Duke Energy®

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Dianne B. Kuhnell
Senior Paralegal

VIA HAND DELIVERY

March 30, 2009

Mr. Jeff Derouen
Executive Director
Kentucky Public Service Commission
211 Sower Blvd
Frankfort, KY 40601

Re: Case No. 2008-00408

Dear Mr. Derouen:

Enclosed please find for filing an original and twelve copies of the Responses to Initial Requests for Information from the Commission Staff to Duke Energy Kentucky in the above captioned case.

Please date-stamp the extra two copies of the filing and return to me in the enclosed envelope.

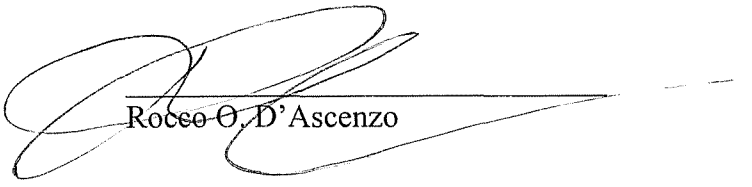
Sincerely,

Dianne B. Kuhnell
Senior Paralegal

cc: Parties of Record

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of Duke Energy Kentucky, Inc.'s Initial Data Request of Commission Staff served on the following by overnight mail, this 30th day of March 2009.



Rocco O. D'Ascenzo

Hon. Dennis G. Howard, II
Hon. Paul Adams
Assistant Attorneys General
1024 Capital Center Drive, Suite 200
Frankfort, Kentucky 40601

VERIFICATION

State of Ohio)
) SS:
County of Hamilton)

The undersigned, Stephen M. Fischer, being duly sworn, deposes and says that I am employed by the Duke Energy Corporation affiliated companies as Director, Asset Management; that on behalf of Duke Energy Kentucky, Inc., I have supervised the preparation of the responses to the foregoing responses to information requests; and that the matters set forth in the foregoing response to information requests are true and accurate to the best of my knowledge, information and belief after reasonable inquire.

Stephen M. Fischer

Stephen M. Fischer, Affiant

Subscribed and sworn to before me by Stephen M. Fischer on this 27 day of March 2009.

Anita M. Schafer

NOTARY PUBLIC

My Commission Expires:

ANITA M. SCHAFER
Notary Public, State of Ohio
My Commission Expires
November 4, 2009

VERIFICATION

State of Ohio)
) SS:
County of Hamilton)

The undersigned, Todd W. Arnold, being duly sworn, deposes and says that I am employed by the Duke Energy Corporation affiliated companies as Senior Vice President, – SmartGrid and Customer Systems; that on behalf of Duke Energy Kentucky, Inc., I have supervised the preparation of the responses to the foregoing responses to information requests; and that the matters set forth in the foregoing response to information requests are true and accurate to the best of my knowledge, information and belief after reasonable inquire.

Todd W. Arnold

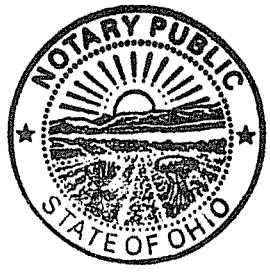
Todd W. Arnold, Affiant

Subscribed and sworn to before me by Todd W. Arnold on this 24th day of March 2009.

Anita M. Schafer

NOTARY PUBLIC

My Commission Expires:



ANITA M. SCHAFER
Notary Public, State of Ohio
My Commission Expires
November 4, 2009

VERIFICATION

State of Ohio)
) SS:
County of Hamilton)

The undersigned, David E. Freeman, being duly sworn, deposes and says that I am employed by the Duke Energy Corporation affiliated companies as Director, Integrated Resource Planning for Duke Energy Business Services, LLC; that on behalf of Duke Energy Kentucky, Inc., I have supervised the preparation of the responses to the foregoing responses to information requests; and that the matters set forth in the foregoing response to information requests are true and accurate to the best of my knowledge, information and belief after reasonable inquire.

David E. Freeman, Affiant

Subscribed and sworn to before me by David E. Freeman on this 23 day of March 2009.

NOTARY PUBLIC

My Commission Expires:

NOTARY PUBLIC STATE OF OHIO

ANITA M. SCHAFER
Notary Public, State of Ohio
My Commission Expires
November 4, 2009

VERIFICATION

State of Indiana)
) SS:
County of Hendricks)

The undersigned, Jeffrey R. Bailey, being duly sworn, deposes and says that I am employed by the Duke Energy Corporation affiliated companies as Director of Pricing and Analysis for Duke Energy Business Services, Inc.; that on behalf of Duke Energy Kentucky, Inc., I have supervised the preparation of the responses to the foregoing responses to information requests; and that the matters set forth in the foregoing response to information requests are true and accurate to the best of my knowledge, information and belief after reasonable inquire.

Jeffrey R. Bailey, Affiant

Subscribed and sworn to before me by Jeffrey R. Bailey on this 23RD day of March 2009.

NOTARY PUBLIC LANA J. HORNER

My Commission Expires: 4/19/2015

VERIFICATION

State of Ohio)
) SS:
County of Hamilton)

The undersigned, Richard G. Stevie, being duly sworn, deposes and says that I am employed by the Duke Energy Corporation affiliated companies as Managing Director, Customer Market Analysis; that on behalf of Duke Energy Kentucky, Inc., I have supervised the preparation of the responses to the foregoing responses to information requests; and that the matters set forth in the foregoing response to information requests are true and accurate to the best of my knowledge, information and belief after reasonable inquire.

Richard G. Stevie, Affiant

Subscribed and sworn to before me by Richard Stevie on this 26th day of March 2009.

NOTARY PUBLIC

My Commission Expires:

NOTARY PUBLIC STATE OF OHIO

ANITA M. SCHAFER
Notary Public, State of Ohio
My Commission Expires
November 4, 2009

TABLE OF CONTENTS

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-021

REQUEST:

State whether Duke Kentucky believes that EISA 2007, Section 532(a)(16)(B), under which electric utilities shall adopt policies establishing costeffective energy efficiency as a priority resource, is consistent with Kentucky's integrated resource plan ("IRP") regulation, 807 KAR 5:058. Explain why or why not.

RESPONSE:

Kentucky's Integrated Resource Planning Regulation, 807 KAR 5:58 (the "IRP Regulation") makes energy efficiency an integral part of the utility's resource planning process to meet load growth. Under this regulation, each electric utility must file an IRP every three years. The IRP Regulation sets forth specific requirements for the utilities to evaluate in its IRP, including but not limited to projected load growth, as well as the resources planned to be implemented to meet that growth. Section 5 of the IRP Regulation requires utilities to submit a summary of the plan including a description of the utility's resource acquisition plan including, among other things, improvements in operating efficiency of existing facilities and demand-side management programs. Under Section 7 of the IRP Regulation, utilities are required to submit historical information including an identification and description of existing demand-side management programs and an estimate of the impact on utility sales and coincident peak demand.

As part of its fifteen year forecast, utilities are required to include the estimates of existing and continuing demand-side management programs. Utilities must include the impact on both energy sales and system peak demands, including utility and government sponsored conservation and load management programs.

As part of the required Resource Assessment and Acquisition Plan, Section 8 of the IRP Regulation requires utilities to develop a plan to provide an adequate and reliable source of electricity to meet forecasted energy requirements at the lowest possible cost. The plan must include an assessment of potentially cost-effective resource options available to the utility, including improvements to and more efficient utilization of existing utility generation, as well as conservation and load management or other demand-side management programs not already in place.

Clearly, the current IRP Regulations are consistent with the EISA 2007 standard and make energy efficiency an integral part of the utility's resource plans.

Also, the Commission has jurisdiction to approve utilities' energy efficiency plans as a priority resource through the Demand Side Management statue. This statue gives the Commission authority to review utility sponsored demand-side management and energy conservation plans and approve such plans for recovery by a discrete rider adjustment.

Duke Energy Kentucky has recently proposed a modification to its current demand-side management plan which it refers to as its Save-a-watt approach. In this sense, Duke Energy Kentucky considers energy efficiency as a "fifth fuel" source. The Commission can approve such programs if the Commission determines that the programs are reasonable.

PERSON RESPONSIBLE: David Freeman

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-022

REQUEST:

Notwithstanding the Direct Testimony of David E. Freeman ("Freeman Direct") and Duke Kentucky's consideration of energy efficiency as a "fifth" fuel, explain in detail how Duke Kentucky treats energy efficiency as a priority resource. Identify and describe any goals Duke Kentucky has developed in terms of kWh (or KW or MW if more appropriate) that are displaced or saved.

RESPONSE:

Duke Energy Kentucky is pursuing all cost effective energy efficiency as evidenced in the Company's recent application to expand its energy efficiency effort in Case No. 2008-00495. In that proceeding, the Company has identified the level of energy efficiency it intends to achieve over the next four years. This is summarized in the table below.

Projected Load Impacts from SAW Proposed Programs

	kWh	MW
Year 1	17,777,533	20.5
Year 2	37,626,858	24.4
Year 3	58,771,987	28.6
Year 4	90,602,837	34.9

PERSON RESPONSIBLE: Richard G. Stevie

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-023

REQUEST:

State whether Duke Kentucky believes that EISA 2007, Section 532(a)(16)(B), under which electric utilities shall adopt policies establishing cost-effective energy efficiency as a priority resource, is consistent with Kentucky's certificate statute, KRS 278.020. Explain why or why not.

RESPONSE:

Duke Energy Kentucky believes that EISA 2007, Section 532(a)(16)(b) does not conflict with KRS 278.020. KRS 278.020 provides Commission approval before a utility (or any other entity) provides utility service to or for the public, or begins construction of any plant, equipment, property, or facility that is not considered an ordinary extension of an existing system. The statute further states that if the application is for the construction of a base load facility, the Commission "may" consider the General Assembly's policy of encouraging the use of Kentucky coal. The clear language says that the promotion of Kentucky coal is a factor that may be considered. It is not the only factor to be considered, nor is it a factor that must be considered. Therefore the language in KRS 278.020 does not restrict the Commission's consideration of many factors as part of the determination of need of the project. Cost effectiveness is one factor that may be considered. This interpretation is supported under the Commission's regulation for Certificates of Convenience and Necessity set forth in 807 KAR 5:001 Section 9 and in conjunction with the Commission's regulations for Integrated Resource Planning in 807 KAR 5:058. The Certificate regulation, among other things, requires the utility to demonstrate the need for the new facility, and provide the Commission with certain information including the cost of operation and "all other information necessary to afford the Commission a complete understanding of the Situation." The utility seeking the Certificate necessarily bears the burden of proof in demonstrating the need for the project and the Commission would have the ability to weigh whether the project is worthy of approval.

To the extent a Certificate is sought for a base load or other generating facility, presumably the investment was supported through the utility's integrated resource plan (IRP). The IRP analysis, by regulation, includes consideration of the impact of demand-side management programs and other energy efficiency initiatives.

PERSON RESPONSIBLE: David E. Freeman

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-024

REQUEST:

Identify all electric DSM programs offered by Duke Kentucky. If appropriate, identify any programs offered that have not been specifically authorized by the Commission per KRS 278.285. Identify the annual kWh (or KW or MW if more appropriate) that are displaced or saved by each program.

RESPONSE:

Duke Energy Kentucky currently offers the following programs:

Program 1: Residential Conservation and Energy Education

Program 2: Residential Home Energy House Call

Program 3: Residential Comprehensive Energy Education Program (NEED)

Program 4: Payment Plus

Program 5: PowerManager

Program 6: Energy Star Products

Program 7: Energy Efficiency Website

Program 8: Personalized Energy Report (PER)

Program 9: C&I High Efficiency Incentive (for Businesses and Schools)

Program 10: PowerShare

The following table reports the load impacts from these programs for the period July 1, 2007 through June 30, 2008. That is the most recent reporting period for these programs.

Summary of Load Impacts Juiy 2007 Through June 2008

Residential Programs	Incremental Participation	Load Impacts Net of Free Riders kWh	kW
Home Energy House Call	568	149,952	17.0
Energy Efficient Website	445	100,161	27.5
Energy Star Products	43,123	1,644,079	280.6
Low Income Program	265	165,095	45.4
Refrigerator Replacement	85	92,395	22.3
Personalized Energy Report			
Power Manager	919		946.6
NEED	625	72,681	6.3
Total Residential	46,030	2,224,363	1,345.7
**Energy Star Products is number of bulbs not participants.			

Non-Residential Programs	Incremental Participation	Load Impacts Net of Free Riders kWh	kW
C&I Lighting	24,777	16,712,153	2,408.2
C&I HVAC	2,683	7,198,758	2,728.8
C&I Motors	4	1,851	0.6
Power Share	1		629.0
Total Non-Residential	27,465	23,912,762	5,766.6
Total	73,495	26,137,125	7,112.3

The Commission is yet to hear the case on the new programs proposed in Case No. 2008-00495. The proposed programs not yet authorized by the Commission are listed on pages 13 and 14 of the testimony of Dr. Richard Stevie. The projected load impacts from each program are provided in the following table.

	Year 1	Year 2	Year 3	Year 4
Residential Energy Assessments				
kW	396	806	1,250	1,885
kWh	1,425,275	2,899,803	4,483,448	6,731,973
Smart Saver® for Residential Customers				
kW	782	1,544	2,290	3,295
kWh	5,759,872	11,363,829	16,859,076	24,256,300
Home Performance				
kW	64	192	372	609
kWh	312,090	936,270	1,810,122	2,964,855
Reach and Teach Energy Conservation				
kW	56	112	168	224
kWh	421,731	843,461	1,265,192	1,686,923
Low Income Services				
kW	201	392	556	773
kWh	1,372,304	2,679,260	3,784,576	5,243,593
Energy Efficiency Education Program for Schools				
kW	341	991	1,965	3,680
kWh	1,638,404	4,759,173	9,440,328	17,679,159
Power Manager				
kW	10,512	10,512	10,512	10,512
kWh	-	-	-	-
Non-Residential Energy Assessments				
kW	NA	NA	NA	NA
kWh	NA	NA	NA	NA
Smart Saver® for Non-Residential Customers				
kW	1,608	3,289	4,854	7,336
kWh	6,847,857	14,145,060	21,129,245	32,040,035
Power Share®				
kW	6,604	6,604	6,604	6,604
kWh	-	-	-	-
Total				
kW	20,563	24,442	28,572	34,918
kWh	17,777,533	37,626,858	58,771,987	90,602,837

PERSON RESPONSIBLE: Richard G. Stevie

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-025

REQUEST:

State whether Duke Kentucky believes that its rate RS for residential service, which includes a customer charge and flat energy charge, supports energy efficiency. Explain why or why not.

RESPONSE:

Duke Energy Kentucky believes its current rate design for Rate RS, which is a flat charge for all kWh consumed in addition to a customer charge, reasonably promotes conservation. In it last electric rate case, Case No. 20067-00172, Duke Energy Kentucky provided an extensive analysis for the justification of its residential rate design[1]. In this analysis, Duke Energy Kentucky demonstrated that the relationship between coincident demand and kWh usage is a linear function. In other words, as kWh consumption increases, the amount of demand contributed to the system peak increases proportionally. As the testimony states in greater detail, this type of analysis supports a single charge for each kWh consumed. This analysis also tends to refute declining as well as inclining block rates. This analysis also supports the general goal that the design should be reflective of the utility's underlying costs. To the extent rate design accomplishes this goal, it should likewise support the goal of promoting conservation.

PERSON RESPONSIBLE: Jeffrey R. Bailey

[1] Please refer to the testimony of Jeffrey R. Bailey in the above mentioned case, beginning on page 8 and concluding on page 15.

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-026

REQUEST:

State whether Duke Kentucky believes that its rate DS and rate DP, each with a declining block energy charge, support energy efficiency. Explain why or why not.

RESPONSE:

Both Rates DS and DP are designed to reduce per unit costs to customers that can improve load factor. The notable feature of these rates is that it is somewhat tilted, which means the energy charges reflect some additional fixed costs in the pricing as improvements in load factor occur. This implies that as customers improve their load factor, and therefore coincidence with peak periods, additional demand-related (fixed cost) dollars are collected for the greater imposition of on-peak costs. Since improvements in load factor also would include some additional usage in off-peak, low cost periods, this tilted design reasonably reflects cost and therefore does not overtly penalize or encourage additional usage.

PERSON RESPONSIBLE: Jeffrey R. Bailey

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-027

REQUEST:

State whether Duke Kentucky supports inclining block rates. Explain your answer in detail.

RESPONSE:

To the extent that inclining structures have charges that are significantly higher than preceding blocks, Duke Energy Kentucky does not support their use. High usage (i.e. greater than average use) tends to be associated with high levels of peak period, weather sensitive, consumption. However, Duke Energy Kentucky's data is not supportive of this theory. In addition, there is a common misconception that "high" usage is wasteful and "low" usage is inherently efficient. Duke Energy Kentucky has no data supportive of this view.

Usage can be influenced by housing, family size, and many other factors, and therefore the link between usage and cost, or efficiency vs. inefficiency, after some predetermined point for rate design purposes is not at all clear. Accordingly, Duke Energy Kentucky does not support the use of inclining block structures.

PERSON RESPONSIBLE: Jeffrey R. Bailey

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-028

REQUEST:

With reference to EISA 2007, Section 532(a)(17)(B)(i), under which the Commission shall consider removing the throughput incentive, address the following:

a. State whether or not Duke Kentucky supports decoupling. Explain your answer in detail.

b. Current literature describes a myriad of decoupling mechanisms. If applicable, describe specifically the form of decoupling that Duke Kentucky supports.

RESPONSE:

a. Duke Energy Kentucky generally supports decoupling to fully realize the potential of energy efficiency. To successfully accomplish this, the throughput incentive and other regulatory and management disincentives to energy efficiency must be removed. Because energy efficiency programs actually reduce sales, utilities have a natural incentive to focus more on supply side options than demand side options.

b. There are several methods which may be utilized for removing the throughput incentive. These range from revenue per customer models, restructuring of rates, and even formula rates. While Duke Energy Kentucky generally supports the concepts of decoupling, it has not formed an opinion as to which of the models it can support for implementation.

PERSON RESPONSIBLE: Jeffrey R. Bailey

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-029

REQUEST:

Explain whether or not Duke Kentucky believes the Commission should implement decoupling to support energy efficiency.

RESPONSE:

While DE-Kentucky generally supports the concepts of decoupling, the Company would urge caution in prescribing a set decoupling methodology across all electric utilities in Kentucky.

PERSON RESPONSIBLE: Jeffrey R. Bailey

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-030

REQUEST:

Explain whether any components of automated meter reading ("AMR") hardware can be utilized when a utility implements AMI.

RESPONSE:

Automated meter reading (AMR) hardware typically uses one way communications to collect meter reads from meter end points. AMR systems deployed at Duke Energy, such as the ITRON drive by system in the Carolinas, relies on one way radio transmissions from the meter to radio receivers within trucks dispatched to collect monthly meter reads. Duke Energy is currently assessing the benefits and cost effectiveness of integrating AMR and AMI technologies that could allow Duke Energy to leverage existing AMR assets while deploying newer AMI technologies. It may be possible for Duke Energy to continue use of its one way communications network to transmit data to meter head end and other back office systems without use of the truck fleet, although the full benefits of a two way AMI communications network would not be realized. Duke Energy's AMI initiative within Kentucky includes approximately 26,000 gas AMI modules and approximately 37,000 electric AMI meters in Northern Kentucky that will remain in place.

PERSON RESPONSIBLE: Todd W. Arnold

STAFF-DR-01-031

REQUEST:

Refer to page 15 of the Bailey Direct Testimony.

a. Provide the number of customers served under each of the following tariffs: DS, DP, DT and TT.

b. Explain whether Duke Kentucky believes there is any potential to increase participation in Rates OS, DP, DT or TT.

c. Provide the number of customers served under each of the following load management tariffs: Rider PLM and Rider LM.

d. Explain whether Duke Kentucky believes there is any potential to increase participation in Rider PLM or Rider LM.

RESPONSE:

a. Rate DS, 12,091 customers; Rate DP, 10 customers; Rate DT, 225 customers; Rate TT, 11 customers.

b. The Company does not believe that there is potential to increase participation in these four rates because they apply based on customers' peak demand and service voltage. Rates DT and TT are not optional. Rate DT applies to distribution voltage customers with average monthly demands of 500 kW or higher. Rate TT applies to transmission voltage customers. Rates DS and DP apply to secondary and primary distribution voltage customers with average monthly demands of less than 500 kW.

c. Rider LM: 98 customers; Rider PLM: 23 customers.

d. Both Riders LM and PLM have been available for years. Thus, significant increases in participation are unlikely.

PERSON RESPONSIBLE: Jeffrey R. Bailey

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-032

REQUEST:

Refer to page 1 of the Direct Testimony of Richard G. Stevie ("Stevie Direct"). Under its save-a-watt program, Duke Kentucky seeks to recover 50 percent of the net present value of avoided energy and capacity costs achieved for energy conservation programs and 75 percent of the avoided capacity costs achieved for demand response programs. From those revenues, Duke Kentucky must cover energy efficiency program costs. What margin, after program costs, does Duke Kentucky believe is necessary to encourage significant utility investments in energy efficiency technology, products and services? Explain the response.

RESPONSE:

To truly provide an incentive to utilities to pursue energy efficiency, the margin from implementing energy efficiency programs should be equal to or greater than that which can be earned from supply side options. The Company has proposed that the margin be capped at 15% of program costs to eliminate the risk that the Company's earnings on energy efficiency might be considered unlimited.

PERSON RESPONSIBLE: Richard G. Stevie

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-033

REQUEST:

Provide a summary of Duke Kentucky's AMI program as discussed in the testimony of Mr. Jim L. Stanley in Duke Kentucky's last general rate case, Case No. 2006-00172 in which the revenue increase under the settlement agreement included the costs and reflected the savings of the proposed AMI program. Describe any changes to the plan as outlined in Mr. Stanley's testimony. Include any updated information regarding the costs and savings achieved to date and an estimate of total costs and savings.

RESPONSE:

In Jim Stanley's testimony the Company stated approximately $24M in capital expenditures would be used for the TWACS technology deployment. That amount assumed full deployment in that technology. The Company continues to examine new technologies as they develop.

The Company only completed the first phase of TWACS and BADGER technologies deployment as part of the Proof of Concept. As a result, this total deployment cost was approximately $11 million of the projected $24 million in capital expenditures. This equates to approximately 25,800 gas modules and 37,300 electric AMI meters. The Company has not yet quantified the savings or benefits to date but anticipates starting to see benefits associated with meter reading savings this year.

PERSON RESPONSIBLE: Todd Arnold

STAFF-DR-01-034

REQUEST:

If not included in the discussion of the previous question, describe any transmission and distribution automation equipment deployed by Duke Kentucky.

RESPONSE:

There currently is no installed distribution automation in the Duke electric system in Northern Kentucky. Though we have SCADA control of substation breakers, there are no self-healing concepts installed on the distribution lines. With respect to the transmission system in northern Kentucky, the 69kV system is owned by Duke Kentucky, however, the 138kV transmission system in Kentucky is currently owned by Duke Ohio. The 69kV transmission system does not currently have any automation installed to sectionalize a line to keep a substation in service for failures on only one source to a substation. That switching is now done manually. In late 2008, Duke Ohio installed transmission sectionalizing equipment at the new Dayton substation to allow the faulted section of 138kV line to be isolated so the Dayton substation can be re-energized with only a few second outage. This concept is still under engineering and operations review.

PERSON RESPONSIBLE: Steve Fischer

STAFF-DR-01-035

REQUEST:

If not included in the discussion in the responses to questions No. 33 and No. 34 above, describe any digital communications or any other smart grid technology deployed by Duke Kentucky.

RESPONSE:

The communications deployed during the Kentucky Proof Of Concept involved PLC technology to the substation then backhauling the data from the substation to head end application for processing

PERSON RESPONSIBLE: Todd Arnold

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-036

REQUEST:

Refer to the Amended Direct Testimony of Todd W. Arnold ("Arnold Direct"), at page 7, lines 3 through 4. Identify and describe the 12 projects Duke Energy is working on under EPRI's "Intelligrid" umbrella. Identify any of the 12 that directly involve Duke Kentucky.

RESPONSE:

2008 Engagement

Program 161 D **Infrastructure and Technology for Integrating Demand Response and Energy Efficiency**

See Attachment Staff-DR-01-036 (a)

Supplemental Project titled **Development of a Roadmap for Intelligent Transmission System Architecture**

See Attachment Staff-DR-01-036 (b)

2009 Engagement

Program 161B **Infrastructure for Intelligent Transmission System**

See Attachment Staff-DR-01-036 (c)

Program Descriptions are attached for each of the above program/projects. Duke Energy switched from 161D to 161B in 2009 because it used the supplemental project in 2008 to develop a roadmap for an intelligent transmission system at Duke Energy and it wanted to keep that momentum going with the developments in transmission.

PERSON RESPONSIBLE: Todd W. Arnold

Electric Power Research Institute
2008 Portfolio

161 IntelliGrid

Program Overview

Industry Needs and Issues Addressed

- Need for guidance on deployment of infrastructure technology (monitoring, communications, computing, and information management) to support advanced applications, automation, and systems integration that will enhance system operation and maintenance and enable demand response and energy efficiency applications
- Assistance in deploying monitoring, communications, computing, and information technologies efficiently and cost effectively to meet current and future needs
- 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

Key Accomplishments

- IntelliGrid architecture providing methodology, tools, and recommendations for standards and technologies for utility use in planning, specifying, and procuring IT-based systems, such as advanced metering, distribution automation, and demand response.
- Successful application of IntelliGrid architecture by several utilities 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.

Value

- Provides utilities 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 utilities with independent, unbiased testing of technologies and vendor products
- Provides forum for leading utilities worldwide to exchange plans and experiences
- Provides direct support to utilities implementing program results
- Provides and supports ongoing development of communications architecture that will enable interoperability between products and systems

Anticipated Deliverables

- Field demonstration of fast simulation and modeling
- Common Information Model (CIM) extensions for distribution operations, advanced metering, customer operations, and demand response
- Guidelines for deploying communications infrastructure for transmission operations, advanced distribution automation, demand response, and energy efficiency
- Security metrics
- Security of communications and control systems
- Regular reports on laboratory testing of technologies and products
- Customer integration reference design application guide
- Design for advanced customer communications architectures

Industry Involvement

- Estimated total 2008 budget: $5.0M
- Program financial leverage: $15:$1

Program Technical Lead
Donald Von Dollen
650-855-2679
dvondoll@epri.com

Summary of Projects

PS161A IntelliGrid Technology Transfer and Information Systems (063528)

Project Set Description: This project set focuses on integration and implementation assistance, education and technology transfer, as well as activities to continue establishing a foundation for developing the grid of the future. 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 and especially this project set 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 (e.g., IEEE Intelligent Systems Committee) working on the development and definition of future system architectures and integration needs.

Project Number	Project Title	Value
P161.001	IntelliGrid Technology Transfer and Information Services	Supports users of the IntelliGrid Architecture and technology assessment results and introduces potential users to the benefits of adopting the results. Benefits include: • Promotes interoperability among vendor products, lowering capital costs for utilities • Provides most current information on technical, policy and implementation issues related to smart grids • Enables cost-effective integration of advanced automation applications and diverse vendor products into transmission and distribution systems

Project Descriptions

P161.001 IntelliGrid Technology Transfer and Information Services (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 the 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 funders 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 funders of the IntelliGrid program find value.

Value

- Provides guidelines for deploying advanced technologies in the areas of monitoring, communications, computing, and information technology
- Enables cost-effective integration of advanced automation applications and diverse vendor products into transmission, distribution and end-user systems
- Promotes interoperability among vendor products, lowering capital costs for utilities
- Provides the most current information on technical, policy and implementation issues related to smart grids
- Provides direct implementation support and integration assistance
- Provides coordination with a wide variety of research and industry initiatives related to development and definition of the smart grid

How to Apply the Results

Project results can be used by utility executives responsible for "grid of the future" planning, IT architects designing the infrastructure to support the future grid, and project engineers deploying systems.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
On-site/telephone support integration assistance	12/31/2008	Technical Resource
Smart Grid Conference	6/30/2008	Workshop, Training, or Conference
Executive Roundtable	9/30/2008	Workshop, Training, or Conference
Integration Guidelines	12/31/2008	Technical Update
Intelligent Grid Newsletter	12/31/2008	Technical Update
Intelligent Grid Development Roadmap	12/31/2008	Technical Update

PS161B Infrastructure and Technology for Intelligent Transmission Systems (063437)

Project Set Description: This project set develops the communication and computing foundations for an intelligent, self-healing grid, and will demonstrate and deploy them in transmission applications. An intelligent, self-healing grid 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	IntelliGrid Architecture Development for *Transmission Operations*	Development of requirements, use cases and object models for advanced transmission operations such as remedial action schemes and wide area measurement and control systems. Benefits include: • Enable consistent approach to design and production of interoperable equipment through completion of device and data models • Promote mature standards that enable competitive equipment procurement and result in 20-25% capital cost reductions for advanced automation equipment
P161.003	Transmission Fast *Simulation and Modeling*	Development of a suite of tools designed to provide the *mathematical foundation and look-ahead capability for a self-*healing grid. Benefits include: • Enhance grid operation performance • Identify tools needed for future control centers to manage intelligent grid

Project Descriptions

P161.002 IntelliGrid Architecture Development for Transmission Operations (063425)

Issue

Transmission operations need a wide-area view of system performance and health. The communications and distributed computing infrastructures to support advanced transmission applications need to be interoperable across vendor equipment and across the enterprise. Increasingly, transmission and protection systems require higher levels of integration to enable advanced applications for protection and control, including the use of phasor measurements. The standards-based device models supporting diverse equipment and environments need to be complete and stable so utilities can build systems *independent of vendors. The integration of key standards is necessary to effectively integrate* transmission operations and protection across the enterprise. Particular focus is necessary for the effective integration of Wide Area Measurement and Control standards from IEEE C37.118 with IEC Standards for Substation and Control Center operations (e.g., IEC 61850, 61968, 61970).

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 IEC standards, and as the basis for advanced applications that can be developed using equipment from different vendors. This work develops initial designs for implementing advanced transmission operations and protection applications based on emerging standards from IEC and the IEEE. The requirements for new protection applications, such as remedial action schemes and special protection systems, form the basis for device and object models necessary for designing systems built to the IEC Standards. The project also develops modeling approaches for virtual measurements effectively integrating different real-time measurements from across the system.

Value

- Enable consistent approach to design and production of interoperable equipment through completion of device and data models
- Promote mature 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
- Promote true interoperability and enable integration of applications across the enterprise via systems built to open standards
- Enable new applications not previously available via the integration of advanced equipment

How to Apply the Results

Project engineers and IT architects can use results when procuring next-generation transmission operations equipment, such as relays and protection equipment compatible with IEC Standards.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Technical Architecture for Transmission Operations and Protection: The report provides the requirements for advanced transmission operations control, protection and integration between control centers and substations, as well as an assessment of key IEEE and IEC Standards and integration recommendations.	12/31/2008	Technical Report

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Utility and energy industry demonstration projects	2009	Technical Report
IntelliGrid architecture model version 5.0	2009	Technical Update

P161.003 Transmission Fast Simulation and Modeling (063424)

Issue

Fast Simulation and Modeling (FSM) is a suite of tools designed to provide the mathematical foundation and look-ahead capability for a self-healing grid, one capable of automatically anticipating and responding to power system disturbances while continually optimizing its own performance. Many currently available software applications and equipment solutions provide partial solutions, but none provides the foundation for an open and integrated environment in which these solutions could achieve the necessary functions for FSM.

Description

The project builds on IntelliGrid architecture principles and on the first functional requirements developed in the earlier stage of this work. The current stage of transmission FSM (T-FSM) development contributes to the integration of the many components that will form the T-FSM platform. In 2007, a roadmap defined the priorities for the FSM functionalities and identified when these solutions will be available. The 2008 work focuses on development of the architectural "bricks" that connect these first components in a seamless, open and interoperable manner. Activities include developing use cases that describe the processes and all interactions needed between these components and the environment, complemented by the definition of key interfaces, using an object model description compatible with state-of-the art

standards such as the Common Information Model and IEC 61850. 2008 activities also include demonstration projects to implement and validate the architectural elements produced by the project.

Value

- Enhance grid operation performance
- Identify tools needed for future control centers to manage intelligent grid
- Decrease procurement costs by maximizing integration among software applications and "off the shelf" equipment

How to Apply the Results

Transmission system operators and project engineers can use results to prioritize investment decisions of new automation schemes as well as new tools for control centers. They will find the architectural elements useful in planning the integration of new solutions into the grid operation environment. The strategic information can also help utilities define strategies that continue the transition of grid operations toward greater automation with improved decision making tools for operators.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Field Demonstration of T-FSM	12/31/2008	Technical Resource
Architecture development to foster standardization and interoperability of fast simulation and modeling for transmission applications	12/31/2008	Technical Update

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Prototype development and off-the-shelf products test bed: Continued development of architectural principles and increased product testing. T-FSM tools demonstrations will continue, and lessons learned will be documented to ensure efficient future applications.	2009	Technical Report
Lessons learned during field demonstrations of T-FSM	2009	Technical Update
Architecture development to foster standardization and interoperability of fast simulation and modeling for transmission applications	2009	Technical Update

PS161C Monitoring, Communication and Control Systems for Advanced Distribution (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, utilities will 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 development and demonstration of low-cost,

standards-based, two-way communications between utilities and their customers. 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 in ongoing development and enhancement of the Common Information Model (CIM) and other industry standards (e.g. Multi-Speak) for integration of system information management and integration. The Distribution Fast Simulation and Modeling Research builds on the communications and information infrastructure with advanced computing methods. The project set coordinates closely with projects on monitoring and control system technologies developed and demonstrated in the ADA program (P124).

Project Number	Project Title	Value
P161.004	Communications Infrastructure for Advanced Distribution Automation	Development of open standards that effectively integrate distribution equipment from different vendors. Benefits include • greater power system reliability and functionality, • greater value to consumers, • enhanced system security, and • lower costs for infrastructure upgrades and expansion.
P161.005	CIM Applications and Development for Distribution Operations and Management	Development of a guide for specifying interfaces between information systems for distribution applications that builds on common information model objects. This guide will enhance future applications that interface with outage management systems, energy management systems, geographical information systems, customer information systems, and distribution models Benefits include • reduced life cycle costs by integrating disparate systems and maintaining them for longer periods • capital cost savings by competitively procuring and integrating advanced intelligent equipment from multiple vendors.
P161.006	Distribution Fast Simulation and Modeling	• Development of a suite of tools designed to provide the mathematical foundation and look-ahead capability for a self-healing grid. Benefits include: • Enable mature infrastructures needed for integrating and effectively managing and securing distribution automation equipment and applications. • Enable capital savings through competitive procurement of advanced next generation automation equipment and supporting communications networks and infrastructures.
P124.006	Control Technologies and Assessment for ADA	Helps utilities begin to automate or more fully automate their systems, which in turn improves energy efficiency of distribution operations Helps utilities improve system functionality, allowing better power quality and a wider variety of customer services to be delivered to customers Enables automated response to mitigate outages or to speed recovery from outages Supports migration over time to open systems based on international standards from legacy proprietary systems • Improves decision making from among the circuit,

Project Number	Project Title	Value
		reconfiguring, protection, and control choices for ADA and the Distribution System of the Future • Supports integration of distributed generation and storage into distribution system operations
P124.007	Distribution Fault Anticipator (DFA)	Provides early warning of failing equipment Enables recognition of operational problems with apparatus Prevents outages and enables faster service restoration Increases reliability and overall situational awareness Reduces the need for costly, ineffective (even counterproductive) preventative maintenance Provides valuable data for forensic analysis
P124.008	ADA Monitoring System Infrastructure and Integration	Optimizes real-time system operations, prevents outages, and aids in basic automated operations in the near term Increases energy efficiency, reduces O&M costs, and increases system security Helps utilities begin to automate or more fully automate their systems, which in turn improves energy efficiency of distribution operations Improves system functionality, allowing better power quality and a wider variety of customer services to be delivered to customers Enables automated response to mitigate outages or speed recovery from outages Supports migration from legacy proprietary systems to open systems based on international standards Improves decision making from among the technology, software, sensor, data processing, AMI, and system integration choices for real-time ADA monitoring systems in the Distribution System of the Future

Project Descriptions

P161.004 Communications Infrastructure for Advanced Distribution Automation (063428)

Issue

Advanced distribution automation (ADA) equipment and applications require corresponding advances in the supporting communications infrastructure. Existing infrastructures do not have the ability to scale and effectively integrate across different communications media. In addition, limited capabilities to integrate different networks, physical communications media, and equipment all point to the need for more effective open standards. While next-generation standards are in development and use for advanced substation operations, these have not been developed for distribution equipment or ADA applications. ADA equipment and applications require open standards to enable functions such as self description, assisted auto configuration of equipment and networks, and robust management and security.

Description

This project is a multi-year effort that tracks communications technology developments and their application to advanced distribution communications architecture. The project also provides support for application of industry standards to enhance the applications of the communications infrastructure for advanced applications in an interoperable manner. The objective is to provide tools and methodologies

needed to design, implement, and deploy open communication systems with a knowledge of available technologies and systems. The project develops the requirements for communications infrastructure support of distribution automation functions, including network and systems management and security support. Functional requirements are accompanied by non-functional requirements that support the performance, management and security infrastructure necessary to integrate ADA functions. Once the requirements are analyzed, data and device models necessary for field equipment and master station "client" equipment are developed. The project also develops a model of distribution operations based on the unified modeling language. The project focuses on developing an architecture that integrates across distribution-specific areas as well as transmission operations and consumer communications areas. This architecture will result in widely available advanced automation equipment that can be integrated, managed, and secured in distribution operations.

Value

- Enable capital savings through competitive procurement of advanced next-generation automation equipment that can function with an open communications architecture
- Support a range of products from multiple vendors via standardized interfaces and use techniques, avoiding single vendors and proprietary systems for key communications applications and equipment
- Enable large-scale integration within field equipment and with enterprise applications
- Enable new applications that use open communications architecture for distribution operations that leverage capital investments in intelligent equipment
- Enable mature communications infrastructures needed for integrating and effectively managing and securing distribution automation equipment and applications
- Enable life-cycle cost savings through the use of well-known and standardized open communication systems infrastructures for ADA applications

How to Apply the Results

Distribution project engineers, automation designers, and IT architects can use these results when developing the design for an open distribution communications architecture to support advanced distribution applications. This work also serves to provide infrastructure to vendors, providing a basis for developing equipment to meet ADA needs.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Technical Report: Communications Infrastructure for ADA Equipment and Applications: Requirements for Advanced Distribution Automation communications infrastructure captured in use case formats. The requirements also define the data as well as performance requirements for ADA equipment that will interface with the communications infrastructure.	12/31/2008	Technical Report

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Designs of ADA communications equipment based on IEC Standards: Designs for ADA equipment communications include the specifications for constructing field equipment and master station clients based on ADA system requirements and next generation applications.	2009	Technical Report

Deliverable Title & Description	Planned Completion Date	Deliverable Type
IntelliGrid Architecture Model Version 5.0: An industry model rendered in unified modeling language provides the basis for documenting large and complex systems and complements the development of ADA designs.	2009	Technical Update

P161.005 CIM Applications and Development for Distribution Operations and Management (065546)

Issue

A common language is needed to integrate and communicate with applications across the enterprise and the industry. Currently, the Common Information Model (CIM) has not been fully developed for communications with distribution automation equipment and applications. Application-level communications objects have not been fully developed for field equipment, distribution master stations, distributed energy resources, and other devices that need to be integrated and managed over the enterprise. The CIM is also used for interfaces to electrical models of distribution systems, monitoring databases representing real time and historical conditions on the distribution system, and other information systems that are integrated for system operation, management, and planning (such as OMS, GIS, CIS, and EMS). The industry needs to develop a complete library of standardized CIM objects for the distribution system operations and planning environment.

Description

This project develops a set of CIM objects to support a variety of applications across the enterprise including outage management and crew dispatch, information sharing between field equipment and substations, and between field equipment and protection systems, including integration with the system model and the EMS. The project cooperates with standards groups at the International Electrotechnical Commission (IEC) to develop such models. The CIM for distribution operations draws upon the requirements put forward in the IntelliGrid architecture and in key projects across the industry. The project develops appropriate contributions to standards and user groups to effectively integrate real-time field operations with IT systems. Applications of important elements of the CIM for distribution are demonstrated with the cooperation of members.

Value

- Capital savings through competitive procurements of applications and equipment
- Life cycle savings from standards-based systems built to stable open industry standards

How to Apply the Results

Application of the results in less expensive integration of future applications that will enhance the planning and operation of distribution systems. These applications will result in better planning, control, and operation of the distribution system through standardized interfaces to a variety of information systems.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Guide for specifying common interfaces for information systems used in Distribution Applications – Initial draft with scope and definitions	12/30/2008	Technical Update

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Guide for specifying common interfaces for information systems used in Distribution Applications – First full version	2009	Technical Report

P161.006 Distribution Fast Simulation and Modeling (063310)

Issue

Fast Simulation and Modeling (FSM) is a suite of tools designed to provide the mathematical foundation and look-ahead capability for a self-healing grid, one capable of automatically anticipating and responding to power system disturbances while continually optimizing its own performance. Many currently available software applications and equipment solutions can contribute partially to development of this intelligent grid, but a foundation is still needed for an open and integrated environment in which these solutions can achieve the necessary functions for FSM. Many questions remain unanswered regarding the best structure and algorithms for a real-time simulation capability for distribution systems. This project takes a systematic approach to evaluating different aspects of this problem and evaluating options for the distribution FSM implementation.

Description

The project builds on IntelliGrid architecture principles and on the first functional requirements developed in the earlier stage of this work. The current stage of distribution FSM (D-FSM) development contributes to the integration of the many components that will form the D-FSM platform. In 2007, a roadmap defined the priorities for the FSM functionalities and identified a timetable for these solutions. A test bed platform, including a mock-up of a distribution state estimator was developed and the performance of the algorithm tested on typical configuration cases. The 2008 work focuses on the development of architectural "bricks" to connect these first components in a seamless, open and interoperable manner. Use cases describe the processes and all interactions needed between these components and the environment, complemented by the definition of key interfaces, using an object model description compatible with state-of-the art standards such as the Common Information Model and IEC 61850. New modules that assess the best location and types of monitoring information complement the test bed. This project continues demonstrations to implement and validate the architectural elements produced.

Value

- Enhance performance of distribution grid operations
- Identify new tools for control center and advanced distribution automation
- Decrease procurement costs by providing solutions that connect with minimal integration efforts

How to Apply the Results

Distribution system operators, design engineers and IT architects can use results to help prioritize investment decisions of new automation schemes as well as new tools for control centers. The architectural elements help planning of integration of new solutions into the distribution operation environment. The strategic information helps define strategies for transitioning grid operations toward more automation and better decision-making tools for operators.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Status of software test-bed and field demonstration of distribution Fast Simulation and Modeling	12/31/2008	Technical Update
Architecture development to foster standardization and interoperability for Fast Simulation and Modeling for distribution applications	12/31/2008	Technical Report

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Prototype development and off-the-shelf products test bed: Develop architectural principles and increased testing of available products. Continued demonstrations of D-FSM tools and documentation of lessons learned to ensure an efficient application of these new tools.	2009	Technical Update
Lessons learned during field demonstrations of D-FSM	2009	Technical Update
Architecture development to foster standardization and interoperability of Fast Simulation and Modeling for distribution applications	2009	Technical Update

P124.006 Control Technologies and Assessment for ADA (065544)

Issue

As utilities modernize their distribution systems to include wider use of advanced distribution automation (ADA), they need to assess the relevant distribution circuit configurations and reconfiguring capabilities, including associated control and protection systems. They also need to better understand the value of these emerging capabilities and the ways they can be most effectively used in advancing future distribution system development and operations. Utilities also need to conduct actual field experience assessments of emerging capabilities in partnership with host utilities to assess the advantages and disadvantages of specific capabilities in specific cases.

Description

This project performs assessments of advanced circuits, controls, and protection, and documents them for sponsor use. The assessments include both technical and economic issues, and are conducted in partnership with utilities that are planning to field test key new capabilities. Working with project sponsors, EPRI identifies key emerging circuit configurations, reconfiguring approaches, and associated protection and control techniques that merit field evaluation. The concepts are screened and prioritized as to their functionality and performance in ADA and advanced distribution system operations. Examples include feeder autolooping approaches and intentional islanding of distribution circuits with sufficient distributed generation. The work takes advantage of the prior EPRI requirements definition and design work on advanced circuits, protection, and control for ADA and past utility projects in the area. The objective is to complete a round of field assessment every two years.

Value

- Helps utilities begin to automate or more fully automate their systems, which in turn improves energy efficiency of distribution operations, because ADA improves overall system performance and energy throughput
- Provides the basis for integration of distributed resources (generation and storage) with distribution operation
- Helps utilities improve system functionality, allowing better power quality and a wider variety of customer services to be delivered to customers
- Enables automated response to mitigate outages or to speed recovery from outages
- Supports migration over time to open systems based on international standards from legacy proprietary systems
- Improves decisionmaking from among the circuit, reconfiguring, protection, and control options for ADA and the Distribution System of the Future

How to Apply the Results

Electric distribution managers, engineers and designers will apply better practices in implementing ADA and use more efficient development processes. Use of advanced systems enables significant gains in energy efficiency, system reliability, outage management, integration of distributed generation and storage, and a variety of customer services. These in turn can improve customer satisfaction and provide visible action to the public and regulators (i.e., a serious effort to improve energy efficiency and act as a steward of environmental resources). The results can be used at all levels of automation, ranging from a utility that is just beginning to automate to a utility that is automating an entire distribution system.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Status Report on Field Experience Assessment for New Circuit Configurations, Reconfiguring, Control, and Protection for ADA and the Distribution System of the Future: This report covers progress to date on this project.	12/31/2008	Technical Update

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Final Report on Field Experience Assessment for New Circuit Configurations, Reconfiguring, Control, and Protection for ADA and the Distribution System of the Future: The process described and deliverables are repeated on a two-year cycle to capture ongoing technology advances and integrate them into the knowledge base of capabilities for ADA. If there is sponsor interest in an in-depth look at some specific circuit, protection, or control approach in a given year, a special assessment report on that specific topic may be completed as per agreement with sponsors that year, assuming the funding base is sufficient.	2009	Technical Report

P124.007 Distribution Fault Anticipator (DFA) (SP0766)

Issue

Reliability and economics are key motivating factors for electric utilities. Customers and regulatory agencies apply significant pressure to utilities to provide affordable service with high levels of quality and reliability. Approaches to system maintenance range from run-to-failure to aggressive preventative maintenance. Neither is particularly efficient or effective at achieving reliability at an affordable cost.

Advances in electronics and microcomputer technologies make advanced, intelligent monitoring feasible and provide the potential for affordable improvements in reliability, situational awareness, and operations. Distribution Fault Anticipation (DFA) technology exploits these advances. It detects subtle early warning signs of incipient failures, enabling proactive diagnosis and repair. DFA installations have documented many types of failures and incipient failures, but some of the types of failures with the most severe consequences are statistically infrequent and have yet to be seen in significant numbers, if at all.

Description

The chance of a specific type of failure occurring on a given feeder over a given period of time is probabilistic in nature. DFA equipment has documented numerous episodes of some failures but other failures have occurred infrequently or not at all. For example, although DFA equipment has recorded many cable failures and precursors, only one involved a substation cable—but that single failure led to an outage of 26,000 customers. Similarly, there have been no load tap changer (LTC) contact failures at DFA-monitored installations, but a single LTC failure can have devastating consequences. This project will expand the base of documented failures, incipient failures, and other problems with feeder apparatus. It also will address integration of DFA technology into new and existing systems.

Value

- Provides early warning of failing equipment
- Enables recognition of operational problems with apparatus
- Prevents outages and enables faster service restoration
- Increases reliability and overall situational awareness
- Reduces the need for costly, ineffective (even counterproductive) preventative maintenance
- Provides valuable data for forensic analysis

How to Apply the Results

The results of this project will expand the widespread deployment of DFA technology on distribution systems, thereby allowing utilities to systematically identify and correct incipient failures and operational problems, which ultimately will help in avoiding failures and outages. The results of this project will be used by distribution system managers, designers, and planners.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Distribution Fault Anticipator Phase 3 – System Integration	12/31/2008	Technical Report

P124.008 ADA Monitoring System Infrastructure and Integration (065545)

Issue

The utility industry is rapidly moving to modernize distribution systems, including wider use of advanced distribution automation (ADA). The Distribution System of the Future will be based on ADA that includes two key aspects:

- ADA will enable new system configurations and reconfiguring capabilities, which will increase the flexibility and reliability of the distribution system, as well as prevent or recover from outages.
- ADA will enable integration and strategic use of new intelligent electric devices (IEDs) embedded in power electronic components, advanced volt amperes reactive (VAR) management systems, power quality enhancement equipment, distributed generation, and fault anticipators. These IEDs not only enable the more flexible electrical architecture mentioned above, but also provide the means for expanded customer service options. These IEDs also act as components of a larger monitoring system capability. Integration of an Advanced Metering Infrastructure (AMI) will also be a key component in the monitoring system infrastructure for ADA.

Realizing this vision of ADA requires widespread distribution system monitoring, data processing, and diagnostic capabilities.

Description

This project addresses the development and evaluation of monitoring systems for ADA and the distribution system of the future. In past work in this project, a requirements definition and design basis were developed for the real-time ADA monitoring system. This work included determining the monitoring system objectives, its functions, technology options, and a general system design. The monitoring system is to be based on use of off-the-shelf technology wherever possible. The monitoring system will require integration of information from a wide variety of technologies and systems. This will include various IEDs throughout the distribution system, new sensor technologies that provide low-cost monitoring of specific signals, and widespread AMI. A key aspect of the monitoring systems will be to integrate data from AMI, which one utility has called "the ultimate supervisory control and data acquisition (SCADA)."

In the next phase of the project, the design basis is used as a framework for testing and evaluating specific components, data processing capabilities, and other features identified as needed in the design basis. The project team evaluates these monitoring system features and prepares for system integration into a final monitoring system specification.

The principal emerging international standard for communication architecture for real-time automation of distribution systems is IEC 61850. To achieve cost-effective interoperability of the large number of components in the monitoring systems, the components need to be migrated to this standard (at least in terms of having standard information models for the information being collected). EPRI will continue its involvement in this standard development and work with vendors and utilities to develop a rational plan for migrating monitoring system components to conform to IEC 61850 and report the status of the standards work as part of this project.

The monitoring system will also incorporate capabilities emerging from other EPRI projects as they become available, such as the Distribution Fault Anticipator (DFA) and embedded monitoring capabilities in devices such as the EPRI Solid-State Switchgear System (the 4-S) and the intelligent universal transformer (IUT). Vendor and utility cost sharing are sought for the field testing and evaluation of specific monitoring system features. Due to the time needed to set up these teaming arrangements, as well as test and evaluate monitoring system features, the next phase is a two-year project. Following this phase, a final report will be prepared that presents the findings and integrates the results into a specification for ADA monitoring systems that sponsors can use to procure entire systems. Based on member need and

interest, a second round on monitoring system evaluations may then be initiated using the same process to evolve a specification for a second-generation system.

Value

- Optimizes real-time system operations, prevents outages, and aids in basic automated operations in the near term
- Increases energy efficiency, reduces O&M costs, and increases system security
- Helps utilities begin to automate or more fully automate their systems, which in turn improves energy efficiency of distribution operations, because ADA improves overall system performance and energy throughput
- Improves system functionality, allowing better power quality and a wider variety of customer services to be delivered to customers
- Enables automated response to mitigate outages or speed recovery from outages
- Supports migration from legacy proprietary systems to open systems based on international standards
- Improves decisionmaking from among the technology, software, sensor, data processing, AMI, and system integration options for real-time ADA monitoring systems in the Distribution System of the Future

How to Apply the Results

Electric distribution managers, engineers, planners, designers, information technologists, and operators will use the results to more efficiently implement a monitoring infrastructure that will support automation and intelligent applications that benefit system operations and asset management. Decisions regarding monitoring technologies and overall infrastructure design will be made based on an understanding of best practices. Continued development of standards will facilitate convenient integration of advanced applications using the monitoring system infrastructure. Use of advanced systems enables significant gains in energy efficiency, system reliability, outage management, and variety of customer services. These in turn improve customer satisfaction and provide visible action to the public and regulators (i.e., a serious effort to improve energy efficiency and act as a steward of environmental resources). The results can be of significant value to utilities at all stages of automating their systems, and they enable planners to incrementally move to increasingly sophisticated automation over time.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Status Report on Monitoring System Development and Field Experience Evaluation for ADA and the Distribution System of the Future: This report covers progress to date on this project.	12/31/2008	Technical Update

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Final Report on First-Generation Specification for Real-Time Monitoring System Development for ADA and the Distribution System of the Future: The process described and deliverables are repeated on a two-year cycle to capture technology advances and integrate them into subsequent generations of specifications for the monitoring system infrastructure. If there is sponsor interest in an in-depth look at some specific sensor, data processing, or other monitoring system technology in a given year, a special assessment report on that specific topic may be completed as per agreement with sponsors that year.	2009	Technical Report

PS161D Infrastructure and Technology for 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 energy efficiency technology living laboratory. 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
P161.007	Communications and Control Architecture Requirements for Integrating Demand Response, Customer Resources and Energy Efficiency Technologies	Communications and control infrastructure for integrating customer operations on a large scale remains a largely unsolved technical issue. The ultimate use of a variety of different communications systems over the wide area and the ability to connect to different in-building networks poses significant challenges for management and security infrastructures. This project will define requirements and proposed designs for the equipment necessary to support a robust customer communications infrastructure.
P161.008	Extension of Common Information Model to Integrate Demand Response, Customer Resources, and Energy Efficiency Technologies	A common language is needed to integrate and communicate with applications across the enterprise and the industry that can make use of data from customer systems and metering. Presently the Common Information Model has not been developed for communications with metering and customer equipment in support of energy efficiency, demand response, customer-sited distributed resources and general customer services. This project will develop a proposed set of common information model objects for communications and application integration with customer systems data.
P161.009	Designs for Interfacing Intelligent Building Controls for Demand	This project will develop designs for interfacing utility communications with customer systems. The designs will include development of interfaces for utility master stations, customer

Project Number	Project Title	Value
	Response, Energy Efficiency and Distributed Resources	gateways and in-building equipment to execute energy management, demand response, and energy efficiency services as well as control of customer-sited distributed generation.
P161.010	Infrastructure Living Laboratory – Assessment of Communication, Metering and Smart Device Cost, Benefit, Interoperability and Performance	In 2007 EPRI established a vendor network and living laboratory to test "energy efficiency infrastructure" components in joint efforts with equipment suppliers to understand technical capabilities, and determine where gaps exist. The laboratory conducts unbiased evaluations of equipment and systems for advanced metering, demand response and energy efficient dynamic systems.

Project Descriptions

P161.007 Communications and Control Architecture Requirements for Integrating Demand Response, Customer Resources and Energy Efficiency Technologies (063432)

Issue

Communications and control infrastructures for integrating customer operations on a large scale present numerous unsolved technical issues. The ultimate use of a variety of different communications systems over a wide area and the ability to connect to customer communications and control systems pose significant challenges for management and security infrastructures. The industry needs to develop robust designs for communications networks that can be effectively scaled up to cover millions of customers across diverse geographic environments. Robust designs must make use of emerging open standards development from across a variety of industries, including telecommunications, data networking, building automation, and utility automation systems. Research and development efforts are needed to fill in key gaps in systems management and security in order to deploy communication systems with customer interfaces that can last for decades.

Description

This project defines requirements and proposed designs for the equipment necessary to support a robust customer communications infrastructure. It draws from the many requirements that are being developed through utility and industry projects to develop proposed open systems designs based on key emerging standards for customer communications. The focus of this project is on the architectural issues necessary to integrate systems from different industries to provide a well-managed communications infrastructure that meets present and future needs. The project also reviews communications technologies being deployed for communication with customer systems in order to identify advantages, disadvantages, and gaps in capabilities of the existing systems and technologies. Designs that will provide best in class capabilities for integrating with customer intelligent systems and devices will include the following;

- Development of a common communications language for integrating customer operations, such as effectively integrating applications-level languages needed for residential and commercial standards communities
- Development of management and security infrastructures that are critical to building, maintaining, securing, and managing millions of customers integrated with energy system operations
- Enable capability to control loads through prices and signaling as well as integrating customer distributed generation with advanced utility operations
- Development of infrastructures to support plug in hybrid electric vehicle (PHEV) charging and metering independent of location.

The development work includes key contributions to consortia and standards organizations to ensure the specifications can be realized in real equipment supplied by numerous vendors. The designs will be captured through a combination of requirements, specifications, and an industry model using standardized unified modeling language notation. The designs will be evaluated with respect to ongoing actual designs and deployments with cooperation of members.

Value

- Develops an infrastructure specification for customer communications that is open, secure, extensible, and well managed
- Enables competitive procurement of equipment to support customer communications integration including metering, gateways, and in-building energy management systems
- Enables vendors to produce equipment compatible with well-understood open standards, resulting in effective life cycle management of customer communications systems
- Enables customers to buy equipment from a variety of vendors that can become effectively integrated into dynamic utility operations
- Assists in developing customer communication systems that can be scaled up and managed over a reasonable lifetime of fifteen years or more

How to Apply the Results

The results of this project will assist utilities in specifying their own systems in a way that is consistent across the industry. These specifications also help to create markets for the equipment that will be built to the open standards that are the basis of the architecture. The designs from this work also assist the maturity of the key standards to be able to support the emerging requirements.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Designs for advanced customer communications architectures	12/31/2008	Technical Update
IntelliGrid architecture model	12/31/2008	Technical Update

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Utility and energy industry demonstration projects: Designs using emerging broadband communications media and advancements in systems management infrastructures now developing in computer and networking industries	2009	Technical Report
IntelliGrid architecture model version 5.0:	2009	Technical Update

P161.008 Extension of Common Information Model to Integrate Demand Response, Customer Resources, and Energy Efficiency Technologies (065588)

Issue

A common language is needed to integrate applications across enterprises, especially when considering the variety of applications that can be built around the new information systems that will be associated with advanced metering infrastructures, advanced demand response systems, and new customer services to enhance energy efficiency. Currently, the Common Information Model (CIM) has not been developed for integrating metering and customer equipment in support of energy efficiency, demand response, customer sited distributed resources, and general customer services. Application-level information objects have been developed for specific customer equipment communities, such as within building automation standards for commercial buildings (e.g., Building Automation Control network (BACnet™)) and the CEMA EIA 721 Standard Common Application Language (CAL) for residential systems). Other application-level communications languages have been developed for managing networks and computers. The industry needs to effectively integrate an industry-level CIM for enterprise and industry-level applications that require customer integration on large scales. In addition, new application areas of energy efficiency services, plug-in hybrid vehicles, and other end-use services will need a common language for integration with associated information systems.

Description

This project will provide a forum and experts for development of the common language needed to integrate new applications in the area of advanced customer services, energy efficiency, and demand response. The results will be coordinated with industry standards development efforts and will be organized into a guide for utilities to specify new applications and information systems in a way that will minimize integration costs. Development of new information objects will build on an analysis of the data and information models that have been developing within building automation, metering, residential home automation and networking and other related standards communities (including efforts related to electric and hybrid electric vehicles). The intent behind this project is to reduce or eliminate the need for semantic mapping or translation as information is integrated across applications and industries. The applications supported draw upon functions and requirements defined within industry-level use cases and requirements documents from the IntelliGrid architecture, utility customer communications and advanced metering infrastructure (AMI) projects, and the Open AMI, Utility AMI and AEIC metering groups.

Value

- Expedite development of advanced applications and integration that can be implemented at enterprise level via development of common objects for industry-wide information integration
- Support development of powerful concepts for information and data sharing (e.g., service-oriented architecture) via development of a common information model
- Enable competitive procurement of advanced applications by reducing or eliminating translating systems and gateways (use of the guide for specifying systems using the common information model)
- Reduce life cycle costs of systems by reducing or eliminating translating systems and gateways

How to Apply the Results

Utilities will use the guide developed to implement improved specifications for systems that can significantly reduce the costs of integration with existing and future information systems.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Guide for specifying interfaces between information systems for support of demand response, energy efficiency initiatives, and customer services – scope and initial draft	12/31/2008	Technical Update

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Guide for specifying interfaces between information systems for support of demand response, energy efficiency initiatives, and customer services – First full version	2009	Technical Report

P161.009 Designs for Interfacing Intelligent Building Controls for Demand Response, Energy Efficiency and Distributed Resources (063430)

Issue

Utilities are beginning to specify equipment and systems for interfacing with customer in-building equipment. These interfaces need to be based on open standards already developed by building and appliance automation industries. Initial designs are necessary to assist in the development of interoperable equipment that can be appropriately integrated with electric power delivery operations. Customers can cooperate with utility operations if they have the ability to communicate with power system operations and take action through automated responses. The enabling infrastructures now emerging from key standards organizations need equipment designs that assist standard maturation and provide true product interoperability. These designs enable further standards codification and foster vendor cooperation in developing interoperable equipment.

Description

This project develops designs for interfacing utility communications with customer systems. The designs include development of interfaces for utility master stations, customer gateways and in-building equipment to execute energy management, demand response, energy efficiency services, and control of customer-sited distributed generation. Communications interfaces include both the application-level communications as well as the services to be performed by the equipment. These designs apply emerging open systems communications standards that have been in development by the utility industry as well as the building and appliance automation industries. Proposed designs will be developed for commercial and residential equipment that are based on open standards appropriate to these environments. The designs will be tested and evaluated in actual field demonstrations with the cooperation of members.

Value

- Contributes to continued maturation of open standards, ensures application of these standards to actual equipment
- Enables two-way communications between customer-owned equipment and utility equipment to implement a variety of dynamic actions
- Enables development of energy efficiency functions, such as end-use equipment diagnostics and management
- Enables effective management of customer-sited distributed generation and storage including plug-in hybrid electric vehicle (PHEV) integration

- Enables utilities and customers to competitively procure interoperable, intelligent equipment from any vendor
- Extend equipment life cycles from more standardized equipment and open-systems-based designs
- Evaluates important concepts and capabilities of the standardized interfaces through real-world applications

How to Apply the Results

Utilities will use these results to develop improved specifications and product implementations involving communication and control interfaces with customer equipment in commercial buildings. The interfaces will support advanced applications that can benefit local distribution systems and the overall power system operation, as well as local customer systems. Additionally this work will be contributed to key standards organizations, such as ASHRAE BACnet committees, for codification. In this way these functions become embedded within products available from any vendor.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Customer integration reference design application guide: Defines data and control actions at the interfaces, and includes use cases supported by the interfaces to customer equipment. Develops and contributes communications data and device models to key standards organizations.	12/31/2008	Technical Update

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Reference implementations to integrate utility and customer operations and equipment: Reference designs are developed on the bench top and are used to implement and evaluate the interfaces for conformance to the relevant standards as well as interoperation between equipment from different vendors.	2009	Technical Report

P161.010 Infrastructure Living Laboratory – Assessment of Communication, Metering and Smart Device Cost, Benefit, Interoperability and Performance (065589)

Issue

Advanced metering, demand response, and energy efficient dynamic systems are beginning to be deployed by utilities and customers and are being closely watched by regulators. Commercial products for providing these capabilities are being offered by hundreds of companies. Many of these products, and their underlying technologies, have limited track records in the electric utility industry. The costs for installing these systems are substantial; for instance, the cost for deploying advanced metering throughout California is estimated to be $5 billion. Utilities are making decisions on which applications to deploy, which products to install and which technologies to apply. To make informed decisions and to minimize risk, utilities need credible and unbiased assessments of technologies and products. Research in related projects will help foster improved specifications and design guidelines for these technologies (e.g. open systems). This project focuses on actual technology assessments through a combination of laboratory evaluations and actual field deployments.

Description

In 2007, EPRI established a vendor network and living laboratory to test intelligent "energy efficiency infrastructure" components in joint efforts with equipment suppliers to understand technical capabilities, and determine where gaps exist. EPRI's Power Electronic Application Center (PEAC) laboratory in Knoxville is the hub of the living laboratory and is linked and coordinated with other industry, university, manufacturer, and utility testing laboratories as well as U.S. national laboratories. This project works closely with vendors and funding utilities to determine the highest priority testing and field demonstrations and develops evaluation procedures to enhance the understanding and future technology designs. The project results in ongoing technology assessment reports related to testing projects in the laboratory and actual field deployments of the technologies. The living laboratory of dynamic energy management technologies also provides for special test projects on a "pay-as-you-go" basis for utilities that are considering the installation of systems of their own. The performance assessments for these systems can be linked with the overall library of technology assessments.

Value

- Provides credible, unbiased assessment of products and their underlying technologies to inform utility decision making and to minimize risk
- Provides industry-level reference designs for components and systems to promote interoperability

How to Apply the Results

Executives and engineers from utilities that are installing, or considering installing, advanced metering, demand response, and energy efficient dynamic systems can use the results from the Living Laboratory when procuring equipment.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Technology Assessments of key products and technologies related to dynamic energy management and energy efficiency initiatives, including advanced metering infrastructures to support these initiatives	12/31/2008	Technical Resource
Maintenance of a dynamic energy management technology and product database	12/31/2008	Technical Resource
Reports of laboratory testing and field trials of dynamic energy management infrastructure technologies	12/31/2008	Technical Update

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Technology Assessments of key products and technologies related to dynamic energy management and energy efficiency initiatives, including advanced metering infrastructures to support these initiatives	2009	Technical Resource
Maintenance of a dynamic energy management technology and product database	2009	Technical Resource
Reports of laboratory testing and field trials of dynamic energy management infrastructure technologies	2009	Technical Update

PS161E Security Issues for the Power System Communication and Control Infrastructure (065436)

Project Set Description: This project set is better known as the Energy Information Security project set and consists of two major components:

Information sharing: Information exchange through member workshops, a member-only email listserve, and the production of practical documents has traditionally been the foundation of the EIS program. Examples of EIS 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. EIS 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: Research continues to explore new technologies for securing critical operations, transmission, and wireless-based communications systems. In 2008, the EIS Project Set continues work on two important security projects: (1) demonstration of secure deployment of emerging communications technologies to support energy management systems, and (2) development of a tool to measure the quantitative benefits of deploying security technologies. These results will help program members to (1) assess the value of emerging communication technologies and, should they wish, to implement it on their own critical systems, and (2) to perform reliable cost-benefit analyses of planned security deployments.

For 2008, research focuses on the following areas:

- P161.012 provides procedures and techniques to securely deploy emerging high speed communications technologies into energy management systems.
- P161.013 provides a tool to quantitatively measure the value of security deployments

Project Number	Project Title	Value
P161.011	Security Information Sharing and Lessons Learned	Provides information sharing and facilitates the industry's proactive, technical, and operational response to infrastructure threats. Benefits include: • Maintain awareness of emerging security technologies and 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 including opportunities to provide input on their applicability and contribute to directing future research in beneficial directions
P161.012	Security of High Speed, High Bandwidth Communications in Energy Management Systems	Implements secure communications from a control center to a substation and document lessons learned. Benefits include: • Enables secure and effective management of substations to help companies best meet societal needs for reliable electric power delivery

Project Number	Project Title	Value
		• Enables utilities to securely monitor access and environmental conditions at substations and switching yards • Enables monitoring of environmental conditions and system health while reducing physical site visits significantly
P161.013	Security Metrics for Energy Management Systems	Develops a tool that will allow utilities to quantitatively estimate benefits from implementing security solutions. Benefits include: • Enables accurate and consistent cost-benefit analyses of proposed security activities and deployments • Demonstrates fiscal responsibility of utilities in their security activities to government, regulators, share holders, and customers

Project Descriptions

P161.011 Security Information Sharing and Lessons Learned (065590)

Issue

The energy industry is becoming more automated and electronically connected. Critical data and information are being sent through corporate local and wide area networks (LANs and WANs), in many instances with direct connections to the Internet. While a significant focus for security work has been Internet and e-commerce applications, less attention has been paid to 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 connectedness, operations 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 continued information sharing, which facilitates the industry's proactive, technical, and operational response to infrastructure threats. Member-directed, collaborative sharing of technical information, via three workshops annually, the member-only email listserve, and other communications media has been a key component of the Energy Information Security (EIS) Program from its inception. The information sharing and lesson learned activity has been the highest ranked project for funding by members in the past.

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) are also delivered to members of this project.

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 including opportunities to provide input on their applicability and contribute to directing future research in beneficial directions
- Maintain current knowledge of NERC cyber security standards and the commonly understood 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

How to Apply the Results

The workshops in this project are aimed at attracting utility personnel who have the responsibility or want to gain more knowledge on utility security infrastructure. When these staff attend any of the project workshops, they can 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 can also 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.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Three Workshops	12/31/2008	Workshop, Training, or Conference

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Workshops: Workshops as described above.	2009	Workshop, Training, or Conference

P161.012 Security of High Speed, High Bandwidth Communications in Energy Management Systems (065591)

Issue

Emerging high-speed and high-bandwidth communication technologies are being adopted by electric power utilities for use within energy management system (EMS) networks. These technologies offer increased capabilities for managing substations and switchyards. For example, they enable the use of security technologies such as video monitoring, card-activated door and gate locks, motion sensors, and system management tools for computerized control systems. They also enable environmental monitoring for temperature and moisture and for system health for the automated control systems. However, these technologies also introduce new vulnerabilities as they inherit all of the vulnerabilities of the Internet at large.

Description

This project works with electric power companies and DOE laboratories to implement the results of work done in this area in 2006 and 2007. Work in 2006 delivered an overview of the pertinent technologies. In 2007, the project evaluated security of wireless technologies in a substation environment. The 2008 work includes at least one demonstration project to evaluate technologies deemed important by the funding companies. This project also implements communications from a control center to a substation and publishes a thorough "lessons learned" report.

Value

- Provides processes and procedures so utilities can securely deploy emerging high-speed and high-bandwidth communications technologies to best advantage within their energy management system networks
- Enables utilities to securely monitor access and environmental conditions at substations and switching yards via use of emerging communications technologies
- Enables monitoring of environmental conditions and system health while reducing physical site visits significantly
- Enables secure and effective management of substations to help companies best meet societal needs for reliable electric power delivery
- Positions companies to move to the 'intelligent' grid of the future via secure implementation of emerging communications technologies
- Enables companies to manage field resources more economically and more securely

How to Apply the Results

Transmission operators and substation planners will use these results to improve communications in existing substations and to implement secure, modern communications technologies in new substations. This enables them to effectively and efficiently implement emerging communication technologies in a manner that is appropriate and beneficial to their own company.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Security of Communication and Control Systems	12/31/2008	Technical Report

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
TBD – depending on interest of the program funders and results from 2008	2009	

P161.013 Security Metrics for Energy Management Systems (065592)

Issue

It is difficult to estimate the monetary value to be obtained from implementing security technologies to protect energy management systems. There is a need for a tool that will allow utilities to quantitatively estimate such value. This will provide a means to conduct a rigorous cost-benefit analysis of any particular security activity, whether it entails changing procedures, implementing new policies, or installing new security technologies. This tool will enable transmission managers to present solid cost-benefit information to the corporate managers who must prioritize project funding.

Description

Continuing activities begun in 2006, this project generates a tool to provide quantitative value for the benefits of implementing security solutions. 2007 efforts produced a prototype tool upon which the final product will be built in 2008. EPRI coordinates with other metrics activities focused on the electric power industry (e.g., i3p metrics work and NIST metrics work).

Value

- Enables quantitative estimates of the benefits of security activities and deployments
- Enables accurate and consistent cost-benefit analyses of proposed security activities and deployments, facilitating prioritization of security expenditures along with other business expenses
- Demonstrates fiscal responsibility of utilities in their security activities to government, regulators, shareholders, and customers

How to Apply the Results

Energy Managements System (EMS) managers, security planners and planning engineers will use this stand-alone tool on Windows workstations to quantitatively estimate the value of security activities. The tool facilitates the production of information in a format suitable for presentation to management.

2008 Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
Security Metrics for the Electric Power Industry	12/31/2008	Software

Future Year Deliverables

Deliverable Title & Description	Planned Completion Date	Deliverable Type
TBD – depending on interest of the program funders and results from 2008	2009	

Exhibit 1
Supplemental Project Agreement
CF 12500-10759 (Project ID No. 65893)

"Development of a Roadmap for Intelligent Transmission System Architecture"

A. Background, Objectives and New Learnings:

Many utilities are interested in developing a roadmap for implementation of a communications, control, and data management architecture that can facilitate monitoring, control, and automation functions at both the transmission and distribution system levels.

This is a work statement for a project to work with utilities in the development of a roadmap for the infrastructure that will support an intelligent grid. This project focuses on the Intelligent Transmission System Architecture. It involves working with system architects, engineers, and planners to develop a roadmap for implementation of the communication and information system infrastructure to support an intelligent transmission system to be demonstrated at Duke.

There are many advantages to a technology assessment that looks at the overall requirements for the future power system communication, control, and data management requirements. As many different applications are foreseen, it is important to look at the common requirements and evaluate the potential for a common architecture to provide the basis for these applications. Important applications include:

- Transmission EMS
- Communications for DFRs and other IEDs that have more detailed waveform recording functionality than traditional RTUs (integration of data from many types of IEDs)
- Phasor Measurement Unit applications
- Monitoring of transmission capacitor banks for harmonics and transient concerns
- Substation automation including possible migration to IEC 61850 type of architecture in the future
- Intelligent equipment diagnostic applications and information management for these applications
- Application of the Common Information Model for information management and interfaces for intelligent applications

For each of these applications, functional requirements need to be understood as well as requirements for security, reliability, and infrastructure management. Important standards, such as the Common Information Model for integrating applications, should be considered. The future infrastructure will also take into account important regulatory requirements for security and other issues (e.g. NERC/ERO requirements).

The work will be organized in the following steps:

1. Characterize existing utility communications and control systems and facilities for transmission system management, control, and equipment diagnostics.
2. Work with Duke and other participating utilities to develop requirements for future systems based on applications (use cases) that will likely be cost justified based on

system management, equipment diagnostics, real time performance assessment and risk assessment, etc.

3. Map the requirements to technologies that are available and are likely to be available in next generation systems.
4. Develop a roadmap and implementation plan for the recommended technologies and the associated applications.

Many utilities have the need to develop a roadmap for implementation of an architecture to support a future intelligent grid.

A roadmap developed in this project as the final deliverable will contribute to more general industry infrastructure and technology requirements and be specific to the requirements and existing infrastructure at Duke Energy. Generic versions of selected use cases and roadmap development procedure will be available for the collaborative effort.

Objectives

- Characterize existing communication, control, and information systems (including projects that are under way to improve these systems) at Duke as a foundation for implementation of future applications and systems. Also characterize existing vision for the future system infrastructure and the applications that will be enabled.
- Conduct workshops to obtain input from utility personnel for development of use cases that can be used to define requirements for existing and future applications that will take advantage of the communications, control, and information systems infrastructure.
- Document use cases for these applications as a means of deriving functional requirements for the infrastructure.
- Determine range of technologies for communications and information systems infrastructure that can support the functional requirements. Evaluate costs and benefits of different technologies taking into account migration from existing infrastructure.
- Evaluate and incorporate non-functional requirements (especially security requirements) into the overall roadmap.
- Develop recommended progression (demonstrations, evaluation, more widespread implementation) for the recommended technologies. Identify important assessment guidelines for evaluation of progress in the roadmap implementation.
- Conduct a workshop to review recommended roadmap with Duke and possibly in combination with other participating utilities, taking advantage of the value of information sharing.

New Learning

- The research will provide plans for implementing a communication and information system infrastructure for the transmission system.
- The plan will identify important applications for the communication and information infrastructure that can benefit both the utility and society.

- These applications will drive the requirements and the technologies that can be applied for the communications and information infrastructure.
- Important gaps in available technologies and research needs will be identified.

Benefits

Creating an intelligent transmission system will improve the reliability and controllability of the entire transmission grid.

Important benefits to the industry include:

- Integrated management of information from the transmission system will allow more intelligent decisions for operating the system.
- More timely and comprehensive information about transmission assets will improve asset management decisions and equipment reliability.
- Integrated disturbance monitoring will facilitate fault location and disturbance analysis, resulting in improved reliability.
- Better visibility of transmission system conditions and operation will help operators make better decisions about managing the transmission systems and will facilitate development of algorithms for automating the operation of the system.
- The project is fundamental research on development of a migration path for implementation of the intelligent grid. Actual implementation of technologies and systems at Duke is not part of this project.

Important benefits to the public include:

- Improved reliability and security of the transmission grid, reducing costs associated with outages.
- Improved efficiency of managing the transmission grid, reducing overall costs for the power system infrastructure.
- Understanding and management of power quality issues, which can also have cost impacts in power system customers.
- Reduced losses on the transmission system, resulting in reduced carbon impacts of operating the transmission system.

B. Tasks:

Task 1 – Characterize Existing Infrastructure and Develop More Detailed Plan for Roadmap Development

The first task will involve information gathering from the utility as well as a Kickoff meeting to help establish the boundaries and most important objectives for the roadmap.

It will be very important to develop a good understanding of existing systems that can form a foundation or need to be included in the future architecture:

- SCADA/EMS
- GIS

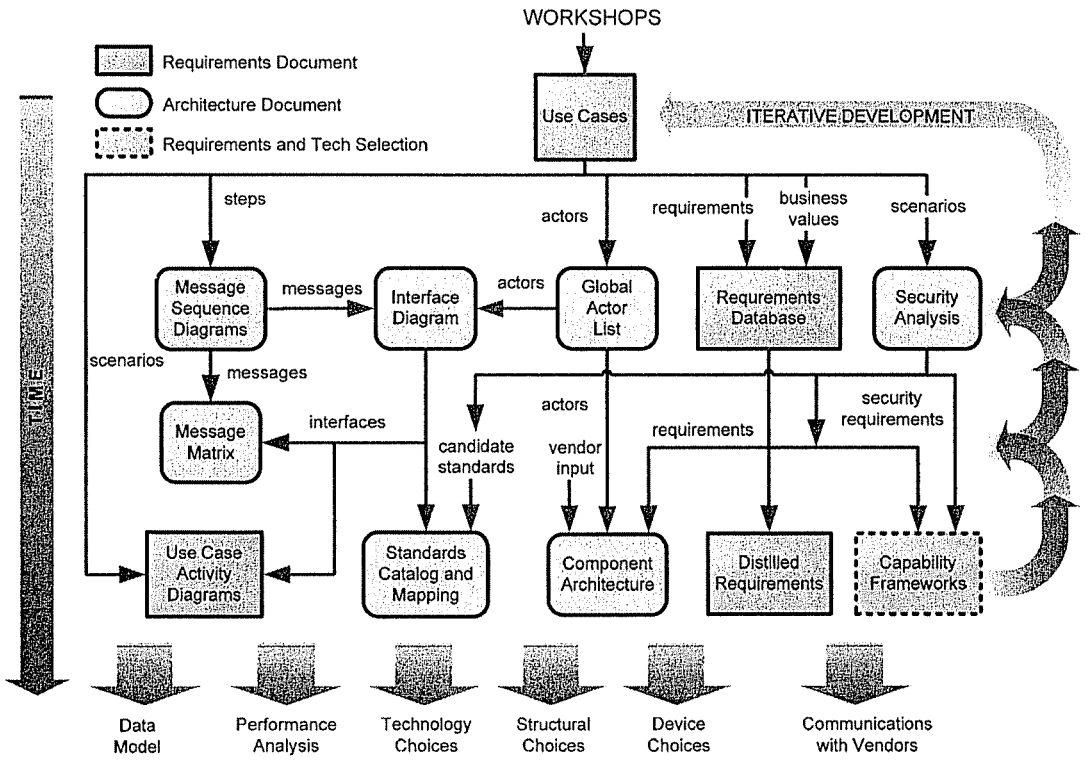
- Asset management systems, intelligent equipment diagnostics systems (transformers, breakers, etc.)
- DFRs and other IEDs for disturbance recording
- Phasor measurement units
- PQ monitoring systems
- Electrical models for planning and operations (PSS/E, PSLF)
- PI Historians
- Transmission communication technology and architecture
- Capacitor controls (transmission)
- Security guidelines and practices – possible changes in requirements based on NERC/ERO issues

A kickoff meeting will be held for initial characterization of existing systems, ongoing projects, and efforts already completed towards the future system vision and discussion of overall project objectives for the roadmap. Additional information and data collection requirements will be identified at the kickoff meeting.

The information describing the existing infrastructure will be used by the EPRI team to develop an "as built" document that describes the base systems. This document will include projects that are currently planned and under way.

Task 2 – Workshops to Develop Functional Requirements

A major aspect of the IntelliGrid Architecture is related to implementing a highly disciplined approach to capturing, documenting, and analyzing requirements for a system (see diagram below). This task involves working with utility engineers and system architects to capture the core requirements of the future infrastructure by application of the IntelliGrid use case approach to documenting system functional requirements. This effort will be focused on critical functions that are expected to be fundamental applications of the future infrastructure.



The EPRI Team will develop a list of possible applications for consideration prior to the first workshop. These will be used as a starting point for definition of the use cases as a collaborative process between the EPRI Team and a core group of utility engineers and architects representing appropriate parts of the company. This work will also take advantage of related use cases being developed as part of the collaborative project with other utilities.

Note that this task can also take advantage of use case work already performed at Duke for smart grid development. Existing use cases can provide a valuable starting point for refinement in this process for focus on critical transmission applications.

Two workshops are proposed for the requirements development process:

1. The first workshop will provide a review of the use case process and will include joint development of a use case for the project. The group will also help refine the list of important use cases at this stage, including taking advantage of previous Duke use case work. It is expected that this workshop can be done with a single day (half day on use case process and half day devoted to a use case and refining the list of use cases).

2. The second workshop will involve more in depth evaluation of the use cases identified in the first workshop. Group refinement of the use cases based on understanding of the applications will be accomplished and then important requirements will be derived from the use cases.

3. The second workshop will also help refine non-functional requirements. These typically have to be addressed in a more general sense. It is often difficult to define these requirements based on particular use cases:
    i. Communication Configuration Issues
    ii. Quality of Service Requirements
    iii. Security Requirements
    iv. Data Management Requirements

Task 3 – Technology Assessment and Development of Technology Recommendations for Roadmap

This task will use the information from the data gathering (existing infrastructure) and the requirements development to characterize technologies that could be part of the utility infrastructure.

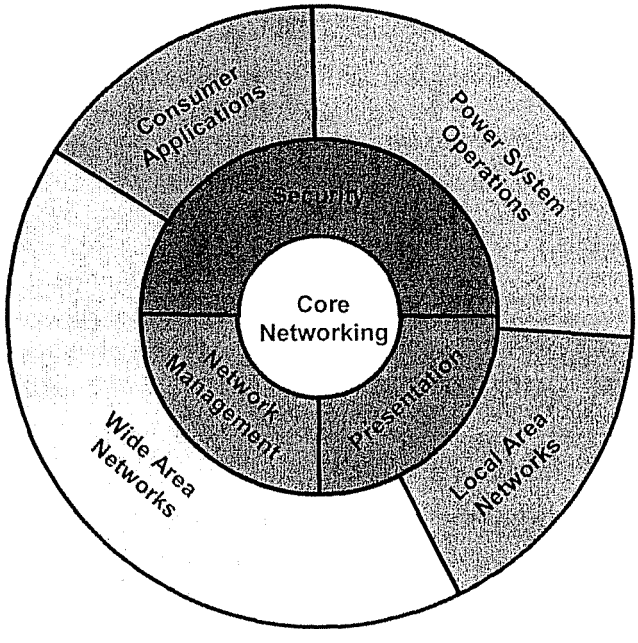
Important technologies to address in this stage include communications technologies and information system technologies. They will be evaluated with respect to both the functional and non-functional requirements (e.g. NERC CIP standards) for utility applicability.
The technologies can range from more generic, shared or common technologies such as core networking, security and network management to more specialized technologies that may be employed for advanced substation monitoring and system communications (wireless technologies in substations, high speed network options for the transmission system). The technologies reviewed will also include the various information models (e.g. Common Information Model) and technologies used for existing power system communication applications.

The main results of this task will consist of a summary of the different communications and information technologies that may be appropriate for the intelligent transmission system infrastructure.

This assessment will take the following approach:

- Criteria are defined, based on the initial recommendations of the IntelliGrid Architecture, as well as discussions in the workshops.
- Criteria are applied to a subset of the technologies identified in the IntelliGrid Architecture to create a table of technology ratings. These technology ratings provide a starting point for the evaluation of technologies for particular applications but may be adjusted for utility requirements.
- Technologies are organized according to "communications service groups" as follows:
    - Core Networking – a common suite of protocols is needed to provide interoperable connectivity in a network that may vary greatly in topology and bandwidth.
    - Security – Because the applications involve real-time information about the status and state of power network systems, security is mandated by NERC CIP regulations.

- Network Management – Because of the huge numbers of devices that can be involved in the power system management and control, it is vital that standard technologies be used for managing the network, i.e. collecting statistics, alarms and status information on the communications network itself.
- Data Structuring and Presentation – A key principle of the IntelliGrid Architecture is the use of "meta-data" for formally describing and exchanging how devices are configured, and how they report data. The infrastructure will benefit from this capability to manage the large number of devices involved.
- Wide Area Network (WAN) Technologies – The problem of how to reach the distribution system sites represents the most rapidly-changing area of the infrastructure requirements and deserves special attention.
- Local Area Network (LAN) Technologies –The local vs wide-area networking becomes very important for substation applications. For instance, use of a substation data manager is a key design criteria when developing the architecture for the transmission system communications and information management.
- Power System Operations – Several of the key applications will involve integration with operations (EMS, OMS, fault location, continuous equipment diagnostics, etc.).



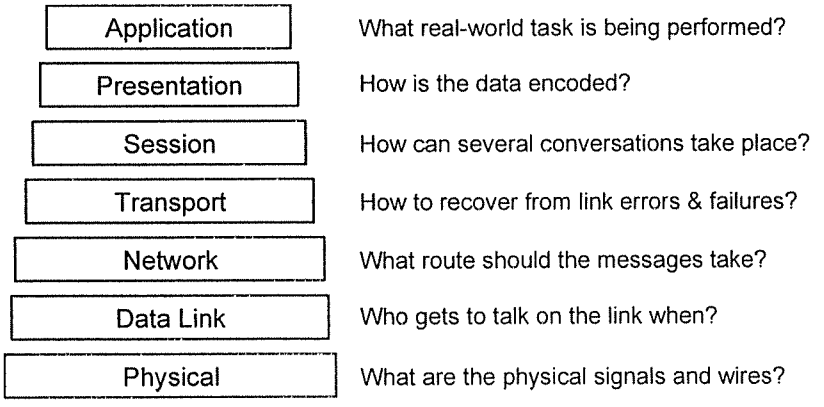
Communications Service Groups

The result will be documentation of important technologies with their characteristics related to the requirements of the utility infrastructure.

Note that the communication service group concept illustrated above (from Intelligrid) is different than the seven-layer Open Systems Interconnect (OSI) model, illustrated below. The OSI model is more traditionally used to evaluate communications technologies. However, many

of the candidate technologies will cross multiple OSI layers. For instance, DNP3, IEC 61850, and even some paging systems use portions of all seven OSI layers.

Furthermore, many of the problems the OSI layers were intended to solve have been well-described and fairly well addressed over the years. As a result, most of the technologies have well-defined layered interfaces and therefore can easily co-exist within a device and on a network.



Open Systems Interconnect (OSI) Reference Model

Note that the applications interoperability problems that are most likely to cause concern in the power system monitoring and control infrastructure are best described as being "above" the topmost OSI layer – in the realm of application object models and process orchestration. This is another reason for using the communication service groups concept when evaluating the technology options. This grouping is essentially orthogonal to that of the OSI model; a given technology can exist simultaneously in a particular set of layers and in a particular service group.

Some Important Conclusions from Previous Technology Assessments

These are some important results from previous Intelligrid work that can provide a foundation for the technology assessment in this task:

- It is important that any power system communication and control reference design or implementation include technologies from *each* of the service groups. Individual projects may choose to emphasize one service group over another, but for a good design, all service groups are necessary.
- In each service group, there are typically two or three candidate technologies, each of which is nearly equally suited for the kinds of applications being evaluated. For example, IPSec and TLS, SNTP and CMIP, or DNP and IEC 61850. The success of a reference design may rely on how they can be made to work together, rather than choosing one over the other.
- There are liable to be overlaps even between technologies in different service groups. Therefore a reference design will need to clearly identify roles and options that will permit them to work together properly, and not just define a "shopping list" of technologies.

- It is vital that any reference design be completely independent of the local-area or wide-area networking technologies available.

Many of the application technologies support mechanisms that would allow their data to be "tunneled" through an IP network. One possible strategy for harmonization of these various technologies would be for the device port to simply act as a gateway for such tunnels, "wrapping and unwrapping" messages in IP "envelopes" from clients at the utility site to power system equipment and vice versa.

Task 4 – Roadmap Development

This task will use the applications identified, the existing infrastructure information, and the technology assessment to develop an actual roadmap for the system infrastructure implementation at each utility.

The roadmap will identify:

- Priorities for technology implementations to maximize benefits in the ability to implement important applications (highest value applications).
- Methodology for migrating from existing infrastructure to proposed infrastructure
- Technology demonstrations that can confirm assumptions and results of the technology assessment, as well as demonstrate the benefits of important applications
- Assessment procedures for ingoing assessment of the infrastructure performance and issues
- Important infrastructure management issues (data management, security, reliability, infrastructure monitoring, etc.)
- Procedures for monitoring technology progress and updates that could change the conclusions and recommendations of the roadmap
- Overall timetable for implementation

The roadmap will illustrate how the important applications are enabled by the infrastructure in stages.

Task 5 – Workshop and Final Roadmap Update

A final workshop will be held to review the recommendations and the overall roadmap. This is expected to be a half day workshop where feedback on the proposed approach can be formalized (there will be opportunities for feedback through webcasts and updates during the roadmap development process but the workshop will provide a more formal mechanism for review by utility staff).

Input obtained during the workshop will be the basis of final modifications to the roadmap document.

Of course, the roadmap should be treated as a living document and it will be important to establish ownership of the document for ongoing updates as technologies and systems evolve.

C. Deliverables:

The non-proprietary results of this work will be incorporated into EPRI R&D program Intelligrid Program P161, and made available to funding members of that program and to the public, for purchase or otherwise.

The roadmap for migration to an intelligent grid is an integral part of the Intelligrid Program (P161) and the results of the project will contribute to the use case library that is part of this program.

Task 1 - Interim report documenting important existing systems and establishing overall objectives for the roadmap.

Task 2 - Documented use cases that form the basis of requirements for the system architecture, documentation of functional requirements, documentation of non-functional requirements.

Task 3 - Interim report providing technology assessment based on existing infrastructure and requirements for future infrastructure.

Task 4 - Draft roadmap for communications, monitoring, control, and data management infrastructure implementation at Duke.

Task 5 - Draft roadmap for communications, monitoring, control, and data management infrastructure implementation at Duke.

D. Estimated Period of Performance / Estimated Schedule:

The recommended duration for the project is nine months to allow time for participation of different groups within Duke Energy during the use case development process, review time for draft roadmap, and delivering a final workshop.

Electric Power Research Institute
2009 Portfolio

161 IntelliGrid[SM]

Program Overview

Program Description

The IntelliGrid[sm] 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

Donald Von Dollen, 650-855-2679, dvondoll@epri.com

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	• Provides industry coordination for smart grids activities • Tracks progress on industry standards related to smart grids • Provides information on smart grid deployment activities • Provides information on vendors and products related to smart grids • Provides guidelines for developing smart grid roadmaps • Refines the vision of a smart grid

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
Repositories of smart grid, business cases, pilots and implementations: 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
Advanced Metering Infrastructure (AMI) function / technology / value trade off analysis tool Version 2.0: 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
Guidebook for developing a Utility-Specific Smart grid Roadmap: 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 *Communication Networks Guidebook for Intelligent Transmission Systems* 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: • CIM Interoperability test • Tracking and contributions to key standards committees and industry organizations • CIM / IEC 61850 Harmonization

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
Communication Network Guide Book for Intelligent Transmission Systems: *Communication Network Guide Book* 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
Conduct industry CIM/GID interoperability tests in conjunction with current IEC revisions: 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
Smart Grid standards and industry activities tracking and analysis: 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
Harmonization of CIM and IEC 61850	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	• Develop a *Communication Networks Guidebook for Intelligent Distribution Systems* 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 • Help understand the opportunities for use of a common infrastructure to support both distribution management and customer communications (for example, AMI) • Evaluate opportunities to apply IEC 61850 methods for distribution communications infrastructures and develop migration strategies from existing infrastructures like DNP
P161.005	Common Information Model and Information Integration for Distribution Applications	• Develops a guide for using CIM for distribution applications • CIM interoperability test • Tracking and contributions to key standards committees and industry organizations

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
Assessment of Communication Network Technologies for Intelligent Distribution Systems: *Communication Network Guide Book* 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
Guide for using the Common Information Model in Distribution Applications – First full version: Provides members with a guide for using the Common Information Model (CIM) for distribution applications	12/31/2009	Technical Report
Strategy for migrating from DNP to IEC 61850: Provides strategies for members that wish to migrate from the DNP protocol to IEC 61850	12/31/2009	Technical Update
Conduct industry CIM/GID interoperability tests in conjunction with current IEC revisions: 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
Smart Grid standards and industry activities tracking and analysis: 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	• Develop a *Communication Networks Guidebook for AMI / Demand Response System* that will provide an unbiased document for educating utility members
P161.007	Common Information Model and Information Integration for Meter Data Management, Demand Response, and Distributed Resource Integration	• Develop standard data objects for dynamic pricing and direct load control • Conduct an interoperability test of AMI systems using the CIM data objects
P161.008	Business Case Framework for Advanced Metering	• Assess the societal benefits of advanced metering infrastructure systems
P161.009	Gateway and Home Area Network Interface for Integrating Demand Response Systems	• Develop an industry standard reference design for consumer gateways
P161.010	Living Laboratory Assessments of Technologies for Advanced Metering, End Use Communications, Smart Devices, and Controls	• Laboratory assessments of advanced metering systems and home area communications networks

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
Assessment of Communication Network Technologies for AMI / demand response systems: *Communication Network Guide Book* 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
Dynamic pricing and direct load control data objects – stakeholder engagement and use case development: 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
CIM Interoperability test – advanced metering extensions: 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 if 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
Framework for Quantifying the Benefits of SmartGrid and AMI Investments: 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-curtailment 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
Consumer gateway – stakeholder engagement and requirements development: 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
Technology profiles on the products and technologies tested: 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
Advanced metering test procedure: 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	• Maintain awareness of emerging security technologies 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 including opportunities to provide input on their applicability and contribute to directing future research in beneficial directions • Characterize and develop tools and methods for implementing and assessing EMS/SCADA security performance
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
Workshops: Workshops as described above	12/31/2009	Workshop, Training, or Conference
A Report on Best Practice Guide on Hardening of existing or new SCADA/EMS systems in control centers.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Three Workshops: 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
Technical Report on the Analysis: 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 21st 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

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

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-037

REQUEST:

With reference to Arnold Direct, page 17, lines 18 through 23, and page 18, lines, 1 through 5, address the following:

a. Identify specifically the types of smart grid investments Duke Kentucky believes the Commission can approve pursuant to the DSM Statute, KRS 278.285.

b. Identify specifically the types of smart grid investments which Duke Kentucky believes cannot be approved pursuant to the DSM Statute, KRS 278.285.

RESPONSE:

a. KRS 278.285(h) allows the Commission to approve: "Next-generation residential utility meters that can provide residents with amount of current utility usage, its cost, and can be capable of being read by the utility either remotely or from the exterior of the home." The Company believes that this authority would include the system infrastructure including communication equipment and information technology necessary to provide the functionality set forth in the statute. The meters alone cannot provide the benefits set forth in the statue without the infrastructure investment. The recovery through a "rider mechanism" is limited to residential customers.

b. The Company believes that the statute limits the recovery via a discrete rider charge to residential customers only.

PERSON RESPONSIBLE:

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-038

REQUEST:

With reference to the discussion of Duke Kentucky's proposed save-a-watt initiative in Case No. 2008-00495 in Stevie Direct, address the following:

a. Describe any smart grid investments included in the specific programs proposed by Duke Kentucky.

b. If not specifically discussed in part a. above, describe the impact of any smart grid investment in the specific programs proposed by Duke Kentucky.

RESPONSE:

a. At this time, there are no smart grid investments included in the specific programs proposed under the save-a-watt initiative. These will come over time as the Company develops customer acceptable offers that leverage the capabilities of the smart grid.

b. Not applicable. However, as new programs are developed that leverage smart grid capabilities, the Company expects to be able to reduce energy consumption and peak loads.

PERSON RESPONSIBLE: Richard G. Stevie

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-105

REQUEST:

Explain in detail how the utility treats energy efficiency as a priority resource. Identify and describe any goals the utility has developed in terms of Mcf or Btus displaced.

RESPONSE:

For the natural gas utility, the Company treats energy efficiency as a priority resource for residential customers by offering programs that enable customers to reduce their gas usage and better manage their utility bill. For natural gas planning and operations, the Company does not conduct an Integrated Resource Planning (IRP) analysis that integrates energy efficiency options with supply side options. Natural gas is a purchased resource distributed through a pipeline network. Natural gas energy efficiency does not function as a supply side resource in the same fashion as a vertically integrated electric utility. There is little/no investment in capacity that can be avoided through the implementation of gas energy efficiency programs.

PERSON RESPONSIBLE: Richard G. Stevie

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-106

REQUEST:

Identify all DSM programs offered by Duke Kentucky. If appropriate, identify any programs offered that have not been specifically authorized by the Commission per KRS 278.285. Identify the annual Mcfs or Btus that the utility estimates are displaced by each program.

RESPONSE:

All of the energy efficiency programs currently offered by the Company are provided in response to Commission Staff Data Request No. 24. Of those programs, a subset has energy impacts. The following table lists the applicable programs and CCF impacts.

Program	2008 CCF Impacts
Gas Weatherization	5,611
Home Energy House Call	3,006
Online Home Energy Calculator	3,068
Total	11,685

PERSON RESPONSIBLE: Richard G. Stevie

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-107

REQUEST:

Identify and describe Duke Kentucky's current rate designs that promote energy efficiency. Identify the annual Mcfs or Btus that the utility estimates are displaced by each rate design.

RESPONSE:

Since most of the rate is for the cost of natural gas, the Company is sending a price signal to customers that encourages conservation, primarily based on the cost of gas. The Company has not estimated the level of conservation from the rate design. As part of the gas load forecast process, the Company has estimated the price elasticity of natural gas which indicates the responsiveness of customers to changes in price given the rate design. The amount of conservation is dependent upon the change in natural gas price.

PERSON RESPONSIBLE: Richard G. Stevie

STAFF-DR-01-108

REQUEST:

With reference to the Direct Testimony of Jeffrey R. Bailey ("Bailey Direct"), page 9, lines 7 through 10, address the following:

a. Describe any "appropriate incentive" needed if Duke Kentucky's rates are further designed (beyond that described in Question 107 above) to encourage energy efficiency.

b. Explain why the "appropriate incentive" identified in 108. a. above cannot be implemented under the authorization of the current DSM Statute, KRS 278.285.

RESPONSE:

a. Duke Energy Kentucky believes that successful management of energy efficiency should be incentivized by allowing the utility to retain a portion of the cost reducing benefits accruing from the program.

b. Duke Energy Kentucky believes that sufficient statutes and regulations are in place to accomplish the goals of the EISA 2007 standards.

PERSON RESPONSIBLE: Jeffrey R. Bailey

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-109

REQUEST:

With reference to the discussion of decoupling on page 10 of Bailey Direct, address the following:

a. If applicable, describe the specific the form of decoupling Duke Kentucky supports.

b. Explain how the form of decoupling supported by Duke Kentucky differs from the recovery of fixed costs entirely from per-unit fixed rates.

RESPONSE:

a. While DE-Kentucky generally supports the concepts of decoupling, it has not formed an opinion as to which of the models it can support for implementation.

b. N/A

PERSON RESPONSIBLE: Jeffrey R. Bailey

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-110

REQUEST:

Explain whether or not the DSM Surcharge authorized by KRS 278.285 needs to be supplemented by a decoupling provision.

RESPONSE:

The surcharge authorized by KRS 278.285 already allows for recovery of lost margins. This is an accepted method in the industry for addressing the negative impact on a utility from implementing energy efficiency programs that reduce energy sales. The current surcharge mechanism does not need to be supplemented by a decoupling mechanism.

PERSON RESPONSIBLE: Richard G. Stevie

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-111

REQUEST:

With reference to the new PURPA Standards of EISA 2007, Section 532(b)(6)(B)(ii), referring to the provision of incentives for the successful management of energy efficiency programs, and Bailey Direct on page 11, lines 5 through 11, identify and describe any incentives Duke Kentucky believes are needed in addition to those authorized by the DSM statute, KRS 278.285.

RESPONSE:

Currently, the Company does not receive any incentives for the implementation of natural gas energy efficiency programs. The Company believes that the current statute could be employed to provide incentives for the implementation of natural gas energy efficiency programs, but statements from the Commission that clarify this would be useful. Duke Energy Kentucky believes that an incentive structure like what it has proposed for electric energy efficiency programs in its save-a-watt initiative should provide a reasonable incentive for implementation of natural gas energy efficiency programs.

PERSON RESPONSIBLE: Richard G. Stevie

Duke Energy Kentucky, Inc.
Case No. 2008-00408
First Set Staff Data Requests
Date Received: March 16, 2009

STAFF-DR-01-112

REQUEST:

With reference to the new PURPA Standards of EISA 2007, Section 532(b)(6)(B)(ii), referring to the provision of incentives for the successful management of energy efficiency programs, and the Stevie Direct Testimony on page 16, lines 2 through 8, explain whether or not Duke Kentucky believes that the Commission can authorize utilities to retain a portfolio of the cost-reducing benefits accruing from energy efficiency programs pursuant to the current DSM statute, KRS 278.285.

RESPONSE:

The Company believes that the Commission can authorize utilities to retain a portion of the cost-reducing benefits accruing from energy efficiency programs under the current DSM statute.

PERSON RESPONSIBLE: Richard G. Stevie

STAFF-DR-01-113

REQUEST:

Refer to page 10 of Bailey Direct. Duke Ohio has recently implemented a form of decoupling that places a greater portion of the utility's fixed costs in the customer charge portion of the customer's bill. Describe the resulting impact on the customer charge and volumetric charge for Duke Ohio.

RESPONSE:

Following are the rates prior to the case and the rates approved in the case:

The new residential gas base rates were phased in.

Rate RS (Residential Service) – prior to Rate Case

Customer Charge: $6.00

Volumetric Charge: $0.18591 per CCF

Rate RS (Residential Service) – Approved – June 2008 Through September 2008

Customer Charge: $15.00

Volumetric Charge: First 400 CCF at $0.401134 per CCF, Additional CCF at $0.465634 per CCF

Rate RS (Residential Service) – Approved – October 2008 Through May 2009

Customer Charge: $20.25

Volumetric Charge: First 400 CCF at $0.107044 per CCF, Additional CCF at $0.171544 per CCF

Rate RS (Residential Service) – Approved – June 2009 and after

Customer Charge: $25.33

Volumetric Charge: First 400 CCF at $0.040828 per CCF, Additional CCF at $0.105378 per CCF

The non-residential rate (GS – General Service) was split into two rates: General Service-Small (Rate GS-S) and General Service-Large (Rate GS-L). Rate GS-S applies to non-residential customers that used 4,000 CCF or less during the prior calendar year. Rate GS-L applies to customers that used more than 4,000 CCF during the prior calendar year.

Rate GS (General Service) – prior to Rate Case

Customer Charge: $21.00

Volumetric Charge: First 1,000 CCF at $0.1630 per CCF, Next 4,000 CCF at $0.1570 per CCF, Additional CCF at $0.1540 per CCF

Rate GS-S (General Service-Small) – Approved – June 2008 Through May 2009

Customer Charge: $40.00

Volumetric Charge: $0.1455 per CCF

Rate GS-S (General Service-Small) – Approved – June 2009 and after

Customer Charge: $45.00

Volumetric Charge: $0.107552 per CCF

Rate GS-L (General Service-Large) – Approved – June 2008 Through May 2009

Customer Charge: $130.00

Volumetric Charge: $0.152775 per CCF

Rate GS-L (General Service-Large) – Approved – June 2009 and after

Customer Charge: $180.00

Volumetric Charge: $0.11293 per CCF

PERSON RESPONSIBLE: Jeffrey R. Bailey