g., via *Green Button Connect*), Electronic Data Interchange (EDI) capability in areas where energy is billed through a competitive supplier, and through real-time information accessed from smart meters on the customer's premise.

In instances where AMF has failed to live up to its promise, failure can often be traced back to lack of data access and the lack of quantification of customer and societal benefits. Therefore, utility regulators should request annual reporting, as one way to ensure that the value of the investment is maximized.

Advanced metering functionality is a foundational element of the modern grid, with the potential to transform how customers, third parties, and utilities manage electricity generation, delivery, and usage. AMF can improve system-wide efficiency, reliability, and resiliency as well as fuel and resource diversity, either directly or as an enabler of other technologies and services. It can also lead to better DER integration, increased customer engagement, customer bill savings, and third-party market animation. Whether AMF lives up to its potential depends on how it gets put to use. Policymakers, regulators, utilities, and customers all have a role to play in getting the most out of the investments.

Customer Benefits

Customer benefits are often what makes AMI deployment cost effective. Baltimore Gas & Electric's peak time rebate (PTR) program, *Smart Energy Rewards*, made up 50% of the total benefits presented in its AMI business case, equivalent to $1.25 billion over the 15-year expected life of the AMI components. In total, customer benefits accounted for 70% of the total benefits.[16] Any AMF business case must include a commitment to achieving well-defined and quantifiable customer benefits, along with a detailed strategy for how customer benefits are to be achieved.

END NOTES

[1] http://info.aee.net/21ces-issue-briefs
[2] Advanced Energy Economy (AEE) is comprised of a diverse membership. As such, the information contained herein may not represent the position of all AEE members.
[3] Massachusetts Department of Public Utilities. 23 December 2013. Order 12-76-A in the Investigation by the Department of Public Utilities on its own Motion into Modernization of the Electric Grid (12-76). Available at http://170.63.40.34/DPU/FileRoomAPI/api/Attachments/Get/?path=12-76%2f12-76-Order-7382.pdf.
[4] http://www.eia.gov/electricity/data/eia861/index.html
[5] Distributed Energy Resources are defined broadly to include energy efficiency, demand response, distributed generation of all types, energy storage, electric vehicles, and microgrids.
[6] For more on TVR, see our Issue Brief on Rate Design in a DER Future.
[7] http://www.eia.gov/electricity/data/eia861/index.html
[8] For more on data sharing, see our Issue Brief on Access to Data.
[9] https://www.ferc.gov/EventCalendar/Files/20070423091846-EPRI%20-%20Advanced%20Metering.pdf
[10] The utility need not own or operate all components of an AMI system. For example, it can outsource operation of the meter data management function.
[11] For example, see: https://us.sunpower.com/residential-solar-energy-system-equinox/
[12] Similar to data limit alerts from mobile phone providers, high bill alerts use AMI data to notify customers if they are on track to receive a higher-than-average bill. These alerts can be coupled with individualized tips to help save energy and avoid high bills.
[13] A peak time rebate program is one of several options utilities can implement via AMF to achieve peak load reductions by sending signals to participating customers.
[14] For more information on privacy and data access, please see the issue brief on *Access to Data*, available at http://info.aee.net/21ces-issue-briefs
[15] Ahmed Faruqui "The Customer Side Benefits of Smart Meters," Presentation, Brattle, Nov 7, 2013. Available at:http://www.brattle.com/system/publications/pdfs/000/004/953/original/The_Customer-Side_Benefits_of_Smart_Meters.pdf?1383853357
[16] Baltimore Gas & Electric Company, 2011, "Application for Authorization to Deploy Smart Grid Initiative and to Establish a Surcharge Mechanism for the Recovery of Costs", Case Number 9208.