POTENTIAL IMPACTS OF ADVANCED METERING INFRASTRUCTURE ON RENEWABLE ENERGY POLICY

A Solar ABCs White Paper

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DISCLAIMER

EXECUTIVE SUMMARY

Advanced Metering Infrastructure (AMI) allows bidirectional communication between the utility and the customer. This allows the utility to gain rapid feedback on the condition of and events occurring on its electric grid and the opportunity to assert controls over load-side parameters.

This white paper is a primer that gives the reader an overview of AMI and identifies possible impacts on renewable energy policy and the integration of renewable energy generation into the electric utility grid.

Key Findings

Renewable and distributed generation will be integral parts of the future grid. As AMI is adopted, regulator decisions on AMI adoption will impact renewable energy policy and utility integration. The following list presents some of the areas that will be most affected.

Utility Rate Structure

AMI has the potential to bring time-of-use and real time pricing to the mass-market and, in many cases, to provide utilities with a strong business case for doing so. Renewable energy advocates must educate themselves about the proposed rates to ensure that they do not adversely affect the market for solar PV or other renewable technologies.

Incentives

The meter data management system must be able to incorporate the calculation of both the net energy generation and incentives, and communicate these derivations to the customer. Additionally, the speed of detection and response of all communications must be assessed and made compatible with other levels of communications. It is likely that some utilities will not consider these issues on their own and could resist incorporating these calculations into an AMI project because the additional costs do not appear to have a benefit for operation. However, as more renewable energy is integrated into the electric grid, these features will be needed and may force a later and costly modification to any existing AMI application.

Data

AMI technologies will often allow access to real-time data about the conditions of the utility grid as well as the manner in which individual consumers use electricity. These data will be valuable to many parties, but customer privacy must be observed. Utilities may be reluctant to share the information. One solution that has been used is that regulators not allow utilities to have control of the data; instead, third-party vendors should be engaged to manage the data and assure neutrality.

Interconnection

The control functionality and the capabilities of AMI may reduce the barriers to interconnection of distributed renewable energy technologies. For example, the current practice of limiting distributed generation (DG) penetration to 10% of local distribution rating may be eased as the utilities can be assured of knowing the conditions on its grid at all times and of controlling DG device interaction. Thus, AMI technologies may allow greater penetration of distributed generation and reduce the barriers to interconnection.

Engaging Policy Makers

As AMI projects are designed, it is likely that their implementation may affect current policies. Due consideration to the impact of any plan that may restrict existing, successful policies should be given to ensure that the recognized societal benefits are maintained.

Standardization of AMI Requirements

Those reviewing any plans for the implementation of AMI projects must consider the ability of the proposed technology to communicate with other technologies. The renewable energy community should be aware of new standards and ensure that devices such as inverters meet the standards necessary to be integrated into the future grid.

Work with Utilities

The renewable energy community should seek out opportunities to work with electric utilities and technology manufacturers. Many of the existing business models governing investor-owned utilities would need revision under the new paradigm that adoption of AMI will introduce. These new paradigms offer an opportunity for the renewable energy community to have input into new methods of transacting business in the energy sector.

AUTHOR BIOGRAPHY

Keith McAllister is currently the Program Manager for Clean Energy Applications at the North Carolina Solar Center at North Carolina State University. He is also the Director of the US DOE's Southeast Clean Energy Application Center and a member of the Solar ABCs Steering Committee. In these roles, Mr. McAllister continues to investigate technology and policy initiatives that increase the efficient use of energy. Mr. McAllister has also investigated novel concepts for the electric grid such as micro-grids and advanced metering infrastructure. As an engineer in the research section of Progress Energy (formerly known as Carolina Power & Light Company) Mr. McAllister worked on programs in the areas of Thermal Energy Storage, air-source and ground-source heat pumps, building envelope improvement, lighting, distributed generation, and industrial energy efficiency. This experience has given him a broad knowledge of both the electric utility's and end user's perspective on energy use, energy reliability and security and energy efficiency. Mr. McAllister holds both a BS and MS in Mechanical Engineering from North Carolina State University and he is also a licensed professional engineer in the State of North Carolina.

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The Solar America Board for Codes and Standards (Solar ABCs) is a collaborative effort among experts to formally gather and prioritize input from the broad spectrum of solar photovoltaic stakeholders including policy makers, manufacturers, installers, and consumers resulting in coordinated recommendations to codes and standards making bodies for existing and new solar technologies. The U.S. Department of Energy funds Solar ABCs as part of its commitment to facilitate wide-spread adoption of safe, reliable, and cost-effective solar technologies.

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INTRODUCTION

Over the last two decades, groundbreaking changes have occurred within the electric utility industry: deregulation in certain regions, utility mergers and acquisitions, the convergence and subsequent divergence of the electric and natural gas industries, energy trading, organized electricity markets in the form of Regional Transmission Operators (RTOs) or Independent System Operators (ISOs), renewable portfolio standards, greenhouse gas (GHG) policies, and many others. The next groundbreaking change has begun (see Figures 1 & 2) and may be the most dramatic of all. The North American electric system has begun to transcend its historic, one-way supplier-to-buyer structure to move to a fully integrated digital network—a new paradigm called Advanced Metering Infrastructure (AMI) — in which suppliers and buyers may, in many cases, communicate using near real-time information to make choices regarding electricity supply and usage.

Figure 1: AMI, AMR & Smart Grid Projects as of November 2008 (Google maps 2008)

The American Recovery and Reinvestment Act of 2009 (ARRA), also known as the Stimulus Plan, has provided some funding for these and other initiatives. The ARRA provides $4.5 billion specifically for Smart Grid technologies; (Smart Grid News 2009) additionally, other portions of the ARRA contain language which could incorporate stimulus funding.

These include:

- New loan authority for Bonneville Power and Western Area Power Authority for transmission projects ($6.5B)
- Energy Efficiency and Conservation Block Grant ($3.2B)
- Transportation, including electric vehicles ($1.7B)
- Renewable energy loan guarantees ($6B)
- Research in energy efficiency, renewables, batteries and clean fossil energy ($8.4B)
- Broadband Technologies Opportunities Program ($7.2B)

Additionally, the DOE has increased capital funding for Smart Grid project grants from $20 million to $200 million. (Smart Grid News 2009) This funding, as well as the proven advantages of AMI technologies to significantly reduce utility operational costs and enable significant demand-side response (Duke Energy 2008), has led to a dramatic increase in the number of projects as shown in Figure 2.

Figure 2: AMI, AMR & Smart Grid Projects as of October 2009 (Google maps 2009)

As these projects are implemented, legislative and regulatory decisions are being made which will impact renewable energy policies.

This paper is a primer that gives the reader an overview of AMI and identifies possible impacts on renewable energy policy and the integration of renewable energy generation into the electric utility grid.

The first section provides a high level description of the technologies. Providing a detailed explanation of how AMI and its related technology Automatic Meter Reading (AMR) work is outside the scope of this document. Many other industry documents are publicly available for that purpose. For a more detailed knowledge of these technologies, please see the "Suggested Further Reading" section at the end of the paper.

The next section identifies some of the impacts on the following renewable energy issues:

- Rate structures
- Incentives
- Ownership of data
- Technical interconnection issues
- Engaging policy makers
- Standardize AMI requirements

The paper encourages policy makers and regulators to become educated on these and other potential impacts and to become engaged in the regulator process of AMI proceedings.

AMI & AMR TECHNOLOGIES

In order to understand the current environment which is fostering the explosive growth of AMI projects, one should understand the vision of the future electric transmission and distribution grid. In 2003 the United States Department of Energy's (DOE) Office of Electricity Delivery and Energy Reliability (OE) gathered 65 senior executives from electric utilities, equipment manufacturers, information technology providers, federal and state government agencies, interest groups, universities, and national laboratories. The mission of this group was to develop a national vision of the future electrical system with a focus on "the portion of the electric infrastructure that lies between the central power plant and the customer —as well as the regulatory framework that governs system planning and market operations." The result of that meeting was a vision document entitled "Grid 2030" – A National Vision for Electricity's Second 100 Years," (US DOE 2003) which has provided the framework for DOE's research, development and implementation of Smart Grid technologies which includes AMI and AMR.

On a national level, Congress began to recognize the potential benefits of smart grid technology several years ago. The Energy Independence and Security Act of 2007 (EISA 2007) Section 1301 establishes a federal policy to modernize the electric utility transmission and distribution system to maintain reliability and infrastructure protection. (EISA 2007) AMI refers to a distribution system that allows for flow of information from a customer's meter in two directions: both inside the house to thermostats, appliances, and other devices, and from the house back to the utility. Section 1307 directs the states to encourage utilities to employ AMI technology and allow utilities to recover AMI investments through rate structures. This could be in a rate rider form which could be charged on a kWh or a per dollar basis. However, utility commissions may allow a flat charge to be applied to the service and facility charges.

Through AMI, today's peaks and valleys of consumer demand may be smoothed as the industry's supply side becomes attuned to and is supplemented by information and input from the demand side (PJM 2007). The report draws the conclusion that from the perspective of the utility, accurate real-time or time-of-use pricing will drive demand-side behavior. Integrated distributed generation and demand response capabilities may support load leveling, allowing central plants to run at a higher capacity factor. The grid of the future will incorporate renewable energy, such as wind and solar, energy storage and management, photovoltaics, and deliver signals to consumer appliances which will modify their energy use characteristics.

The following sections give a very high level review of AMR and AMI technologies.

Automated Meter Reading Technology

AMR technology, often used to reduce metering reading costs, uses a solid-state meter (SSM) to automatically collect energy data from a customer's premise and transmit it to a centralized database, sometimes called a meter-data management system (MDMS), for billing and analysis. The information may be passed from the meter to the database in a variety of methods, including handheld scanners, transmission to personnel either walking or driving by, or over a variety of communications networks. Meters may simply capture energy usage data or may include features such as tamper detection, alarm conditions, or interval data. AMR automates the meter reading functions of the utility. There are many features available in these systems. The New York Public Service Commission identified a few of these features in a 2008 report.

AMR is expected to provide multiple benefits to the utility:

- elimination of manual meter reading,
- deferral of metering capital costs,
- increased revenue due to improved meter accuracy,
- reduction of off-cycle reads,
- fewer estimated bills,
- lower load research costs,
- reduction of revenue losses from unoccupied premises,
- reduction of field service orders,

- reduction of call center contacts for bill-related and power quality calls, and
- reduction of compensation/claims for manual meter reading accidents.

Future and societal benefits include decreased costs through use of remote reconnect/disconnect or load limiting devices, and the potential for more accurate cost allocation and rate design because of accurate hourly billing consumption data. (NYPSC 2008)

Advanced Metering Infrastructure Technology

AMI builds on the capability of AMR by adding more robust communications technologies, which allows the utility to communicate with the customer, the customer to communicate with the utility and, in many cases, allows the utility to gain rapid feedback on the condition of and events occurring on its utility grid.

An Advanced Metering Infrastructure (AMI) system typically utilizes an SSM, a Home Area Network (HAN), a communications system, a meter-data management system (MDMS), and a utility operating system (UOS) that makes use of the data provided by the other components of the system.

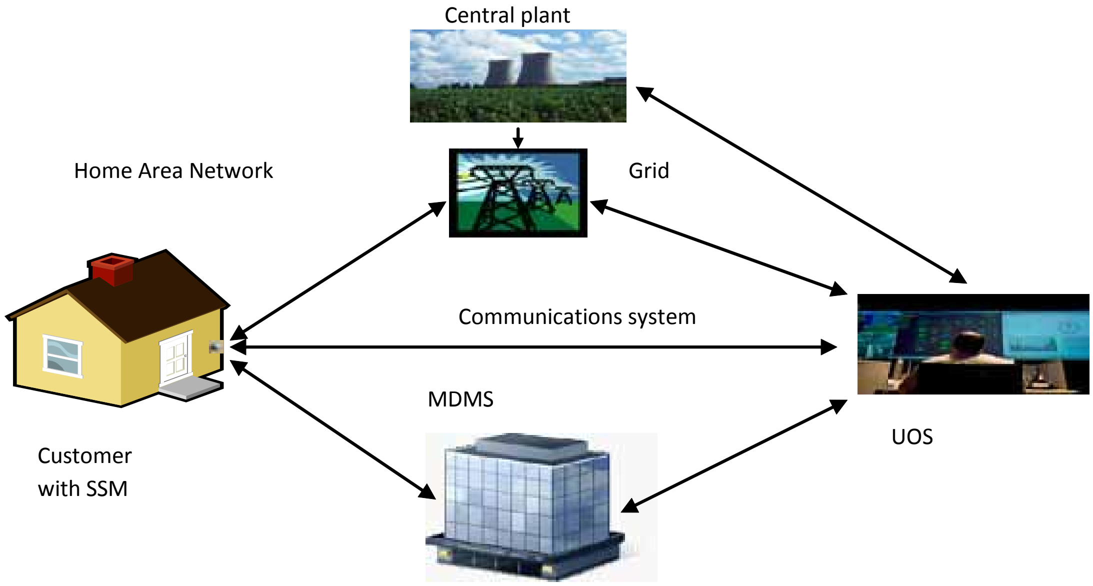

Figure 3: AMI System

In addition to the benefits gained from the AMR system, an AMI system offers reduction of costs to support other R&D initiatives by providing a low cost method of gathering data, reduction of false outage dispatches, reduction of nested-outage restoration time, reduction of long-term outage response time, increased customer participation in demand-response programs that may defer transmission and distribution system upgrades, decreased costs through use of remote reconnect/disconnect or load limiting devices, additional reduction of field service orders, possible increased customer utilization of eCommerce channels, avoided capacity costs due to increased load management participation, and the ability to meet increased demand from cutting edge technologies (NYPSC 2008).

ISSUES FOR RENEWABLE ENERGY

AMI, and its component technology AMR, have begun a transformative revolution within the electric utility industry, as has been seen in other network-based industries such as the telecommunication industry. It is clear that AMI is and will continue to be a disruptive technology that replaces existing methods and systems. A lesson learned from the telecommunications and internet experiences shows that standardized architecture and techniques are required for the distributed intelligence and "smart" power systems, which will enable this revolution (USDOE 2003).The two-way communication features and distributed intelligence that are emerging in these technologies will change the way that electricity is generated, transmitted, and ultimately used. Renewable and Distributed generation are viewed to be integral parts of the future grid as it reaches its potential as seen by the DOE and others. As AMI is adopted, decisions are being made in the regulatory process which impact Renewable Energy Policy. While this list is not intended to be comprehensive, some of the areas which will most affect Renewable Energy Policy are briefly discussed below.

Issue: Utility Rate Structure

AMI has the potential to bring time-of-use (TOU) and real time (RTP) pricing to the mass-market and, in many cases, to provide utilities with a strong business case for doing so. In the past, TOU tariffs were often seen as overly complicated for both the utility and the customer. However, the two-way communication feature of AMI will allow pricing signals to be sent to the customer. These pricing signals may match rates to the actual cost of energy at a given time period. The utilization of these rate structures may allow one of the great potentials of AMI, the ability to reduce the peak demands in electrical energy usage, to be realized. Currently, the average capacity factor of central power plants is 55% (Pullins 2008). Thus, up to 45% of the capital dollars spent to build these facilities was necessary just to meet peaking requirements. While a small portion of this excess capacity can be attributed to the need for a reserve margin, even that need could be reduced or nearly eliminated once the full capabilities of an AMI enabled grid are realized. The pricing signals along with rate design are expected to modify customer behavior. Automation within the HAN will allow appliances to react to these signals without the need for customer intervention, but the customer may chose to have the ability to be notified a day in advance and make these decisions based on predicted costs. It is envisioned that modified customer behavior will serve to flatten demand curves. As peak demands are reduced the need for demand charges within tariffs may also be reduced. The two-way communication ability facilitates customer choice. Xcel Energy provides two potential examples through its pilot Smart Grid project in Boulder, CO (James 2008). Xcel expects to be able to offer customers a variety of rates from which to select. Consumers may desire a flat-rate, a TOU structure or a critical-pricing model. One novel initiative that has been discussed by Xcel would allow the consumer to set a price for their electricity purchase. The customer would choose from a low-cost option to a range of higher cost options which would include more Renewable Energy (RE) generation assets. In essence, consumers would have input into the dispatching decision making process (personal meeting with Xcel).

Renewable Energy advocates must educate themselves about the proposed rates to ensure that they do not adversely affect solar PV or other renewable technologies. For example, many net metering rates initially had Net Excess Generation (NEG) (IREC 2010) credits forfeited to the utility at the end of the calendar year. However, PV systems could build up more NEG credits during the summer than could be expended by the end of the year. Several jurisdictions have changed the "true-up" date to the spring of the new calendar year to alleviate this issue.

Issue: Incentives

The information gathering capability of AMI could have a dramatic impact on the way incentives are measured, especially for performance-based and time-of-use incentives, as well as a means of providing customers a simple way to understand the impact of these incentives. The Solar Alliance, alliance of solar manufacturers, integrators and financiers and a respected voice in the solar PV marketplace, states that a "commitment to analytical rigor and technical analysis is critical to demonstrate the effectiveness of a solar [incentive] program." (Solar Alliance 2008) These data can be easily captured by AMI systems. These data can be used to verify both the performance of systems and to provide documentation for successful systems that can be replicated.

An ability of a fully integrated AMI system is that utility sub-systems have the ability to communicate with one another. Distributed generation assets, such as PV, could be monitored in real time and the data could be incorporated into the utilities billing systems which could reduce the costs of incentive programs while allowing access to data that could be used to evaluate incentive programs. (Connecticut DPUC 2008) Additionally, the information could be relayed to a HAN. If properly designed, the customer interface will allow an open, easily understood and transparent means of communicating the value of incentives to consumers.

Those interested in the development of RE must become part of the discussion of any AMI docket. The appropriate features of the AMI components must be included if the previously stated scenarios are to become reality. For example, the SSM must have the ability to distinguish the direction of power flow and to communicate with inverters. The HAN must have the ability to display the information in a clear and meaningful way. The MDMS must be able to incorporate the calculation of both the NEG and incentives and communicate these derivations to the customer. The speed of detection and response of all communications must be assessed and determined compatible with other levels of communications. It is likely the utilities will not even consider these issues on their own and are likely to resist incorporating additional costs for what are seen as a small portion of ratepayers. However, as more RE is integrated into the electric grid these features will be needed and would most likely force a costly modification to any existing AMI application. In the cases of states where munis and co-ops are not regulated by Utility Commissions, legislation may be necessary to ensure these issues are addressed.

Issue: Data

AMI technologies will often allow access to real-time data about the conditions of the utility grid as well as the manner in which individual consumers use electricity. It is clear that energy use and load information will be valuable to many entities. Manufacturers, integrators, billing aggregators, NGOs and many others will want access to these data, which will be invaluable in the development of innovation that will benefit all. For example, RE & Distributed Generation (DG) developers may use the data for target marketing purposes, equipment and appliance manufactures would want to know when consumers' products require maintenance or replacement, RE advocates would want access to real-time data in order to develop new policies and incentives, to name a few.

In this environment, it is essential to carefully define ownership rights for metering data; however, any policy that defines ownership rights and access to data must also give careful consideration to privacy rights and security risks. Rule makers must balance the benefits of making data available to entities outside of the electric utility while limiting potential issues related to privacy and security. One solution that has been used is that regulators not allow utilities to have control of the data; instead, third-party vendors should be engaged to manage the data and assure neutrality. (IESO 2007) Additionally, any regulations must also include language that will protect the utilities from liabilities associated with unauthorized use of these data. A utility must be held harmless, if they are complying with the regulations, in the event that personal information is stolen or otherwise misused.

Issue: Interconnection

The control functionality and the capabilities of new power electronics devices may reduce the barriers to interconnection of distributed renewable energy technologies. Traditionally, distribution engineers made calculations based on static conditions. Protection, with protection and coordination device settings derived based on one-way power flows. Now, with the ability to gather real-time data on grid operations, to communicate updated control settings to protection devices and control DG equipment, interconnection could become plug and play.(FREEDM 2009) Smart Grid and AMI have the ability to positively impact RE and DG technology by reducing the cost of interconnection studies, shortening the time to get interconnection approval, allowing larger systems to be integrated into the grid and facilitating different rules for different sized systems. (McGranahan 2008) The current practice of limiting DG penetration to 10% of local distribution rating could also be eliminated as the utilities can be assured of knowing the conditions on its grid at all times and controlling DG device interaction. Thus, these technologies may allow greater penetration of distributed generation and reduce the barriers to interconnection.

RE and DG technologies will play a crucial role in this new paradigm. These assets can be used to relieve congestion, potentially improve reliability, reduce restoration times, and help flatten load profiles on central plants. While the potential of RE and DG to achieve these impacts have been discussed for years, communication and control issues have limited the actual implementation of these capabilities. However, the widespread use of AMI may help enable the potential to become reality. RE advocates must educate themselves on the capabilities of AMI technologies and ensure that the features necessary to facilitate the integration of DG is included in a utility’s plan to integrate AMI onto their T&D grid.

Issue: Engaging Policy Makers

As seen in Figure 2, many electric utilities have deployed large numbers of AMR and / or AMI systems. As these plans go through the regulatory process, decisions are being made that will impact RE policy. The RE community must fully understand the potential of AMI to impact its industry. Once these policies are in place, they will become difficult to modify.

Existing RE policy benefits, such as Net Metering, Renewable Portfolio Standards, Public Benefit Funds, were designed to recognize the societal benefits of distributed RE, such as greenhouse gas reduction, resource diversification, renewable portfolio standard requirement compliance, and alleviation of demand in transmission-constrained load pockets. Current policies have been successful in approaching these objectives. As AMI projects are designed, it is likely that their implementation may affect current policies. Due consideration to the impact of any plan that may restrict existing, successful policies should be given to ensure that the recognized societal benefits are maintained. Existing RE policies should be examined with an eye on the disruptive capabilities of AMI and the RE policies may need to be revised to maximize the benefit to society.

Issue: Standardize AMI Requirements

The Grid 2030 document (USDOE 2003) concluded that standardization of protocols take place between the different technology components of AMI. A key feature of AMI is its ability to communicate. If devices are not able to communicate with each other due to proprietary designs, the ability of AMI to reach its full potential will be severely limited. Those reviewing any plans for the implementation of AMI projects must consider the ability of the proposed technology to communicate with other technologies. Several IEEE standards are being developed. In May 2009, the DOE announced that any projects receiving stimulus funding must comply with no less than 16 standards addressing such topics as cyber security, SSM’s, and DG components (WSJ 2009) and the IEEE P2030 interoperability standards (IEEE 2009) began proceedings in 2009.

The RE community should be aware of these standards and ensure that devices such as inverters meet the standards necessary to be integrated into the future grid.

Issue: Work with Utilities

The RE community should seek out opportunities to work with electric utilities and technology manufacturers. AMI technologies will change the way we generate, distribute and utilize electricity. Many of the existing business models governing investor owned utilities are becoming outdated under the new paradigm that will develop. These new paradigms offer an opportunity for the RE community to have input into new methods of transacting business in the energy sector. The RE community has insight into the emerging technology that is early in its technology development cycle. The insight that this community brings will be valuable to regulators, policy makers, technology manufacturers and utilities. By working with utilities to address issues such as the depreciation of equipment, contracting issues related to the utilities obligation to serve when confronted with DG assets which they do not own, and intelligent tariff / rate and incentive designs which drive behavior, the RE community can gain a valuable negotiating position to push issues that are important to its goals. Becoming educated on the issues and the capabilities of the technologies, as well as comprehending the potential impact of today’s decisions on future policy goals could enhance the many of the gains made over the last thirty years and provide new opportunities for the RE community.

References

Connecticut DPUC final decision in Docket 03-07-02RE10, (Connecticut DPUC) (2008) dated January 31, 2008. See www.dpuc.state.ct.us/dockcurr.nsf/(Web + Main + View/Search + Electric)?OpenView&StartKey = 03-07-02RE10

Duke Energy (2008). Transcript of proceedings. South Carolina Public Service Commission March 28. Retrieved 8 June 2008 from www.psc.sc.gov/exparte/briefing28Mar2008/Ex_parte_briefing_materials_03-28-2008_transcript.pdf

Energy Independence and Security Act 2007 (EISA) (2007), Retrieved on June 9, 2008 from http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname = 110_cong_bills&docid = f:h6enr.txt.pdf

FREEDM Center, *About: FREEDM Systems.* (n.d.). (FREEDM 2009) Retrieved November 17, 2009, from FREEDM Center: http://www.freedm.ncsu.edu/index.php?s = 1&p = 6

Google Maps (2008), Retrieved on November 3, 2008 from http://maps.google.com/maps/ms?ie = UTF8&hl = en&msa = 0&msid = 115519311058367534348.0000011362ac6d7d21187&ll = 53.956086,14.677734&spn = 23.864566,77.519531&z = 4&om = 1

Google Maps (2009), Retrieved on October 26, 2009 from http://maps.google.com/maps/ms?ie = UTF8&hl = en&msa = 0&msid = 115519311058367534348.0000011362ac6d7d21187&ll = 53.956086,14.677734&spn = 23.864566,77.519531&z = 4&om = 1

IEEE P2030 Work Group's Smart Grid Draft Guide, (IEEE) (2009) http://grouper.ieee.org/groups/scc21/2030/2030_index.html

Independent Electricity System Operator, (IESO) (2007) *IESO Selects IBM for Ontario's Smart Meter Data Repository.* IESO press release, January 15. Retrieved on 8 June 2008 from http://www.ieso.ca/imoweb/media/md_newsitem.asp?newsID = 3231.

Interstate Renewable Energy Council (IREC) (2010). State by State Net Metering Table retrieved January 19, 2010, from http://irecusa.org/wp-content/uploads/2009/12/December_2009_NM_Table.doc

James, D. (2008), Xcel Energy's SmartGridCity™, 8/21/2008, Retrieved on August 21, 2008 from http://www.irecusa.org/uploads/media/DJames_IREC_Presentation_081408.pdf

McGranahan, M. (2008). Renewable Systems and Interconnection Study: Advanced Grid Planning and Operations. Sandia National Laboratories, report number SAND2008-0944 P, February 2008.

New York Public Service Commission (NYPSC) (2008). Issued March 3, 2008. Retrieved on 8 June 2008 from http://www3.dps.state.ny.us/pscweb/WebFileRoom.nsf/Web/E63EDFAA3BC1867B852574010065I3BB/$File/201_00e0165_AMINotice.pdf?OpenElement

PJM Interconnection (PJM) (2007). *Bringing the Smart Grid Idea Home* (2007). PJM 2007 Strategic Report. April. Retrieved 8 June 2008 from http://www2.pjm.com/documents/downloads/strategic-responses/letters/smartgrid.pdf

Pullins, S (2008), Smart Grid: Enabling the 21st Century Economy, December 2008, Retrieved on January 10, 2009 from http://www.netl.doe.gov/moderngrid/docs/SG-Enabling % 20the % 2021st % 20Century % 20Economy_Pullins_2008_12_02.pdf

Smart Grid News – Smart Grid Stimulus Toolkit, Retrieved on June 8th, 2009 from http://www.smartgridnews.com/artman/publish/news/SGN_Stimulus_Tool_Kit-541.html#finding_money

Smart Grid News: What to expect, Retrieved on June 8th, 2009 from http://www.greentechmedia.com/articles/read/smart-grid-stimulus-what-to-expect-6069/

Solar Alliance (2008), Retrieved on November 11, 2008 from http://www.solaralliance.org/model_policies/incentives.html

US Department of Energy (USDOE) (2003). *"Grid 2030" A National Vision for Electricity's Second 100 Years*, Office of Electric Transmission and Distribution, Retrieved on March 27, 2006 from http://www.ferc.gov/eventcalendar/files/20050608125055-grid-2030.pdf

Wall Street Journal Online May 18, 2009, (WSJ) (2009) Retrieved on June 9th, 2009 from http://online.wsj.com/article/SB124266629459331175.html

SUGGESTED FURTHER READING

Brockway, N. (2008). *AMI: What Regulators Need to Know About its Value to Residential Customers.* National Regulatory Research Institute, February 13. http://nrri.org/pubs/multiutility/advanced_metering_08-03.pdf

CPUC Decisions # D.06-07-027 for PG&E. July 20, 2006; Decision # D.07-04-043 for SDG&E, April 12, 2007; and SCE's Edison SmartConnect application A.07-07-xxx, filed July 31, 2007.

FERC staff report, "Demand Response and Advanced Metering," AD-06-2-000, August 2006. FERC staff report, "Demand Response and Advanced Metering," Chapter 3 – Building Blocks of Advanced Metering, AD-06-2-000, August 2006.

Federal Energy Regulatory Commission:
www.ferc.gov/industries/electric/indus-act/smart-grid.asp

GridWise® Alliance: www.gridwise.org

Independent Electricity System Operator (2007). *IESO Selects IBM for Ontario's Smart Meter Data Repository.* IESO press release, January 15. 2007, http://www.ieso.ca/imoweb/media/md_newsitem.asp?newsID=3231.

McGranahan, M. (2008). Renewable Systems and Interconnection Study: Advanced Grid Planning and Operations. Sandia National Laboratories, report number SAND2008-0944 P, February 2008.

National Energy Technology Laboratory: www.netl.doe.gov/moderngrid/

PJM Interconnection (2007). *Bringing the Smart Grid Idea Home* (2007). PJM 2007 Strategic Report. http://www2.pjm.com/documents/downloads/strategic-responses/letters/smartgrid.pdf

Smart Grid News: www.smartgridnews.com (Smart Grid News free e-mail newsletter also available here)

US Department of Energy (2003). *"Grid 2030" A National Vision for Electricity's Second 100 Years*, Office of Electric Transmission and Distribution, http://www.ferc.gov/eventcalendar/files/20050608125055-grid-2030.pdf

U.S. DOE Office of Electricity Delivery and Energy Reliability: www.oe.energy.gov/smartgrid.htm

NOMENCLATURE

ARRA	The American Recovery and Reinvestment Act of 2009
AMI	Advanced metering infrastructure
AMR	Automated meter reading
DG	Distributed generation
DOE	US Department of Energy
DSM	Demand-side management
EISA 2007	Energy Independence and Security Act of 2007
GHG	Greenhouse gases
HAN	Home Area Network
ISO/RTO	Independent System Operator or Regional Transmission Operator
kW	Kilowatt: one thousand watts of electrical power
kWh	Kilowatt-hour; one thousand watt-hours
MDMS	Meter data-management system
NEG	Net Excess Generation
NGO	Non-Government Organizations
OE	US DOE Office of Electricity Delivery and Energy Reliability
PV	Photovoltaics; solar electric panels
RE	Renewable energy
SSM	Solid-state meter
T&D	An electric utility's transmission and distribution system
TOU	Time-of-use
UOS	Utility operating system

For a comprehensive AMI and time-of-use glossary, see http://www.ferc.gov/industries/electric/indus-act/demand-response/2006/survey/glossary.pdf

FREQUENTLY ASKED QUESTIONS

Q: What is the difference between AMR, AMI, and Smart Grid? Are they all the same?

A: First, there is a distinction between each of these technologies, and each is evolving. There is not a universally agreed upon definition for any of them. In many cases the technologies overlap. One way to draw a distinction between the technologies is the degree of sophistication of the communications and control systems.

For AMR, the communication system is still one-way, from the customer to the utility. The frequency of communication is intermittent and dependant on the utility to initiate it. Generally, there are no automatic control functions in an AMR system. However, an advanced meter is required, which does have communications capability. Generally, a MDMS is also required and data from the MDMS may be shared with groups, such as system planners within the utility. A HAN is not present and the UOS and the MDMS do not necessarily communicate with each other. Any DSM programs are generally separate from the AMR system, either driven by rate structures or an independent communications system.

For AMI the communication system becomes persistent and two-way. The customer and the utility can now interact with each other. The HAN allows the customer to begin to automate choices about energy use based on signals sent from the utility. Equipment and appliances within the customer's premise can receive signals directly from the utility and change their operating conditions based on predetermined settings made by the customer. The MDMS and the UOS are integrated that allow a higher degree of automation to be present on the utility grid. Algorithms within the UOS utilize data from the MDMS and from other advanced equipment on the utility's grid to determine conditions which allow operators to more effectively control the flow of power and react to abnormal conditions much quicker.

Smart Grid adds a higher degree of automation to the scenario. Intelligent equipment and computer software can make decisions about grid operations that remove human error. These systems can either make suggestions to operators or take control of the grid to reroute the flow of power to mitigate grid congestion or to rectify fault conditionsExactly where the line between these different technologies begin and end can be blurred, particularly between Smart Grid and AMI. However, as a utility moves up the technology curve to Smart Grid, it and its ratepayers will continue to enjoy the benefits of AMR and AMI.

Q: Does a utility have to install AMR, then AMI, then Smart Grid?

A: No, a utility and its regulating body must make a choice about which technology is best suited for the rate payers and the utility. Certainly a utility could begin with an AMR system; in fact many have decided that AMR is the most cost effective of these technologies. However, a utility, with regulatory approval, could start with a Smart Grid application, completely bypassing AMR and AMI.

Q: Why should the RE community worry about Smart Grid technologies? Once a Smart Grid project is installed RE assets such as PV will be able to take advantage of it benefits, right?

A: This seems like a logical conclusion, but there is a great danger to RE if these projects are allowed to be developed without input from the RE community. Each of the components of a Smart Grid system has different features which may affect the cost of the overall system. It is analogous to making a decision about the purchase of a personal computer. Should one choose a desktop or a laptop? Should one choose a separate CD player to ease the process of copying CD's and DVD's, is a separate video card required or is the video capability of the motherboard adequate? Which operating system and software are best to meet the purchaser's needs? How large should the hard drive and RAM be? Each of these choices will impact the performance of the computer system as well as the initial cost. Certainly one would be able to make changes at a later date, i.e. new software or an additional RD player can be added, but usually these modifications are more expensive than they would be had the decision had been made to include them with the original order.

Left to their own, utilities and regulatory bodies are likely to focus on solutions to traditional grid issues. For example, the ability to determine which way the power is flowing by a SSM is a feature that must be specified and may add cost to the meter. If decisions are made based on traditional grid issues, this feature may be omitted; either to reduce costs or because it was not considered necessary. Without this feature, the meter will be unable to credit DG assets for the power they generate; in fact, the customer would be charged for this generation as if it had come from the utility.

Any number of these scenarios can be envisioned that will affect the ability of RE assets to be interconnected, the design of rates and incentives, or the enactment of new policies and legislation favorable to PV and other RE technologies.

Q: Do “Smart Meters” have the capability to disconnect a customer from the grid? If so, would this feature do away with the need for a Utility External Disconnect Switch (UEDS) for PV generators?

A: Currently, some meters have the capability to disconnect a customer’s premise for systems up to 200A. This is typically a residential or small commercial customer. However, the communications features of AMI and Smart Grid could easily incorporate this ability for larger systems if the proper equipment is installed at the customers premise.

It should be noted that the need for a Utility External Disconnect Switch has been challenged by the RE community for many years. Michael Sheehan, from the Solar ABCs and Mike Coddington, from NREL, have recently written two excellent position papers on the subject. Many utilities are beginning to eliminate this requirement, and those that have the requirement do not have plans to utilize the UEDS in the event of an outage.

It is the position of the Solar ABCs that a UEDS is not required in any case. If a utility has this requirement and is seeking approval for an AMI or Smart Grid project, this feature should be mandated by regulators and the UEDS requirement should be eliminated.