Smart Meters and Smart Meter Systems: A Metering Industry Perspective

An EEI-AEIC-UTC White Paper

A Joint Project of the EEI and AEIC
Meter Committees

March 2011

Attribution Notice and Disclaimer

This work was prepared by Ellery E. Queen for the Edison Electric Institute (EEI). When used as a reference, attribution to EEI is requested. EEI, any member of EEI, and any person acting on its behalf (a) does not make any warranty, express or implied, with respect to the accuracy, completeness or usefulness of the information, advice or recommendations contained in this work, and (b) does not assume and expressly disclaims any liability with respect to the use of, or for damages resulting from the use of any information, advice or recommendations contained in this work.

The views and opinions expressed in this work do not necessarily reflect those of EEI or any member of EEI. This material and its production, reproduction and distribution by EEI does not imply endorsement of the material.

Published by:
Edison Electric Institute
701 Pennsylvania Avenue, N.W.
Washington, D.C. 20004-2696
Phone: 202-508-5000
Web site: www.eei.org

Table of Contents

Acknowledgements

This report was conducted with the oversight of the Edison Electric Institute (EEI) and Association of Edison Illuminating Companies (AEIC) Metering Committees and the Smart Meter Report Project Team. We would like to acknowledge the contributions of the core team consisting of:

EEI Sponsor	Gregory T. Obenchain	EEI
EEI Team Leader	Jim Thurber	Baltimore Gas & Electric
Editor and Project Manager	Ellery E. Queen	Qtech Professional Services
Vendor Leader	Harley Gilleland	The HarGil Group
AEIC Sponsor	Len Holland	AEIC
AEIC Team Leader	Anthony Hawkins	CPS Energy
Technical Contributor	Klaus Bender	UTC
Technical Contributor	Tim Morgan	Duke Energy
Technical Contributor	Larry Barto	Georgia Power Company

We would like to give special thanks to the leadership of the EEI and AEIC Meter and Service Committees for the support necessary to make this project a reality. We also thank the many EEI & AEIC members, vendors, and other meter professionals who provided input and feedback towards the completion of this report. The report could not have been completed without the input this group so generously provided.

1. Introduction

The following industry discussion of Smart Meters and Radio Frequency (RF) Issues was prepared by the member company representatives from the following organizations.

Edison Electric Institute (EEI)

The Edison Electric Institute (EEI) is the association of U.S. Shareholder-Owned Electric Companies. Our members serve 95 percent of the ultimate customers in the shareholder-owned segment of the industry, and represent approximately 70 percent of the U.S. electric power industry. Organized in 1933, EEI works closely with all of its members, representing their interests and advocating equitable policies in legislative and regulatory arenas.

The Association of Edison Illuminating Companies (AEIC)

AEIC was founded by Thomas Edison and his associates in 1885. AEIC encourages research and the exchange of technical information through a committee structure, staffed with experts from management of member companies.

AEIC's members are electric utilities, generating companies, transmitting companies, and distributing companies – including investor-owned, federal, state, cooperative and municipal systems – from within and outside the United States. Associate members include organizations responsible for technical research and for promoting, coordinating and ensuring the reliability and efficient operation of the bulk power supply system.

AEIC's Six Technical Committees are: Load Research, Meter and Service, Power Apparatus, Power Delivery, Power Generation and Cable Engineering. AEIC also provides highly valued literature on load research and underground cable specifications and guidelines.

Utilities Telecom Council

The Utilities Telecom Council (UTC) is a global, full-service trade association dedicated to creating a favorable business, regulatory, and technological environment for members. Founded in 1948, UTC has evolved into a dynamic organization that represents the broad communications interests of electric, gas, and water utilities; natural gas pipelines; other critical infrastructure entities and other industry stakeholders. Visit www.utc.org for more information on UTC and its services.

The purpose of this paper is to give an overview of the Smart Meter and Smart Meter Systems; how they are planned, certified, deployed, operated and maintained. It emphasizes these processes, as well as applicable standards, and due diligence used by utilities to assure the accuracy, integrity, security, strength and safety of this current technology. Also discussed is the role of the metering professionals in these projects and the Smart Meter's position in the national Smart Grid initiative.

While this paper highlights and discusses many of the more prominent approaches and processes used in deploying, operating, and maintaining Smart Meter systems, it does not attempt to describe or discuss all existing or potential processes or industry best practices. The activities and practices discussed throughout this paper are used to help define a broad range of factors that should be considered in planning and deploying Smart Meter Systems. Significantly, each Smart Meter project has a different set of demographics and assumptions, and should be designed to meet the needs of the specific utility and its customers.

Accordingly, this paper is presented as a resource for understanding and applying Smart Meter Technologies and Systems.

2. Executive Summary

Smart Meters and Smart Meter Systems are being deployed throughout North America, and utilities are continuing their efforts to improve grid reliability and promote energy efficiency while providing improved services to their customers. However, concerns have been raised regarding not only the accuracy, security and integrity of these meters, but also with respect to the potential impacts of radio frequency (RF) exposure on the public. Hence, this paper provides a basic overview for understanding how the electric utility industry seeks to ensure the appropriate level of accuracy, safety, and security. It also makes evident that before being accepted and deployed Smart Meters must meet a number of national standards and comply with state and local codes designed to ensure proper operation, functionality and safety.

Meter Accuracy

While there are technological differences between Smart Meters and older mechanical metering devices,[1] the electric industry exercises the same due diligence and precision for ensuring the accuracy of Smart Meters as it has to older mechanical metering devices for revenue billing application. The accuracy of Smart Meters, both in development and practice, has been confirmed to improve on the older electro-mechanical meter technology. All meters, regardless of technology and design, are required to meet national standards such as ANSI C12 for meter accuracy and operation before being installed.

Radio Frequency (RF) Exposure

Several Smart Meter Systems operate by transmitting information wirelessly. However, this has raised some concern about the health effects of wireless signals on electric consumers and the general public. However, studies show the RF exposures of Smart Meters are lower compared to other common sources in the home and operate significantly below Federal Communications Commission (FCC) exposure limits.[2] Additional discussions explain how the location, distance from the transmitter, shielding by meter enclosures, attenuation of building materials, direction of RF emissions, and transmit duty cycle significantly reduce exposure to consumers. It also includes a review of the conclusions of several Smart Meter RF studies and actual measurements of Smart Meter RF emissions to support this conclusion. Other observations included are:

- All smart meter radio devices must be certified to the FCC's rules.
- Tests simulating multi-family metering locations containing several meters in close proximity have shown RF exposure levels dramatically less than FCC limits.
- The FCC limits on maximum permissible exposure (MPE) for application to the general public were set using safety factors fifty times lower than the levels of known effects.
- Exposure levels drop significantly (1) with the distance from the transmitter, (2) with spatial averaging, and (3) in living spaces due to the attenuation effects of building materials.

[1] See Section 3, Overview of Smart Meters and Smart Meter Systems.

[2] See Section 6. Smart Meter System Issues

- Due to shielding of the meter enclosure and signal patterns, RF exposure from the rear of a metering location is nominally 10 times less than in front of the meter and dramatically below FCC limits, not including the spatial averaging and building material attenuation reductions.[3]
- For measurement and calculation purposes some studies use a 100% duty cycle parameters. However, the maximum operational Duty Cycle for Smart meter systems is less than 50% to prevent message traffic congestion and collisions. The typical Duty Cycles for Smart Meter Systems is between 1% and 5%.
- An RF exposure comparison of a person talking on a cell phone and a person 3 and 10 feet from a continuously operating Smart Meter would result in Smart Meter RF exposure 125 to 1250 times less than the cell phone.[4]
- In test environments simulating operational conditions, for power (250 mWatt - 2 Watt), duty cycle (2%-5%) at close distance (1 foot) from in front of the transmitter, Smart Meters produce very low RF exposure to the consumer, typically well under 10 % of the FCC exposure regulations.

In Addition, before utilities accept and deploy Smart Meters, these devices must meet a number of national standards and comply with state and local codes designed to ensure proper operation, functionality and safety. In particular, Smart Meter and Smart Meter installations are typically designed to conform with and certified to comply with: [5]

- *ANSI C12 .1, 12.10, and 12.20* standards for accuracy and performance
- *NEMA SG-AMI 1 "Requirements for Smart Meter Upgradeability"*
- FCC standards for intentional and unintentional radio emissions and safety related to RF exposure, *Parts 1 and 2 of the FCC's Rules and Regulations [47 C.F.R. 1.1307(b), 1.1310, 2.1091, 2.1093]*.
- Local technical codes and requirements
- Utility specific and customer beneficial business and technical requirements

The electric utility industry is continuously developing standards and guidelines to improve the safety, accuracy and operability of meters and associated metering devices. An example of these continuing improvement is *NEMA SG-AMI 1 "Requirements for Smart Meter Upgradeability"* released in September 2009 to support the needs of developing the Smart Grid.

Finally, manufactures conduct complete performance and life cycle testing for all meter types and for major design changes to existing meter types, including hardware and firmware. Once the testing is successfully completed, the Smart Meter System components are utility or third party certified for production and purchase. Furthermore, after certification and purchasing, the utility materials acceptance process to evaluate each shipment of equipment for quality and compliance to specification. Completion of this process by utilities allows for receipt of equipment for field installation.

---

[3] "An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter", EPRI (2010),December 2010

[4] "*Health Impacts of Radio Frequency (RF) from Smart Meters*"; California Council on Science and Technology (CCST); January 2011; page 20

[5] This list is not exhaustive, and there may be other sets of rules/standards/requirements not reflected but applicable.

Security

Clearly, security and integrity of customer meters has been and continues to be a major focus by utilities and vendors. In this regard, a number of efforts by government and industry have started to address potential security risks. For example, a comprehensive set of cyber security guidelines published by the National Institute of Standards and Technology (NIST), and explains that endpoint and system vendors have been asked to comply with new requirements to address remote access, authentication, encryption, and privacy of metered data and customer information.

The deployment of a Smart Meter System begins with selection of the technology and the planning for installation, operation and maintenance. Utilities have integrated within the deployment process many elements of management, control, and compliance to support successful project implementation. The In-Service testing process is an integral part of a utility's due diligence for measurement accuracy of its meters. Utilities are designing appropriate transition and new post deployment testing plans to meet both local regulatory requirements and their business needs for post deployment operations.

Utility Metering Services operations are responsible to ensure the accurate, precise, reliable and robust operations of the revenue billing meters and support devices. With the significant increase of new measurement technologies and integration of communication systems into basic meters, metering operations will be challenged both technically and operationally in the near and long term. The emphasis on metering operations in utilities will increase as more sophisticated billing and measurement systems are developed, designed and deployed.

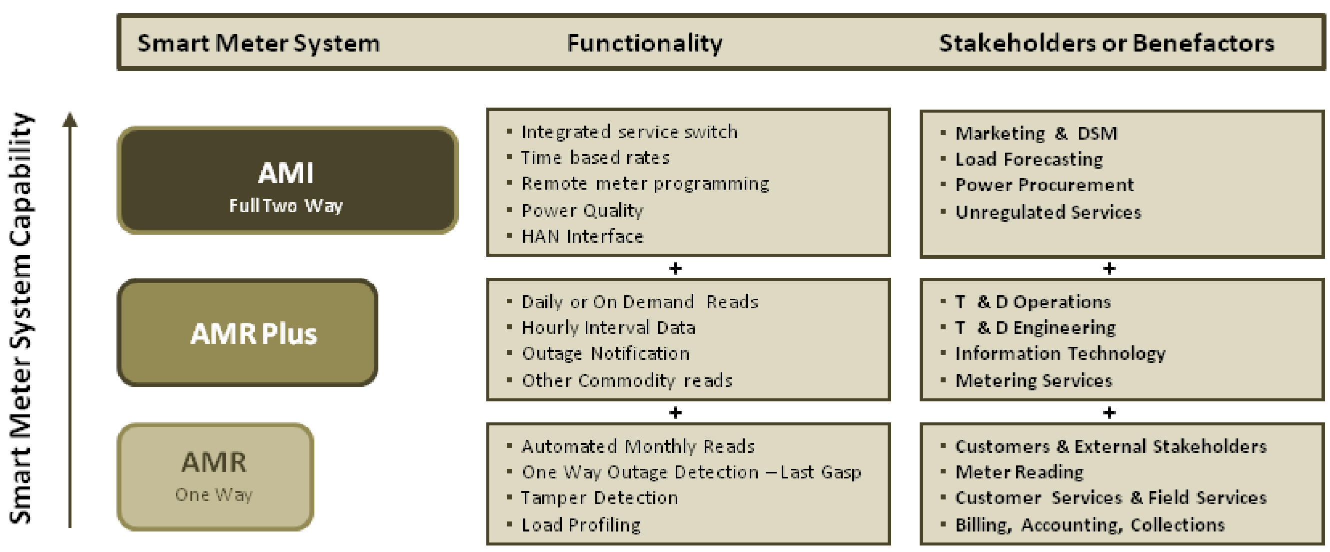
3. An Overview of Smart Meters and Smart Meter Systems

3.1 Definition of Smart Meter and Smart Meter Systems

Smart Meters are electronic measurement devices used by utilities to communicate information for billing customers and operating their electric systems. For over fifteen years electronic meters, have been used effectively by utilities in delivering accurate billing data for at least a portion of their customer base. Initially, the use of this technology was applied to commercial and industrial customers due to the need for more sophisticated rates and more granular billing data requirements. The use of electronic meters came into service to the largest customers of the utility and over time gradually expanded to all customer classes. This migration was made possible by decreasing cost of the technology and advanced billing requirements for all customer classes.

The combination of the electronic meters with two-way communications technology for information, monitor, and control is commonly referred to as Advanced Metering infrastructure (AMI). Previous systems, which utilized one-way communications to collect meter data were referred to as AMR (Automated Meter Reading) Systems. AMI has developed over time, from its roots as a metering reading substitute (AMR) to today's two-way communication and data system. The evolution from AMR to AMI is shown in figure 1 with lists of stakeholders and benefactors for each step in Smart Meter evolution.[6]

Figure 1 – Smart Meter Technology Evolution



[6] Note: All functionality and stakeholder interests are additive, progressing up the chart

Not until the Smart Grid initiatives were established were these meters and systems referred to as "Smart Meters and Smart Meter Systems". Hence, the present state of these technologies should be more appropriately referred to as "an evolution, not a revolution" because of the development and use of Smart Meter technology and communications over the last fifteen years. The combined technologies are also required to meet national standards for accuracy and operability essential in the industry.

Although the Smart Meters are relatively new to the utility industry, they are treated with the same due diligence and scrutiny associated with electronic meters and older electromechanical counterparts. These meters have always met or exceeded national standards such as American National Standards Institute (ANSI) C12.1 for meter accuracy and design. In addition, equipment used to certify meter performance must be traceable to the National Institute of Standards and Technologies (NIST), a federal agency that works with industry to properly apply technology and measurements.

Other standards in use for the Smart Meter installations include National Electric Code (NEC) for home electrical wiring, National Electrical Manufacturers Association (NEMA) and Underwriters Laboratories (UL) for enclosures and devices, and National Electric Safety Code (NESC) for utility wiring. Through the leadership of utility metering professionals and metering manufacturers, the meticulous and deliberate development of these solid state electronic measurement devices has resulted in meter products that have advanced functionality, are stable and have tighter accuracy tolerances, and are more cost effective for advanced features than the legacy electro mechanical technologies.

3.2 Smart Meter System Benefits

The benefits of Smart Metering installations are numerous for many different stakeholders of the systems. The table below mentions some of the major benefits for utility stakeholders.

Stakeholder	Benefits
Utility Customers	• Better access and data to manage energy use • More accurate and timely billing • Improved and increased rate options • Improved outage restoration • Power quality data
Customer Service & Field Operations	• Reduced cost of Metering reading • Reduced trips for off-cycle reads • Eliminates handheld meter reading equipment • Reduced call center transactions • Reduced collections and connects/disconnects
Revenue Cycle Services - **Billing, Accounting, Revenue Protection**	• Reduced back office rebilling • Early detection of meter tampering and theft • Reduced estimated billing and billing errors
Transmission and Distribution	• Improved transformer load management • Improved capacitor bank switching • Data for improved efficiency, reliability of service, losses, and loading • Improved data for efficient grid system design • Power quality data for the service areas
Marketing & Load Forecasting	• Reduced costs for collecting load research data

Stakeholder	Benefits
Utility General	• Reduced regulatory complaints • Improved customer premise safety & risk profile • Reduced employee safety incidents
External Stakeholders	• Improved environmental benefits • Support for the Smart Grid initiatives

3.3 The Role of Utility Metering Operations

Metering Services operations in utilities have traditionally been tasked with providing customer billing measurement and have been responsible for accuracy, precision, and robust operations of the meters and support devices. Using a national system of standards, formal quality processes, utility best practices, and a dedicated sense of purpose, utility metering professionals have strived to produce the best system for billing utility customers in the global electric industry. In joint partnership with meter and communications manufacturers, they have driven the development of electronic metering and metering communications to deliver the top notch Smart Metering Systems available in the marketplace today.

For successful Smart Meter projects, Metering Services operations are an integral part of the project planning, deployment and maintenance of the systems. Their contributions in these areas of the process are required and fundamental to the project success. The most important contributions include:

- Development of the Business and Technical requirements of the Systems
- Participant of the technology selection team
- Certification of the system meters and devices
- Acceptance of the incoming production products
- Development of safe and appropriate installation plans and processes
- Development of a maintenance model to support the new systems
- Development of training programs
- Design and implementation of an appropriate In-Service Testing & Compliance process

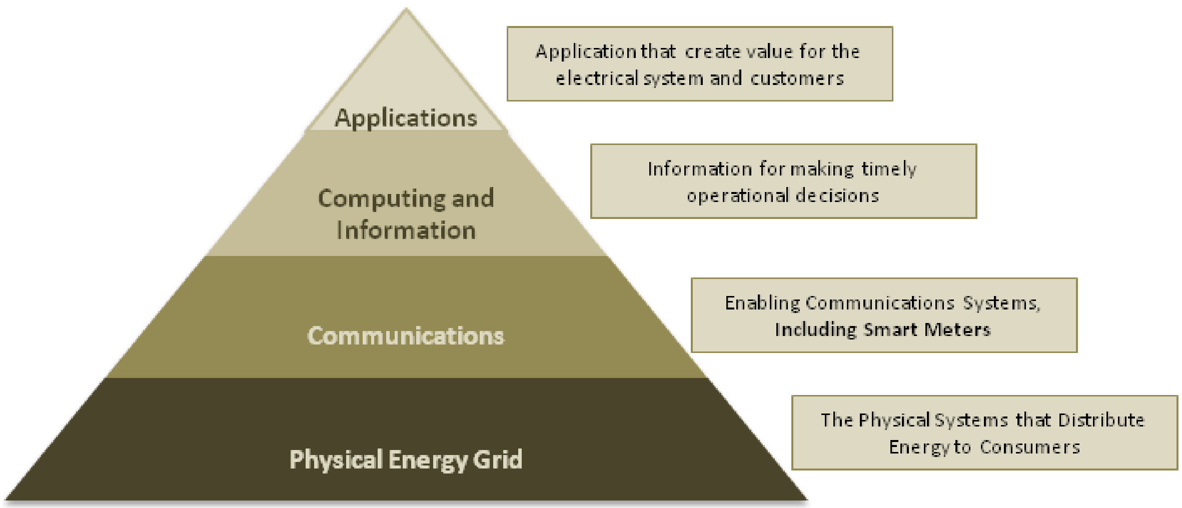
With the significant increase of new measurement technologies and integration of communication systems into basic meters, metering operations will be challenged both technically and operationally in the near and long term. The emphasis on metering operations in utilities will increase as more sophisticated billing and measurement systems are developed, designed and deployed.

3.4 The Smart Grid and Smart Meter Systems

Smart Meter Systems are an integral part of the Smart Grid infrastructure (See figure 2) in data collection and communications. The Smart Grid is essentially the modernization of the transmission and distribution aspects of the electrical grid. Functionally, it is an automated electric power system that monitors and controls grid activities, ensuring the efficient and reliable two-way flow of electricity and information between power plants and consumers—and all points in between. A Smart Grid monitors electricity delivery and tracks power consumption with smart meters that transmit energy usage information to utilities via communication networks. Smart meters also allow the customers to track their own energy use on the

Internet and/or with third-party computer programs. The two-way nature of Smart Meter Systems allows for sending commands to operate grid infrastructure devices, such as distribution switches and reclosers, to provide a more reliable energy delivery system. This is known as Distribution Automation (DA).

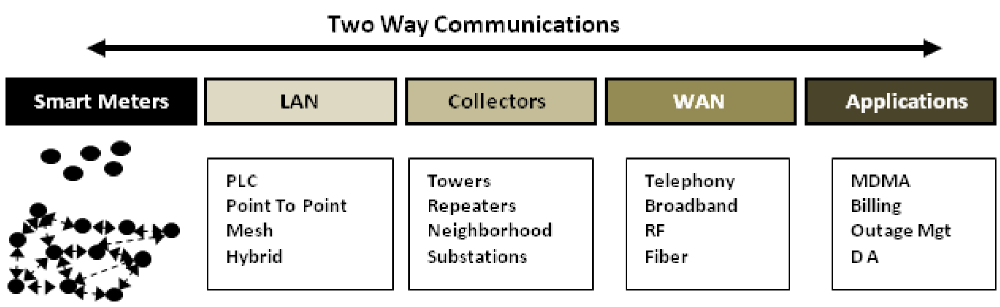
Figure 2: Smart Grid Infrastructure



3.5 Smart Meter Technologies

Smart Meter Systems are varied in technology and design but operate through a simple overall process. The Smart Meters collect data locally and transmit via a Local Area Network (LAN) to a data collector. This transmission can occur as often as 15 minutes or as infrequently as daily according to the use of the data. The collector retrieves the data and may or may not carry out any processing of the data. Data is transmitted via a Wide Area Network (WAN) to the utility central collection point for processing and use by business applications. Since the communications path is two -way, signals or commands can be sent directly to the meters, customer premise or distribution device. Figure 3.0 shows the basic architecture of Smart Meter System operations.

Figure 3: Smart Meter System Basic Architecture



Basic Types of Smart Meter Systems

There are two basic categories of Smart Meter System technologies as defined by their LAN. They are Radio Frequency (RF) and Power Line Carrier (PLC). Each of these technologies has its own advantages and disadvantages in application. The utility selects the best technology to meet its demographic and business needs. Factors that impact the selection of the technology include evaluation of existing infrastructure; impact on legacy equipment, functionality, technical requirements as well has the economic impact to the utility's customers. The selection of the technology requires a thorough evaluation and analysis of existing needs and future requirements into a single comprehensive business case.

Radio Frequency – RF

Smart Meter measurements and other data are transmitted by wireless radio from the meter to a collection point. The data is then delivered by various methods to the utility data systems for processing at a central location. The utility billing, outage management, and other systems use the data for operational purposes. RF technologies are usually two different types:

- **Mesh Technology**
  The smart meters talk to each other (hop) to form a LAN cloud to a collector. The collector transmits the data using various WAN methods to the utility central location.
  - Mesh RF Technologies' advantages include acceptable latency, large bandwidth, and typically operate at 915[7] MHz frequencies.
  - Mesh technologies disadvantages include terrain and distance challenges for rural areas, proprietary communications, and multiple collection points
- **Point to Point Technology**
  The smart meters talk directly to a collector, usually a tower. The tower collector transmits the data using various methods to the utility central location for processing.
  - Point to Point RF technologies advantages include little or no latency, direct communication with each endpoint, large bandwidth for better throughput, some are licensed spectrum, and can cover longer distances.
  - The disadvantages of point to point RF networks are licensing (not for 900MHz), terrain may prove challenging in rural areas (Line of Sight), proprietary communications used for some technologies, and less interface with DA devices.

[7] Generally refers to the FCC's "license free" band of 902-928 MHz

Power Line Carrier - PLC

Smart Meter measurements and other data can be transmitted across the utility power lines from the meter to a collection point, usually in the distribution substation feeding the meter. Some solutions have the collection point located on the secondary side of a distribution transformer. The data is then delivered to the utility data systems for processing at a central location. The utility billing, outage management, and other systems use the data for operational purposes.

- PLC technology advantages include leveraging the use of existing utility infrastructure of poles & wires, improved cost effectiveness for rural lines, more effective in challenging terrain, and the capability to work over long distances.
- PLC disadvantages include longer data transmit time (more latency), less bandwidth and throughput, limited interface with Distribution Automation (DA) devices , and higher cost in urban and suburban locations.

There are other Smart Meter Systems in use that differ from those described above. However, these are generally a hybrid or combination design, a slight variation of the basic types, or niche products. The major Smart Meter System Technologies in use today are of one of these basic types.

4. Deployment of Smart Meter Systems

The deployment of a Smart Meter System begins with selection of the technology and the planning for installing, operating and maintaining it. Utilities have integrated within the deployment process many elements of management, control and compliance to support successful project implementation.

4.1 Selection of Smart Meter Systems

There are several steps in the selection process for Smart Meter Projects. These steps are important to the success of the project and for acceptance by the stakeholders.

Development of Business, Financial and Technical Requirements

The objectives of developing these documents are very important and set the baseline for future decision making and to make sure that due diligence and compliance focus are included in the process. The objectives are:

- To establish among the utility, project team, and vendor a common understanding of the business requirements that must be satisfied by the Smart Meter System.
- To maintain a common set of expectations among all project stakeholders related to the business requirements that must be satisfied by the system and provide a benchmark for the RFP selection process.

Project RFP Bidding Process

After the requirements are developed and approved, the project undergoes a bidding process starting with issuing a Request for Proposal (RFP). The process begins with the formation of a bid team. The team drafts the RFP document, sets time tables, and develops evaluation criteria. The RFP is then sent to qualified Smart Meter system vendors. An initial screening for qualified vendors can be done with assumptions made in the requirements phase. If the RFP is not a turnkey project, a second similar RFP process is used to determine the deployment services vendor.

RFP Evaluation

After the RFP's responses are returned, the bids are evaluated using the criteria determined in the planning. The bids are measured against the business, financial and technical requirements of the utility and then scored. A vendor is selected, approved, and contracts are negotiated. The Smart Meter System Project then transitions to the deployment planning and installation stages.

4.2 Customer Care and Communications

Communications with utility customers concerning the utility's Smart Meter project begins before the deployment of meters begins. These communications should inform the customer about the new Smart Meter System, the benefits, and how it will affect their energy delivery and billing. It is also important to address concerns or issues that may have been raised earlier locally or in other jurisdictions. The communications can be in the form of news releases, mailings or bill stuffers. Customer satisfaction begins with customer communication and education.

Once deployment begins, customers are informed before their meter is changed about the procedures and effects to their specific premise. In addition, the customers are informed face to face at the time of the meter change or a door hanger is left for their information. If the change cannot be made and the customer must be present, a notification on how to make an appointment is left. Mailings, door hangers and call center numbers are intended to help make the process as smooth as possible for individual customers.

4.3 Meter and System Certification and Acceptance

A plan to certify the meters and other system components for purchase and installation is essential to the deployment of the Smart Meter System. The technical requirements developed by the utility will include the Smart Meter equipment specifications for meeting national standards for accuracy, compliance, and functionality criterion.

Smart Meter hardware to be certified must be production units and must conform to or exceed:[8]

- FCC standards for intentional and unintentional radio emissions, and safety related to RF exposure, *parts 1 and 2 of the FCC's Rules and Regulations [47 C.F.R. 1.1307(b), 1.1310, 2.1091, 2.1093*.
- *ANSI C12 .1, 12.10, and 12.20* specifications for meter accuracy and performance
- Local technical codes and requirements
- A functional test designed to verify the compliance to utilities technical and business requirements
- Utility specified requirements that are expected to exceed the standards. Examples:
    - Higher surge requirements for areas with lightning issues
    - Stainless steel enclosures for close seaside locations

The electricity utility industry is continuously developing standards and guidelines to improve the safety, accuracy and operability of meters and associated metering devices. An example of these continuing improvements is the *NEMA SG-AMI 1 "Requirements for Smart Meter Upgradeability"* under development by AEIC and in conjunction with NIST and Smart Grid Interoperability Panel (SGIP).

Complete performance testing is done by manufacturers and utilities for all meter types and for major design changes to existing meter types, including hardware and firmware. Once the testing is completed successfully, the Smart Meter System components are certified for production and purchase.

After certification and purchasing, the utility establishes a materials acceptance process to evaluate each shipment of equipment for quality and compliance with specification. The acceptance plan is usually a

[8] This list is not exhaustive, and there may be other sets of rules/standards/requirements not reflected but applicable.

combination of vendor manufacturing test data and a sample test plan designed by the utility to meet its risk criteria. In addition to testing items included in the certification phase, other items may be evaluated, such as binding or marrying of the communication module to the meter, accuracy of the face plate data and format, and quality of the meter data received, etc. Completion of this process allows receipt of equipment for field installation.

4.4 Logistics

One of the most important processes in the successful deployment of Smart Meter systems is the logistic and warehousing process. Materials make up 80% of the project capital and management of the processes is a critical success point. The major logistic processes are presented in the table below:

Basic Logistics Processes	Criticality
Smart Meter Ordering	Timely and accurate equipment availability
Smart Meter Shipping, Staging, and Receiving	Sets up the other logistics processes for proper execution
Smart Meter Acceptance Testing	Accept equipment for incoming quality compliance - IQC
Smart Meter Staging for Installation	Proper materials available at the right time for installation
Smart Meter Returns (RMA)	Assessing product issues quickly – disposal of old meters
Data Flows for Materials Tracking	Proper data to set up system head end & customer billing

The proper management and control of the logistics activities improve project cost containment, product availability and management of vendors. The overall process has several handoffs of equipment and data that could be a major source of error in delivery of product, installation of the Smart Meters and network, setting up the system and billing customers. In addition, there are multiple entities involved in the process; including procurement, field installation, metering, materials, customer operations and customer service. It is critical that these groups work together through detailed, planned interactions and that processes are executed smoothly.

The following best practices are representative of procedures that can help the utility use the logistic process to achieve a successful deployment of a Smart Meter Project.

- Single Point of Contact (SPOC) for all invoices from manufacturer and Deployment Services provider
- Tracking of all meter orders from Purchase Order creation to receiving to installation
- Use of tools for tracking every meter removed and installed to a customer premise
- Open lines of communication between the utility, manufacturer and deployment services provider for proactive sharing of information and issue resolution
- A data plan for controlling the quality and accuracy of the data through the logistics process

4.5 Smart Meter Installation

The planning for the installation of Smart Meters is just as important as the actual installation itself. This part of the process, if done correctly, can lead to smooth installation with a minimum of errors, customer issues or installation delays. The safety aspects of the installation conform to:

- The National Electric Safety Code (NESC) for utility wiring
- The National Electric Code (NEC) for home wiring
- ASNI C12.1 – Code for Electricity Metering
- Local building codes

The customer is notified of the installation; if they are present and the installation process begins. The first step in installation involves assessment of access to the meter location and safety of the existing equipment. After proper access has been established, actions include:

- Check meter location for safety issues, damage, and diversion
- Verify meter data for service voltage and meter form type
- Verify premise information for correct address, meter number, GPS Location, etc
- Safely replace old meter with Smart Meter and re-seal
- Update customer premise information for new installation

National demographics show a housing unit split of approximately 74% single family and 26% multi-family homes, with percentages varying from state to state. [9] Therefore, the vast majority of the Smart Meter installations will be to single family homes with single meter base designs. Typically the meter base is mounted to the surface of an exterior wall [10] where the service entrance attaches to the house. Gang meter socket designs are used to consolidate multiple meters to a few locations for the multi-family dwelling units. Generally, these gang sockets are located in designated meter rooms, on the outside wall of apartment buildings, or in the basement of high rise apartment buildings.

Although the single family installations are less complicated than multi-family, the installation processes for both are basically the same. In addition, both processes are designed to address physical access and safety concerns, to make sure the proper type of Smart Meter is installed safely and correctly, and the correct information is obtained and delivered for accurate setup of customer billing.

After the Smart Meter is installed, it is usually ready for operation and is automatically registered with the network system. If the customer is not present and the installation cannot be completed, a notification is left detailing the process to schedule the installation for a later date.

[9] "*Historical Census of Housing Tables, Units in Structure";* U.S. Census Bureau, Housing and Household Economic Statistics Division; December 16, 2005

[10] See section 6.2 for further discussion

4.6 Data Management

The Smart Meter installation and billing process must be seamless to the customer to maintain customer satisfaction. Even though there is a short interruption of service to the customer premise, this small outage should be acceptable if the customer is properly notified of the installation and their bill is timely and correct. This requires installing the meter at the proper time of the month and maintaining correct management of the data flow during the Smart Meter process and the legacy billing systems.

Planning for proper data interfaces of the Smart Meter System and the utility legacy systems is imperative. At the end of the day, the correct meter, at the correct premise, communicating properly to the utility billing system, with correct premise data will insure an accurate and timely bill generated for the customer. This is the fundamental goal of deployment of a Smart Meter System.

A software system not part of the utilities' traditional metering systems but required to operate a Smart Meter System is a Meter Data Management System (MDMS). MDMS is a major component of Smart Meter deployment and operations, and is the least understood and sometimes forgotten component of the project. This software platform receives meter data from one or multiple Smart Meter technologies, verifies and stores the data, and delivers data subsets to the utility operations applications such as billing, outage management, etc.

An MDMS is installed and operational prior to Smart Meter deployment and is designed to meet the utilities core business needs as well as Smart Meter support. Detailed technical and business requirements, including data storage needs are developed before MDMS application selection. In addition, the data architecture and the IT infrastructure requirements are included in the requirements planning, and cannot be underestimated.

The data system required for supporting Smart Meter deployments is determined by data requirements and number of customers. For small utilities, usually less than 100,000 customers, the Smart Meter head-end can handle the data management needs. For medium and large deployments of Smart Meters, however, the massive data and functional requirements demands a more sophisticated data management system. Interfacing to utility legacy systems is an important step in the successful operation of the system for the utility. The MDMS serves as the interface from the Smart Meter head end to the utility legacy applications to address interface issues and provide the necessary data requirements.

5. Post Deployment Operations and Maintenance

The installation of a Smart Meter System brings on a new set of challenges for the organizations that operate and maintain the utility's legacy processes. Almost all operational processes will change in some fashion once the Smart Meters are installed. This is especially true in the areas of daily interface with the customer by field services and in the maintenance processes for the system. Two important processes significantly affected by the Smart Meter deployment are operational compliance and meter maintenance.

5.1 Operational Compliance

In-Service Testing

The In-Service testing process is an integral part of a utility's due diligence for accuracy of its meters. The two different approaches of in-service testing are periodic and sample methods. The periodic method requires the testing of all meters on a periodic schedule. The sample method requires the yearly sampling of metering groups or strata, usually determined by product manufacturer and purchase date. The in-service sample method is based on sampling techniques specified by ANSI/ASQ Z1.4 or Z1.9. Sample testing is the preferred method for electronic meters because they tend to fail in groups or certain production runs. Sample testing presents a sample of each test group every year and provides indication of issues that may need to be addressed using statistical analysis.

In-service testing has changed over the years as electronic meters have been added to utility service areas. The introduction of a total electronic meter population will require an overhaul of the methodology and redesign of the in-service test plan. However, the revised plan should be appropriate for a total electronic meter population. For example, electronic meter failure modes are different from mechanical meters and should be considered in determining the sampling strata or test groups of the new residential sampling population.

When the Smart Meter System is under deployment, there will be a transition process to take care of new and old meter populations. Since all of the old meters will be removed in a short period of time, some utilities test only the new population of meters deployed using the redesigned test plan. Others may choose to suspend the in-service testing until the project has been completed. Utilities are designing appropriate transition and new steady state plans to meet local regulatory requirements and their business needs.

Periodic On Site Safety Audits and Read Verification

Prior to the Smart Meter System deployment a utility employee would visit the customer premise to read the meter monthly. Generally, utilities leverage this on-site visit to inspect the safety of the electric service, condition of the meter location, access problems, meter anomalies, hot sockets and the general physical condition of the customer site. If possible, issues would be resolved at the time of the visit. The visit was part of a company's due diligence process and became integrated into their asset and risk management procedures.

After deployment is completed, a periodically scheduled site visit to audit the site for safety, meter access and meter reading verification will generally be an element of the operational plan for the Smart Meter project. The plan should begin implementation before deployment is completed. The exact cycle of the site audits will depend upon regulatory requirements, system technology, resources, and business need. Even so, the visual site audit will continue to be an important part of the operational process after Smart Meter deployments ends.

5.2 Meter System Maintenance

Post installation of the meter and communications systems, meter maintenance will become a major change to utility operation. The meter population will be entirely electronic with an additional communications device on board. The challenges associated with supporting the new system will require a new look at existing resources skill sets and the number of available resources left after the project completion. Some of the utility organizations that will share in the new maintenance model are Metering Services, Customer Services, Field Operations, Distribution, IT, and Revenue Protection.

The new model will require the assessment of existing processes and resources, reallocation and organization, shifting of responsibilities, possible supplemental resources, and extensive training. Most utilities have experienced a similar change from the evolution of electronic meters deployed to service commercial and industrial customers in the last fifteen years. The challenge will be handling the magnitude of the changes in process.

6. Smart Meter System Issues

The implementation of Smart Meter Systems has generated some concerns, which the local jurisdictions and serving utilities have addressed or are addressing. Three major issues have been raised and addressed by utilities and the industry. In this regard, utilities have used verification, technical data, and numerous third party investigations to address the customer concerns appropriately.

6.1 Meter Accuracy

As Smart Meter Systems have been deployed nationally, concerns have been raised in different parts of the country concerning the accuracy of these new meters. Although the term Smart Meter is relatively new, the electronic metering technology has been used effectively by utilities for over fifteen years in delivering accurate billing data for at least a portion of their customer base. This new technology was developed with the same due diligence and scrutiny associated with the older mechanical counterparts. All meters, of any technology and design, are required to meet national standards such as ANSI C12 for meter accuracy and operation. Test Equipment used to certify meter performance are traceable to the National Institute of Standards and Technologies (NIST).

Metering professionals have been working with manufacturers over this period to develop the electronic technology referred to today as the Smart Meter. Electronic meters have tighter accuracy tolerances than their mechanical counterparts. Mechanical meters tend to slow down over time due to friction whereas electronic meters have no moving parts. From a technical point of view, Smart Meters were designed to be a more precise and functional measurement device over the life of the product. In addition, the meters are tested for accuracy as part of the manufacturing process and go through acceptance testing by the utility before they are qualified for installation.

Even though Smart Meters as a group are very accurate and precise devices, individual meters can and do sometimes fail. Therefore, utilities have controls in their billing and operational processes to screen for these anomalies and errors can then be corrected before the customer's bill is generated. A large subset of recent complaints came after installation and was perceived to be caused by the changing from an older mechanical meter to a new electronic Smart Meter. In actuality, most changes in meter usage are usually caused by differences produced by load additions, longer billing periods, estimation, new rate structures, or extraordinary weather occurring simultaneously with meter upgrades.[11]

Texas was one of the first areas that had accuracy concerns raised by customer groups. The utilities in this jurisdiction conducted additional tests at the request of the Public Utility Commission of Texas to satisfy customer complaints. This study was conducted by an independent third party not affiliated with any local utility or the regulatory agency. They addressed the meter accuracy and the results of the Smart Meter installation processes. The meter testing consisted of using new Smart Meters and returning Smart Meters installed in the field for testing in a third party testing facility. In addition, some smart meters were tested in

[11] "*Accuracy of Digital Electricity Meters*"; Electric Power Research Institute (EPRI); May 2010

parallel field tests with the old premise meter and the installation process was studied for accuracy. Both types of meter tests confirmed the accuracy of the new Smart Meter devices. The study concluded:[12]

- 99.96 % were within +/- 2% and 99.91% were within +/-0.5%.
- Smart Meters were more stable with tighter accuracy control, and consistently performed better than their mechanical counterparts.
- There was no statistically significant difference in electricity usage that can be attributed to the installation and use of advanced meters.
- The increase in customer complaints correlated with a difference in weather, not with the deployment of Smart Meters.

In summary, the same due diligence and precision have been used to develop Smart Meters as with previous mechanical devices. The accuracy of Smart Meters, both in development and practice, has been proven to improve on the accuracy of the old meter technology. The installation practices were developed to improve and enhance the process of customer billing. All meters, utilizing different technology and designs, are required to meet national standards such as ANSI C12 for meter accuracy and operation before being installed. The development of electronic Smart Meters spanned over fifteen years and produced more stable accuracy, more functionality, and less costly devices for delivery of customer bills.

6.2 Radio Frequency (RF) Exposure

Various Smart Meter Systems work by transmitting information wirelessly. The Federal Communications Commission (FCC) has jurisdiction over the approval and use of radio frequency devices, whether a license is required for the devices or if unlicensed operation is allowed. The FCC has a twofold role in ensuring safety:

- The FCC has allocated the radio spectrum into a variety of sections, most of which needs coordination and a license before operation is permitted. At the same time, the FCC has allocated some frequencies for unlicensed operation (e.g., allowing consumers to purchase products at retail outlets and install them in their homes). These devices operate at low power levels, enabling communications but posing no known health effects to humans. Examples include the WiFi routers already discussed, wireless baby monitors and garage door openers. Most Smart Meters fall under this low power, unlicensed criteria.
- The FCC's second role is to approve radio devices for manufacture, import and sale. Regardless of whether the equipment operates on low power unlicensed channels or at higher power levels that require authorization, each device must be tested to meet FCC standards. The sale of untested and unapproved equipment is a serious offense and the FCC aggressively prosecutes violators. FCC Rules governing the approval and sale of radio devices can be found in the Code of Federal Regulations (CFR) title 47, Part 15. These rules govern all aspects of radio emission, including both intentional and unintentional radiators.

Specific to RF safety issues, the FCC is required by the National Environmental Policy Act of 1969, among other things, to evaluate the effect of emissions from FCC-regulated transmitters on the quality of the human environment. Several organizations, such as the American National Standards Institute (ANSI), the Institute

[12] *"Evaluation of Advanced Meter System Deployment in Texas – Meter Accuracy Assessment"*; Navigant Consulting (PI) LLC; July 30, 2010

of Electrical and Electronics Engineers, Inc. (IEEE), and the National Council on Radiation Protection and Measurements (NCRP) have issued recommendations for human exposure to RF electromagnetic fields.

On August 1, 1996, the Commission adopted the NCRP's recommended Maximum Permissible Exposure (MPE) limits for field strength and power density for the transmitters operating at frequencies of 300 kHz to 100 GHz. The Commission's requirements are detailed in Parts 1 and 2 of the FCC's Rules and Regulations [47 C.F.R. 1.1307(b), 1.1310, 2.1091, 2.1093]. The FCC also presents OET Bulletin 65 to offer suggestions and guidelines for evaluating compliance. The revised OET Bulletin 65 has been prepared to provide assistance in determining whether proposed or existing transmitting facilities, operations or devices comply with limits for human exposure to RF fields adopted by the FCC.

All Smart Meter radio devices must be certified to the FCC’s Rules. Vendors develop products based on technical and regulatory specifications. Often, radio transmitters are integral parts of the meter itself; integrated into the circuit board of the device. The manufacturers test the devices to FCC specifications and then present the test results to an independent certification laboratory, or the FCC directly. Only when the FCC reviews the detailed report and certifies the device can the manufacturer market and sell the devices. The same procedures are used for Wi-Fi network equipment in PCs and wireless routers located nearly everywhere in our homes and offices.

There are two types of potential effects due to RF emissions, non-thermal and thermal. To date, there is no conclusive research that confirms negative non-thermal health impacts caused by non-ionizing RF emissions. There is, however, scientific consensus that for certain RF signal strengths there could be negative health effects. Therefore, most health studies have focused solely on the thermal effects of RF.[13,14] Several studies have been prepared to investigate the RF exposures of Smart Meters with relatively consistent conclusions:

- Smart Meter exposures even at close range and with exaggerated duty cycle are many times less than other household devices and are compliant with FCC limitations.
- As an example, an RF exposure comparison of a person talking on a cell phone and a person 3 and 10 feet from a continuously operating smart meter would result in Smart Meter RF exposure of 125 to 1250 times less exposure than the cell phone.[15]

Utility installation and operational practices and the impacts of all equipment used in the premise service location affect the exposure levels of RF greatly. Smart Meters are universally mounted in metal enclosures referred to as sockets or bases. These enclosures are generally mounted outside and facing away from the living space of a home. Single family dwellings typically have one socket located at the point of service. For multi-family housing such as apartments, condominiums, and townhouses, the sockets are a single unit with multiple meters. They are usually located in designated meter rooms, on the outside structure wall, or in the basement of high rise apartment buildings. Most of these typical mounting locations are either facing away from or are not adjacent to living areas. In addition, local fire codes and practical construction techniques limit the number of meters that are typically wall mounted, as described above for multi-family

[13] “*Health Impacts of Radio Frequency (RF) from Smart Meters*”; California Council on Science and Technology (CCST); January 2011

[14] “*Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”;* OET Bulletin 65; Edition 97-01; August; Federal Communications Commission, Office of Engineering & Technology

[15] “*Health Impacts of Radio Frequency (RF) from Smart Meters*”; California Council on Science and Technology (CCST); January 2011; page 20

dwellings and are not usually readily accessible. In larger multi-family buildings, i.e. mid-rise and high-rise units, the meters are typically located in meter rooms or in the basements and are ordinarily secured for limited access.

Even in a meter room or basement with large numbers of meters, it is impossible to obtain peak exposure from every meter. For example, if the meter room is 12 feet wide and the body is 2 foot wide, a person could only be within one foot of 17 % of the meters. Typical exposure to Smart Meter fields is usually at some considerable distance. But for those relatively rare instances that result in close proximity to the meters, measurements have shown exposure well below FCC standard limits. Exposure in living spaces will be even less due to the attenuation of RF signal caused by building materials in the walls and other structures. A typical building wall construction combined with a surface mounted meter base will represent a nominal minimum 10 inch (25 cm) distance between the transmitter and the interior wall surface and potential internal dwelling RF exposure to humans. Actual measurements directly behind the meter on the inside of the wall have produced MPE's of 0.01 % of the FCC limits. [16]

At all meter premise locations, the meter socket acts as a barrier for RF emissions entering the home. Manufacturers point out that the area behind the meter socket is virtually a dead spot for RF emissions. In addition, measurements have shown that at 8 inches behind gang meter sockets, the RF exposure is over 10 times less than the same distance in front of the sockets and less than 1% of the FCC exposure limits.[17] The metal meter socket reflects almost all of the RF out of the front of the meter. The only path for RF to get into a building is by first bouncing off the ground or an adjacent house and then back into the building. The distances required for this to happen dramatically reduce the power signal by the time it has traveled a minimum of 4-5 feet to the ground and into the living space.

The following are examples of measured RF exposure level with transmitter at continuous operation (an unrealistic condition) from a gang meter arrangement simulating an apartment metering location.

Example 1

Duty Cycle	% FCC Limit @ 1 ft μW/cm^2	% FCC Limit @ 2ft	% FCC Limit @ 3 ft	% FCC Limit @ 5 ft
100%	8.1 %	3.9%	2.5%	1.4%

A 10 meter rack with a 250 mWatt 915 MHz Smart Meter transmitter simulating an apartment wall meter installation demonstrating of exposure variance with distance[18]

[16] "An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter", EPRI (2010), December 2010

[17] An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter", EPRI (2010), December 2010

[18] "An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter", EPRI (2010),December 2010

Example 2

Duty Cycle	Front Exposure @ 1 ft % FCC MPE	Rear Exposure @ 8 in % FCC MPE	Rear Exposure @ 5 ft % FCC MPE
100%	8.1%	0.6%	0.25%

A 10 meter rack with a 250 mWatt 915 MHz Smart Meter transmitter front and rear measurement RF exposure comparison[19]

The FCC limits on maximum permissible exposure (MPE) for application to the general public were set using safety factors fifty times lower than the levels of known effects. The MPE's are those values of RF field strength, or power density that have been averaged over any 30-minute period (time averaging) and averaged over the dimensions of the body (spatial averaging). Discussed below are several basic factors that affect RF exposure:

RF frequency

Most Smart Meters use the same frequencies as other RF devices in the home, the 915 MHz band and 2.4 GHz band. The RF exposure limits, MPE, set by the FCC for Smart Meters are rated at the frequencies they use to communicate:

- 915 MHz 601 $\mu W/cm^2$ avg.
- 2.4 - 100 GHz[20] 1000 $\mu W/cm^2$

Transmitter Power

Smart Meters use low power transmitters, generally one watt or less for unlicensed frequency, 2 watts licensed, and produce relatively weak RF signals.

Distance

The power density decreases proportional to the square of the distance from the RF source at single meter locations. At multi-meter sites, the power density decreases significantly but at a lesser rate, proportional to the distance.

Duty Cycle (RF Exposure time)[21]

The percentage of time an RF device is in operation is called the duty cycle. The actual percent of time the Smart Meter is transmitting, especially in the initial years of operation, is very small, usually less than 1% (less than15 minutes accumulated total per day). There are several other factors that affect the duty cycle for Smart meter systems.

19 "An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter", EPRI (2010),December 2010

20 To date there are no known Smart Meter Systems that operate above 6 GHz.

21 "An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter", EPRI (2010),December 2010

The first factor of the duty cycle is how many meters communicate at the same time. As a practical design matter, when several Smart Meters are placed in a cluster, they generally have to communicate with a single controller. In order to ensure that the controller receives the information properly, transmitters are typically programmed to communicate with a controller in a random fashion, significantly decreasing the potential for exposure to multiple signals at the same time.

The second factor is the length of the communication. Smart Meter communications are typically less than a second and under normal operations, the programmed interval for randomized transmissions is 4 to 6 hours or longer. Over time, while it is possible that the duty cycle could rise due to additional use of the system for Smart Grid initiatives, the use of higher data transfer rates could, in fact, diminish the duty cycle.[22] All meters transmitting continuously will disrupt the system from functioning properly due to message traffic congestion and collisions. Therefore, the practical operational limit is less than 50%; well below 100% duty cycle sometimes used for comparisons. In spite of this, several RF exposure studies consider 2% -5% duty cycle operational scenarios, and a 100% duty cycle, continuous operation, scenario to establish an absolute maximum exposure value.

Spatial Averaging

MPE values are measured by averaging the exposure value over the dimensions of the body. Since different parts of a person's body are at varying distances from the transmitter, the RF exposure will vary at different parts of the body. At the typical 5 foot mounting height, a person's head may have maximum exposure but the person's knee will receive less exposure. The spatial average MPE is 18% to 24% of the peak value MPE on the body.[23]

In summary, the RF exposure effects of Smart Meters are very small compared to exposure from other sources in the home. Smart Meters operate significantly below FCC exposure limits. In addition, the location, distance from the transmitter, shielding by meter enclosures, attenuation of building materials and direction of RF emissions even further reduce exposure to consumers. A review of the results of several Smart Meter RF studies and actual measurements of Smart Meter RF emissions support these observations. Other summary observations include:

- All smart meter radio devices must be certified to the FCC's rules.
- Exposure levels drop significantly with the distance from the transmitter, with spatial averaging, and in living spaces due to the attenuation effects of building materials.
- The FCC limits on maximum permissible exposure (MPE) for application to the general public were set using safety factors fifty times lower than the levels of known effects.
- Tests simulating multi-family metering locations containing several meters in close proximity have shown RF exposure levels dramatically less than FCC standards.
- Due to shielding of the meter enclosure and signal patterns, RF exposure from the rear of a metering location is nominally 10 times less than in front of the meter and dramatically below FCC limits, not including the spatial averaging and building material attenuation reductions.[24]

---

[22] *"Wireless Transmissions: An Examination of OpenWay Smart Meter Transmissions in a 24 hour Duty Cycle"*; Itron Inc.; 2011; page 6, note #2.

[23] "An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter", EPRI (2010),December 2010

[24] "An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter", EPRI (2010),December 2010

- For measurement and calculation purposes some studies use a 100% duty cycle parameter. However, the maximum operational Duty Cycle for Smart meter systems is less than 50% to prevent message traffic congestion and collisions. The typical Duty Cycles for Smart Meter Systems is between 1% and 5%.
- An RF exposure comparison of a person talking on a cell phone and a person 3 and 10 feet from a continuously operating Smart Meter would result in Smart Meter RF exposure 125 to 1250 times less than the cell phone.[25]
- In test environments simulating operational conditions, for power (250 mWatt - 2 Watt), duty cycle (2%-5%) at close distance (1 foot) from the transmitter, Smart Meters cause very low RF exposure to the consumer, typically well under 10 % of the FCC exposure regulations.

6.3 Smart Meter Security

Since the inception of advanced meters with communications capabilities in the last 10-15 years, utilities and vendors have recognized the need for robust security provisions to protect the integrity of data and billing information. As meters evolved with optical ports, RS232/RS485 connections, as well as power line and wireless communications modules concerns have been raised about uncontrolled access to the revenue meters.

With the evolution to AMR and AMI system deployments, the stakes have been raised to protect data and data privacy. These security efforts have extended beyond endpoint security to the collector and head-end system level access control, data validation, and error checking as well as the encryption of data. The use of utility backhaul communications and increase usage of public wireless networks has increased the exposure to potential security intrusions. The proliferation of using the internet and provocative media reports about computer network hacking has raised concerns around the world about the integrity and security of the Smart Grid.

The 9/11 Commission report in 2002 outlined key business continuity expectations and also raised concerns about security of critical infrastructure. Furthermore, the passage by Congress of the Energy Independence and Security Act (EISA 2007) also raised the bar on cyber security of the energy delivery systems and the Smart Grid. Though not directly applicable, NERC CIP requirements for critical infrastructure cyber security at the bulk transmission level has influenced the perspective of cyber security for the entire electrical grid. While specifically intended to address the generation plants, control centers, and major transmission assets/systems, these security concepts have been used as a template to evaluate current Smart Meter systems as well.

With the advent of the EISA 2007 directives that named NIST as the national coordinator for Smart Grid standards, specific efforts has been made to address Smart Grid Cyber Security including Advanced Metering systems. Groups such as the Utility Communications Architecture International User’s Group (UCAIug) and their AMI-SEC task force have developed security guidelines, recommendations, and best practices for AMI system elements to lead the industry forward.

In 2009, Congress passed the American Recovery and Reinvestment Act (ARRA or Stimulus Package) which allocated over $3B in federal funding from the Department of Energy (DOE) for Smart Grid Investment Grants (SGIG), including AMI and Smart Grid systems. This placed additional federal scrutiny of the cyber security of systems being specified and deployed. Ultimately, the formation by NIST of the SGIP in 2009 led to the creation of the Smart Grid Interoperability Panel Cyber Security Working Group (CSWG).

---

[25] “*Health Impacts of Radio Frequency (RF) from Smart Meters*”; California Council on Science and Technology (CCST); January 2011; page 20

The culmination of the CSWG efforts was achieved in August 2010 with the release of a comprehensive set of cyber security guidelines as outlined in the publication of the NIST interagency report ***NISTIR 7628 - Guidelines for Smart Grid Cyber Security***. This document recognized the major role that Smart Meters play in the build out of the Smart Grid. The publication of this document has triggered important development and enhancements to Smart Meter systems across the industry. Endpoint and system vendors are being asked to comply with new requirements to address remote access, authentication, encryption, and privacy of metered data and customer information. Third party security certification of smart meter vendors is now being seen across the industry. This will continue to improve and enhance the security and reduce the vulnerability of systems being deployed, including smart meters with integral service switches and load control devices. These cyber security provisions could also extend into Home Area Networks (HAN) as they evolve as well.

Clearly, security and integrity of customer meters has been and continues to be a major concern by utilities and vendors. As the cyber security guidelines continue to evolve, the industry will continue to keep their eye on the ball with regard to data integrity and privacy of customer data.

7. References

- *"Evaluation of Advanced Meter System Deployment in Texas – Meter Accuracy Assessment"*; Navigant Consulting (PI) LLC; July 30, 2010
- *"Accuracy of Digital Electricity Meters"*; Electric Power Research Institute (EPRI); May 2010
- *"Health Impacts of Radio Frequency (RF) from Smart Meters"*; California Council on Science and Technology (CCST); January 2011
- *"Supplemental Report on An Analysis of Radiofrequency Fields Associated with Operation of the PG&E Smart Meter Program Upgrade System,"* ; Prepared for Pacific Gas 8 Electric Company, Richard Tell Associates, Inc.; October 27, 2008
- *"Radio Frequency Exposure Levels from Smart Meters"*; Electric Power Research Institute (EPRI); November 2010
- *"A perspective on radio-frequency exposure associated with residential automatic meter reading technology,"*; Electric Power Research Institute (EPRI); February 2010
- *"No Health Threat From Smart Meters"*; Klaus Bender; Utilities Telecom Council (UTC); 2010
- *"Review of Health Issues Related to Smart Meters"*; State of Maine CDC; November 8, 2010
- *"An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter"*; Electric Power Research Institute (EPRI) ; December 2010
- *"EPRI Comment: Sage Report on Radio-Frequency (RF) Exposures from Smart Meters"*;Electric Power Research Institute (EPRI); February 2011
- *"NIST Framework and Roadmap for Smart Grid Interoperability Standards – Release 1.0"*; NIST 1108; (January 2010)