

## **161 IntelliGrid<sup>SM</sup>**

### **Program Overview**

#### **Program Description**

The IntelliGrid<sup>SM</sup> program creates the enabling technology and methodologies for the smart power grid. The smart grid overlays the electricity network with communications and computer control. When this enabling infrastructure is matched with smart grid application in transmission, distribution, or within a customer portal, then the resulting smart grid can reach significant gains in reliability, capacity, demand response, and offer value added customer services.

A major early accomplishment of the EPRI research is the IntelliGrid architecture, an open-standards, requirements-based approach for integrating data networks and equipment that enable interoperability between devices and systems.

The IntelliGrid research provides members with the methodologies, tools, recommendations for standards, and unbiased assessments of technologies when implementing new systemwide technology solutions for advanced metering, distribution automation, demand response, and wide-area monitor and control.

#### **Industry Needs and Issues Addressed**

- Understanding what smart grids are, the value they provide, and what utilities are doing to implement them
- Migration towards interoperable systems and components that reduce capital and life-cycle costs
- Understanding communications and information system architecture requirements to support a smart grid
- Assistance in how best to deploy monitoring, communications, computing, and information technology to address unique business and regulatory drivers, addressing questions as to which products and technologies to use, when to implement solutions, how to integrate new and existing systems, and how to manage and secure systems
- Effective and consistent security and system management policies

#### **Impact**

- Provides members with the methodology, tools, and recommendations for standards and technologies when implementing systems such as advanced metering, distribution automation, demand response, and wide-area measurement
- Provides specific guidance on the communications and information systems that will support smart grid applications
- Provides members with independent, unbiased testing of technologies and vendor products
- Provides forum for leading utilities worldwide to exchange plans and experiences
- Provides and supports ongoing development of communications architecture that will enable interoperability between products and systems

#### **Key Accomplishments**

- IntelliGrid architecture providing methodology, tools, and recommendations for standards and technologies for utility use in planning, specifying, and procuring the communications and information systems to support smart grid applications such as advanced metering, distribution automation, and demand response.
- Successful application of IntelliGrid architecture by several members including Southern California Edison, Long Island Power Authority, Salt River Project, and TXU Electric Delivery

- Establishment of a living laboratory for assessing devices, systems and technologies

**Current Year Objectives**

- Security requirements and recommendations for advanced metering infrastructure (AMI)
- Guidebook for using the common information model (CIM) for distribution applications
- CIM Interoperability tests for transmission, distribution, and advanced metering
- Guidelines for deploying communications infrastructure for transmission operations, advanced distribution automation, demand response, and energy efficiency
- Regular reports on laboratory testing of technologies and products

**Industry Involvement**

- Estimated 2009 funding: \$4.5M

**Program Technical Lead**

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**Summary of Projects**

**PS161A IntelliGrid Technology Transfer and Industry Coordination (063528)**

**Project Set Description:** This project set provides the overall industry coordination and high-level tech transfer activities related to continued development of the utility infrastructure to support smart grids. It supports users of the IntelliGrid architecture methods and introduces potential users to the benefits of migrating towards an intelligent grid. Every activity is designed to enhance access to research results—so continuing and new funders of the IntelliGrid program alike will find value. The IntelliGrid program includes membership of utilities, vendors, public organizations, and other research organizations. One of the important objectives through this project set is to enhance coordination across all the different research organizations and industry organizations (for example, the Department of Energy [DOE], the Institute of Electrical and Electronics Engineers [IEEE] Intelligent Systems Coordinating Committee, and European smart grids efforts) working on the development and definition of future system architectures and integration needs.

Project Number	Project Title	Value
P161.001	IntelliGrid Technology Transfer and Industry Coordination	<ul style="list-style-type: none"><li>• Provides industry coordination for smart grids activities</li><li>• Tracks progress on industry standards related to smart grids</li><li>• Provides information on smart grid deployment activities</li><li>• Provides information on vendors and products related to smart grids</li><li>• Provides guidelines for developing smart grid roadmaps</li><li>• Refines the vision of a smart grid</li></ul>

## Project Descriptions

### P161.001 IntelliGrid Technology Transfer and Industry Coordination (065585)

#### Issue

Utilities increasingly deploy advanced technologies (monitoring, communications, computing, and information technologies) to enhance system operation and maintenance and to enable demand response and energy efficiency applications. The challenge utilities face is how to deploy these technologies efficiently and cost-effectively to meet today's needs as well as future needs. Some of their questions include which applications to deploy and when to do so; what are the requirements for these technologies; what technologies are available that meet these requirements; what are the costs and benefits of different alternatives; how new systems should be integrated with existing systems; how these systems should be managed and secured.

#### Description

This project supports users of the IntelliGrid results and introduces potential users to the benefits of adopting the results. Activities support the integration of new technologies, educate users about equipment procurement methods, keep members abreast of the latest technology developments and standards trends, coordinate ongoing activities within the marketplace, create forums to discuss real-world implementation of IntelliGrid results, and gather experts to consider the future possibilities of an intelligent grid. Every deliverable enhances access to research results, so both continuing and new participants of the IntelliGrid program find value.

#### Value

- Promotes the cost-effective integration of advanced automation applications and diverse vendor products in transmission, distribution, and end-user systems
- Promotes interoperability among vendor products, lowering capital costs for members
- Provides the most current information on technical, policy and implementation issues related to smart grids
- Provides coordination with a wide variety of research and industry initiatives related to development and definition of the smart grid

#### How to Apply Results

Utility executives responsible for "grid of the future" planning, information technology (IT) architects designing the infrastructure to support the future grid, and project engineers deploying systems can use the project results as information resources. These resources are intended to familiarize members with the latest in technology advancements, as well as highlight vendor activities on smart grid efforts. The AMI software product can be used by members to study the trade offs of AMI functionality vs. value. The software also can provide a list of requirements (based on the functions selected), which are mapped to vendor products. This list and the vendor products can assist members in selecting AMI technologies.

#### 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Repositories of smart grid, business cases, pilots and implementations:</b> Provides information on business cases that utilities have developed for smart grid applications, tracks utility activities to pilot or implement smart grid applications	12/31/2009	Technical Update
<b>Advanced Metering Infrastructure (AMI) function / technology / value trade off analysis tool Version 2.0:</b> Provides a tool for members to study the trade offs of AMI functionality vs. value. It also provides a list of requirements based on the functions selected and maps vendor products to the identified requirements.	12/31/2009	Software

Product Title & Description	Planned Completion Date	Product Type
<b>Guidebook for developing a Utility-Specific Smart grid Roadmap:</b> This guidebook draws on the results of several utility-specific smart grid roadmap development projects that EPRI has conducted with utilities through supplemental projects. It describes the methodology used to develop a road map and recommends best practices.	12/31/2009	Technical Report

## PS161B Infrastructure for Intelligent Transmission Systems (063437)

**Project Set Description:** This project set develops the communication and information systems foundations for an intelligent, self-healing transmission system. An intelligent, self-healing transmission system is one that anticipates problems and automatically reconfigures itself after an event. With these capabilities, utilities can improve reliability and optimize utilization of assets. Utility partners will realize capital cost savings from the ability to competitively procure and interoperate advanced intelligent equipment from different vendors. They also will cut life-cycle costs by gaining the ability to integrate disparate systems and maintain them for the long term.

Finally, the project set offers strategic and societal benefits by supporting greater power system reliability, functionality, and consumer value; enhanced system security; improved energy efficiency; lower costs for infrastructure upgrades and expansion; and greater economic productivity.

Project Number	Project Title	Value
P161.002	Development and Assessment of Communications Technology for Intelligent Transmission Systems	Develops a <i>Communication Networks Guidebook for Intelligent Transmission Systems</i> that provides an unbiased document for educating utility members. The report also will provide a detailed and systematic analysis of issues directly related to integration, interoperability, and performance.
P161.003	Common Information Model and Information Integration for Transmission Applications	Development of requirements, use cases, and object models for advanced transmission operations. Activities include the following: <ul style="list-style-type: none"> <li>• CIM Interoperability test</li> <li>• Tracking and contributions to key standards committees and industry organizations</li> <li>• CIM / IEC 61850 Harmonization</li> </ul>

## Project Descriptions

### P161.002 Development and Assessment of Communications Technology for Intelligent Transmission Systems (063425)

#### Issue

Federal and state regulators and legislators are increasingly driving utilities towards the concept of a smart grid. Several utilities have embraced this concept and are aggressively installing the infrastructure to make the concept a reality. For transmission systems, a smart grid will provide a wide-area view of system performance and health. It will anticipate events and take action to avoid them or minimize their impact. Robust and highly integrated communications and distributed computing infrastructures will be needed to create a smart grid. There are numerous communication technologies. It is often confusing to understand all of the advantages/disadvantages of each technology and how it can be best applied to

transmission smart grid applications. Identifying, analyzing, and selecting the right networks can be a daunting and complicated process especially in a multi-network environment to support different applications.

### Description

The *Communication Networks Guidebook for Intelligent Transmission Systems* will provide an unbiased, straightforward document for educating utility members on communication networks relevant for electric utility applications. Details for understanding functional and technical capabilities and comparisons of such networks will be included. The report also will provide a detailed and systematic analysis of issues directly related to the integration, interoperability, and performance aspect of the communication networks for transmission applications. The focus will be to better understand the behavior of individual networks especially when integrated or functioning in the close proximity of other communication networks. Emphasis will be to identify the integration and implementation methods and techniques to isolate the riding applications from the complexities of underlying individual networks to assure seamless and secure access with consistent and predictable performance.

### Value

- Utility members will be able to develop their own assessment of various communication networks in a timely manner by referencing to the Guidebook as a single consolidated resource.
- Utility members will be able to plan, design, develop, and implement a reliable and functional network with consistent performance and predictable results.

### How to Apply Results

Utility members will be able to apply the knowledge gained from the project products for designing and implementing communication networks for their transmission applications. Members will be able to make informed and technically sound decisions on how to design and implement a functional, secure, efficient, and predictable communication network.

### 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Communication Network Guide Book for Intelligent Transmission Systems:</b> <i>Communication Network Guide Book</i> will provide functional and technical information on major communication networks that are the industry's preferred choices for advanced transmission applications.	12/31/2009	Technical Report

## P161.003 Common Information Model and Information Integration for Transmission Applications (063286)

### Issue

Federal and state regulators and legislators are increasingly driving utilities towards the concept of a smart grid. Several utilities have embraced this concept and are aggressively installing the infrastructure to make the concept a reality. For transmission systems, a smart grid will provide a wide-area view of system performance and health. It will anticipate events and take action to avoid them or minimize their impact. Robust and highly integrated communications and distributed computing infrastructures will be needed to create a smart grid. These infrastructures need to be interoperable across vendor equipment and across the enterprise. Achieving the necessary level of interoperability requires the development and industry adoption of a tightly coupled suite of standards. The Common Information Model (CIM) provides a common language for integrating applications across the enterprise and is a foundation standard for smart grids. IEC 61850, Distributed Network Protocol (DNP), and the Internet Protocol (IP) also are key

standards. Significant work has been done on these standards, but a substantial amount of work is needed.

**Description**

This project develops requirements and use cases for advanced transmission operations. These requirements, in turn, serve as the basis for data and device models for emerging standards and as the basis for advanced applications that can be developed using equipment from different vendors. This project tracks and makes contributions to activities within key standards organizations such as IEC, IEEE and industry organizations such as DOE, National Institute of Standards and Technology (NIST), Federal Energy Regulatory Commission (FERC), National Association of Regulatory Utility Commissioners (NARUC), and National Electrical Manufacturer’s Association (NEMA) relating to transmission smart grid applications. CIM interoperability tests will be conducted with vendor products. Migration strategies from DNP to IEC 61850 will be developed. This project also will identify architectural issues and provide analysis and recommendations for transmission smart grid implementations.

**Value**

- Promote true interoperability and enable integration of applications across the enterprise via systems built to open standards
- Promote standards that enable competitive equipment procurement and result in 20-25% capital cost reductions for advanced automation equipment
- Enable improved life-cycle savings through equipment that is common and well known to systems administrators

**How to Apply Results**

Utility control center information technology project managers, automation project engineers, operators, and transmission planners will use the tools and knowledge produced in this project to apply the CIM standard within their organization. The results from this project will help the utility to plan for future requirements for upgrades to its energy management systems and when procuring next-generation transmission operations equipment such as relays and protection equipment.

**2009 Products**

Product Title & Description	Planned Completion Date	Product Type
<b>Conduct industry CIM/GID interoperability tests in conjunction with current IEC revisions:</b> EPRI will work with several vendors to test the interoperability of their products in conformance with the CIM / Generic Interface Definition (GID) standard.	12/31/2009	Technical Report
<b>Smart Grid standards and industry activities tracking and analysis:</b> Tracks and analyzes activities within standards bodies (such as IEC and IEEE) and other industry organizations (such as DOE, NIST, FERC, NARUC, and NEMA) that are relevant to smart grids	12/31/2009	Technical Update
<b>Harmonization of CIM and IEC 61850</b>	12/31/2009	Technical Report

### PS161C Infrastructure for Intelligent Distribution Systems (063438)

**Project Set Description:** By creating an intelligent grid that seamlessly integrates communications, monitoring, distributed computing, and solid state control and that automatically reconfigures itself after an event, members can improve customer power quality, reduce outages, and improve reliability indices. This project set focuses on the communications infrastructure and the information integration required for advanced distribution systems and coordination of this infrastructure with overall power system communications and information management requirements. The project tracks important industry developments that can be applied to distribution systems and will support specifications and demonstrations of communication technologies that can provide the basis for advanced distribution automation and applications. The project set also focuses on integration of communication infrastructures for two-way communications between utilities and their customers (for example, the advanced metering infrastructure, or AMI) with distribution management communications needs. This interactive exchange of information provides enhanced reliability and security, lower energy bills, and new, value-added services, ultimately realizing greater satisfaction among electricity consumers. The two-way communication with customers can become an integral part of distribution system management. The information integration efforts focus on ongoing development and enhancement of the Common Information Model (CIM) and other industry standards for integration of system information management and integration. There are a number of issues that need to be addressed to standardize distribution information models, and the program will focus on these industry gaps and help the industry move towards adopting these information models to make implementation of advanced applications more economical. The project set coordinates closely with projects on monitoring and control system technologies developed and demonstrated in the Advanced Distribution Automation (ADA) program (P124).

Project Number	Project Title	Value
P161.004	Development and Assessment of Communication Infrastructure for Intelligent Distribution Systems	<ul style="list-style-type: none"> <li>• Develop a <i>Communication Networks Guidebook for Intelligent Distribution Systems</i> that provides an unbiased document for educating utility members. The report also will provide a detailed and systematic analysis of issues directly related to integration, interoperability, and performance</li> <li>• Help understand the opportunities for use of a common infrastructure to support both distribution management and customer communications (for example, AMI)</li> <li>• Evaluate opportunities to apply IEC 61850 methods for distribution communications infrastructures and develop migration strategies from existing infrastructures like DNP</li> </ul>
P161.005	Common Information Model and Information Integration for Distribution Applications	<ul style="list-style-type: none"> <li>• Develops a guide for using CIM for distribution applications</li> <li>• CIM interoperability test</li> <li>• Tracking and contributions to key standards committees and industry organizations</li> </ul>

## Project Descriptions

### P161.004 Development and Assessment of Communication Infrastructure for Intelligent Distribution Systems (063428)

#### Issue

Federal and state regulators and legislators are increasingly driving utilities towards the concept of a smart grid. Several utilities have embraced this concept and are aggressively installing the infrastructure to make the concept a reality. For distribution systems, a smart grid will require greater amounts of automation to optimize operations and maintenance. Robust and highly integrated communications and distributed computing infrastructures will be needed to create a smart grid. There are numerous communication network technologies. It is often confusing to understand all of the advantages/disadvantages of each technology and how it can be best applied to distribution smart grid applications. Identifying, analyzing, and selecting the right networks can be a daunting and complicated process especially in a multi-network environment to support different applications.

#### Description

The *Communication Networks Guidebook for Intelligent Distribution Systems* will provide an unbiased, straightforward document for educating utility members on communication networks relevant for electric utility applications. Details for basic understanding of functional and technical capabilities and comparisons of such networks will be included. The report also will provide a detailed and systematic analysis of issues directly related to the integration, interoperability, and performance aspect of the communication networks for distribution applications. The focus will be to better understand the behavior of individual networks especially when integrated or functioning in the close proximity of other communication networks. Emphasis will be to identify the integration and implementation methods and techniques to isolate the riding applications from the complexities of underlying individual networks to assure seamless and secure access with consistent and predictable performance.

#### Value

- Utility members will be able to develop their own assessment of various communication networks in a timely manner by referencing to the Guidebook as a single consolidated resource.
- Utility members will be able to plan, design, develop, and implement a reliable and functional network with consistent performance and predictable results. They will be able to mitigate the risks associated with the integration and performance issues in a typical large network of heterogeneous technologies and systems.

#### How to Apply Results

Utility members will be able to apply the knowledge gained from the project products for designing and implementing communication networks for their distribution applications. Members will be able to make informed and technically sound decisions on how to design and implement a functional, secure, efficient, and predictable communication network.

#### 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Assessment of Communication Network Technologies for Intelligent Distribution Systems:</b> <i>Communication Network Guide Book</i> will provide functional and technical information on major communication networks that are industry's preferred choices for advanced distribution applications.	12/31/2009	Technical Report

## P161.005 Common Information Model and Information Integration for Distribution Applications (065546)

### Issue

Federal and state regulators and legislators are increasingly driving utilities towards the concept of a smart grid. Several utilities have embraced this concept and are aggressively installing the infrastructure to make the concept a reality. For distribution systems, a smart grid will utilize greater amounts of automation to optimize operations and maintenance. Robust and highly integrated communications and distributed computing infrastructures will be needed to create a smart grid. These infrastructures need to be interoperable across vendor equipment and across the enterprise. To achieve the necessary level of interoperability will require the development and industry adoption of a suite of standards. The Common Information Model (CIM) provides a common language for integrating applications across the enterprise and is a foundational standard for smart grids. IEC 61850, DNP, and the Internet Protocol (IP) are also key standards. Relatively little has been done within these standards relating to distribution smart grid applications.

### Description

This project develops requirements and use cases for advanced distribution automation. These requirements, in turn, serve as the basis for data and device models for emerging standards and as the basis for advanced applications that can be developed using equipment from different vendors. This project tracks and makes contributions to activities within key standards organizations such as IEC, IEEE, and industry organizations such as DOE, NIST, FERC, NARUC, and NEMA, relating to advanced distribution automation. Guidelines for using the CIM for distribution applications will be developed. CIM interoperability tests will be conducted with vendor products. This project also will identify architectural issues and provide analysis and recommendations for distribution smart grid implementations.

### Value

- Promote true interoperability and enable integration of applications across the enterprise via systems built to open standards
- Promote standards that enable competitive equipment procurement and result in 20-25% capital cost reductions for advanced automation equipment
- Enable improved life-cycle savings through equipment that is common and well known to systems administrators

### How to Apply Results

Information technology project managers, automation project engineers, distribution system operators, and planners will use the tools and knowledge produced in this project to apply the CIM standard within their organization. The results from this project will help the utility member to plan for future requirements for upgrades to its enterprise systems and when procuring next-generation distribution equipment.

### 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Guide for using the Common Information Model in Distribution Applications – First full version:</b> Provides members with a guide for using the Common Information Model (CIM) for distribution applications	12/31/2009	Technical Report
<b>Strategy for migrating from DNP to IEC 61850:</b> Provides strategies for members that wish to migrate from the DNP protocol to IEC 61850	12/31/2009	Technical Update
<b>Conduct industry CIM/GID interoperability tests in conjunction with current IEC revisions:</b> EPRI will work with several vendors to test the interoperability of their distribution products in conformance with the CIM / GID standard.	12/31/2009	Technical Report

Product Title & Description	Planned Completion Date	Product Type
<b>Smart Grid standards and industry activities tracking and analysis:</b> Tracks and analyzes activities within standards bodies (such as IEC and IEEE) and other industry organizations (such as DOE, NIST, FERC, NARUC, and NEMA) that are relevant to smart grids	12/31/2009	Technical Update

### PS161D Infrastructure and Technology for Advanced Metering, Integrating Demand Response and Energy Efficiency (063439)

**Project Set Description:** This project set focuses on development and demonstration of low-cost, standards-based, two-way communications between energy service providers and their customers and demonstration of technologies that integrate with this communications infrastructure through the EPRI living laboratory. The project also addresses the information integration approaches for making customer information such as AMI part of the overall information system available for advanced applications. The resulting interactive exchange of information provides enhanced reliability and security, lower energy bills, and new, value-added services—ultimately fostering greater satisfaction among electricity consumers. The living laboratory provides an independent, unbiased assessment of technologies and products. Finally, the project set offers strategic and societal benefits by supporting greater power system reliability, functionality, and consumer value; enhanced system security; improved energy efficiency; accelerated rate of reduction of carbon emissions; lower costs for infrastructure upgrades and expansion; and greater economic productivity.

Project Number	Project Title	Value
P161.006	Development and Assessment of Communication Infrastructure for Advanced Metering, Integrating Demand Response, and Distributed Resources	<ul style="list-style-type: none"> <li>Develop a <i>Communication Networks Guidebook for AMI / Demand Response System</i> that will provide an unbiased document for educating utility members</li> </ul>
P161.007	Common Information Model and Information Integration for Meter Data Management, Demand Response, and Distributed Resource Integration	<ul style="list-style-type: none"> <li>Develop standard data objects for dynamic pricing and direct load control</li> <li>Conduct an interoperability test of AMI systems using the CIM data objects</li> </ul>
P161.008	Business Case Framework for Advanced Metering	<ul style="list-style-type: none"> <li>Assess the societal benefits of advanced metering infrastructure systems</li> </ul>
P161.009	Gateway and Home Area Network Interface for Integrating Demand Response Systems	<ul style="list-style-type: none"> <li>Develop an industry standard reference design for consumer gateways</li> </ul>
P161.010	Living Laboratory Assessments of Technologies for Advanced Metering, End Use Communications, Smart Devices, and Controls	<ul style="list-style-type: none"> <li>Laboratory assessments of advanced metering systems and home area communications networks</li> </ul>

## Project Descriptions

### **P161.006 Development and Assessment of Communication Infrastructure for Advanced Metering, Integrating Demand Response, and Distributed Resources (063432)**

#### **Issue**

Utilities are installing advanced metering infrastructure (AMI) to enable demand response and energy efficiency programs. Many utilities are using AMI as the foundation for their smart grid strategy. Utilities would like to procure AMI systems that are interoperable and easily integrated into their enterprise systems. To reach this level of interoperability, the industry needs to develop a suite of standards. Some of the standards are currently being developed, but several others are missing.

#### **Description**

The project will develop a *Communication Networks Guidebook for AMI / Demand Response System* that will provide an unbiased, straightforward document for educating utility members on communication networks relevant for electric utility applications. Details for basic understanding of functional and technical capabilities and comparisons of such networks will be included. The report also will provide a detailed and systematic analysis of issues directly related to the integration, interoperability, and performance aspect of the communication networks for AMI / demand response.

#### **Value**

- Utility members will be able to develop their own assessment of various communication networks in a timely manner by referencing to the Guidebook as a single consolidated resource.
- Utility members will be able to plan, design, develop, and implement a reliable and functional network with consistent performance and predictable results. They will be able to mitigate the risks associated with the integration and performance issues in a typical large network of heterogeneous technologies and systems.

#### **How to Apply Results**

The operational side of distribution companies will use the *Communication Networks Guidebook for AMI / Demand Response* to help them implement the research results.

Information technology (IT), information security staff (within a distribution company), and the chief information officer's organization (CIO of the distribution company) also can use the results of this project. The IT knowledgeable staff will use results to calibrate their own implementations of AMI / demand response technologies within their own service territories. The CIOs will use the results to design data integration architecture.

The IT experts within the electric utility trade organizations and state and federal agencies focused on grid security also are good audiences for the research results. These organizations will find the research is very valuable in helping to understand the current status of AMI / DR technology and determining the technology gaps for future innovation.

Standards organizations (for example, IEC, International Organization for Standardization [ISO], American National Standards Institute [ANSI], and National Institute of Standards and Technology [NIST]) can use these results as background information for interoperability standards they are working on.

## 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Assessment of Communication Network Technologies for AMI / demand response systems:</b> <i>Communication Network Guide Book</i> will provide functional and technical information on major communication networks that are industry's preferred choices for AMI and demand response.	12/31/2009	Technical Report

### **P161.007 Common Information Model and Information Integration for Meter Data Management, Demand Response, and Distributed Resource Integration (067466)**

#### **Issue**

Utilities are installing advanced metering infrastructure (AMI) to enable demand response and energy efficiency programs. Many utilities are using AMI as the foundation for their smart grid strategy. Utilities would like to procure AMI systems that are interoperable and easily integrated into their enterprise systems. The development and adoption of common language provides some measure of interoperability. Standardized data objects using the Common Information Model (CIM) are in the process of being developed by IEC. There is an industry need for standardized data objects for dynamic pricing and direct load control.

#### **Description**

This project will engage a broad set of stakeholders to develop standard data objects for dynamic pricing and direct load control. The appropriate standards bodies will be engaged and contributions will be made. The project will conduct interoperability testing of AMI systems that use the CIM data objects. The project will track and makes contributions to activities within key standards organizations such as IEC, IEEE, and ANSI and industry organizations such as DOE, NIST, FERC, NARUC, and NEMA, relating to AMI, demand response, and energy efficiency.

#### **Value**

- Provides common data objects for dynamic pricing and direct load control
- Reduces cost of end-use demand response / direct load control equipment by providing equipment manufacturers a standard data object to develop equipment.

#### **How to Apply Results**

The data objects will be contributed to appropriate standards bodies and will be available to the utility industry.

## 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Dynamic pricing and direct load control data objects – stakeholder engagement and use case development:</b> The product will describe the stakeholder engagement process and the development of use cases needed to develop the standard data objects for dynamic price and direct load control.	12/31/2009	Technical Update
<b>CIM Interoperability test – advanced metering extensions:</b> The product will describe the interoperability testing of AMI systems that have implemented the CIM advanced metering data objects.	12/31/2009	Technical Report

## **P161.008 Business Case Framework for Advanced Metering (067467)**

### **Issue**

Utilities evaluating SmartGrid and AMI investments are finding that the operational savings generated are not sufficient to cover the cost of systems that contain the full functionality the technology allows, despite the prodigious efficiency gains that result. However, because these technologies enable the implementation of price and demand repose that tie consumers' energy usage decisions more closely to supply costs, in both a spatial and temporal way, an additional stream of benefits may be applicable to the business case. Additionally, there are other potential sources of benefits, such as improved service quality, reduction of externalities such as emissions, and even beneficial local and regional macroeconomic impacts. However, there is no generally accepted framework for translating changes in consumption into benefits at the level of detail needed by utilities and regulators to assess the validity of such benefits. This project will resolve that shortcoming.

### **Description**

The EPRI team will compile and review AMI societal benefit approaches from a variety of sources to establish possible sources of benefits and sort them into mutually exclusive and exhaustive categories. As a starting point, EPRI has identified several categories of benefits that are often not included, or fully explored, in the first-pass benefit/cost analyses because of their nature, enhanced reliability, improved productivity, macroeconomic impacts and new products and services. EPRI will catalogue the methodologies described above through the following efforts:

- Summarize the approaches used in and the results of AMI filings by U.S. utilities and others to establish the universe of benefits attributable to AMI investments that result from improved service reliability.
- Devise a categorization scheme for sorting benefits according to how they are manifest, measured, and quantified.
- The EPRI team will prepare a comparative assessment of the methodologies identified in each category, establish the strengths and weaknesses of each, and map the methods to particular utility circumstances. EPRI will then specify a plan for demonstrating the efficiency of some or all of the recommended methodologies using data that is representative of a variety of IOUs.

### **Value**

- A methodology that provides credible and reliable estimates of AMI investments benefits
- Can be used in conjunction with other EPRI tools for establishing sources of operational savings and the database of vendors of AMI technology
- Summary of filings and analyses to date according to the methods employed and the results produced will buttress individual filing applications
- Transparency with regard to key modeling and data assumptions that explain variances in estimates of AMI benefits will facilitate open and insightful evaluations and establish meaningful performance expectations

### **How to Apply Results**

Utility staff involved in assessing the value of current or potential AMI infrastructure or developing a business case for AMI investment for regulatory approval can directly apply the results of this study to account for AMI costs and benefits in a comprehensive manner using a robust framework honed through utility experience and expert judgment. The project products can be applied to develop a more accurate business case for AMI investment that can pass the analytical litmus tests of rigor and transparency for regulatory consideration.

## 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Framework for Quantifying the Benefits of SmartGrid and AMI Investments:</b> A guidebook that categorizes the types of benefits attributable to SmartGrid and AMI investments, describes methods available for quantifying the associated benefits, and compares and contrasts them over salient measures of usefulness, practicality, and effort and data requirements to employ in terms of applications	12/31/2009	Technical Report

### P161.009 Gateway and Home Area Network Interface for Integrating Demand Response Systems (067468)

#### Issue

Utilities are installing advanced metering infrastructure (AMI) to enable demand response and energy efficiency programs. Many utilities are using AMI as the foundation for their smart grid strategy. Utilities would like to procure AMI systems that are interoperable and easily integrated into their enterprise systems. To reach this goal, the industry needs to develop suite of standards. Some of the standards are currently being developed, but several others are missing. One of the most critical missing pieces is a standard reference design for a consumer gateway.

#### Description

This project will engage a broad set of stakeholders to develop a reference design for a consumer gateway. Stakeholders will include utilities, ISO/RTO, market operators, regulators, vendors and standards bodies. Requirements will be determined and a design will be developed.

#### Value

- Utility members will benefit from having more gateway vendors who will support the open-source coding and standard protocols for gateways development supporting load-curtailement or AMI programs.
- Integration of systems such as demand response, building automation, energy management systems, and home area network gateways will be easier, consistent and cost-effective.
- More vendors and software developers will enter this market with innovation and increased choices in the gateway and related software benefiting the utilities and customers.

#### How to Apply Results

The joint collaboration between gateway vendors, standards bodies, and utility members to promote the open-source code development effort could help save system development cost while mitigating the risk of building proprietary and standalone monolithic systems. Members can leverage their buying power in the AMI and energy efficiency industry, which badly needs the insertion of open and non-proprietary solutions.

## 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Consumer gateway – stakeholder engagement and requirements development:</b> This product will document the stakeholder engagement and requirements development process of the consumer gateway reference design development.	12/31/2009	Technical Update

**P161.010 Living Laboratory Assessments of Technologies for Advanced Metering, End Use Communications, Smart Devices, and Controls (067469)**

**Issue**

Planning for AMI deployments and pilots requires significant education. Advanced metering involves many components besides the meter—for example, a data concentrator, communication backbone, and meter data management systems—all that play essential roles in an advanced metering infrastructure. Each AMI equipment provider (for example, Itron, Echelon, Elster, GE) offers different components and technologies in their systems. While the vendors can provide detailed information on their own product, they are not able to provide the broader view and issues of different AMI products especially in an unbiased and independent manner. This creates the burden for utilities to discover, learn, and decide the right products and technologies for their specific business needs. There is an urgent need to provide an unbiased, independent, and vendor-neutral knowledge transfer capability where utilities can learn about AMI industry, products, technologies, and the implementation process and methodology with a focus on field pilots and full system deployment

**Description**

EPRI’s Living Laboratory in Knoxville, Tennessee, will test commercial AMI systems as well as home-area communications network and neighborhood-area communications network technologies. Test procedures will be developed in cooperation with members and vendors. Technology profiles will be developed on the products tested. Members will be able to tour the laboratory.

**Value**

Provides unbiased test evaluations of AMI systems and communications technologies

**How to Apply Results**

Members will be able to make informed and technically sound decisions on how to design and implement a functional, secure, efficient, and predictable communication network with the confidence that the risks stemming from the integration, performance, and interoperability issues in a heterogeneous network will be mitigated or eliminated.

**2009 Products**

Product Title & Description	Planned Completion Date	Product Type
<b>Technology profiles on the products and technologies tested:</b> AMI systems and communications technologies will be tested in EPRI’s Living Laboratory in Knoxville, Tennessee. Results will be published as technology briefs.	12/31/2009	Technical Update
<b>Advanced metering test procedure:</b> Working in collaboration with members and AMI vendors, this project will develop a test procedure for AMI systems.	12/31/2009	Technical Update

## PS161E Security Issues for the Power System Communication, Information, and Control Infrastructure (065456)

**Project Set Description:** This project set consists of two major components:

**Information sharing:** Information exchange through member workshops, a member-only email listserve, and the production of practical documents. Examples of reports include guidelines for developing policies and procedures, assessing vulnerabilities, detecting and mitigating cyber attacks on the electric power industry, responding to NERC security threat alert levels, and securing supervisory control and data acquisition (SCADA) and distribution automation systems. Program workshops offer a forum for discussing security practices, concerns, and other topics of mutual interest with peers. Workshops typically bring together a mix of program members, representatives from regulatory agencies (such as FERC and state utility commissions), government agencies (such as FBI, DOD, DOE, and NIST), industry groups (such as EEI and NERC), and vendors.

**Research initiatives:** The program research initiatives focus on all levels of the utility communications and information infrastructure. In particular, the program will research security issues and develop guidelines related to the following levels of the infrastructure:

- Security Issues for EMS/SCADA and the Intelligent Transmission Infrastructure
- Security Issues for the Intelligent Distribution Infrastructure
- Security Issues for Advanced Metering, Demand Response, and Integration of Distributed Resources

Project Number	Project Title	Value
P161.011	Security Issues for EMS/SCADA and the Intelligent Transmission Infrastructure	<ul style="list-style-type: none"> <li>• Maintain awareness of emerging security technologies and cost-effective applications of those technologies to secure communications within EMS networks</li> <li>• Maintain knowledge of common industry security practices</li> <li>• Maintain awareness of national research efforts including opportunities to provide input on their applicability and contribute to directing future research in beneficial directions</li> <li>• Characterize and develop tools and methods for implementing and assessing EMS/SCADA security performance</li> </ul>
P161.012	Security Issues for the Intelligent Distribution Infrastructure	This project will develop techniques and procedures, tailored to the contributor's needs, to effectively secure DNP3.0 at substations and DNP3.0 communications from substations to control centers, as well as evaluate benefits and issues associated with migration to 61850 communications.
P161.013	Security Issues for Advanced Metering, Demand Response, and Integration of Distributed Resources	This project will focus on the security features of leading AMI technologies and how they will fit into the overall security architecture of an electric utility's smart grid.

## Project Descriptions

### **P161.011 Security Issues for EMS/SCADA and the Intelligent Transmission Infrastructure (065590)**

#### **Issue**

Economic requirements have driven the energy industry to a high level of dependence on automation and communications. Critical operational data and information are transmitted through corporate local and wide area networks (LANs and WANs), in many instances with direct connections to the Internet. While security work has primarily been focused on Internet and e-commerce applications, less attention has been paid to the operational systems used by the electric power industry. In addition, since electric power infrastructures are increasingly being stretched to their operational limits, they are becoming more fragile and vulnerable to attack. Increased linking, operation of the transmission system at close to operational limits, and new national security requirements all point to a need for increased focus on the security of the bulk electric power system.

#### **Description**

This project focuses on information sharing to facilitate the industry's technical and operational response to infrastructure threats. Member-directed, collaborative sharing of technical information, via three workshops annually, occasional webcasts, and other communications as required has been a key component of this information security program since its inception. The information sharing and lesson learned activity has been the highest ranked project by security program contributors in each year of the program.

Facilitated workshops provide an opportunity for members to discuss security practices, concerns, solutions, and other topics of mutual interest with EPRI, other industry experts, and peers. Representatives from regulatory and research agencies (such as the Department of Homeland Security [DHS], Department of Energy [DOE], National Laboratories, North American Electric Reliability Corporation [NERC], and Federal Energy Regulatory Commission [FERC]), vendors, and other subject matter experts are regularly invited to participate in these workshops, which provide first-hand interaction with security professionals directly related to the electric power industry sector.

Information sharing also consists of timely information e-mailed directly to members and provided through periodic web casts on pertinent issues. Topical application documents (such as policies and procedures, guidelines, primers, frameworks, and methodologies) also are delivered to contributors of this project.

This project also includes a technical report on *Best Practice Guide in Hardening Existing or New SCADA/EMS Systems Within a Control Center*. This will provide guidelines on operating system hardening, EMS/SCADA network hardening, security hardening of SCADA/EMS consoles, IDS usage, logging, change control, and other topics.

#### **Value**

- Maintain awareness of emerging security technologies and the appropriate and cost-effective applications of those technologies to secure communications within EMS networks
- Maintain knowledge of common industry security practices
- Maintain awareness of national research efforts, provide input on their applicability, and contribute to directing future research in beneficial directions
- Maintain current knowledge of NERC cyber security standards as they evolve and understand the commonly accepted methods to become and remain compliant with them
- Provide guidance on estimating costs and value of security applications so accurate, cost-benefit analyses can be conducted

- Understand how to best and most safely utilize modern communication technologies within EMS networks
- Provide guidelines for hardening existing and new SCADA/EMS systems with in control centers

### How to Apply Results

The workshops are aimed at attracting utility personnel who have the responsibility or want to gain more knowledge on utility security infrastructure. When these people attend any of the project workshops, they discuss security issues with colleagues in a safe and secure environment (workshops), learn what has worked and failed for other utilities and, hence, avoid false starts and wasted effort. They contribute to the improvement of security for the North American electric power industry, and provide direction to national research efforts to ensure that they provide products and technologies that are beneficial to the industry.

### 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Workshops:</b> Workshops as described above	12/31/2009	Workshop, Training, or Conference
<b>A Report on Best Practice Guide on Hardening of existing or new SCADA/EMS systems in control centers.</b>	12/31/2009	Technical Report

### Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<b>Three Workshops:</b> Same as for 2009 with modifications to address issues of (then) current security concern	2010	Workshop, Training, or Conference

## P161.012 Security Issues for the Intelligent Distribution Infrastructure (067470)

### Issue

#### **DNP3.0 Security and advantages of migration to 61850:**

DNP3.0 protocol is being adopted worldwide as the standard protocol for inter- and intra-substations communication and communication between substations and control centers. IEC TC57 WG15 (International Electro technical Commission, Technical Committee 57, Working Group 15) has developed standards to ensure security of these communications under IEC 62351-5 for both serial DNP3.0 and DNP3.0 over Transmission Control Protocol / Internet Protocol (TCP/IP) communications. Correctly implementing these standards requires significant expertise and an in-depth knowledge of the standards. IEC 61850 has been widely used in Europe, and North American utilities are slowly migrating to obtain high bandwidth and more secure communications for advanced substation and substation-to-control-center communications. It is important to obtain in-depth knowledge of security advantages with migration or implementation to IEC-61850 for substation communications.

### Description

This project will develop techniques and procedures, tailored to the contributor's needs, to effectively secure DNP3.0 at substations and DNP3.0 communications from substations to control centers. The specifics will be determined by the companies funding the project and will result in specific guidelines for implementing IEC-62351-5 standards to secure DNP3.0 communications.

This project also will emphasize the advantage of securely using IEC-61850 over DNP3.0

### Value

- Obtain the techniques to securely implement DNP3.0 based on IEC-62351-5 standards of data modeling features to capture and communicate the complete functionality within substations
- Be able to securely utilize DNP3.0 from current serial implementation to address NERC Critical Infrastructure Protection (CIP)
- Be able to migrate from Serial DNP3.0 communication to DNP.3 over TCP/IP in a secure way
- Be able to group substation control blocks to allow secure switching between groups as the operational situation may dictate
- Be able to securely monitor substation activity
- Ability to securely send commands to the substation
- Ability to securely store configured substation data
- Implement technologies for secure and fast transmission of substation events by considering IEC-61850

### How to Apply Results

Transmission operators and substation planners will use these results to securely implement IEC-61850 as they upgrade substations. This will enable them to effectively and efficiently implement an emerging, standard technology in a manner that is appropriate and beneficial to their own company.

### 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Technical Report on the Analysis:</b> A report will be produced that will detail the steps required to securely implement IEC-61850 either in a substation or between a substation and a control center. The report will be tailored to meet the consensus requirements of the companies that fund the project. The report will be based, in so far as it is possible, on practical experiences of other companies that have implemented IEC-61850 (EPRI international experience will contribute to this). This report will be practical in nature and will be immediately useful to the participants.	12/31/2009	Technical Report

### P161.013 Security Issues for Advanced Metering, Demand Response, and Integration of Distributed Resources (067471)

#### Issue

Advanced Metering Infrastructure (AMI) is the enabling technology that will allow electric utilities to establish a two-way communication network to offer demand response programs to their residential and light commercial customers to reduce peak load and better harness energy from distributed resources including renewables. The extension of the utility communication network into the customer premises will expose the informational assets of both the utility and the customers unless strict security policies are enforced to block unauthorized access and limit information dissemination to a “need-to-know” basis. The utilities, the AMI technology vendors, and the customers all have to abide by a consistent set of security standards and methodologies to maintain a safe, reliable, and consistently available smart grid in the 21<sup>st</sup> century.

#### Description

This project will focus on the security features of leading AMI technologies and how they will fit into the overall security architecture of an electric utility’s smart grid. The project combines a theoretical and empirical approach to security to offer advice and tangible results to the planners, designers, and

implementers of AMI programs at the sponsoring utilities. The project will provide a database of use cases and security requirements from member utilities AMI programs benchmarked against EPRI's own AMI lab tests. The project will track the information security related policies and guidelines for the utility industry from U.S. national agencies such as FERC, NERC, Federal Bureau of Investigation (FBI), and National Security Agency (NSA) and provide security briefs to the project sponsors on a regular basis. This project will be carried out in close coordination with the Advanced Metering Infrastructure Security Task Force (AMI-SEC) User Group's activities.

**Value**

- A benchmark of information security standards and methodologies for utility AMI rollout programs
- A repository of information on AMI security relevant national policies and guidelines
- A working relationship with the AMI-SEC User Group to develop new security standards and methodologies and address technology gaps in the market
- A security technology platform for AMI at EPRI's Living Lab for empirical testing of AMI vendor products, systems, and communication protocols' security features

**How to Apply Results**

The member utilities that sponsor this project will receive periodic EPRI Technical Reports, Technical Updates, and Technical Briefs on AMI security documenting the findings from literature search, surveys, and lab tests. The project technical team will be available to the sponsoring member utilities to discuss the project products and advice on the specifics.

**2009 Products**

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Product Title & Description	Planned Completion Date	Product Type
Technical Update	12/31/2009	Technical Update

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