Unitil Energy Systems, Inc.
Docket No. DE 10-055
PUC Staff Information Requests – Set 3

Received: July 1, 2010 Date of Response: July 15, 2010
Request No. Staff 3-96 Witness: Thomas P. Meissner, Jr.

Request:

What is Unitil's Smart Grid roadmap? Include a 5-year plan and discuss the role of the assets deployed in the 2007 AMI deployment.

Response:

Unitil's general outlook on Smart Grid development, and the role of its AMI in that development, was articulated in a filing with the Massachusetts Department of Public Utilities in August 2008, a copy of which is provided as Staff 3-96 Attachment 1.

Subsequent to the filing of that report, Unitil has undertaken a number of initiatives to move forward on Smart Grid development, notably including –

- The development and implementation of an Outage Management System (OMS) integrated with AMI, as described in the Project Plan filing filed in response to the DOE SGIG program (see Staff 3-96 Attachment 2). While Unitil did not receive funding in the DOE SGIG process, it has proceeded with implementation of an OMS and expects it to be fully operational by later this year.
- The development of a Smart Grid Pilot Program designed to test consumer response to three alternative options: Simple Time-of-Use Rates (with Critical Peak Pricing); TOU Rates with Enhanced Energy Management Technology; Automatic Demand Reduction with Smart Thermostat. This program was reviewed and approved by the Commission in Docket DE 09-137. A copy of the Smart Grid Evaluation Plan recently filed with the Department of Public Utilities in Massachusetts and with the Commission is attached as Staff 3-96 Attachment 3.
- Development of a program to implement RSA 374-G providing authorization for an electric distribution utility to invest in distributed energy resources. The Company filed a proposal for implementation in Docket DE 09-137 which the Commission approved, with modifications, on June 12, 2010. Pursuant to that Order, the Company will be incorporating DER into its Least Cost Resource Planning process on a going-forward basis.

Staff 3-96
Attachment 1

Unitil
Unitil Service Corp.

August 28, 2008

BY OVERNIGHT MAIL

Mary L. Cottrell, Secretary
Department of Telecommunications and Energy
One South Station, Second Floor
Boston, MA 02110

Re: Fitchburg Gas and Electric Light Company d/b/a Unitil
D.P.U. 07-71

Dear Secretary Cottrell:

Enclosed on behalf of Fitchburg Gas and Electric Light Company d/b/a/ Unitil ("Unitil") please find the original and nine (9) copies of the Company's response to the Department of Public Utilities request for a report regarding its plan for the implementation of the next phase of its AMI project (see D.P.U. 07-71 at page 44).

Please do not hesitate to contact me directly if you have any questions concerning this filing. Thank you for your attention to this matter.

Sincerely,

/s/ Gary Epler

Gary Epler
Attorney for Unitil

Enclosure

cc: Carol Pieper, Hearing Officer
Colleen McConnell, Assistant Attorney General
Rachel Evans, Legal Counsel, DOER
Jerrold Oppenheim, Esq.
David Rosenzweig, Esq.
James Avery, Esq.

Gary Epler
Chief Regulatory Counsel

6 Liberty Lane West
Hampton, NH 03842-1720

Phone: 603-773-6440
Fax: 603-773-6640
Email: epler@unitil.com

COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF PUBLIC UTILITIES

Fitchburg Gas and Electric Light Company, d/b/a Unitil	)	D.P.U. 07-71

REPORT ON THE IMPLEMENTATION PLAN FOR THE NEXT PHASE OF THE AMI PROJECT

FITCHBURG GAS AND ELECTRIC LIGHT COMPANY
d/b/a UNITIL

August 28, 2008

I. INTRODUCTION

A. Purpose

This report is provided in response to the Department of Public Utilities' ("Department") directive that Fitchburg Gas and Electric Light Company d/b/a Unitil ("Unitil" or "Company") prepare a report regarding its plan for the implementation of the next phase of its Advanced Metering Infrastructure ("AMI") project. The Company has shown that AMI is more than a meter-reading system, and will serve as a platform for other functionalities that can contribute to more efficient and effective utility operations. Specifically, AMI can serve as a platform for demand-response and time-of-use programs that will encourage resource conservation, and that can offer other benefits relating to energy delivery and customer empowerment via informed energy usage choices. The Department has expressed interest in further understanding the attributes and capabilities of Unitil's AMI system, especially its conservation and demand-response capabilities. Therefore, the Company was directed to file this report within six months from the date of the Department's Order in D.P.U. 07-71. Among the issues to be addressed:

1. What demand-response, conservation-based programs does Unitil intend to run or research as part of its AMI strategy?
2. What ancillary program features of the AMI (e.g., immediate meter read-outs, power quality monitoring, disconnection features, outage reporting) does the Company intend to pursue as part of its AMI strategy?
3. What are the future cost-benefit savings for each capability of the system?
4. What is the master time-table for future application development?

B. Advanced Metering Infrastructure System

Unitil's AMI system is an automated meter reading system by which customer meter data can be sent automatically over the Company's distribution lines to data collection centers where it can be processed for billing. Data is transmitted by ultra-low bandwidth to a server with router capability located at a substation; it is then transmitted by telecommunication lines to Unitil's centralized customer service center in Concord, New Hampshire, where it is made available across the information network to all of the operating centers. The AMI system provides two-way communication between the meters and the service center, as well as automatic reading of meters, significantly enhancing customer service through more timely and accurate meter reading.

The Company views the AMI system as offering a strategic platform for additional technological, management, and evaluative capabilities, including: (1) better estimating load shapes and peak load conditions of specific circuits; (2) on-demand meter reads; (3) remote "virtual" access (e.g., for disconnections and reconnections); (4) electric system monitoring, including load, voltage, reliability, power quality, outage detection, and management; (5) remote configuration of demand meters and time-of-use meters; and (6) distribution automation. Most importantly, AMI can serve as the platform for demand-response and time-of-use programs that will encourage resource conservation, and that can offer other benefits relating to energy delivery and customer empowerment via informed energy usage choices.

Unitil has begun to explore the other capabilities of the AMI system, including time-of-use billing, peak period billing, outage management, distribution planning and optimization, and voltage monitoring and anticipates that the next phase of the AMI project, expected to take place over the next three to five years, will involve integrating the AMI system with regulatory requirements through additional investments. This future development and evolution of the AMI system is part of the Company's larger strategy to develop and implement elements of what has become known in the industry as the "Smart Grid."

II. UNITIL VISION OF THE SMART GRID

A. Conceptual Framework

Grid modernization has emerged as an important element of national energy policy in recent years in conjunction with new priorities aimed at improving the cost, efficiency, reliability, independence, and environmental friendliness of the nation's energy supply. Many names have been given to this vision of a modern grid, though the term "Smart Grid" has become most synonymous with a modern 21st century grid that incorporates state of the art technologies to achieve important functional capabilities. While there is no standard definition of a Smart Grid, it is most often described in terms of robust two-way communications, advanced sensors, and distributed computing/control to enable intelligent decisions in order to run the grid more efficiently, reliably and at lower cost. The Smart Grid is also described in terms of its ability to seamlessly integrate energy efficiency, demand response and other distributed-resources and to enable the interaction of loads and resources in real time.

Unitil's AMI system is but one element of a larger vision to achieve the functionality of the modern Smart Grid. The Company envisions a future in which resources are increasingly distributed, with much greater penetration of distributed generation, energy storage, and demand response technologies. A "smart" utility network will have the ability to reduce customer power consumption during peak hours through utility intervention (load control) and/or customer empowerment (demand response), enable grid connection of distributed generation and energy storage devices, and provide grid energy storage and supplemental service for extensive distributed generation load

balancing (net metering). These changes will have profound implications for the design of distribution system.

In order to effectively and efficiently pursue a Smart Grid strategy, it is first necessary to have a clear vision of what the strategy is intended to achieve. A Smart Grid is defined not by specific technologies and features, but by its ability to deliver desired capabilities. In this regard, Unitil has defined its vision of the Smart Grid around the work of the National Energy Technology Laboratory ("NETL") Modern Grid Strategy.[1] The NETL Modern Grid Strategy seeks to revolutionize the electric system by integrating 21st century technology to achieve seamless generation, delivery and end use that benefits the nation. This strategy is then further defined in terms of six key goals, and seven key characteristics that benefit consumers, business, utilities and national security.

B. Goals and Characteristics of the Modern Grid

The NETL Modern Grid Strategy identifies six key goals of grid modernization in order to achieve the power system required for the future:[2]

(1) The grid must be more reliable
A reliable grid will provide power dependably, when and where its users need it and of the quality they value.

(2) The grid must be more secure
A secure grid will withstand physical and cyber attacks without suffering massive blackouts or exorbitant recovery costs. It will also be less vulnerable to natural disasters and will recover faster.

---

[1] The National Energy Technology Laboratory (NETL), part of DOE's national laboratory system, is owned and operated by the U.S. Department of Energy (DOE). NETL supports DOE's mission to advance the national, economic, and energy security of the United States.

[2] National Energy Technology Laboratory, The Modern Grid Strategy. http://www.netl.doe.gov/moderngrid/

(3) The grid must be more efficient
An economic grid will operate under the basic laws of supply and demand, resulting in fair prices and adequate supplies.

(4) The grid must be more economic
An efficient grid will take advantage of investments that lead to cost control, reduced transmission and distribution electrical losses, more efficient power production and improved asset utilization.

(5) The grid must be more environmentally friendly
An environmentally friendly grid will reduce environmental impacts through initiatives in generation, transmission, distribution, storage and consumption.

(6) The grid must be safer
A safe grid will not cause any harm to the public or to grid workers and will be sensitive to users who depend on it as a medical necessity.

The NETL Modern Grid Strategy further defines seven key characteristics of the modern grid. These characteristics represent the NETL's vision, and the desired functionality, for the modern grid.

(1) Self-healing
The modern grid will perform continuous self-assessments to detect, analyze, respond to, and as needed, restore grid components or network sections.

(2) Motivates and includes the consumer
Consumer choices and increased interaction with the grid bring tangible benefits to both the grid and the environment, while reducing the cost of delivered electricity.

(3) Resists attack
The grid deters or withstands physical or cyber attack and improves public safety.

(4) Provides power quality for 21st century needs
Digital grade power quality avoids productivity losses of downtime, especially in digital device environments.

(5) Accommodates all generation and storage options
Diverse resources with "plug-and-play" connections multiply the options for electrical generation and storage including new opportunities for more efficient, cleaner power production.

(6) Enables markets
The grid's open-access market reveals waste and inefficiency and helps drive them out of the system while offering new consumer choices such as green power products. Reduced transmission congestion leads to more efficient electricity markets

(7) Optimizes assets and operates efficiently
Desired functionality at minimum cost guides operations and fuller utilization of assets. More targeted and efficient grid maintenance programs result in fewer equipment failures.

Unitil uses these goals and characteristics as the framework for its own strategy related to AMI and Smart Grid development, and has been focusing efforts primarily in the areas of customer empowerment and demand response, accommodating generation and other Distributed Energy Resource ("DER") options, and optimizing assets and improving the efficiency of grid operations.

C. The Role of AMI in Advancing the Smart Grid

The advanced metering and two-way communication capabilities inherent in the AMI system are essential to meeting key functional capabilities and characteristics of the Smart Grid. In particular, the ability to implement time-based rates and demand response programs is essential to motivating and empowering consumers by providing accurate pricing signals as well as choices to increase customer interaction with the grid and thereby reduce consumption. Future evolutions of the AMI system are expected to include hourly meter intervals, bringing metered consumption closer and closer to real time. Furthermore, meters currently under development will include ZigBee[3] wireless

[3] ZigBee is the name of a specification based on the IEEE 802.15.4-2006 standard for wireless personal area networks (WPANs).

communication capability and the ability to communicate consumption information wirelessly into the home, and to interact with other devices, appliances, and gateways within the home over a Home Area Network ("HAN"). Ultimately, the line between the utility grid and the in-home network will become increasingly blurred as utility meter and equipment providers work together with white goods manufacturers, home energy management and networking solutions providers to develop smart appliances and energy management and demand response solutions incorporating utility consumption information and pricing signals.[4]

In addition to customer empower programs, the AMI system provides important functionality to optimize utility assets, improve operating efficiency, and enhance outage restoration, while delivering new and enhanced services to customers. These improvements are already evident in Unitil's ability to get more timely and accurate readings. The Company has seen a reduction in billing estimates and improvement in on cycle reads. This performance is expected to further improve with enhancements to the information systems associated with the Company's billing and work order systems. System operations data captured by the AMI system on a daily basis is also being leveraged to improve the design and operation of the system. The AMI system captures outage data, voltage data, and power quality data that are now being incorporated into the planning, design, and maintenance of the system, improving the quality of service. Since this information and customer usage data is available on a daily basis, it can also be

[4] The ZigBee Alliance is an association of companies working together to enable reliable, cost-effective, low-power, wirelessly networked, monitoring and control products based on an open global standard.

utilized to answer customer inquiries regarding billing or outages. The company has plans to further leverage this data by more closely integrating the AMI system with its billing, work order, planning systems and a future outage management system. These plans are discussed in more detail below in response to the Department's specific questions regarding projects.

III. RESPONSE TO QUESTIONS RAISED BY THE DEPARTMENT

A. What demand-response, conservation-based programs does Unitil intend to run or research as part of its AMI strategy?

Unitil is currently developing a sophisticated pilot that will incorporate time-of-use ("TOU") rates, advanced ("smart") meters with ZigBee wireless communication capability, automated load management systems on the customer premises, and demand-response technologies activated in response to extreme peaks in either New England wholesale markets, or on the local distribution system. Unitil is finalizing a Request for Proposal ("RFP") for a two-phased approach to roll out this pilot and intends to retain a vendor to complete detailed design of the pilot, including establishing sample sizes and developing marketing and recruiting approaches to minimize non-response bias. The Company expects to fully develop this pilot for filing at the Department prior to April 1, 2009. A preliminary draft of the RFP is provided as Attachment 1 to this report.

As part of this pilot, the Company intends to determine the cost-to-benefit associated with low, medium and high cost time-based rates with a critical peak price period ("CPP") and different levels of enabling technology. The pilot is targeted specifically to residential customers and information will be obtained for three distinct customer groups:

- *Simple Program*: Customers on a TOU/CPP rate will receive education material only and basic CPP notification via email or phone. This group will receive no other technology enhancement.

- *Enhanced Technology Program*: Customers on a TOU/CPP rate will receive an in-home energy management system, utility integration portal, and flexible control devices allowing for automated load control and demand response.
- *Smart Thermostat Program*: Customers will receive a utility controllable smart thermostat that offers digital programming features and customer feedback, with no time-based rates.

The Company expects the pilot to yield sufficient information to design time-based rate programs and demand-response programs that could be offered to all of its residential customers on an optional (non-mandatory) basis. Should multiple approaches prove to be economic on a cost-to-benefit basis, customers may have the option to choose among different programs to achieve the benefits of demand-response and energy management in the manner best suited to their specific circumstances and preferences.

In addition to satisfying the Company's objective of finding methods to manage or control peak demand on its distribution network, Unitil expects this pilot will satisfy two requirements of the Green Communities Act. Section 85 of the Green Communities Act requires electric utilities to develop and file with the Department plans for two specific pilot programs:

1) a proposed plan to establish a smart grid pilot program; and

2) a proposal to implement a pilot program that requires time of use or hourly pricing for commodity service for a minimum of 0.25 per cent of the company's customers.

The Company expects to design a pilot program and incorporate the advanced features of its AMI system in such a manner as to satisfy both of the pilots under the Green Communities Act.

It is worth noting that the Company's AMI system with its advanced metering and two-way communication capabilities already meets much of the functionality specified in the first pilot. Furthermore, the combination of two-way communication capability and reprogrammable endpoints permits the Company to implement TOU and CPP rate designs without the need for costly meter change-outs. Therefore, it is the Company's goal to begin exploring and testing more advanced capabilities including ZigBee enabled advanced meters interacting with ZigBee Home Area Network ("HAN") appliances and devices and in-home energy management systems.

B. What ancillary program features of the AMI (e.g., immediate meter read-outs, power quality monitoring, disconnection features, outage reporting) does the Company intend to pursue as part of its AMI strategy?

The Company has already completed several initiatives that leverage the AMI systems and expects to initiate a variety of AMI related projects over the next five years. These projects can be segregated into short-term (12-24 months), mid-term (24 – 36 months), and longer term (3 – 5 years) projects.

1. Completed Projects:
    a. Operational improvements:
        i. End of line voltage monitoring

During the AMI implementation, strategic locations were identified at the end of each circuit where the voltage is expected to be the lowest. Unitil took the opportunity to deploy meters in these locations with the capability to record voltage measurements. On a daily basis, these meters not only report the required consumption and demand data for customer billing, but also report maximum voltage, minimum voltage and the time that the minimum voltage was recorded. This information has become very useful to the operations and engineering departments.

From an operational standpoint, Unitil uses the end of line voltage data to verify that system operation is consistent with industry guidelines. The AMI voltage data is also used to verify customer voltage concerns to determine if the concern is local to a given service or if it may be a larger area concern.

From a system planning standpoint, Unitil conducts analysis on its distribution circuits at a minimum of once every three years and more often if the load growth requires it. The analysis focuses on loading and voltage concerns that may occur based upon forecasted load growth over the next five years. The end of line voltage monitoring is used to verify circuit models to ensure that the models are accurate and represent actual field operating conditions. The minimum voltage data has proven beneficial in determining the actual timing of system improvement projects and deferring projects until they are needed.

ii. Endpoint diagnostics

The AMI system, utilizing a two way communication system, is capable of self diagnostics. The meter endpoint is constantly self-monitoring and reporting on its

functioning status. Since the AMI system relies on a power line carrier system for communicating data, the communication path can be interrupted or affected by electric system design, operation, and environmental effects. The Company has developed tools to assist the trouble shooting capabilities of the technicians by integrating Unitil's Geographic Information System (GIS) and AMI data, allowing the technicians to view and query performance data in a format directly related to the communication paths. The spatial representation of the communication issues coupled with the querying capability of GIS lends an intuitive view to the problem solving process. One such communication problem is loose connections, which increase the noise on the system and has the effect of reducing the meter communication signal strength. These loose connections are now found through our AMI troubleshooting tools and have the ancillary benefit of reducing associated energy losses.

iii. Outage viewer using AMI data in GIS

Every meter endpoint on the Unitil system has the capability to record when it is experiencing an outage condition. It also has the functionality to understand if the outage is momentary or sustained in nature, and if it is part of an overall outage event (a combination of momentary outages and a sustained outage). This information is reported back to the Command Center. Each endpoint has a Global Positioning System (GPS) location associated with it which was captured during the meter endpoint deployment. The GPS locations and the information from the outage information from the Command Center are used to spatially represent all of the meter endpoints in the Unitil GIS system. Unitil has used the spatial outage information during larger scale events to assist with

categorizing and assessing the overall size of outages. The information is used to dispatch crews to address the areas of highest concern. This has proven to be a beneficial alternative to sorting paper trouble interruption slips during larger events with a large quantity of concurrent outages.

b. Engineering & Planning:

i. Improved accuracy of system models

The AMI system provides daily information that allows Unitil to develop and maintain circuit planning models with an improved level of accuracy than was available before the system was installed. The AMI system uses current transducers located at the substation collection devices to measure the current signal on a per phase basis. As a result, per phase voltage and loading data is available for every meter endpoint. This per phase voltage and loading data is used to verify the allocation of load in the circuit models. Models with a higher level of accuracy ensure that Unitil is constructing system improvements at the appropriate time and not too far in advance of the need.

ii. Residential customer daily demands

The AMI system provides daily peak demand information for every meter endpoint installed on the Unitil system. Prior to AMI, only monthly peak demands were available for customers who had demand as one of their billing components. Daily peak demand information has allowed Unitil to correlate house size and AC usage to the overall size of the house to develop a service transformer sizing guideline to be used when sizing service transformers that may be serving one or more customers. The analysis indicated that Unitil's sizing assumptions were underestimating the actual peak

demands. The new guideline should result in fewer outages related to transformer overload.

iii. Stepdown transformer watt/var data

Unitil has historically installed thermal demand ammeters on most distribution stepdown transformers. These meters provide simple maximum and instantaneous current values and do not provide any information on power factor. This data is collected manually on a monthly to quarterly basis. This information is used: 1) to ensure that the load growth is not exceeding the capacity of the stepdown transformers; and 2) for measured load points used for distribution circuit planning. Unitil has begun a pilot installation using the AMI system to measure and report daily peak watt and var data on stepdown transformers. If this pilot is successful, the data will: 1) be gathered automatically and reduce the number of field visits; 2) be gathered on a daily basis as opposed to a monthly or quarterly basis; 3) provide watt and var data as opposed to simple current values; 4) result in a more proactive monitoring of transformer loading resulting in fewer stepdown transformer overloads; and 5) be used to further increase the accuracy of the circuit models.

iv. AMI data displayed spatially in GIS (signal quality, loads, voltage, diagnostic information, endpoint status, outage information, etc)

Every meter has a GPS location which resides as a data point in the GIS system. A database link has been developed between the GIS system and the AMI Command

Center as a means to display AMI data in a spatial format. This data has been valuable to Unitil in addressing signal quality issues, viewing loading and voltage data, meter diagnostic data, endpoint status and outage information. Implementation of this link was completed by Unitil staff at minimal cost. The benefits of spatial data representation will continue to be realized as more uses for the data become apparent.

The AMI system uses a signal quality measurement to determine the strength of the meter endpoint signal as it is gathered at the collection device located in the substation. The spatial representation of this data has enabled Unitil to identify areas where signal quality problems have existed. This was most beneficial during the implementation stage, but is now used to identify areas where failing equipment or connections may be increasing the noise level on the system (see loose and noisy connections).

The ability to view loading and voltage data in a spatial format has provided the distribution circuit planners the ability to visually see where the loads are the highest on their circuits. This information has also been used to increase the accuracy of circuit models. Models with a higher level of accuracy ensure that Unitil is constructing system improvements at the appropriate time and not too far in advance of the need.

A minimal amount of diagnostic data is provided from the meters on a daily basis. Once a week, the system provides detailed diagnostic data for all meter endpoints. This diagnostic data can be viewed spatially to determine if there may be a grouping of meter endpoints that are having problems due to a common cause. This enables the AMI

troubleshooting to be more efficient and minimize the number of trips in the field to address concerns.

Every meter endpoint is actively monitoring its functioning status. Changes in status are transmitted to the Command Center within minutes of the status change. A meter status would change due to an outage event, low signal quality or the overall health of the endpoint. A spatial representation of this data is available in the GIS system. The endpoint status function is the manner in which outage detection is represented in GIS.

The AMI system is able to capture momentary and sustained outage information for every customer. Since the data is captured at the meter location, the AMI system can provide an accurate representation of the total quantity of events affecting a single customer. A spatial representation of this data is available in GIS. The data is used to visually identify areas that appear to be experiencing more events than other areas. These areas are then analyzed to determine if there is a common cause to the outages.

c. Customer Service:

i. On-demand customer reads

The AMI system captures daily usage and peak demand for every customer on a daily basis. The AMI system also has the capability of quickly querying and presenting this data in a graphical or tabular manner allowing a Customer Service Representative to respond to customer inquires concerning usage with recent load data, and provides a more relevant picture of customer behavior or equipment impacts on service costs.

ii. Individual outage history available for customer inquiries

Prior to the AMI system, Unitil only had the technology in place to identify the quantity of sustained outages that a customer has experienced. The infrastructure was not in place to accurately determine how many momentary outages an individual customer may have experienced. As described above, the AMI system is able to capture momentary and sustained outage information on every customer. Since the data is captured at the meter location, the AMI system can provide an accurate representation of all events affecting a single customer.

The data provided by the AMI system is used during customer inquiries to determine if the trouble is limited to the specific customer or if the events are affecting a larger area. This data can be represented spatially in the GIS system to provide a visual representation of where customers may be experiencing the most outage activity. Unitil can then provide a more focused approach to those areas. The data is not detailed enough to use for reporting service quality type data because the algorithms used for identifying an outage are different in the AMI system than required by the service quality guidelines.

2. Short-Term Projects (12 – 24 months):

    a. Virtual turn-offs/ons and meter tampering

The AMI system has additional capabilities that have yet to be incorporated into our existing processes or related billing systems. Two such examples are the ability to do virtual turn-offs and turn-ons and remote detection of meter tampering. The Company plans to initiate system and process changes that will automate the use of AMI data to affect improvements related to these processes.

The customer, when moving in or out of a location will request a final bill or initiation of usage, resulting in the need to read the meter even if the read is not planned at the time of the request. The current process and work order systems necessitate a manual read of the meter. The AMI system, since it receives data on a daily basis, can be used to get a turn-off read regardless of the regular read cycle. The Company will start using this AMI feature to reduce or eliminate the need to capture a manual read. The cost of this is minor and will require small changes to the existing work order system to accomplish.

Every AMI meter also contains a tamper detection switch which when jostled or moved, will record an event. Tamper event data can be communicated through AMI and if this data is incorporated into our existing work order systems could trigger investigations that might otherwise go unnoticed.

b. Pilot project of capacitor bank control

Unitil is required to maintain its system power factor within the limits set by ISO-NE. This is accomplished through daily capacitor bank switching as well as seasonal switching to address heavier loading periods of time. The daily capacitor switching is used as a fine tuning approach to account for daily variations in load cycle while the seasonal switching is required to account for seasonal variations in load. Daily switching is completed through a combination of SCADA controlled and automated capacitor banks switched on voltage or power factor.

At the present time, seasonal switching is completed by line crews which are dispatched to place the capacitor bank in service. The AMI system is capable of

providing some increased level of distribution automation that Unitil does not presently have. The AMI system, with some modifications to the capacitor banks, is capable of switching these banks similar to a SCADA system. Unitil is in the conceptual stages of designing a pilot installation to test the capabilities of the system. Based upon this pilot, Unitil will determine the cost and benefit of the installation to determine if a larger deployment would be cost effective. If this is effective, it would eliminate a line crew having to switch capacitor banks on a seasonal basis. The cost of the installation is estimated to be $2,000 to $3,000 if the capacitor is already equipped with switches and $8,000 to $10,000 if not. It is assumed that Unitil could implement this with internal resources.

3. Mid-Term Projects (24 – 36 months):

    a. Outage Management

Unitil does not currently have an Outage Management System (OMS). An OMS will provide a means to use real-time information to manage outage related events in a more effective manner and contribute to reducing the outage restoration process. The system will have intelligence to make recommendations and decisions based upon the information it obtains. The data management interface will be efficient when collecting outage information in order to provide data for crew management and real time reporting statistics. The system will have two way communication and the flexibility to change when more demands are placed upon reliability management.

An OMS system can use several different data sources to make predictions about the outage size and severity. The data sources can be from customer calls, SCADA

interfaces and/or the AMI system. Since the Unitil AMI system is a two way system capable of communicating outage information, it is apparent that the AMI system may play a key role in the development of an OMS. The continuous monitoring (24 hours per day, 7 days per week, 365 days per year) at every meter point provides valuable information about the status of each and every customer. The AMI system notifies the Command Center within minutes the full extent of an outage. This data may be useful in assessing the situation so that crew dispatch can be completed in an efficient manner to resolve the outage and verify restoration of the area, before the crews move on to another location. This system is able to distinguish between a sustained and a momentary outage based upon predefined, hardwired settings.

Currently, Unitil relies on customer calls to identify if there is an outage. The AMI system provides that information automatically and does not need to rely on customer calls to determine the full extent of the outage.

An OMS will provide the following benefits:

- Increase reliability and control costs with improved visibility and response time
- Increase return on invested capital by better managing distribution assets
- Provide access to real-time, decision-driving data, thus reducing risk and uncertainty
- Minimize restoration time
- Improve operations efficiency
- Provide ability for segmented or sequential implementation.
- Leverage existing systems.

An OMS will take Unitil approximately three years to implement from start to finish and is estimated to cost between $400,000 to $500,000. The process for implementing an OMS at Unitil will consist of: 1) a GIS conflation project to fix spatial

inaccuracies between the historical landbase used to develop GIS and the meter endpoints which use actual GPS coordinates; 2) develop a connection between customer and facility: and 3) implement outage management software. Unitil is still developing the cost benefit analysis for an OMS. Unitil will require external resources to implement an OMS.

b. PQ monitoring of harmonics and voltage distortion using kV2C meters

Unitil chose to implement the GE kV2c meter for all three phase demand customers. The basic GE kV2c meter does not have the capability to record power quality values beyond the basic min-max voltage and current. However, the meter can be upgraded with an additional measurement switch and have the ability to record power quality information such as voltage and current per phase measurements, voltage sags and swells, voltage distortion, current distortion, and total harmonic distortion. This information could not be passed along the AMI system at this point because of the overall size of the information packet. It would require a field visit to upgrade and reprogram the meter and download the data. Unitil believes that this would provide some benefit to customers who may be experiencing some power quality concerns. Unitil still needs to evaluate cost-benefit of this functionality. It is assumed that Unitil could implement this with internal resources and the assistance of the meter vendor.

c. System load shapshot

The AMI system has the capability of providing a system load snapshot. A system load snapshot is the ability to schedule the AMI system to provide instantaneous demand readings for every meter at any given point in time. For instance, if a stretch of

hot weather is forecasted over the next four days, the AMI system can be programmed to obtain instantaneous demand readings for all meters at 5:00 PM on the third day. That data would then be available to the distribution planning group to model the distribution system with coincident peak demands at a peak load time. This functionality currently exists, but has not yet been tested. To implement a system load snapshot, some minimal programming modifications are required to initiate the process. It is assumed that Unitil could implement this with internal resources. The benefit will be a model that more accurately represents peak loading conditions, resulting in better decision making and more timely system improvements.

d. Distribution service transformer loading analysis

Distribution service transformer loading is generally not actively managed by electric utilities. Unitil does not have the infrastructure in place to routinely measure the loading on each service transformer. As stated earlier, Unitil relies on transformer loading guidelines to size service transformers.

Once Unitil is able to develop an accurate method to determine which service transformers are serving each customer, the AMI system will provide the daily loads required to calculate the loading on each service transformer. Unitil has plans as part of the outage management project to develop the link between the customer meter and the service transformer. This will enable Unitil to develop a program for analyzing and replacing overloaded service transformers prior to a transformer failure. This will have an effect of reducing the quantity of service transformer failures due to overload. It is assumed that Unitil could implement this with internal resources.

4. Longer-Term Projects (3 – 5 years):

a. Pressure monitoring for gas planning purposes

The AMI endpoints have the ability to accept data from multiple inputs. Unitil believes that if a pressure monitor can be developed that communicates with the AMI system, system pressure data could be transmitted back to the Command Center in a similar manner that voltage is measured on the electric side. These pressure monitoring devices could be installed at strategic end-of-line points where pressure is lowest. The minimum pressure data would be transmitted to the Command Center and used to increase the accuracy of system models. Models with a higher level of accuracy ensure that Unitil is constructing system improvements at the appropriate time and not too far in advance of the need.

Unitil is currently investigating the commercial availability of this pressure transducer technology, and will continue to work with manufacturers to incorporate this functionality with the AMI system. A cost-benefit analysis will determine if such a device can be made that would be beneficial.

b. Momentary event analysis incorporated into tree trimming

As stated previously, the AMI system has the capability to record momentary and sustained outages for every customer. Unitil believes that most momentary outages occur primarily due to momentary tree contacts. The momentary outage information recorded by the AMI system can be combined with the GIS system to spatially represent where Unitil may be experiencing a higher level of tree related momentary outages. Unitil also records historical tree trimming schedules in GIS. The combination of tree trimming

history and momentary events in GIS will allow the Company to more efficiently and effectively direct tree trimming activities on a routine basis. It is assumed that Unitil could implement this with internal resources.

c. Condition-based maintenance

Most of the equipment that is used on an electric system must be maintained on a routine basis. Unitil's current maintenance schedule is based upon past history and industry guidelines. However, manufacturers are publishing more information that rely on actual field information (i.e. number of operations and loading history) to determine what level of maintenance is required and when. As Unitil continues to evaluate the benefits of condition based maintenance, the benefit of the AMI momentary information will be evaluated to determine if it will provide the information required to make appropriate maintenance decisions. It is assumed that Unitil could implement this with internal resources.

C. What are the future cost-benefit savings for each capability of the system?

The project cost-benefit analysis of these projects will be pursued on an incremental basis, meaning that each project will be justified on its own merits. Some of these costs and benefits are included above for discussion purposes.

D. What is the master time-table for future application development?

The expected schedule of development and deployment is outlined above in response to question B.

Unitil
Request for Proposals
Demand Reduction Technology Evaluation Pilot Project – Phase I

September 3, 2008

Unitil is seeking proposals from qualified contractors to conduct Phase I of a Pilot Project to investigate the demand reduction opportunities of Load Control ("LC"), Demand Response ("DR") and Time-of-Use (TOU) rates with varying levels of technology enhancement. Unitil plans to implement this Demand Reduction Pilot Project in its New Hampshire and Massachusetts service territories and will provide residential customers with varying levels of load control technology, in some cases coupled with Time of use ("TOU") rates, in order to evaluate future rate design and potential program cost/benefits. Three TOU/DR programs are to be evaluated: a TOU program with basic education only and no technology enhancement; a TOU program that includes the same educational component, but which also incorporates an in-home energy management system that allows consumers to manage consumption using a browser based application controlling in-home devices; and a non-TOU program using utility controlled, user programmable smart thermostats. The TOU rates will incorporate three different cost periods and a Critical Peak Price ("CPP") initiated by Unitil during periods of extreme electricity demand.

Description

The Pilot Project will investigate the cost/benefits of three distinct demand response programs. Two programs will investigate TOU rates incorporating low, medium and high-cost time based rates with a critical peak price (CPP) that can be initiated during periods of extreme electricity demand. The non-TOU program will investigate the cost/benefits of a utility controlled thermostat program that requires no intervention from the customer. These three programs are summarized below:

- *Simple TOU Program*: Customers will enroll in a TOU program and will receive basic educational materials, with no technology enhancement. CPP notification will be handled via email or a phone call.

- *Enhanced Technology Program*: Customers will enroll in a TOU program and will receive the same educational materials, but will also be provided with an in-home wireless control system with a suite of energy management tools, a utility integration portal, and flexible control devices (smart thermostats and outlets). This package would allow for both utility and customer automated load control and demand response.

- *Smart Thermostat Program*: Customers will not be enrolled in a TOU rate program, but will instead receive a utility controllable thermostat that offers digital programming features and customer feedback. The utility will have the ability to either cycle the customer's heating and cooling load, or change the

temperature setting on the thermostat, during periods of extreme electricity demand. This change in thermostat setting will be accomplished with no specific notification to the customer, but may be overridden by the customer.

Pilot Project Objectives (Phase I)

Scope of Work

This RFP is for Phase I of a two-phased approach to roll out the Demand Reduction Pilot. Phase I essentially entails designing the pilot from establishing sample sizes for each TOU rate program of the pilot, developing educational materials, and coming up with a marketing and recruiting approach that minimizes non-response bias. Phase I will ultimately deliver a turn-key approach for fully implementing the pilot in Phase II.

The Sample

Unitil has about 24,290 residential and low income customers in their Massachusetts service territory and 63,000 residential and low income customers in New Hampshire. Sampling should be stratified to include participants in each of the three Programs and corresponding control groups. Additionally, results will be presented by state and overall.

For this proposal, the contractor will propose a sampling strategy and estimate a sample size for each test and control group. Enrolled participants will need to have central air conditioning installed in their home for the thermostat technology program. Thought to how baseline consumption should be considered and the correlation between pre-and post consumption addressed in order to measure participant effect with statistical significance.

Marketing, Education and Recruitment

The selected contractor will work with Unitil to develop customer educational materials for pilot participants. This would include developing marketing samples that will "brand" Unitil's TOU/DR Programs. Additionally, we would look to the contractor to advise us on best methods for recruiting customers to participate in the pilot. Would it be practical to conduct a marketing study first to identify the most effective marketing strategy and then use that one approach for recruiting customers for the pilot? When recruiting, do we assume that the marketing approach will affect the savings since those that respond positively to the marketing may be those people who are likely to be "early adapters" or "greener" than those who don't respond? Or, do we assume all things being equal, that the recruitment approach would only impact the acceptance rate but not the actual savings of those who participate? Sampling bias should be addressed.

The recruitment approach established in Phase I will be used to recruit customers for Phase II.

The Technology

The Company plans to implement this pilot using two levels of technology. The enhanced technology program will incorporate a wireless in-home energy management system

offered by Tendril Networks, which utilizes the new home area network communication standard called ZigBee (www.zigbee.org). Through the Zigbee LAN customers will be able to monitor and control their thermostat and outlets and gather load usage data on outlet based appliances. Furthermore, the Tendril technology will be able to communicate directly with a ZigBee enabled meter that will be provided by the utility in order to provide consumption information in near real time. Participants in the enhanced technology program will receive a package of technologies that talk directly to the utility including the Tendril Management Portal, Tendril Thermostat, Tendril Outlet (a 3-pronged ZigBee Smart Energy electric outlet), Tendril Display, and an internet gateway.

Participants in the smart thermostat program will receive a state-of-the-art thermostat that can be programmed by the homeowner much like any other digital thermostat. The thermostat will also include a feature that allows the utility to either cycle the customer's heating and cooling load, or change the temperature setting of the thermostat, during periods of extreme electric demand. Pilot participants in the thermostat program may receive Tendril "smart" thermostats that are linked via ZigBee directly to the utility meter, or may receive a different type of thermostat from a comparable vendor.

Deliverables

Work is anticipated to commence about October 20, 2008. The selected Vendor will deliver the following items.

- Work Plan due at the outset of the project. This is to include a schedule and an allocation of staff resources amongst the various tasks described under the Scope of Work. It should also detail what reports will be issued on what and when.

- Draft marketing and educational materials for review. If a marketing study is deemed appropriate and is part of this proposal, provide a cost estimate for this work and a draft work plan with methodology for conducting such a study. Work plan should address sampling strategy and samples of questions that customers would be asked if surveying will be used.

- Recruitment approach for obtaining customers for implementing Phase II of the pilot.

- Sample selection plan. The Vendor should suggest the number of participants that will need to be included in each of the three program groups and control groups. Where it is possible, the sample should be sized to provide results with a 90% confidence, plus or minus 10% precision. Should this not be attainable, the proposal should suggest an appropriate sample size and estimate the associated level of confidence and precision. The Sponsors will have final approval of the sample selection process.

- Brief report on each task or activity as it is completed (the first of these will need to be issued in draft format for comments, after that it is assumed the format will be set, so that these reports can be issued as soon as the task/activity is

completed).

- Initial Draft Report due upon completion of all the tasks including all supporting documentation.

- Draft Final Report based on Sponsor-provided comments to the Initial Draft Report.

- Final Report based on Sponsor-provided comments to the Draft Final Report.

Pricing

Bidders must provide a "Not to Exceed" time and materials proposal for the execution of the work described in the Scope of Work. The proposal cost should be the bidder's best estimate based on its review of the Scope of Services. Labor costs and other direct costs should be presented separately. Labor costs should specify labor rate and be broken out by task, personnel type (e.g., project management, supervision, clerical support, analyst, site technicians), and hours. In addition, per unit survey costs as opposed to general study costs should be indicated separately where appropriate. For example, should a marketing study be deemed appropriate, the task may require a certain baseline number of personnel hours to prepare for the survey process (general study cost) and then a per-survey labor and/or material cost to conduct the number of surveys needed to attain the requested confidence level.

Estimates of any miscellaneous additional costs should also be indicated and described. All pricing must be submitted on the **Cost Estimation Sheet** included as **Attachment 2**. The form must be completed in its entirety and submitted in order for the bid to be considered. Additional pricing details may supplement the Cost Estimation Sheet if desired. Vendor should identify on the Cost Estimation Sheet if a payment discount for early invoice payment (e.g. 2% 15, Net 30) is offered. Discounts will be factored into the evaluation of the bids and their acceptance is at the Sponsors' option.

Bid Submittal

Unitil requires that interested bidders respond to this RFP no later than **12 NOON, EST October 1, 2008** with a proposal containing the following:

- A detailed description of the complete scope of work including a schedule with deliverables and due dates, flowchart and organizational management structure. This should not be a re-statement of the scope described here, but a carefully thought out plan of how, when, and where the various tasks will take place using example questions wherever possible.

- A sample work plan as described below should be included. For comparative purposes, the bidder should develop a mini work plan for no more than 12 months. This plan should give a reasonably detailed description of how the

bidder plans to complete each of the tasks described in the scope of work. For any survey work, a sample of questions and how they would be analyzed should be included. No more than half a page to a page for each task should be dedicated to this effort, exclusive of any additional pages required to detail some of the questions and how they would be analyzed.

- Statements of qualification that explains why the bidder is fully qualified to perform the work described in the RFP. The bidder's statements should emphasize their (1) knowledge and understanding of energy efficiency program evaluations, (2) experience with designing sample plans, implementing survey instruments and performing detailed survey work, (3) experience with designing marketing and educational materials and recruiting strategies, and (4) specific details of experience with developing and implementing TOU pilots or programs.

- Brief summary of the qualifications of personnel who will be utilized to perform the Scope of Services. Bidders must also proclaim the availability of resources to devote to the project to ensure completion by the desired deadlines. If subcontractors are to be used, include a summary of qualifications and the capacity in which they will be used.

- Summary of Study costs. Please use the attached Cost Estimation Table (Appendix 2) to provide a summary of costs for the entire project including any optional and/or additional tasks envisioned by the bidder. Labor costs should be broken out by task and personnel type (e.g., project management, supervision, clerical support, analyst, etc.). Estimates of miscellaneous additional costs should be indicated.

- One representative example of experience and documentation skills, such as a report or relevant educational/marketing materials that have developed.

- Names, affiliations, and telephone numbers of at least two individuals or organizations for which similar services have been provided. The Sponsors reserve the right to contact these individuals to ascertain the quality and timeliness of previous performance. Details of qualifications of personnel who will be utilized.

Submissions should not exceed 20 pages with the exception of staff resumes and budget spreadsheets.

Proposals must be accompanied by a signed **Bidder's Submission Statement** as included in **Attachment 1**.

Terms and Conditions

The successful bidder's services shall be provided in accordance with Unitil's **Terms and Conditions** included as **Attachment 3.**

Bid Submittal

Bids must be submitted via e-mail not later than **12 NOON, EST, October 1, 2008.** Proposals received after the bid due date and time will not be accepted.

Bidders shall be responsible for submitting their bid via e-mail to:

glover@unitil.com

E-mailed bids shall not be submitted to any other e-mail address. **The SUBJECT line of the e-mail MUST contain the Bidder name as well as the RFP Name (TOU Pilot Phase I).** Proposals shall be prepared in Microsoft Word and Excel (cost estimation sheet) and shall include all proposal details indicated in these Instructions. Proposals shall not be submitted in .pdf format. Telecopies (faxes) of proposals will not be accepted.

In addition to electronic submittal of bids, one (1) original proposal must be mailed to Lisa Glover, Unitil, 6 Liberty Lane West, Hampton, NH 03842. The mailed proposal must be postmarked not later than October 1, 2008. The hard copy proposals are for our records only and therefore need only be postmarked by the date above; the e-mailed proposals are the Bid of Record.

All proposals must be properly dated and executed by an authorized representative of the Bidder's organization. Failure to provide the required hard copy and electronic version of the proposal or all required information may result in rejection of the proposal.

Verification of receipt of Bidder's e-mailed proposal may be obtained by contacting Lisa Glover via e-mail at glover@unitil.com.

All bids will remain active for 90 days, and no bid materials will be returned. Each proposal will be evaluated on technical and commercial merits. All proposals will be opened on or after the due date. Unitil is under no obligation to award the work on a single factor, or to award the work at all. All information provided to Bidders as part of the RFP process is considered confidential and shall be maintained as confidential by all Bidders.

All responses to this RFP, whether or not in compliance with the terms of this RFP, shall be considered unconditional offers by the Bidder, which, if accepted, shall create a binding obligation upon the Bidder. The pricing in any response shall remain valid for one year. Any limited duration offers shall be explicitly noted.

Selection Criteria

Personnel designated by the Sponsors' will confidentially review proposals. Proposals will be judged on:

Responsiveness - Does the proposal address all of the tasks identified in the RFP in a comprehensive manner?

Approach, Work Plan, and Schedule - Does the proposal offer a clear and well-defined strategy with sufficient coordination and interaction with all relevant parties and has the bidder shown that they have the resources to provide the services requested within the expected timeframe?

Qualifications and Experience - Has the bidder/team demonstrated that their firm has the experience and expertise relevant to all aspects of the RFP?

Price - Does the overall proposal and total cost offer good value?

Unitil retains the right not to select any bidders to perform the desired work or to reduce the size of the study contingent upon bidders' cost estimates. Until retains the right to terminate the project at any time and pay for actual documented expenses incurred by the contractor up to that point. Unitil also retains the right to negotiate a change in scope with the successful bidder at any time and will pay for any documented reasonable additional costs incurred for additional scope.

Unitil intends to inform successful bidders of their selection by end of day on October 15, 2008.

Unitil will evaluate bids based on each bidder's original submittal. There will be no negotiation with bidders following bid submittal, nor will unsolicited revised bid pricing be accepted following sealed bid opening. Bidders are encouraged to make their best offer in the original bid submittal.

Contract negotiations will commence in order to complete a signed contract as soon as possible after notification of contract award. All contracts will incorporate the terms and conditions referenced herein and the written documents provided by the Bidder in their Bid

Timeline

The following dates are critical to this RFP. Work is expected to be completed by Spring, 2009 so Phase II can be in place prior to the 2010 summer peak period.

Request for Proposal Distributed to Bidders	September 3, 2008
Last Date for Questions from Bidders	September 10, 2008
Responses to Questions to all Bidders	September 17, 2008
Proposals Due (via email)	October 1, 2008 @ 12 NOON, EST
Hardcopy must be Postmarked by	October 1, 2008

Contract Award	October 15, 2008 (est).
Project Initiation Meeting	Week of October 20, 2008
Final Work Plan	Week of November 3, 2008
Draft Report Completed	February 27, 2009
Presentation of Results to Unitil	Week of March 2, 2009
Unitil Comments Due	March 16, 2009
Draft Final Report Completed	March 30, 2009

Unitil
Bidder's Submission Statement

Demand Reduction Technology Evaluation Pilot Project – Phase I

The following form must be completed and included in each Bidder's proposal:

The undersigned Bidder hereby offers to perform the services as described in the Request for Proposal dated September 3, 2008, prepared by Unitil in accordance with the Proposal attached hereto. This Bid offer is firm and shall remain in effect for a period of ninety (90) days after receipt thereof by the Company.

In connection with such offer, the undersigned represents and warrants to the Company that it has carefully and thoroughly reviewed the entire RFP and that it possesses the experience, skills and abilities necessary to perform the services bid on in accordance with specifications in the RFP. In addition, we certify that the services shall be provided in accordance with Unitil's Terms and Conditions (Attachment 3).

Specifically, we agree to be bound to provide our services at the prices shown in the attached Cost Estimation Sheet (Attachment 2) through March 30, 2009. We understand that the option to extend the purchase order for these products at these prices for any period beyond March 30, 2009 will be at the discretion of Unitil. In addition, if we receive the benefit of any lower prices to use during the duration of this agreement, we agree to pass that benefit onto Unitil.

_____	_____
Name of Bidding Company (print or type)	Signature
_____	_____
Name of Signatory (print or type)	Position with Company (print or type)

Date_____

Attachment 2

UNITIL
DEMAND REDUCTION TECHNOLOGY EVALUATION PILOT PROJECT
PHASE I

PROJECT COST ESTIMATION SHEET

PERSONNEL			Kick Off Meeting		Task 1		Task 2		Task 3		OPTIONAL Task 3a		Task 4		Task 5			
					Workplan		Sample Design		Develop Educational/Marketing Materials		Marketing Study if needed		Develop Recruiting Stragety		Report Preparation		Total Labor Hours	Total Cost
NAME	TITLE	Hourly Billing Rate	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost		
Total Hours																		
Total Labor Cost																		
Other Direct Costs																		
Telephone and Fax																		
Reproduction																		
Delilvery Service																		
Travel																		
Total Other Direct Costs																		
Subcontractor Costs																		
Total Subcontractor Costs																		
Total Estimated Costs																		

Payment discount for early invoice payment (e.g. 2% 15, Net 30)? _____**No** _____**Yes**

BIDDER COMPANY: _____

COMPLETED BY: _____ **SIGNATURE:** _____

TITLE: _____ **DATE:** _____

Attachment 3

Terms and Conditions

1. ACCEPTANCE: This order becomes a binding contract on the terms and conditions set forth herein when accepted by the Vendor either by acknowledgment or com- mencement of performance. No modification hereof and no condition stated by Vendor in accepting or acknowledging this order, which is in conflict or inconsis- tent with, or in addition to the terms and conditions set forth herein, shall be binding upon the Purchaser unless accepted in writing.

2. SHIPMENTS: Vendor shall mail Bill of Lading and Shipping Memo to destination. Notify Purchasing Dept. promptly if unable to make shipment.

3. TERMINATION FOR DEFAULT: The Vendor's failure to comply with any of the specifications, instructions and conditions of this order or deliver material in whole or in part in accordance with the Vendor's agreed upon delivery schedule shall be grounds for cancellation by the Purchaser without penalty, unless the Vendor establishes the delay in delivery is without fault or negligence on his part and results from unforeseeable causes beyond his control including, without being limited to, acts of God, or of the public enemy, any preference, priority or alloca- tion order issued by the government, fires, floods, strikes and freight embargoes.

4. TERMINATION FOR CONVENIENCE OF PURCHASER: The Purchaser may termi- nate this order in whole or in part by written notice to the Vendor. In such event the Purchaser shall make payment to the Vendor for all cost incurred prior to such termination reasonably allocable to this order under recognized account- ing practice, together with a reasonable allowance for overhead and profit on work performed, less disposal or retention value of termination inventory. This provi- sion shall not be deemed to limit or otherwise affect the Purchaser's right to can- cel this order for the default of the Vendor.

5. PRICES: The Vendor agrees that the prices stated on the face of this order shall be considered firm unless otherwise noted, and the Vendor warrants that said prices do not exceed the prices allowed by any applicable Federal State or Local regu- lation.

6. COMPLIANCE WITH LAWS: The Vendor warrants that in performing work under this order he will comply with all applicable laws, rules, and regulations of govern- mental authorities and agrees to indemnify and save the Purchaser harmless from and against any and all liabilities, claims, costs, losses, expenses, and judge- ments arising from or based on any actual or asserted violation by the Vendor of any such applicable laws, rules and regulations.

7. PATENTS: The Vendor agrees to protect and save harmless the Purchaser from all costs, expenses, or damages, arising out of any infringement or claim of infringe- ment of Patents in the use or sale of material or equipment furnished pursuant to this order.

8. ASSIGNMENT: The Vendor agrees that neither this order nor any interest therein shall be assigned or transferred by him except with the prior written approval of the Purchaser.

9. NONDISCRIMINATION IN EMPLOYMENT: By acceptance of this order, the Vendor agrees to comply with all applicable Federal, State, and Local Anti-Discrimination Laws including the Civil Rights Act of 1964 and Executive orders 11246, 11375 and amendments thereto.

10. SUBSTITUTION: No substitution will be permitted under this order except on specific written authority of the Purchaser's Purchasing Department.

11. ERRORS IN MATERIAL: Material or equipment delivered in error, or in excess of the quantity called for, will be returned at the Vendor's expense.

12. VENDOR'S LIABILITY FOR PURCHASER'S PROPERTY: Whenever the Vendor shall have in his possession property of the Purchaser for the Vendor's fabrication or otherwise as herein required, said Vendor shall be deemed the insurer thereof and shall be responsible for same until its acceptance as a common carrier for shipment according to the Purchaser's instructions.

13. VENDOR'S AGENT OR EMPLOYEES: If the Vendor in the performance of this order furnishes the services of himself, his agent or employee as an Erecting Engineer- ing, Superintendent, or otherwise, in respect to the operation, adjustment, repair, installation, erection or dismantling of material and/or equipment furnished here- under or as described herein, the Vendor agrees to assume all liability with respect to the services of himself, his agent or employees while on the premises of the Purchaser and to indemnify and save the Purchaser harmless from all claims, suits, actions and proceedings whatsoever which may be brought on account of injuries or damage to the Vendor, his agent or employee or to other persons or property which shall occur as a result of the performance of said services.

14. INDEMNITY: Vendor will indemnify and hold the Purchaser harmless against any liability, loss, damage or expense resulting from personal injury, death or property damage arising from or in connection with Vendor's performance of this order.

15. INSPECTION: Materials and equipments ordered hereunder are subject to inspec- tion and acceptance, by Purchaser. Such inspection and acceptance however, shall not be conclusive as regard to defects which could not have reasonably been discovered by such an inspection or latent defects, fraud or such gross mis- takes as amount to fraud and shall not be deemed to alter or affect the obligation of the Vendor or the Rights of Purchaser under the clause WARRANTY.

16. UNAUTHORIZED REWORK: Under no circumstances is the Vendor permitted to use substitute material to replace defective articles or to repair or rework them, by welding or otherwise without Purchaser's written permission.

17. ADJUSTMENT: Payment of Vendor's invoices shall be subject to subsequent adjustment for shortages and for allowance for articles rejected and expense of rework incurred by Purchaser.

18. WARRANTY: Vendor warrants that all articles delivered under this order will (a) conform to applicable specifications, drawings, or other description, (b) be free from defects in design. This warranty shall run to Purchaser, its customers and users of Purchaser's products.

19. PREMIUM TRANSPORTATION: Any premium transportation costs incurred by Purchaser and as a result of Vendor's failure to meet the delivery schedule shall be paid for by Vendor.

20. GOVERNING LAW: The rights of the parties hereto and the construction and effect of this order shall be subject to and determined in accordance with the laws of the state in which the Purchaser's company headquarters are located.

Technical File

Project Plan

“Outage Management System Integrated with Advanced Metering Infrastructure”

Unitil Service Corporation

6 Liberty Lane West

Hampton, NH 03842

August 6, 2009

TABLE OF CONTENTS

ATTACHMENTS

1. Project Abstract

Unitil Corporation, through its subsidiary Unitil Service Corp. on behalf of its regulated utility affiliates Fitchburg Gas and Electric Light Company, serving 28,000 electric customers in Massachusetts, and Unitil Energy Systems, Inc., serving 77,000 electric customers in New Hampshire, is pleased to submit an application for a Smart Grid Investment Grant titled "Outage Management System Integrated with Advanced Metering Infrastructure". Unitil Service Corp. is the central services subsidiary of Unitil Corporation, a utility holding company headquartered in Hampton New Hampshire providing electric and gas distribution services to 170,000 customers in Massachusetts, New Hampshire and Maine.

The project falls within the SGIG topic area *Advanced Metering Infrastructure*. The project plan is to integrate the existing energy management systems with an advanced, integrated outage management system (OMS) throughout its entire system to improve outage visibility and response times and provide access to real-time, decision-driving data that reduces risk and uncertainty. Specifically, the OMS will integrate with the existing advanced metering infrastructure (AMI), Supervisory Control and Data Acquisition (SCADA) system, IS infrastructure including its extensive Geographic Information System (GIS) capabilities, Customer Information System (CIS) and Interactive Voice Response (IVR) system.

Unitil views its OMS investment as a critical step forward in the development and implementation of technological advances that will fundamentally change the nature of our energy distribution business in the coming decades. The project contributes to the furthering of smart grid functions by integrating key systems including AMI, SCADA, GIS, CIS and IVR in a real-world, real-time application with significant customer and distribution utility benefits. The technologies and the integration process involved will serve as a model for the industry in identification and deployment of smart grid technology to real world concerns. The company is poised to implement this $2.1 million project immediately and complete it within one year.

2. Project Tasks and Schedule

2.1. Project Description

The project involves the installation of an advanced, integrated outage management system (OMS) that will complement Unitil's existing energy management systems (EMS). An OMS will provide a means to use real-time information to manage outage events in a more effective manner and contribute to reducing the outage management restoration process. The status of restoration and estimated restoration times are extremely important priorities to all of the customers located within Unitil's electric service territories. Implementation of OMS within Unitil's service territories will provide critical support for minimizing time and costs associated with the outage restoration process and providing ready access for customers and the public to information about outages. Anticipating and responding to system disturbances is a specific characteristic of Smart Grid functionality as defined by the DOE.

The OMS will be integrated with the company's existing advanced metering infrastructure (AMI) and its Supervisory Control and Data Acquisition (SCADA) systems as well as its existing IS infrastructure including its extensive Geographic Information System (GIS) capabilities, Customer Information System (CIS) and Interactive Voice Response (IVR) system. In addition to providing real-time information for the company, the OMS is being designed to provide an extensive information interface for customers and the public seeking information regarding outages, progress on restoration and estimated restoration times.

Unitil has developed and issued a detailed request for proposal to multiple vendors. Bid proposals were received from 7 vendors. Each of the proposals was evaluated on the basis of required and valued functionality versus the overall cost. Through the evaluation process, a vendor has been selected. Unitil is working cooperatively with the vendor (ABB Inc.) to develop a final design and scope of work for the installation and integration of the OMS system. The opportunity of receiving funds under the SGIG program has allowed the company and the contractor to maximize both the speed and the depth of the OMS implementation. Originally conceived of as a multi-year staged investment program, the project is now being proposed as a single year two-phase effort leading to full implementation of all key system components and enhancements by early 2010. A contract will not be signed with this vendor until both parties agree on the scope of work. The anticipated scope of activities for the installation, assuming 50% funding match from the DOE SGIG, is outlined below.

As envisioned, the project will be delivered in two phases. The first phase involves the implementation of the OMS system with primary data input from Unitil's IVR and CIS systems and integrated with Unitil's GIS system. The second phase involves the integration of the OMS with Unitil's existing AMI and SCADA systems.

2.2. Project Tasks and Equipment

In the first phase, interfaces will be developed with the existing GIS, CIS and IVR systems to allow data to be entered into the OMS. Once the necessary hardware is specified, purchased, and delivered, the OMS software will be loaded onto the hardware and integrated with a database extract from Unitil's ESRI Miner&Miner GIS data. The software will be tested for compliance with specifications, including the interface to the IVR and CIS system. Start up

tests and site acceptance tests will be conducted and the system will be commissioned for on-line operation. ABB will provide training to Unitil to ensure smooth transition of OMS operation.

This section provides a detailed description of the intended work scope and equipment to be utilized. The scope of work for implementing and integrating the OMS system has been identified in great detail in Unitil's initial request for proposal and ABB's proposal. Specific tasks to be accomplished in Phase 1 include the following:

- **Task 1: System Development**
    - Specify and order the hardware and materials for a fully redundant system. The primary hardware/software to be utilized is ABB's Network Manager Distribution Management System (NM-DMS) Outage Management System (OMS).
    - Review Unitil's existing ESRI Miner&Miner GIS format database. Develop a tool for extracting information from the GIS database that can be utilized in the OMS system.
    - ABB will utilize Multispeak to develop a two-way interface with Unitil's Milsoft/Porche IVR. ABB will conduct a system test using Unitil's historical IVR data.
    - ABB and Obvient Strategies will deliver FocalPoint, Obvient's data integration solution, integrated with NM-DMS to provide Unitil with dashboard reports based upon Unitil's criteria. The FocalPoint scope consists of Asset Reliability, Operation, NM-DMS ETL and Storm Central modules.
- **Task 2: System Testing**
    - ABB will develop test procedures to test all of the functionality provided in this package to Unitil. The test procedures shall be designed to verify the complete operation of the system
    - Initial testing will verify the correctness and adequacy of Unitil's ESRI Miner&Miner GIS database. If the GIS database is sufficient to allow ABB to test effectively, ABB will extract the database for the system and configure the system for test.
        - Unitil is currently in the process of developing a customer to transformer network connectivity link. Unitil requires that this database link be established prior to completing the testing.
    - ABB will develop test procedures specific to the package being provided to Unitil that will test all of the functionality of the OMS system using Unitil's GIS network model. Testing will include verification of all functionality provided including the of the IVR interface using historical information from Unitil's IVR system. ABB will work with Unitil to develop the required test case.
    - The system will then be tested to ensure that it functions per the requirements of the contract. The testing will be done by ABB with assistance by Unitil.
    - Following acceptance of the system testing, operation of the IVR interface will be verified using the IVR verification case developed by Unitil and ABB

- **Task 3: Site Work**
    - ABB will conduct training on the OMS system prior to system installation. Training workshops will include interface overview, GIS migration, hardware and system networking, database structure, operator training, reporting, and a training simulator.
    - All required hardware and required materials will be received on site, and connected to power and required communication links.
    - Unitil will make whatever preparations are needed to switch operations over to the new system. Typical items for this include coordination with Operations, verification of final training on complete OMS package by ABB for operators and support staff and notification of other areas of the company and customers that may be impacted by the change.
    - A site acceptance test will be conducted to re-verify the complete functionality (design and operation) of the system and to verify that the system operates when connected to the Unitil infrastructure and interfaced with Unitil's systems. Special emphasis will be given to testing functions and interfaces that could not be emulated during the factory acceptance testing phase.

The second phase of the project consists of interfacing with Unitil's existing AMI and SCADA systems. The interface with Unitil's AMI system will be a one-way interface that will be able to receive information from the AMI system with respect to individual customer meters. Similarly, the interface with Unitil's SCADA systems will be a one-way interface that will be able to receive information on SCADA device operations. An acceptance test will be conducted following the integration of the OMS with the existing AMI and SCADA systems to verify the complete functionality of the system. Specific tasks to be accomplished in Phase 2 include the following:

- **Task 1: Interface Development**
    - Develop an interface with Unitil's SCADA systems. It will consist of a one-way interface that will be able to receive information on SCADA device operations. Information and data received will be translated into usable information that is linked to the appropriate devices within the OMS system. ABB will modify the prediction algorithm to identify a SCADA operation as a confirmed outage within the OMS. When a SCADA device closes, the OMS shall indicate the change in status and when the individual outage is restored.
    - Develop an interface with Unitil's AMI system. It will consist of a one-way interface that will be able to receive information from the AMI system with respect to individual customer meters. Information and data received will be translated into usable information that is linked to the appropriate customers in the OMS system. ABB will modify the prediction algorithm to identify a SCADA operation as a predicted outage within the OMS system. When the AMI system indicates the change in status, the OMS shall note that the change in status and when that outage was restored.

- **Task 2: Acceptance Testing**
    - The purpose of the site acceptance test (SAT) is to verify the complete functionality (design and operation) of the system with respect to the interface with AMI and SCADA and to verify that the system operates when connected to the Unitil infrastructure and interfaced with Unitil's AMI and SCADA systems. Special emphasis will be given to testing functions and interfaces that could not be emulated during factory acceptance testing.

The primary deliverable for the project is the integration of a fully functional OMS with Unitil's existing AMI, GIS, IVR, SCADA and CIS systems. Documentation will include all meeting minutes, project schedules, and correspondences. ABB will track all defects and resolutions during the development and integration of the programs. At the conclusion of the project, ABB will provide training materials and reports pertinent to the functionality of the OMS system, including all detailed design documents. The installed and integrated OMS system will have the capability to generate the following reports:

ABB will complete the following reports with Unitil assistance:

- Upload Unitil's historical outage information from its Microsoft Access based Trouble Interruption Reporting system. This data will be in a format such that the historical data can be used seamlessly in the Focal Point reporting package.
- Provide the ability to export all reports to Microsoft Excel
- Real-time outage reporting on active and recently restored outages in format compatible with MA DPU ORP reporting system
- ABB will work with Unitil to get the actual calculation to be used for any reliability indices shown in the dashboard or other reports.

- Reporting within NM DMS[1]
  - Prioritization of individual outages for restoration planning
  - Trouble conditions with and without outages
  - Individual service outages
  - Real-time crew assignments
  - Quantity of active outages by DOC, Town, Circuit, etc.
  - Quantity of restored outages by DOC, Town, Circuit, etc. for a given event
  - Length of each active outage by DOC, Town, Circuit, etc.
  - Estimated restoration time by DOC, Town, Circuit, etc.
  - Quantity of active outages by a given cause
  - Quantity of active circuits affected by DOC, Town, Circuit, etc.
  - Quantity of customers who are affected by the active outage by DOC, Town, Circuit, etc.
  - Quantity of customers who have called versus # affected by DOC, Town, Circuit, etc.

- Reporting with Obvient FocalPoint[2]
  - Operations Dashboards (FocalPoint):
    - Current outages
    - Restoration Status
    - Customer Outages
    - Current ERT Status
    - Customer History
  - Storm Central (FocalPoint)
    - Spatial representation of outages:
      - Area map with zones highlighted
      - Area map with outages highlighted
    - Publish outage maps to Unitil website with geographic filtering capabilities for easy navigation
    - Maps and high level statistics shown by service territory (UES Capital, UES Seacoast, FG&E)
  - Asset Management (FocalPoint)
    - Asset Reliability Dashboard
    - Worst Performing Circuits Dashboard
    - Outage History Analysis

[1] The assumption is that these are general reports/information that is available through the NM-DMS
[2] The assumption is that these are general reports/information that is available through Obvient FocalPoint

Unitil will complete the following reports with ABB assistance

- Monthly, quarterly and annual reliability indices (SAIDI, SAIFI, CAIDI, etc.) based upon criteria developed by Unitil, IEEE 1366, NH PUC and MA DPU.
- Historical outage reporting for a given event
- Historical outage reporting for a given customer
- Historical crew assignments
- Historical circuit performance
- Quantity of historical outages by a given cause
- Quantity of historical circuits affected by DOC, Town, Circuit, etc.
- Quantity of historical customers who are affected by the outage by DOC, Town, Circuit, etc.
- Quantity of historical customers who have called versus # affected by DOC, Town, Circuit, etc.
- Length of each active outage by DOC, Town, Circuit, etc.
- Estimated restoration time by DOC, Town, Circuit, etc.
- Crew assignment by DOC, Town, Circuit, etc.

2.3. Project Schedule

This section defines key project milestones and the estimated completion dates. Each of the tasks defined in Section 2.2 is interdependent on the preceding task for the project to move forward. In Phase 1 for example, the system development task which involves data extraction from the GIS system and developing the IVR interface must be completed before the factory acceptance testing can be conducted. The factory acceptance testing must be conducted before the site installation and testing can be conducted, and so on. The sub-tasks can be developed in parallel. Key project milestones and estimated completion dates are:

Description	Completion Date
Phase 1 – System Development	**9/15/09**
Phase 1 – Factory Testing	**10/19/09**
Phase 1 – Site Installation and Training	**11/16/09**
Phase 1 – Site Acceptance Testing	**12/10/09**
Phase 2 – AMI Interface Development	**4/29/10**
Phase 2 – SCADA Interface Development	**6/24/10**
Phase 2 – Acceptance Testing	**7/1/10**

As indicated in the schedule above, project completion is anticipated within 12-months of the receipt of DOE funding. In the funding opportunity announcement, DOE has expressed a preference for projects with shorter durations. Regulatory approvals for the project are not required from with the Massachusetts Department of Public Utilities, or the New Hampshire Public Utilities Commission. Therefore, procurement of regulatory approval is not a critical task to the completion of this project and will not impact the schedule outlined above.

Merit Review: Criterion 2 - Adequacy of the Plan for Project Tasks, Schedule, Management, Qualifications, Organizational Commitment, and Risks

As discussed above and highlighted below, we believe this project meets the DOE's criteria to receive high technical merit on Criteria 2:

- ✓ The project's objectives and scope of activities are relevant to the purpose and goals of the SGIG
  - The project furthers Unitil's ability to anticipate and respond to system disturbances
- ✓ The project schedule is effective in describing the key tasks and their interrelationships, major milestones and deliverables, and a project time period of three years or less.
  - Significant detail provided regarding the tasks necessary for project completion within the **11 month** schedule

Opportunities for High Technical Merit

- ✓ Project plan convincingly demonstrates a comprehensive, integrated approach, indicating a high probability of success, to fulfill the technical promise of the application on schedule and within the budget
  - There is a detailed, comprehensive plan for project success based on equipment and software that is industry proven
- ✓ Plan provides a realistic, well thought out implementation schedule

3. Management Plan

Integration of an OMS with Unitil's existing energy management systems is of the utmost importance to Unitil and serves to further the development of smart grid functionality within Unitil's electric service territory. The project furthers the development of smart grid functions by increasing Unitil's capability to anticipate and respond to system disturbances. The importance of this increased capability is best exemplified by the multi-week outage restoration effort undertaken by Unitil following a massive ice storm in December 2008. Unitil's senior management is committed to the success of the project and to dedicating the resources needed to accomplish it. A letter of commitment from Unitil's Chief Executive Officer, Robert G. Schoenberger is included in Attachment 2 to this technical file.

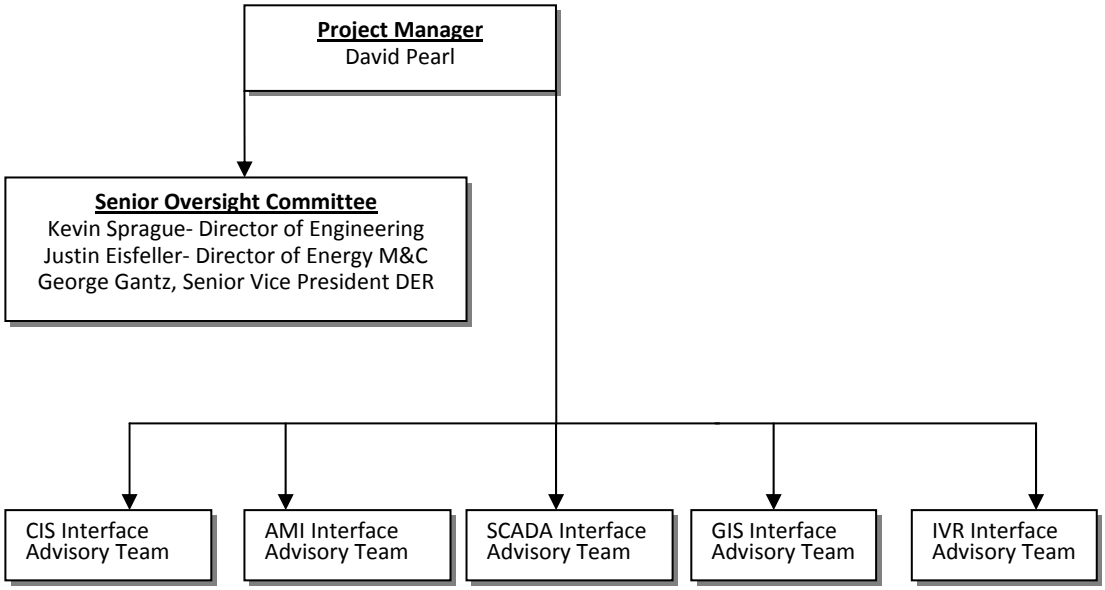
3.1. Project Team Organization

The project team for the OMS project consists of personnel from Unitil and ABB Inc. Both Unitil and ABB will assign a project manager who will serve as the primary contact for the project. The project managers will direct personnel assigned to the project and are responsible for coordinating their activities to accomplish the project objectives. The project managers also have direct access to their respective management, allowing the project managers to report status of the project to senior management and to request assistance if needed.

The success of the project will be determined to a large extent by the project managers for each company and the level of communications between them. It is expected that the project managers will have frequent informal discussions on scope and schedule, making adjustments as needed to ensure that the work is done efficiently and on time. While minor variations are expected, any significant change to either project scope or schedule must be documented and agreed to by both parties prior to the change. ABB's project manager will have the ability to make day-to-day decisions on Unitil's questions and requests. All formal project communication will be through sequentially numbered transmittals issued by the ABB and Unitil Project Managers or their authorized representatives

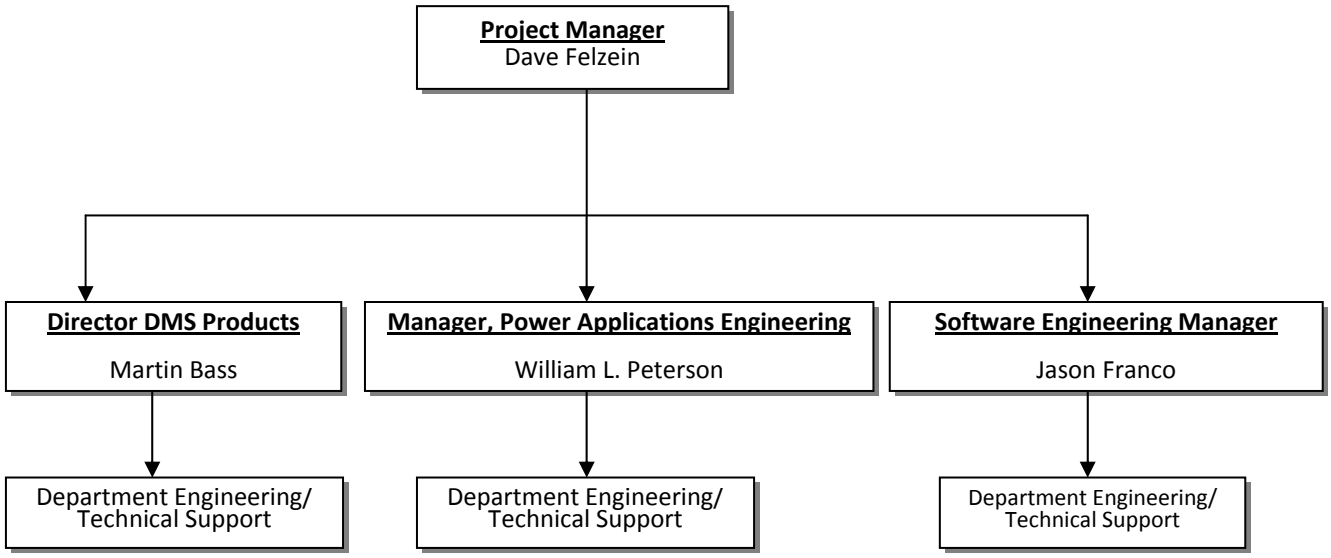
The project manager for Unitil will be David Pearl, a consultant with extensive experience in project management and systems integration, who has been retained specifically to manage this project. Mr. Pearl will communicate directly with a senior oversight committee comprised of Kevin Sprague, Justin Eisfeller and George Gantz from Unitil. This committee will be involved in making key decisions relating to the direction of the project and integration of the project. For day to day issues, Mr. Pearl will also speak directly with advisory teams that will be involved in the integration of each specific interface. The advisory teams will be comprised of individuals with the best working knowledge of each system. Resumes for David Pearl, Kevin Sprague, Justin Eisfeller and George Gantz are included in Attachment 1 to this application. The flowchart below pictorially illustrates the management structure for Unitil.

UNITIL SERVICE CORP.



The project manager for ABB will be David Felzein, Project Leader in the development and delivery of electricity operations, Bidding and Trading Systems. Mr. Felzein will be responsible for day to day correspondence with Unitil's project manager David Pearl. Within ABB, Mr. Felzein will be supported by key personnel with familiarity in the specific product areas. The key personnel include Martin Bass, Director of DMS Products, William Peterson, Manager of Power Applications Engineering, and Jason Franco, Manager of the Software Engineering Department. These key personnel will assist in the decision making processes and in the delegation of specific tasks to support staff. Resumes of ABB's project manager and other key personnel are included in Attachment 1 to this Technical File. The flowchart below pictorially illustrates the management structure for ABB.

ABB



Roles and responsibilities of Unitil and ABB have been clearly established in both the initial request for proposal and in the proposed scope of which, which is currently in the final stages of development. Roles and responsibilities for Unitil include:

- Provide a project manager that will act as the primary point of contact between Unitil and ABB. The individual assigned to this role will not change or alternate through the entire duration of each phase, unless both parties agree.
- Participate in all planned meetings and ensure that proper personnel are in attendance dependent on the topic(s) to be discussed;
- Provide information and data as required for ABB to perform its responsibilities including the Unitil Telvent Miner&Miner ArcFM SQL-Server GIS database backups and information on Distribution System
- Provide data on the Milsoft/Porsche IVR communications interface such as data format and requirements for use by ABB in interface development;
- Work with ABB to develop a performance test using agreed upon call threshold.
- Provide functional test data and emulation software for factory testing the IVR interface developed by ABB;
- Work with ABB to design and implement the interfaces using ABB provided API's for AMI and SCADA;
- Respond to ABB requests for assistance and/or clarification on Unitil supplied documentation in the time frame agreed;
- Take training as may be specified and offered by ABB;
- Provide office and other workspace, including phone and high-speed internet connectivity for ABB personnel while at Unitil;
- Provide other assistance as may be reasonably requested by ABB during any on-site work;
- Work with ABB to define and apply DMS configuration settings;
- Participate in factory testing to the extent agreed;
- Receive and install the equipment when shipped from ABB;
- Provide all required connections for the system at Unitil, including power and communications to all required interfaces;
- Provide remote communications from ABB to the system, including connectivity through any firewall or security device required by Unitil for such connections;
- Work with ABB to develop a detailed site acceptance test that is agreed upon by both Unitil and ABB
- Run the Site Acceptance Testing with ABB assistance; and,
- Provide other services as may reasonably be requested by the ABB project manager.

Roles and responsibilities of ABB include:

- Provide a project manager that will act as the primary point of contact between Unitil and ABB. The individual assigned to this role will not change or alternate through the entire duration of each phase, unless both parties agree.
- Facilitate all planned meetings and ensure that proper personnel are in attendance dependent on the topic(s) to be discussed;
- Specify and provide hardware and other materials as specified in the contract hardware List of Deliverables;
- Stage the hardware in the ABB factory and provide all necessary interconnections for power and communications;
- Receive the Telvent ArcFM SQL-Server GIS database backups as supplied by Unitil;
- Develop a two-way interface to the Unitil Milsoft/Porche IVR using ABB's standard IVR API. This interface will include all functionality as described in the Associated Documents section of this document;
- ABB to work with Unitil to implement ABB provided NM DMS API's for AMI and SCADA interfaces;
- Assist Unitil with NM DMS configuration settings;
- Develop a configurable database extractor for electrical and land based data from the Telvent ArcFM SQL-Server GIS database;
- Test the system and prepare it for Factory Acceptance Test (FAT);
- Perform FAT with Unitil assistance;
- Responsible for executing training;
- Pack and ship the system to Unitil using a shipper as agreed by both parties;
- Provide Unitil with onsite hardware installation requirements prior to installation at Unitil.
- Assist Unitil in installing the system at Unitil;
- Work with Unitil to develop a detailed site acceptance test that is agreed upon by both Unitil and ABB.
- Provide Unitil with a data dictionary for NM DMS.
- Work with Unitil to develop a performance test using agreed upon call threshold.
- Assist Unitil to execute Site Acceptance Tests;
- Provide an individual who will remain on site for the first week that Unitil deploys into production.
- Perform other services as may reasonably be requested by the Unitil project manager.

- Respond to Unitil requests for assistance and/or clarification on ABB supplied documentation in the time frame agreed;

3.2. Project Meetings

Project meetings will be held monthly between the project managers and the lead technical people for both ABB and Unitil to assess and monitor the on-going progress of the project. These will be held at a mutually agreeable time and location, or as decided by the project managers, may be done by a telephone or video conference. An agenda will be developed for each meeting at least one week before the meeting to ensure that the proper people may attend and will issue draft minutes of the meeting within one week following the meeting. Unitil will review the draft minutes and comment within three days. ABB will incorporate the Unitil comments as appropriate and issue final minutes of the meeting within two days. Topics to be discussed at the meetings include:

- Work accomplished in the past report period
- Work scheduled for the next report period
- Work that is behind schedule and possible recovery plans
- Risks to project completion and possible mitigation plans

The project manager will document the agreements of the meeting by issuing minutes of the meeting within two days of the meeting. It is expected that the technical staff for Unitil and ABB will also engage in ad hoc conversations during the project execution. These are usually effective ways to keep all members of the project team informed of the project progress. However, some conversations may have an impact on scope and/or schedule. No such changes are considered valid unless confirmed by agreement of the project managers and, as necessary, a formal contract change. The project manager will document the agreements of the meeting by issuing minutes of the meeting within two days of the meeting.

3.3. Risk Management

As with any large project, there are a number of risks that could impact the outcome. Following is a discussion of known areas of risk for this project.

Technical

In order for Unitil to implement an OMS, Unitil must have a customer to transformer network connectivity model. Unitil has determined that this connectivity model will be developed by identifying and documenting the service transformer that provides service to each electric meter. This connectivity model requires a field survey to accurately develop the connectivity model. Unitil issued a request for proposal to three different contractors who have the experience to complete this project. Following an evaluation process, Unitil has selected Osmose to complete this field survey. This field survey is scheduled to be completed in parallel with the OMS project.

The integration of an OMS system with Unitil's existing energy management systems has been studied by Unitil prior to the development of a request for proposal. A detailed proposal and

solution overview has been presented by a contractor. Therefore, we believe that the project is technically feasible with minor technical risks.

Financial

The primary financial risk rests on the ability of Unitil to fund the project. The company is financially secure and stable. Unitil Corporation has issued regular dividends since the formation of the holding company in 1985, in the past eight months it completed a major acquisition and raised $90 million in debt and secured net proceeds of $95 million through issuance of new common stock equity – all during the worst financial markets in generations. The company has a significant short term line of credit with a consortium of regional banking institutions. This project and its costs are now included in the financial plans for 2009 and 2010 and will be funded through this short term line of credit; it is therefore not contingent on any additional outside financing. The financial risk is therefore very low.

Regulatory

Regulatory approval is not required for the proposed OMS project; therefore there are no regulatory risks to address in this section.

Institutional

ABB has a long and successful track record of executing OMS projects for customers with varying functional, integration, and performance requirements. This extensive history of project implementation has enabled ABB how to deliver projects on the schedule required by their customers. ABB's OMS systems have been installed since the early 1990's and currently has over 60 OMS systems installed worldwide, ranging in size from 25,000 to 5,200,000 customers. In the United States, ABB's OMS system is in service at distribution companies serving over 25 million customers. Both Unitil and ABB are dedicated to implement this project on-time and on-budget. Commitment letters from both organizations are included in Attachment 2 to this application.

3.4. Additional Applications

Unitil Service Corp. is submitting one additional application for consideration in the U.S. Department of Energy's Smart Grid Investment Grant Program entitled "Advanced Metering with Dynamic pricing and Automated Load Management Pilot Program". That application involves conducting a residential demand response and load management pilot program that is proposed to a statistically valid sample across Unitil's New Hampshire and Massachusetts service territories. The proposed pilot program will test the cost effectiveness of three separate residential demand response smart grid programs. The intent is to determine the effectiveness of each program component, with respect to both cost and load management, and to build upon the most successful elements by expanding the programs with an ultimate goal of offering them to all customers in the service territory. The three program components being proposed are:

- Dynamic Pricing Program – Enrolled customers will be set up on a time-of-use rate structure and will receive basic educational materials only with no additional enabling technology. In addition to the daily on-peak and off-peak periods intended to encourage customers to shift usage to off-peak hours, there will be critical peak period pricing at significantly elevated rates when called for by the utility. Notification of a CPP event will be handled via email, pager, or phone call, based on customer preference.
- Enhanced Technology Program – Enrolled customers will be set up on a time-of-use rate structure with critical peak period pricing and will receive the same educational materials, but will also receive an in-home wireless control system with a suite of energy management tools, a utility integration portal, and flexible control devices (smart thermostats and outlets). This package will allow for both utility and customer-automated load control and demand response. The Enhanced Technology Program will not include direct demand control by Unitil through the customer's thermostat.
- Smart Thermostat Program – Enrolled customers will stay on the existing fixed rate billing structure. Unitil will provide a controllable thermostat that offers digital programming features and customer feedback. Unitil will have the ability to either cycle the customer's heating and cooling load, or change the temperature on the thermostat during critical peak periods. This change in thermostat setting will be accompanied by local notification at the thermostat unit. Customers will be able to override the changed setting.

Each of the three programs will be targeted to Unitil's customers with central air conditioning systems. Randomly selected customers with air conditioning will be recruited into the program to minimize the effects of self-selection bias. In addition to providing valuable information on the cost effectiveness and load management benefits of the three program segments, the pilot will allow Unitil to evaluate the ability of the existing AMI meters to support and administer dynamic pricing programs.

Merit Review: Criterion 2 - Adequacy of the Plan for Project Tasks, Schedule, Management, Qualifications, Organizational Commitment, and Risks

As discussed above and highlighted below, we believe this project meets the DOE's criteria to receive high technical merit on Criteria 2:

- ✓ The plan is effective in organizing the tasks, activities, organizations, and personnel to accomplish project objectives in a timely and cost-effective manner and produce top quality deliverables, products, and services, and to define the respective roles and responsibilities of the project manager, supporting personnel, lead organization (e.g., "prime" contractor), and supporting organizations (e.g., "lower-tier" subcontractors).
  - Clear and concise project plan and discussion of roles and responsibilities
- ✓ The organizations and personnel have relevant and significant qualifications for achieving the project objectives and contributing to the overall purpose and goals of the SGIG.
  - Experienced capable project managers and supporting staff
- ✓ High level of organizational commitment to the project as demonstrated by the inclusion of letters of support or other materials from senior executives in the lead and supporting organizations, key vendors, and key stakeholders
  - Letter of support from Unitil and ABB (lead vendor)
- ✓ Project strategies will effectively address technical, financial, regulatory, and institutional risks

Opportunities for High Technical Merit

- ✓ Project has a proven project manager
  - Both ABB and Unitil have proven project managers; resumes included as attachment
- ✓ Plan provides a complete discussion of risk and risk mitigation strategies
  - Primary risk is technical related to development of a connectivity model. The risk has been identified and experienced contractors are being solicited to assist in the development of the model. There are no significant financial, regulatory or institutional risks
- ✓ Appropriate tools will be used to monitor performance
  - Standard, industry accepted reporting techniques to assess improvements in operational performance
- ✓ Plan provides for well established interfaces with all organizational elements
  - Defines clear structure for project communications

4. Technical Approach to Enabling Smart Grid Functions

4.1. Adoption and Integration of Smart Grid Functions

Installation of an OMS throughout Unitil's New Hampshire and Massachusetts electric service territories clearly incorporates two of the seven specific characteristics of what DOE believes a smart grid would accomplish; specifically, anticipating and responding to system disturbances, and operating resiliently to attacks and natural disasters. The proposed project supports and advances two of the specific "smart grid functions" as listed in EISA, Section 1306(d):

- "The ability to sense and localize disruptions or changes in power flows on the grid and communicate such information instantaneously and automatically for purposes of enabling automatic protective responses to sustain reliability and security of grid operations"
- "The ability to detect, prevent, communicate with regard to, respond to, or recover from system security threats, including cyber-security threats and terrorism, using digital information, media, and devices."

The proposed OMS will integrate the capabilities of Unitil's existing CIS, AMI, SCADA, IVR and GIS systems, which will serve to further smart grid functionality. In accordance with EISA, Section 1306(b), the documented purchase cost of software that enables devices or computers to engage in smart grid functions is an eligible investment for the purpose of allocating SGIG funds.

Currently, Unitil has installed AMI meters throughout its service territory, providing two-way communication between the meters and the service center. The continuous monitoring (24 hours per day, 7 days per week, 365 days per year) at every meter point provides valuable information about the status of each and every customer and can be utilized to determine the full extent of an outage. Every meter endpoint on the Unitil system has the capability to record when it is experiencing an outage condition. It also has the functionality to understand if the outage is momentary or sustained in nature, and if it is part of an overall outage event (a combination of momentary outages and a sustained outage). This information is reported back to the Command Center. Each endpoint has a Global Positioning System (GPS) location associated with it which was captured during the meter endpoint deployment. The GPS locations and the information from the outage information from the Command Center are used to spatially represent all of the meter endpoints in the Unitil GIS system. Unitil has used the spatial outage information during larger scale events to assist with categorizing and assessing the overall size of outages and dispatching crews to address areas of highest concern. Currently the evaluation of AMI data, assessment of outage severity and prioritization, and line crew dispatching is done manually. The OMS system provides the capability to use real-time information to manage outage related events in a more effective manner and contribute to reducing the outage restoration process.

The OMS system will use several different data sources to make predictions about the outage size and severity to better anticipate and respond to system disturbances. The data sources are from customer calls through the IVR system, SCADA interfaces and the AMI

system. The approach for developing interfaces for integrating Unitil's existing emergency management systems into the OMS is outlined extensively in Section 2.2 of this application. This section identifies the specific functionalities of the proposed OMS that serve to further smart grid technology throughout Unitil's service territory:

- Outage Prediction: The OMS will have an automated feature used to intelligently and reliably predict the scale of the outage and the most probable device that is open. The algorithm will be designed to distinguish between an individual customer outage, an outage on a secondary line affecting all customers served from a given transformer, a larger scale outage affecting a given primary phase of a three phase line, or an entire circuit or area outage. The algorithm will have the ability to be modified as more information is integrated with the OMS. The OMS will use the outage prediction algorithm to categorize customers into their respective outage grouping.
    - Automation of system components and taking decisions out of the realm of system operators has been a key concept of smart grid functionality expressed by DOE, NIST, and other groups studying the topic.
- Recognize Multiple System Outages: The OMS will have the ability to distinguish between multiple outages throughout the system or even on a given circuit. The system will have the ability to distinguish between nested outages as well as outages in the same area.
- System Event Alarms: The OMS will be designed with alarms with user defined set points. The alarms will be based upon, but not limited to the following:
    - Initial outage indication
    - Most probable device that is open
- System Event Summaries: The OMS will be designed to provide summaries of:
    - Quantity of Outages
    - Size of outages
    - Percent of system
    - Total number of customers experience outages
- Estimated Restoration Times: The OMS will have the ability to estimate and/or allow for user input estimated restoration times for each outage event. These times should be editable by the user as more information of the outage becomes apparent.
- Dynamically Change Outage Situations in Real-time: The OMS will have the ability to receive updates and modify outage tracking in real-time based upon user input and input from other systems. The OMS will then track and report on those changes.
- Crew Management Functions: The OMS will have the ability to manage and track crew functions, including assignment to specific outages. In this respect a crew shall be understood to mean any personnel, whether individuals or teams, that may be used as a resource in any aspect of restoration activities. Crew units will be able to be created and saved within the system in advance of being utilized. Crew units will be able to be modified, redefined and new crew units added throughout the duration of an ongoing

event. The system will allow users to manage crews by categorizing their function and assigning them to present and future tasks, including specific outage assignments. The system will also be able to track the time a crew reported to work, when they are due for a meal, when they are required to take rest time, and when they are due back from rest time. The system will have the ability to retain this crew information in its historical archiving.

- Reporting: The OMS will have the ability to report information based upon real-time or historical information. The OMS will have the ability to produce, but not be limited to, the following types of reports:
    - Real-time outage reporting on active and recently restored outages in format compatible with MA DPU ORP reporting system
    - ABB will work with Unitil to get the actual calculation to be used for any reliability indices shown in the dashboard or other reports.
    - Reporting within NM-DMS
        - Prioritization of individual outages for restoration planning
        - Trouble conditions with and without outages
        - Individual service outages
        - Real-time crew assignments
        - Quantity of active outages by DOC, Town, Circuit, etc.
        - Quantity of restored outages by DOC, Town, Circuit, etc. for a given event
        - Length of each active outage by DOC, Town, Circuit, etc.
        - Estimated restoration time by DOC, Town, Circuit, etc.
        - Quantity of active outages by a given cause
        - Quantity of active circuits affected by DOC, Town, Circuit, etc.
        - Quantity of customers who are affected by the active outage by DOC, Town, Circuit, etc.
        - Quantity of customers who have called versus # affected by DOC, Town, Circuit, etc.

- Reporting with Obvient FocalPoint
  - Operations Dashboards (FocalPoint):
    - Current outages
    - Restoration Status
    - Customer Outages
    - Current ERT Status
    - Customer History
  - Storm Central (FocalPoint)
    - Spatial representation of outages:
      - Area map with zones highlighted
      - Area map with outages highlighted
    - Publish outage maps to Unitil website with geographic filtering capabilities for easy navigation
    - Maps and high level statistics shown by service territory (UES Capital, UES Seacoast, FG&E)
  - Asset Management (FocalPoint)
    - Asset Reliability Dashboard
    - Worst Performing Circuits Dashboard
    - Outage History Analysis
- Monthly, quarterly and annual reliability indices (SAIDI, SAIFI, CAIDI, etc.) based upon criteria developed by Unitil, IEEE 1366, NH PUC and MA DPU.
- Historical outage reporting for a given event
- Historical outage reporting for a given customer
- Historical crew assignments
- Historical circuit performance
- Quantity of historical outages by a given cause
- Quantity of historical circuits affected by DOC, Town, Circuit, etc.
- Quantity of historical customers who are affected by the outage by DOC, Town, Circuit, etc.
- Quantity of historical customers who have called versus # affected by DOC, Town, Circuit, etc.
- Length of each active outage by DOC, Town, Circuit, etc.
- Estimated restoration time by DOC, Town, Circuit, etc.
- Crew assignment by DOC, Town, Circuit, etc.

- Customer Identification: The OMS will have the ability to identify a given caller based upon information from the IVR system or customer information system. The system will be able to identify: who is calling, nature of outage, which outage they belong to, other information to locate outage, and estimated restoration time. The system will be able to quickly find and report on the outage information associated with that customer. The

system will identify medical (life support) customers when they call through tabular list columns and map symbols.

- Customer Call Back: The OMS in conjunction with the IVR system will have the ability to complete mass call back for groups of customers where power has been restored. The OMS will use the information confirmed (i.e. an individual or answering machine answers) from these calls to identify whether all customers for a given outage have been restored.
- Outage History: The OMS will have the capability to store and query all historical records. These records will be accessible to recreate the outage restoration process. All information in the OMS will have user defined queries that can be used to retrieve this information.
- Customer Outage Reporting: The chosen OMS will have the capability for a given customer to access an internet based reporting site to find information on the outage affecting their location. The information will include but not be limited to the cause of the outage and the expected restoration time.
- "What if" Simulations: The chosen OMS will have the ability to run "what if" simulations based upon switching. The user will have the ability to review switching scenarios to determine if the switching can be performed and how the switching would affect the number of customers without power.
- Mobile Access Terminals for Field Use: The OMS will include a web-base client that allows wireless access to information for all of its field supervisors and field crews. The system will have the real-time capability to be accessed through a remote wireless connection.
- Scheduled Outages: The OMS has the capability to identify and notify all customers of a scheduled outage in their area. The system has the capability to update those customers affected by a scheduled outage of the expected restoration time. The OMS also has the capability to export this list for direct letter mailings.
- Crew GPS Location: The OMS has the ability to receive and track location of crews and provide that information to be spatially represented on Unitil's GIS system.

All of the above functionalities of the OMS further Unitil's ability to sense and localize disruptions or changes in power flows on the grid and communicate such information instantaneously and automatically. These capabilities serve the purpose of enabling automatic protective responses to sustain reliability and security of grid operations. This functionality is a clear characteristic of a "smart grid".

The proposed project involves the integration of an OMS throughout Unitil's service territory; therefore there are no plans to extend the installation to a broader set of locations. However, given that Unitil is an investor owned utility serving multiple states, there is potential for the successful adoption of an integrated OMS system to serve as a model for other utilities to adopt similar systems.

4.2. Assessment of Operational Performance

For this project, the primary benefit to the utility is improved operational performance and enhanced ability to manage outage situations. Expected benefits from the installation of an outage management system throughout Unitil's service territory include:

- Reduced cost of power interruptions
- Reduced cost from better power quality
- Fewer and shorter outages for customers
- Lower O&M costs due to better crew dispatch management

A complete discussion of benefits and sources of benefits for this project, along with the means by which the benefits will be measured is included in Section 6 of this technical file. Information that will be collected, analyzed and reported upon to assess improvements in operational performance as a result of the OMS system installation are:

- System Average Interruption Frequency Index (SAIFI)
- System Average Interruption Duration Index (SAIDI)
- Customer Average Interruption Duration Index (CAIDI)
- Activity Based O&M Expenses

4.3. Progress Tracking Metrics

The nature of the OMS project is different than many advanced metering infrastructure and dynamic pricing projects that have clear and defined metrics at the customer, distribution, and transmission system level. Because the project involves the integration of multiple existing energy management systems into a larger, "smart" system, there are no measurable metrics such as the number of meters deployed, or total magnitude of load served by AMI. As indicated in the project description, Unitil Service Corp. has already installed AMI throughout their entire electric service territory covering Massachusetts and New Hampshire. For this project, there are two clear progress stages; completion of Phase 1 and completion of Phase 2. Upon completion of each respective phase, the progress metric will be the presence of a functioning, integrated system. Intermediate progress metrics could include the percent complete of interface development, or hardware installation.

Presently, Unitil controls a number of assets that would be classified as "smart grid assets", including but not limited to system wide AMI meters capable of two-way communication and continuous monitoring, and SCADA systems. These assets are installed throughout Unitil's electric service territory and allow for real time measurement of system parameters. A key distinction of the OMS project is that it involves the integration of multiple data sources into an automated decision making program that will be utilized to quickly and efficiently address system disturbances.

Merit Review: Criteria 1 - Adequacy of the Technical Approach for Enabling Smart Grid Functions

As discussed above and highlighted below, we believe this project meets the DOE's criteria to receive high technical merit on Criteria 1:

- ✓ The project clearly involves smart grid technologies, tools, or techniques that meet the conditions of "qualifying investments"
  - Software that enables devices or computers to engage in smart grid functions
- ✓ The project installs the qualified smart grid technologies, tools, or techniques and connects them to the electric system, building, or piece of equipment
  - OMS system integrated with multiple existing energy management and data systems
- ✓ The project includes a plan for operating the smart grid technologies, tools, or techniques in a manner that clearly causes smart grid functions to actually occur
  - Operated centrally at control center, allows for integrated system with outage restoration activities
- ✓ The project includes a plan for expanding installation and operation of the qualified smart grid technologies, tools, or techniques to a broader set of locations and applications after the project is complete (e.g., company-wide, city-wide, state-wide, system-wide, region-wide, interconnection-wide, nation-wide)
  - Not applicable, installation will be throughout entire service territory immediately
- ✓ The project includes a plan for assessing the operational performance of the smart grid technologies, tools, and techniques and using the results of that assessment to optimize the way electricity is generated, delivered, or used
  - Includes plan for collecting standard, industry accepted data to measure progress towards improved operational reliability

Merit Review: Opportunities for High Technical Merit, Criteria 1 - Adequacy of the Technical Approach for Enabling Smart Grid Functions

- ✓ The project aims to improve operational performance, including improvements in asset utilization and the reliability of electric service
  - Improves ability to manage outages and improve utilization of crews in restoration efforts
- ✓ The project applies smart grid technologies, tools, and techniques to improve operational performance, including improvements in energy efficiency and in reducing peak demand
  - Improves operational performance by means of fewer and shorter outages, improved resource management

5. Technical Approach to Interoperability and Cyber Security

5.1. Interoperability

The OMS system involves the integration of Unitil's existing AMI, SCADA, GIS, CIS and IVR systems. As such, the approach for enabling interoperability and communication between each of the existing systems is of the utmost importance to the success of the project.

The technical approach for enabling interoperability between the NM-DMS and the external applications is to utilize well-structured and well-documented application programming interfaces (APIs) and efficient inter-system communication. Such APIs enable the integration of external applications without the need to modify any basic software codes or to have deep external knowledge of the system design. Since the APIs are guaranteed to be backwards compatible, applications developed by third parties or by Unitil will be independent of any release upgrade of the Network Manager Platform and applications. The approach for integrating Unitil's existing energy management systems are:

AMI System

The NM-DMS will receive AMI calls as customer calls and analyses them as outage calls. The system also has the ability to ping meters which can be used to confirm outage restoration. The meters can also be pinged by the customer call taking function, so that customer meters can be pinged to confirm that the customer is reporting a problem that is not related to their own equipment behind the meter (e.g. circuit breaker). The AMI interface improves the process by which Unitil can manage outages, thus improving reliability and increasing operating efficiency. The AMI interface supports:

- Outage notification
- Outage confirmation
- Restoration confirmation
- Outage accuracy

Outage events either create a trouble report or are placed in a holding table if there is already known to be an outage on that transformer, if there have already been two calls on that transformer, or if the AMR has been disabled for the sub-area. The interface has the ability to perform flow control requests to the AMI, in order to avoid the need for the OMS to receive outage notifications for feeders that are already known to be locked out. The interface also supports the ability for the web-based call taking interface to ping the customer meter while the customer is on the phone. This allows problems on the customer side of the meter to be eliminated before they are entered into the system, this reducing unnecessary crew dispatching.

Geographic Information System (GIS)

A tool will be developed to extract data from the GIS system into XML or comma delimited files. The data is then imported into the Network Manager Distribution Manager System run time environment using the NM-DMS incremental update process.

Interactive Voice Response (IVR)
The IVR interface is used to create trouble calls, call back customers on restoration or status change, and call customers in advance of a planned outage. The IVR system will execute a stored procedure API to access the Network Manager DMS.

When a customer calls to report an outage, the IVR system can identify the customer via automated ID number. The API will then be called to determine whether a.) The caller is calling for the first time, or a subsequent time, for the same outage and b.) If the customer is part of an existing outage. If the customer is part of a known outage, information about the outage such as outage number, estimated time to restore, and status of outage is returned to the IVR for communication to the customer. Finally, the IVR call information is used to create a new trouble report or update an existing trouble report.

The Outbound Dialer (OBD) IVR application will also call the API to receive a callback list for restoration confirmation. The interface creates a new trouble report if the callback result indicates that power is still out. The IVR API can also be used to access call-ahead lists in Network manager DMS. This will return a list of customers to call-ahead in advance of a planned outage.

Supervisory Control and Data Acquisition (SCADA)
The SCADA interface is designed using ABB's existing API in conjunction with messaging out of Unitil's SCADA systems. This interface will enable the OMS system to have real time information on SCADA controlled devices. These devices generally operate for the largest scale outages.

When a customer calls the IVR system, the record is transferred to the OMS system and automatically becomes a predicted outage and the OMS system takes some time to confirm the outage based upon other customer calls. When a SCADA controlled device operates in the field, the information is transferred to the OMS system and is instantly confirmed as and outage and identifies the quantity of customers affected. This eliminates the time delay associated with the prediction engine. Therefore, the dispatcher can assign a crew immediately to restore the outage. When a SCADA device closes, the OMS shall indicate the change in status and when the individual outage is restored.

5.2. Cyber Security

A key element in implementing and maintaining the security of a computer system is the establishment of an adequate IS security policy. For the OMS project, the security policy is based on an analysis and assessment of the functional needs and security objectives of the organization, current and planned network structures, information and control flows, risks in terms of probability of different types of attack and potential consequences, and available technical security solutions. The following security objectives can be identified.

- Availability - avoid denial of service
- Integrity – avoid unauthorized modification
- Confidentiality – avoid disclosure

- Authenticity – avoid spoofing/forgery
- Access control – avoid unauthorized usage
- Audit ability – avoid hiding
- Accountability – avoid denial or responsibility
- Third party protection – avoid attacks on others.

Cyber Security is a moving target, attacks and countermeasures evolve continuously and quickly. It is essential to spend a lot of effort on operating and maintaining the security architecture rather than only the initial investment. “Cyber security is a process, not a product”

In addition to plans for how to avoid risks, a security policy should include plans for regular audits of the IS security. The diagram below shows the different lifecycle activities.

<table>
<tr><th colspan="3">Development</th><th colspan="2">Deployment</th><th colspan="2">Operations</th></tr>
<tr><td>Verify</td><td colspan="2">Security Testing</td><td colspan="2">Security Testing</td><td>Incident Handling</td><td>Repair</td></tr>
<tr><td>Realize</td><td>Secure Design</td><td>Secure Coding</td><td>Secure Configuration</td><td>Security Policy</td><td>Monitor & Audits</td><td>Detect</td></tr>
<tr><td rowspan="2">Verify</td><td colspan="2">Threat Modeling</td><td>Site Security Architecture</td><td rowspan="2">Security Training</td><td>Security Architecture Maintenance</td><td rowspan="2">Protect</td></tr>
<tr><td colspan="2">Developer Modeling</td><td>Site Security Assessment</td><td>Patch Mngmt</td></tr>
</table>

A generally recommended approach to IS security is the onion approach, also known as “defense in depth”. The inner layers, or zones, of a network, where the communication interaction needs to flow freely between nodes are referred to as trusted. Trusted network zones should be kept small and independent. The need to be physically protected by limiting physical access to computers, network equipment, and network cables, and they must through physical means be limited to authorized persons. When connecting a trusted network zone to outer network zones, additional layers of security measures should be applied, isolating the network zones from each other and providing additional security for the network as a whole.

Firewalls, gateways, and proxies are used to control network traffic between zones of different security levels, and to filter out any undesirable or dangerous material. Traffic that is allowed to pass between zones should be limited to what is absolutely necessary, because each type of service call or information exchange translates into a possible route that an intruder may be able to exploit. Different types of services represent different risks. Incoming e-mail as an example, represents a very high risk. Security mechanisms should not only include defensive and preventive means, but also means for detection and reaction. By continuously monitoring a system for intrusion attempts, users can be alerted to potential threats and take suitable actions, such as isolating an inner network from outer zones.

The security policy should be based on the principle of least privilege and compartmentalization, i.e., every application, user, or subsystem should be restricted to the minimum number of rights for the minimum number of resources that is necessary to fulfill its purpose. Network access to functions that are not explicitly required should be disabled. This reduces the possibilities that an attacker can exploit and limits the damage in case an intrusion attempt is successful.

All computer systems should be scanned for viruses at regular intervals. A virus checker of good reputation should be used and it should be updated regularly. Unfortunately, when a virus is found the damage has probably already been done. For a mission critical system it is therefore more important to effectively prevent viruses from being introduced into the system than to run frequent checks. Virus checking has a significant impact on performance and response times on any computer system. For computer systems that are used for real-time applications, such as process control systems, virus scanning should therefore be done at times when normal activity is low.

The proposed OMS system does not in and of itself provide any protection against broad based systemic failures in the electric grid in the event of a cyber security breach because the system will not control any devices out in the field. Should a cyber event on the electric system occur, the OMS system would be able to identify which locations are affected.

Unitil Service Corp. is fully aware of the risks and need for proper security management associated with the transition to a modern digitally enhanced Smart Grid. As summarized above, cyber security will be addressed in every phase of the lifecycle of the project, including development, deployment, and operation of the OMS system. Unitil Service Corp. is committed to a project that is fully compliant with current and emerging standards for cyber security including ANSI NIST, and IEEE standards.

Merit Review: Criterion 3 - Adequacy of the Technical Approach for Addressing Interoperability and Cyber Security

As discussed above and highlighted below, we believe this project meets the DOE's criteria to receive high technical merit on Criteria 3 for Interoperability:

- ✓ Plan provides a clear description of the automation component interfaces (devices and systems)
  - Interfaces with all existing energy management systems discussed in detail
- ✓ Plan clearly details how integration is supported to achieve interoperability
  - Interfaces discussed, goal is integrated management system with capabilities outlined in Section 4
- ✓ Plan explains how interoperability concerns will be addressed throughout all phases of the engineering lifecycle, including design, acquisition, implementation, integration, test, deployment, operations, maintenance, and upgrade

Opportunities for High Technical Merit- Interoperability

- ✓ Plan describes the information exchange interface points for each type of communicating automation device and system
  - Describes interface points for AMI, SCADA, GIS and IVR systems
- ✓ The openly-available and proprietary aspects of the interface specifications are reasonable
- ✓ If existing (legacy) communicating devices or systems are integrated into the project, they are integrated and interoperate at the points of interface with new components.
  a. Interface points for AMI, SCADA, GIS and IVR systems are described
- ✓ Adequate evidence will be provided (interface specifications, interoperability test plans and results, reviews, and other engineering artifacts) to ensure interoperability at the interfaces of communicating automation devices and systems
  - Interface development will include rigorous testing to ensure functionality
- ✓ Project will be able to support compatibility with NIST's emerging smart grid framework for standards and protocols as information becomes available

Merit Review: Criterion 3 - Adequacy of the Technical Approach for Addressing Interoperability and Cyber Security

As discussed above and highlighted below, this project meets the DOE's criteria to receive high technical merit on Criteria 3 for Cyber Security:

✓ Plan explains how new smart grid technologies will integrate into the existing environment

One sentence summary of qualification

- One sentence summary of qualification

✓ Plan details how any new cyber security vulnerabilities will be mitigated through technology or other measures

- One sentence summary of qualification

Opportunities for High Technical Merit- Cyber Security

✓ The methodology used to identify cyber security risks and the results of this assessment (e.g., the assessment considers the mission of the new smart grid project and also potential impacts to other critical grid control functions to which they are connected)

- sentence summary of qualification

✓ Plan details how cyber security risks will be mitigated at each phase of the engineering lifecycle, including policy, procedural, and technical (logical and physical) controls, with special emphasis on strategies for:

  - Ensuring the confidentiality, integrity, and availability of device and system data and communications commensurate with the application requirements
  - Securing, logging, monitoring, alarming, and notification
  - Applications where logical and physical security may not be under the direct jurisdiction of the installing entity

- One sentence summary of qualification

✓ Plan details the relevant cyber security standards or best practices that will be used

- One sentence summary of qualification

✓ The components or system to be updated will be capable of meeting future cyber security requirements or technologies

6. Project Costs and Benefits

This section of the application identifies and provides an initial quantitative estimate of the expected benefits and costs associated with the proposed installation of an OMS within Unitil Service Corp.'s electric service territory in Massachusetts and New Hampshire. In addition, this section provides a discussion on the plan for data collection that focuses on the determination of overall and net benefits to consumers, companies, and society as a whole that are expected to result from the project.

6.1. Types of Benefits and Costs

Consistent with Table 6 in the Smart Grid Investment Grant Program FOA, benefits associated with Marblehead's proposed program include:

- Economic – Lower O&M costs due to improved efficiency through faster more efficient dispatch of repair crews, improved coordination of external crews with internal work force, and improved ability for maintenance scheduling
- Reliability and Power Quality – Reduced cost of power interruptions due to fewer and shorter outages

Additionally, there are a number of benefits to the Utility and to consumers that do not necessarily translate in the DOE cost-benefit model. Some additional benefits of the OMS project are:

- Enhanced operational benefits include faster problem identification, more efficient crew dispatching, improved partial restorations, enhanced awareness of crew status and estimated time of restoration, and more accurate reliability indices.
- Enhanced customer service benefits include the ability to generate real-time reports on individual customers and outage status, the ability to provide customers with better estimated time-of restoration, ability to view outage history by customer, more effective communication with customers, and the ability to automatically notify customers of planned outages

Project costs include the cost of the hardware/software necessary for a fully integrated operational system, and the vendor time and effort to develop the necessary interfaces and ensure interoperability.

6.2. Initial Quantification of Program Costs and Benefits

The data collected to quantify benefits of the OMS project will be the System Average Interruption Disruption Index (SAIDI), the System Average Interruption Frequency Index (SAIFI), the Customer Average Interruption Duration Index (CAIDI) , and Activity Based O&M Expenses for storm restoration activities. The table below summarizes the quantitative elements for project benefits that are expected to result following implementation of the outage management system. The table reports on the baseline set of conditions from which project benefits can be

compared. These benefits are tracked and will be reported for periods before and after the installation of the OMS. Unitil does not have a projection of the incremental quantifiable benefits at this time for the OMS due to the inherent uncertainty in these values and the difficulty of making quantified predictions for factors that are driven in large part by exogenous factors over which the company has not control. During the project, the project team will evaluate options for estimating the incremental improvements for each of these factors independent from exogenous factors.

Unitil will also evaluate the benefits of the OMS on a qualitative basis, using as a baseline its Self-Assessment report prepared in the months after the December 2008 Ice Storm. The Self-Assessment report contained a series of recommendations and the company has established a tracking and reporting process for improvements stemming from implementation of those recommendations.

Data	Baseline
System Average Interruption Disruption Index (SAIDI)	156 minutes
System Average Interruption Frequency Index (SAIFI)	1.95 interruptions
Customer Average Interruption Duration Index (CAIDI)	79.95 minutes per interruption
Activity based O&M Expenses - annually	$230,000
Qualitative Assessment of Improvements in Speed, Accuracy, and Communications in outage events	Self-Assessment Report from the December 2008 Ice Storm

The total project costs are based in large part on a cost proposal received from the primary project Vendor, ABB Inc. The details are provided in the Budget submittal for the grant application. The total project cost includes the software and hardware necessary to support the OMS system, and the technical support developing and testing the required interfaces. The total project cost is estimated to be $2,104,497.

6.3. Data Collection Methodology

SAIFI, SAIDI, and CAIDI indices will be generated directly from the OMS system and are easily quantifiable. Improvements in the interruption indices can be measured against previous statistics reported to the State regulators. The total activity based O&M costs have been identified in previous working budgets to establish the project baseline. Future O&M costs will be identified by during the budgeting process for subsequent years. The budgeting process consists of an annual estimate that is reconciled with actual monthly expenditures throughout the year. O&M budgets are managed to a target of ±2%.

7. Summary

As outlined in this project plan, the proposed installation of an OMS throughout Unitil Service Corp.'s electric service territory will both further the development of smart grid functions and provide tremendous benefit to the utility, customers, and the community as a whole. Unitil Service Corp. has extended considerable time and expense to study the technical and societal impacts of integrating an OMS with their existing energy management systems, has issued a RFP and is in the process of conducting final negotiations with a qualified respected product vendor. Unitil Service Corp. is uniquely positioned to proceed with the project in an expedited manner and complete the project within 12 months of award of funding assistance.

The OMS project furthers the development of smart grid functions by automating analysis and response to outage scenarios and taking decision making out of the realm of operators; this is a specific functionality of a smart grid that has been discussed by both DOE and NIST. The project meets two of the types of projects eligible to receive funds under the SGIG program (per EISA Section 1306(d)):

- ✓ Projects that support or advance the ability to sense and localize disruptions or changes in power flows on the grid and communicate such information instantaneously and automatically for purposes of enabling automatic protective responses to sustain reliability and security of grid operations.
- ✓ Projects that support or advance the ability to detect, prevent, communicate with regard to, respond to, or recover from system security threats, including cyber-security threats and terrorism, using digital information, media, and devices

Unitil's senior management is committed to the OMS project and recognizes the operational and societal benefits of installing the system. We believe that this application presents a logical and comprehensive approach to the project and that the project clearly provides great advancement of smart grid functionality within our electric service territory. We greatly appreciate the opportunity to submit this application for funding. If selected, we are committed to working cooperatively with DOE to track progress and operational improvements resulting from the implementation of the project.

May 12, 2010

BY OVERNIGHT MAIL and ELECTRONIC FILING

Mark D. Marini, Secretary
Massachusetts Department of Public Utilities
One South Station, 2nd Floor
Boston, MA 02110

RE: Fitchburg Gas and Electric Light Company, d/b/a Unitil
Smart Grid Pilot Program Evaluation Plan
Docket: DPU 09-31

Dear Secretary Marini:

On behalf of Fitchburg Gas and Electric Light Company, d/b/a Unitil, enclosed please find the proposed Smart Grid Pilot Program Evaluation Plan, filed in accordance with the Department's Order dated April 12, 2010, in Docket D.P.U. 09-31, which approved the Pilot Program.

The attached Evaluation Plan outlines the study objectives and methodologies that will be used in performing an in-depth evaluation of Unitil's proposed Smart Grid Pilot Program, which will include sample customers in both Massachusetts and New Hampshire. The three treatment groups will include a simple time-of-use (TOU) rate, a TOU rate with enhanced in-home technology and a utility controllable "Smart" thermostat program. The goal of the evaluation will be to make sound recommendations for further testing or deployment of smart grid technologies throughout Unitil's electric distribution territory in both states.

The Department's Order also approved Unitil's proposed Distribution Automation (DA) project, which will convert a fixed capacitor bank to one switched through the Automated Meter Infrastructure ("AMI"). This project is viewed as a potentially cost-effective alternative to existing options to provide control of system power factor. With respect to the evaluation of the DA project, the Company notes that it is distinct from the Smart Grid Pilot Program and is therefore not addressed in the attached Evaluation Plan. The DA project, as discussed in the Order,

Gary Epler
Chief Regulatory Counsel

6 Liberty Lane West
Hampton, NH 03842-1720

Phone: 603-773-6440
Fax: 603-773-6640
Email: epler@unitil.com

is discrete and limited in scope. In evaluating this project the Company will take the following steps:

A. Prepare a summary of the current protocols and estimated operating costs associated with the fixed capacitor bank.

B. Perform an assessment of the protocols and estimated operating costs for the capacitor bank after the conversion.

C. Document the functional operating characteristics including the effectiveness of the control with respect to speed and consistency of response in switching, relative ease of installation, and programming flexibility relative to other available distribution capacitor controls.

D. Prepare and file a report on the operational and cost implications of the conversion.

If you should have any questions or comments, please do not hesitate to contact our office.

Thank you for your consideration of this matter.

Sincerely,

/s/ Gary Epler

Gary Epler
Attorney for Fitchburg Gas and
Electric Light Company

Enclosures:
Cc: Laural Bickel, Hearing Officer
David Cetola, Assistant Attorney General
Robert Sydney, DOER
Service List by electronic mail

Fitchburg Gas and Electric Light Company
d/b/a Unitil

Smart Grid Pilot Program Evaluation Plan
May 12, 2010
Docket DPU 09-31

Filed with the Massachusetts
Department of Public Utilities
May 12, 2010

TABLE OF CONTENTS

I. Introduction

This evaluation plan outlines the objectives and methodologies for performing an in-depth evaluation of Unitil's proposed smart grid pilot program. Key among the objectives are to evaluate and compare the impact and cost effectiveness of three distinct program segments (i.e., Simple TOU, Enhanced Technology, and Smart Thermostat), to evaluate the process and technologies from both the perspective of the customers and the Company, and to make recommendations for further testing or deployment of smart grid technologies throughout Unitil's electric distribution territory in both Massachusetts and New Hampshire. These objectives will be met through implementation of a combination of impact, technology, process and cost effectiveness evaluations as discussed in more detail below.

Unitil's smart grid pilot program was designed in part to fulfill the requirements from Section 85 of the Green Communities Act, which requires Massachusetts electric distribution companies to establish a smart grid pilot program that achieves reductions in peak demand and average load of at least 5 percent for all customers participating in the program. Unitil's smart grid pilot program was also designed to implement a New Hampshire Time-Of-Use (TOU) pilot program in support of the Commission's TOU rates policy. The Company's pilot includes three separate and distinct program segments (treatment groups) as follows:

- *Simple TOU Program* – Enrolled customers will be set up on a time-of-use rate structure and will receive basic educational materials only, with no additional enabling technology.

- *Enhanced Technology Program* – Enrolled customers will be set up on a time-of-use rate structure and will receive the same educational materials, but will also receive an in-home ZigBee-based wireless energy management system that includes an in-home display of near real-time cost and energy consumption data, a customer web portal, and flexible control devices (smart thermostats and outlets). This package allows for both utility and customer-automated load control and demand response. The Enhanced Technology Program will not include direct demand control by Unitil through the customer's thermostat.

- *Smart Thermostat Program* – Enrolled customers will stay on the existing fixed-rate billing structure. Unitil will provide a Honeywell UtilityPro™ digital programmable thermostat. Unitil will have the ability to cycle the customer's heating and cooling load during critical peak periods using a 900 MHz paging network. Thermostat cycling will be accompanied by local notification at the thermostat unit. Customers are able to override the changed setting on the devise itself or through a web interface.

The program structure will allow Unitil to evaluate and compare these three separate and distinct approaches to achieving reductions in peak demand and average load. The Simple TOU program is a low cost option for Unitil to implement through its territory, given the existing system-wide AMI endpoints. The Enhanced Technology utilizes the

same TOU rate structure but also includes a higher cost home energy management system – the evaluation will seek to compare impacts of both program segments as well as the projected cost effectiveness of the two options. Lastly, the Smart Thermostat program uses a different communications technology (900 MHz paging network), is utility controlled and is another low cost program that can be evaluated for cost effectiveness and compared with the other program segments.

The Simple TOU and Enhanced Technology Programs leverage the Company's AMI investments and provide the opportunity to test the time-of-use capabilities of the existing systems, including integration with the Company's back-end systems. The pilot evaluation will review and report on the Company's experience in testing these technologies, integration with existing back-end systems, and the process of conducting the program. The evaluation will also report on the Company's experience with the specific smart grid technologies, including cost and ease of installation, compatibility with existing systems, reliability, and customer acceptance, including the elasticity of customer response to different price points.

A final objective of the evaluation is to assess the experience of customers participating in the program. The evaluation will seek to identify what types of actions were taken by customers to reduce or shift load from peak periods, motivating factors for effecting change, and whether the customers would be interested in participating in a continuing program. Customer reaction to the in-home technologies and web-portals will be assessed and will be used as a tool to help develop recommendations for future program development. Customer feedback will be sought as to how the program could be improved.

The over-arching objective of the evaluation is to provide useful recommendations for the Company, State Regulators, and other distribution Companies on the question of whether to proceed with expanded smart grid initiatives that reduce peak demand and average load. This plan presents the Company's methodology for conducting the evaluation.

II. Experimental Design

A. TARGET POPULATION

The customer population that the Company wishes to study is residential customers with central air conditioning systems, therefore each of the three treatment groups plus a control group will consist of residential customers with central air conditioning. It is the Company's intention to study both market rate and low income rate customer behavior, however no specific quota for low income customers has been established.

B. SAMPLING

The sampling plan is designed to provide measurable results with a precision of 90% confidence with 10% sampling error for each of the three treatment groups and a control group (four sample groups in all). A sample requirement of 68 customers is estimated for

each of the four sample groups to achieve the necessary level of precision.[1] A sample size of 76 customers has been proposed to account for expected drop-outs and still achieve the desired confidence levels. If the number of drop-outs in any one sample group exceeds 8, replacement participants will be recruited to maintain the high level of precision.

Four samples will be selected, one for each of the three treatment groups and one for a control group that will be used as a basis of comparison to the treatment groups. Each sample will contain customers from both New Hampshire and Massachusetts. The purpose of developing samples using customers from both states is to accurately represent Unitil's entire service area while minimizing costs to customers. Therefore, final estimates of demand savings and the corresponding confidence bands will represent the total Unitil system.

It is also the Company's intention to evaluate program results and present statistically valid findings between demographic categories where applicable, albeit at a significantly lower level of precision with a higher range of sampling error due to limited sample sizes. Total sample sizes are presented in Table 1 below.

TABLE 1: TREATMENT GROUP SIZES AND DISTRIBUTION BY STATE

Sample Group	Massachusetts		New Hampshire	
Simple TOU	24	25.0%	52	25.0%
Enhanced Technology	24	25.0%	52	25.0%
Smart Thermostat	24	25.0%	52	25.0%
Control Group	24	25.0%	52	25.0%
Total Received	96	100.0%	208	100.0%

The confidence intervals developed on the final estimated demand savings will be based on the mean and standard deviation of the respective samples. The standard deviation in the measured demand savings typically decreases as the sample size increases, which tightens the confidence interval about the estimated average demand savings.

Stratified random samples will be selected for each of the three programs as well as for the control group. A systematic sampling approach will be used to select the customers for each sample. This method is commonly used in the utility industry as it ensures representation of a total population with respect to geographic location, peak demand, energy consumption, or other key elements.

[1] Sample size computation based on mean kW savings of **1 kW** with a corresponding standard deviation of **0.5 kW**. The actual sample statistics may vary, but these estimates are reasonable and based on previous DR Studies.

C. *MARKETING AND RECRUITMENT*

The Company will utilize an "opt-in" enrollment model. Customers will be recruited using a multi-media approach. First, customers with characteristics representative of central air conditioning usage[2] will be targeted using mailers that include a program brochure and a letter from the CEO inviting them to participate in the program. A total of 5,000 mailings will be sent to randomly selected customers derived from this pre-screened list. In deriving the mailing list from the pre-screened list, the Company first identified and selected all customers on low-income rates (196-MA, 191-NH), then randomly selected from among the remaining residential customers until the target quotas were reached. The enhanced low-income sampling was done in accordance with the Company's Settlement Agreements included as part of Unitil's TOU pilot proceedings in both Massachusetts and New Hampshire. Email marketing may also be used as a low cost option to supplement the mailers if an insufficient number of participants are recruited through the mailers alone. Email marketing will be targeted towards a random selection of customers who have accessed their online accounts in the past 12 months.

The program will be branded as "Energy Savings Management" and marketed as an opportunity for customers to save money on their monthly electric bills and protect the environment. It is important to note that the initial marketing materials will not describe any of the three program segments in any detail, rather just the program as a whole. This has been done to mitigate self selection bias in the various treatment groups.

Interested customers can register by signing and returning a post card, calling an 800 number, or entering their information on-line. Interested customers are screened for qualification on the basis of having a functional central air conditioning system, owning their home, not having any plans to move within the pilot period, and not planning any extended vacations during the pilot period. Qualified customers will then be randomly assigned to one of the three program segments which will be described in detail over the phone by a program representative. Once a customer has been qualified and expressed an intention to participate in the program, an installation contractor will arrange a time to visit their home and install analysis meters and the technology components. The contractor will then review the program in detail with the customer again and provide them with educational materials that further describe the program and offer tactics for reducing peak demand and average load.

D. *CONTROL GROUP*

The control group will be comprised of the Company's existing load research sample and supplemented with newly recruited residential customers as needed to fulfill the control group sample quota. The newly recruited customers will be customers who opted in and qualified for the pilot program (e.g. over enrollment) but were not selected for an active treatment group. Upon further review of the Company's existing load research sample and after conducting phone surveys to this group, it was determined that there is an

[2] Screening criteria is a ratio of maximum summer month (August, September, 2009) to minimum shoulder month (April, May, November, December, 2009) of 175% or higher, AND a maximum summer peak usage of 1,000 kWh or higher. This approach was developed based on results of the Company's initial marketing survey which helped identify actual central air conditioning customers.

insufficient number of load research sample customers with central air conditioning systems to support the 76 customer control group sample size, therefore approximately forty (40) additional customers will be recruited to supplement the existing load research sample to comprise the control group.

E. ATTRITION MITIGATION

The Company seeks to mitigate sample attrition through a combination of customer education, customer service, monetary rebate for the smart thermostat program, and oversampling, as follows:

- *Customer Education:* The Company intends to clearly explain the program to customers so that customers understand what the program involves and how they can take advantage of the program. The program segment they are enrolled in will be explained in detail at the time of recruitment and at the time of the on-site installation; at both times the customers will be asked to confirm that they understand the program and continue to wish to participate. Additional educational material will be provided to the customers at the time of installation and through the customer web portal explaining the program and how customers can take advantage.
- *Customer Service*: A dedicated, experienced customer representative will be assigned to the program and will undergo training on the program design and how to help resolve customer issues. Customers with questions or concerns will be directed to this "live" CSR who will help resolve problems such as high bill complaints or technology defects. Customer drop outs will be permitted if requested by the customer but will be a last resort.
- *Rebate:* For the Smart thermostat program, a peak time rebate incentive will be offered to customers who permit the Company to control the thermostat set point during critical peak days and do not override. The rebate will only be provided if customers remain in the program throughout the entire pilot period.
- *Oversampling:* While every attempt will be made to mitigate sample attrition, the Company understands that some attrition is unavoidable. Thus, approximately 10% oversampling will be conducted so that a small number of drop outs can occur with impacting the level of precision of reported results.

F. CRITICAL PEAK PERIOD SELECTION METHODOLOGY

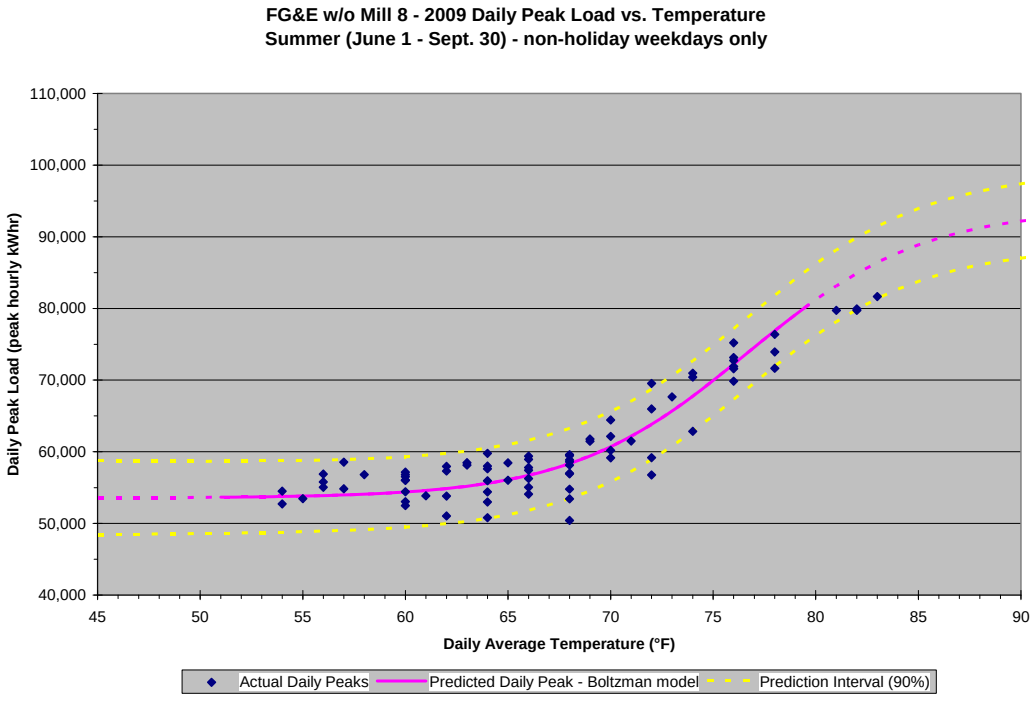
The Company plans to utilize a 2010 temperature vs. load model as a means to schedule demand reduction events on a day-ahead basis. Temperatures corresponding to peak load levels greater than 97% of previous system peak conditions (for either NH or Massachusetts Levels) will be considered as a demand reduction trigger. The Company receives a daily seven day weather forecast which will be monitored for the potential of higher temperatures providing plenty of notice for consideration and communication to customers of planned events. Over the past 10 years, this load level has not occurred more than eight times in a given year, ensuring this trigger represents an appropriate yet extreme condition. This trigger will be reviewed at least every 30 days during the period

of the Pilot Program and may be adjusted to ensure that a minimum of two events and a maximum of eight events are called during the test period.

This temperature vs. load model is developed as a function of the Company's normal planning process. Unitil develops a temperature vs. load model for each of its operating areas. The basis for each model is a series of yearly regressions that are developed to correlate daily loads to daily temperatures in that season. Once a model is established, an estimated peak load can be derived for any given temperature. The probability distribution for annual highest temperatures is assumed to follow the discrete distribution of past historical highest temperatures. The random possibilities of peak load outcomes for any specific temperature are assumed to follow a standard probability distribution model with a mean centered on the point estimate of the peak load at that temperature and varying based on its individual standard deviation according to the fit of the seasonal model to the actual historical values.

To establish load projections, a Monte Carlo simulation is run to produce random annual highest temperatures and random peak load estimates at those temperatures from each year's seasonal model that makes up the historical basis. Each trial in the simulation is projected forward using linear trending. This results in a range of peak load possibilities for each future year assuming linear growth, and varying due to annual highest temperature possibilities and variability in loads versus temperature. The likelihood of specific peak load levels occurring in any particular future year can be estimated from an assumed probability distribution using the mean and standard deviation of the trial results for that year.

The graph below depicts a 2009 version of this temperature vs. load model for the Fitchburg area. 2010 versions will be developed for both MA and NH service areas.



III. Impact Evaluation

A key objective of the Smart Grid Pilot Program ("pilot") is to measure the peak demand reduction and energy usage savings achieved during on-peak ("OP") and critical peak periods ("CPP"), and evaluate the potential for load rebound immediately following these periods. The challenge of measurement and verification ("M&V") is estimating what the load would have been had the control or dynamic pricing not been active. There are several valid statistical methods available for such an evaluation. This section of the plan will outline the objectives, data requirements, and methodology for the impact evaluation.

A. OBJECTIVES

The quantitative evaluation of the pilot program will seek to measure the impact on peak demand (kW) and energy usage (kWh) for each of the three program segments. Impacts will be estimated for the CPP rate for participants with and without enabling technologies. Eight major impacts will be estimated as listed below.

- Overall reduction in total energy usage
- Energy reduction during on-peak periods
- Energy reduction during critical peak periods
- Demand reduction during on-peak periods
- Demand reduction during critical peak periods
- Energy and demand shift to off-peak hours (impact on load shapes)
- Price elasticity of demand (energy changes in response to price changes) for customers on TOU rates only
- Demand response during each of the hours of a critical peak period

B. DATA REQUIREMENTS

Measurement and verification is a data intensive evaluation, especially for the large number of objectives in this pilot. Interval data must be collected for pilot participants, both with and without enabling technologies, and for a control group of customers not on dynamic pricing. Further, data must be collected during non-peak and peak periods and across a number of critical peak periods. Interval data will be collected for the targeted 76 Simple TOU customers, 76 Enhanced Technology customers, 76 Smart Thermostat customers, and the 76 customer control group.

The AMI analysis meters will be set up to collect data in 15-minute intervals. However, the M&V evaluation will convert the interval data into hourly increments. Consumers are typically unlikely to make changes in as little as 15-minute time blocks, rates and billing will be on hourly bases, and the voluminous output from analysis on such a short interval would be cumbersome and of little practical use for interpretation.

Along with the interval metered usage data, hourly and daily weather data will be collected. At a minimum, the statistical models will include temperature or a derivative

of temperature such as degree days. However, the impacts of other weather variables, such as heat index, wind chill, and relative humidity will be collected and tested. Other household characteristics that are collected during the surveying process may also be available for use in the analysis (e.g., size of home, type of home, and number of people in the household).

Additionally, the Company will seek to recruit participants early in 2011 so that analysis meters can be installed before the pilot period and pre-treatment data can be collected.

C. EVALUATION METHODOLOGY

During on-peak and critical peak periods, load is reduced from a level it would have reached without the price signal or demand response measure. The Company conducted a review of ISO New England demand response M&V protocols[3] and other estimation methodologies to instruct its proposal for baseline estimation of this program. A summary of the literature review is included as Attachment A to this plan.

The research literature on comparing the various methods generally reaches the same conclusion that no one baseline method works best for all types of consumers and demand response measures[4]. Prior-day averaging is computationally simple compared to statistical methods, but the method has not been formally shown to be statistically unbiased. Statistical approaches are unbiased and consistent, but less intuitive and more computationally costly.

Unitil will use a statistical method to estimate the energy and demand reductions from the critical peak pricing pilot, even though ISO New England relies on a prior-day averaging methodology for its demand response M&V. For the purposes of the pilot, Unitil plans to provide statistical rigor and use models that are provably unbiased. Furthermore, statistical models are required in order to estimate price elasticity of demand. Both regression and ANCOVA models will be tested, and the impacts of several independent variables will be evaluated during the model specification process. Variables tested will include various weather indicators, pricing levels, and any demographic or customer-specific data that may be available through the surveying process. For the regression approach, a fixed-effects model will be implemented to allow the model to control for those characteristics that Unitil cannot measure that are specific to individual consumers.

[3] A key goal of this program is to utilize an estimation method that is sufficient to satisfy ISO-NE.

[4] See: Coughlin, Katie, Mary Ann Piette, Charles Goldman, and Sila Kiccote. *Estimating Demand Response Load Impacts: Evaluation of Baseline Load Models for Non-Residential Buildings in California*. Ernest Orlando Berkeley National Laboratory, Environmental Technologies Division, January 2008.

Goldberg, Miriam L. *Measurement and Evaluation of Demand Response Resources*. Demand Response in Wholesale Markets Technical Conference, Federal Energy Regulatory Commission, Docket No. AD07-11-000. April 23, 2007.

Woo, C.K. and K. Herter. *Residential Demand Response Evaluation: A Scoping Study*. Ernest Orlando Lawrence Berkeley National Laboratory, June 2006.

A constant elasticity of substitution ("CES") demand model will also be evaluated[5]. A CES model uses two regression equations to constitute a system for predicting electricity consumption by time period. The first equation would predict changes in the load shape caused by changing peak to off-peak price ratios and the second equation predicts change in daily electricity consumption. Price elasticity of demand will be estimated using the statistical approaches because the price differential between time of day and critical day prices will be included as an explanatory variable in the models.

Selection of the final model used to evaluate the pilot program will be made based on examination and comparison of several diagnostic statistics among the various methods and models tested. A list of selection statistics is provided below.

- Signs of all coefficients – The signs of the coefficients indicate whether the relationship between the independent variable and the dependent variable is direct or indirect. The relationship must be theoretically sound in order for the model to be valid (e.g., price should have a negative coefficient since energy usage goes down as price goes up).

- R^2 and Adjusted-R^2 – A measure of how much variation in the dependent variable can be explained by the model. The adjusted-R^2 takes model parsimony[6] into account as well, ensuring that the selected model does not include independent variables that provide relatively little explanatory power. R^2 ranges from 0.0 to 1.0, with higher values indicating a better fit. An acceptable R^2 is not well defined and depends upon the application. Therefore, many other statistics are reviewed as shown in this list.

- F-test – the F-test tests whether the model taken as a whole has any explanatory power. A model that does not pass an F-test should be rejected (a model passes an F-test if the p-value of the F-test ≤ 0.05)

- T-tests on individual independent variables – the t-tests determine whether there is a statistically significant relationship between the single independent variable and the dependent variable. A variable is considered significant if the t-value is ≥ 2.0 or the p-value of the t-test is ≤ 0.05.

- In Sample Mean Absolute Percent Error (MAPE) – a measure of the average absolute percent modeling error. This calculates the average percent error the model has when predicting the historical data used for developing the model coefficients. As with R^2, this value is highly dependent on the application. Typically, projections of shorter intervals and less aggregated data will have higher MAPEs. When comparing two models predicting the same dependent variable, the model with the lower MAPE is generally preferable.

[5] A CES system was used by the Brattle Group to evaluate a pricing pilot for Baltimore Gas and Electric in 2009. Faruqui, Dr. Ahmad and Dr. Sanem Sergici. *BGE's Smart Energy Pricing Pilot Summer 2008 Impact Evaluation*. April 28, 2009.

[6] Parsimony is the statistical theory that it is best to have as simple a model as possible with the fewest number of explanatory variables that will provide an adequate interpretation of the dependent variable.

- Durbin-Watson coefficient – measure of the extent the model exhibits first order serial correlation. This coefficient helps determine if the model needs to include an autoregressive parameter to correct for serial correlation. A Durbin-Watson coefficient between 1.7 and 2.2 typically indicates no problem with serial correlation.

- Residual plots – residuals will be examined to make sure they are independently and identically distributed with mean zero and constant variation, criteria that ensure the model is unbiased.

- Bayesian Information Criterion (Schwarz Criterian) – a statistic to measure the trade-off between model parsimony and model fit. It can be used to select the more parsimonious model if two models otherwise have nearly the same predictive abilities.

- Residual analysis will also be conducted to identify any potential outliers in the data. If an outlier is identified and can be justifiably removed from the analysis, it will be removed and the model will be re-specified. Any outliers removed will be noted in the final report

The final model will be used to estimate the impacts of the program segments on peak demand (load shape) and energy usage. The Company contemplates that the analysis will include comparisons of both treatment to control groups during the pilot period, and comparisons of pre-and post treatment data from within individual treatment groups.

IV. Technology Evaluation

An important goal of the pilot is to test and evaluate new smart grid technologies. The pilot evaluation will assess the TOU capabilities of Unitil's existing AMI infrastructure as well as the ability to integrate a TOU program with existing back-end systems such as billing. Other aspects of the evaluation include the evaluation of distribution automation capabilities, reliability of the new technologies, ease of installation and the customer experience – all of which will factor in the Company's future smart grid investment decisions. Specific study areas that will be reported on and methodologies for the assessment are presented in this section.

A. TOU CAPABILITIES OF EXISTING AMI SYSTEM

The Company initially viewed its AMI system as a strategic platform that would facilitate additional technological, management, and evaluative capabilities including but not limited to the ability to offer TOU programs to customers at low to no cost. The TOU elements of the pilot program provide the Company with the opportunity to test and report on the following TOU capabilities of the AMI system:

Remote Configuration of TOU Meters: The Hunt TS2 endpoints currently deployed throughout Unitil's electric service territory have the capability to record energy usage in up to four pre-defined registers that can facilitate TOU billing. The Company will experiment with the ability to remotely configure endpoints from the

command center to capture TOU usage information. The ability to register customers for a continued simple TOU program and to remotely configure their endpoints without the need for a site visit is an important factor in estimating costs of a continued program.

Issuance of Critical Peak Period Events: Critical Peak Events must be issued from the command center to the specified endpoints so that energy usage during Critical Peak Periods can be effectively captured in a separate register [separate from on-peak register] so that it can be properly billed. The Company will assess the functionality and effectiveness of these critical communications components.

Scheduling the Retrieval of Data Packets: The AMI system is bandwidth limited with respect to the volume of data that can be retrieved from the meters daily. Due to these limitations, TOU data cannot be retrieved every single day. The Company will evaluate options for scheduling the retrieval of daily data packets from the meters that will allow for effective billing, presentation of next day daily reads on the customer web-portal, and retrieval of necessary diagnostic data

Accuracy of TOU Meters: The ability of meters to accurately capture energy usage in TOU registers and report this information for billing purposes is extremely important to any program development involving TOU rates. The Company will utilize the interval analysis meter data to validate and report on the accuracy of the TOU billing data obtained through the pilot

Ability of TOU Meters to Estimate Program Impacts: The Company will seek to determine whether its existing AMI meters provide sufficient information to evaluate load impacts of the pilot program. The existing AMI meters are capable of capturing daily peak readings only. This data will be analyzed with the interval data to determine whether the Company could conduct subsequent pilot experiments that yield statistically valid results without the need for analysis meters.

The pilot program is an excellent venue for the Company to test and report on the TOU capabilities of the existing AMI system. A summary of activities and recommendations will be provided. The recommendations will be focused on the future development of TOU programs given the lessons learned and barriers encountered.

B. ENABLING TECHNOLOGIES

The pilot involves two additional enabling technologies that will be assessed as part of this plan: the Tendril home area network (HAN) and the Honeywell UtilityPro™ thermostats. A secondary technology that will be evaluated is the customer web portal developed by the Company that will provide customers with access to previous day daily usage reads and tools for incorporating energy efficiency and load shifting activities.

Key objectives of the pilot are to evaluate the reliability of the equipment, ease of installation, and customer acceptance and experience with the technology[7].

Equipment Reliability: The reliability of equipment will be assessed using two metrics. First, all customer problems and concerns will be routed through the Company's customer service department. Any calls relating to technical equipment problems will be recorded and tracked. Any problems that necessitate a follow up site visit from the installing contractor will also be tracked. The occurrence of both customer service calls relating to technical issues and additional in-home contractor visits will be reported on in the final evaluation plan for each program segment.

Second, post pilot surveys will be administered to participants to assess their experience in the program and with the enabling technologies. A draft survey instrument is included as Attachment C. Unitil anticipates that the final post-pilot survey will be refined based on guidance from the MA Statewide Evaluation Process and from NH stakeholders and on customer feedback received during the pilot program.

Ease of Installation: The Company will monitor the level of effort required to install and set up the enabling technologies. Time spent on site will be recorded by the installing contractors and will be used to project total installed costs that would be incurred for a full program. This cost information will be utilized in the cost effectiveness analysis of each program.

Another component to this evaluation is the tracking and reporting of any technical barriers encountered. Such potential barriers may include physical distance from the meter to the broadband router, technical issues arising from the installation of dual meters for the Enhanced Technology group, or other factors influencing the strength and communicative abilities of the enabling technologies. Identification of these barriers will allow for more efficient screening of applicants for future program development.

Customer Experience: The experience of the pilot participants with the enabling technologies will be assessed through the use of the post pilot surveys; a draft version of which is presented as Attachment C. The surveys will capture whether customers generally liked or disliked the technologies and will seek to answer the following study questions:

- How easy was the technology to understand and use?
- Did the technologies make them more aware of the energy use habits?
- Did they utilize the technologies to reduce energy usage, or to shift usage to off peak hours? If so, how?
- How would they rate their overall experience with the program and the specific technology?
- Would they participate in a permanent program?

[7] See also Section V.A for evaluation of the customers overall program experience.

- Did they use the Unitil web portal?
- What enhancements to the web portal or instructional material would be helpful?

Direct customer feedback will be solicited from pilot participants during the program period using several methods. First, Unitil will track all calls from pilot participants to customer service by recording the time and date of the call, the program segment that the customer is participating in, and the nature and content of the call. Second, the web portal will include a module that allows pilot participants to post questions or comments regarding the program. Unitil anticipates that the final post-pilot survey will be refined based on guidance from the Statewide Evaluation Process and on the customer feedback received during the program.

V. Process Evaluation

The Company will perform an evaluation of the pilot process that will focus on two key areas: the customer's experience from initial recruitment through pilot completion, and the Company's experience in delivering the program. The process evaluation will help to inform decisions regarding future smart grid investments.

A. CUSTOMER EXPERIENCE

Ensuring a positive customer experience is a key objective of the pilot. The Company will assess the customer experience through the use of pre-pilot, post-pilot and drop-out surveys, in addition to direct customer feedback received through customer service calls and online postings through the web portal. For the pre and post pilot surveys, a census approach will be used (i.e., where responses will be solicited from the entire population of participants). In cases where only a percentage of participants respond, care will be taken to identify and address any potential self-selection and/or response bias. The pre and post pilot surveys will seek to assess the following study topics:

- Was their experience in the program positive or negative?
- What did they specifically like or dislike?
- Would they participate in a continuing program?
- What actions did they take to reduce on-peak usage?
- Did they discuss energy usage and conservation with their families?
- What actions did they take to reduce overall usage?
- Did their monthly bills go up or down during the program?
- Were the bills easy to understand?
- How many critical peak periods did they think were called during the course of the pilot?
- How did they respond during critical peak periods?
- For smart thermostat program participants:
    - Did they notice an appreciable change in comfort during critical peak periods when their central air conditioning systems were cycled?
    - Did they override any events?
    - Were they aware that a control event was taking place?

- Do customers have a better understanding of energy usage in their home after participating in the pilot?
- Are customers more conscious of energy use and conservation after participating in the pilot?
- Will customers continue to incorporate energy efficiency and conservation in their homes?

Pilot participants that wish to drop out of the program will be handled by dedicated customer service representatives with knowledge of the program. The customer service representatives will first try to work through the source of the customer's complaint (e.g. higher bills are likely related to high on-peak usage) and offer suggestions on how the problem could be resolved. If a resolution is not reached and the customer wishes to be removed from the program, the customer service representative will administer a drop out survey to assess why they were dissatisfied and how their experience could have been improved. The following study topics will be assessed in the drop out survey

- What percentage of the overall population in each program dropped out during the pilot period?
- What are the primary reasons for dropping out of the program?
    - Moved
    - Issues with technology
    - Issues with Billing
    - Other (changed mind, illness, no reason, etc.)
- What changes to the program would they recommend?
- Would they participate again if those changes were made?

B. BILL PRESENTATION

The Company will explore options for modifying the CIS/billing system to accommodate TOU rates, and the subsequent presentation of TOU bills to customers. The Company will report on the approach for integrating TOU readings into the billing system, any barriers encountered, and recommendations for how billing could be best conducted for the future development of a full program including estimates for full program implementation.

Another key aspect of the bill presentation to be evaluated is the customer reaction to the TOU bills. Post pilot customer surveys will attempt to capture feedback from the customers as to whether the bills were easy to understand and how they could be improved. A sample of the post pilot customer survey is included as Attachment B.

C. COMPANY EXPERIENCE

As part of the evaluation, the Company will perform a self assessment of our experience in administering the pilot program from initial marketing and recruitment through field installations, customer education, customer service, billing, and pilot termination. The intent of defining the Company's experience is two-fold; first to inform the cost and expected level of commitment should a future program be developed under an expanded pilot or full program. Second, to report on the successes and shortcomings of the pilot

program design and execution so that lessons can be learned by other regional electric distribution companies and applied in subsequent pilots or programs.

The Company will attempt to quantify the cost and time commitment of the various components by evaluating employee time records and charges from consultants and vendors associated with the development of the program. From this baseline of cost and time spent on pilot development, the Company will estimate the time and cost associated with the administration of a full program.

The Company's methodology for self-assessing the overall process will be through an internal focus group comprised of key Company personnel involved with the development and administration of the pilot program. The focus group will be moderated by the Company's consultant representative, GDS Associates, who has assisted with the development, implementation and evaluation of the program. The Company anticipates that the following individuals will partake in the focus group:

- George Gantz, Senior Vice President, Distributed Energy Resources
- Justin Eisfeller, P.E., Director, Energy Measurement and Control
- Mark Lambert, Director, Customer Services
- Michelle Gamble, Senior Customer Systems Analyst
- Lisa Desrochers, Manager, Customer Service
- Carol Valianti, Vice President, Communications
- Sean Baker, Director, Web Development
- Thomas Palma, Esq., Manager, Distributed Energy Resources
- Mary Jane Cleveland, Manager, Billing and Collection
- Karen Asbury, Director, Regulatory Affairs
- Doug Debski, Senior Regulatory Analyst II

The discussion will focus on each group's experience in conducting the pilot and what improvements could be made if an expanded program were offered. A summary of key discussion points and recommendations will be compiled and included in the final evaluation report.

A final aspect of the Company's experience to be evaluated is the process for identifying and declaring critical peak days. The Company will evaluate whether the proposed methodology of using the temperature vs. load model to forecast CPP days is sufficiently robust to translate into an operating model. Specific study questions include but are not limited to:

- How many CPP days were declared using the 97% load threshold?
- Did the Company have to adjust the CPP load threshold to meet the minimum (or maximum) target number of CPP days?
- Did the Company experience any high-load days that were not forecasted using this methodology? If so, what refinements to the forecasting methodology would have been necessary to capture these high load events?
- Did the Company declare any CPP days and subsequently experience lower than expected loads? If so, what factors contributed to this result? What refinements to the forecasting methodology would have been necessary to prevent this occurrence?

- How did system loads vary by operating area (FGE, Seacoast, and Capital) during CPP days?

VI. Program Cost Effectiveness

The Company's smart grid pilot was designed specifically to compare and contrast the cost effectiveness of three separate and distinct approaches to residential demand response. Comparisons of the modeled cost effectiveness for each program will help inform decisions for future smart grid investments. Program cost effectiveness will be evaluated using the Total Resource Cost (TRC) Test and the three-step approach outlined below:

Step 1: Prior to pilot initiation, project the cost effectiveness of each program segment using estimates for equipment and installation costs, and program savings (kW and kWh)

Step 2: At the conclusion of the pilot period, revise the initial estimates of costs and savings to reflect the actual costs and savings witnessed during the pilot. Retrospectively calculate the cost effectiveness of each program segment

Step 3: Project the future cost effectiveness of each program segment assuming full programs were offered to all eligible customers. Assumptions will be made regarding the number of participating customers per year and program costs.

The projected cost effectiveness of each program segment will be instructive to the Company as to which program segments or combinations of program segments should be studied further or fully developed. The Company intends to evaluate the benefits associated with the program utilizing the benefit cost models approved by each State. The models account for the incremental costs of the equipment, most recent avoided energy supply costs, measure life, and other key variables. The Company will disclose all assumptions and screening tools and work cooperatively with regulators in both states to produce mutually agreeable outputs.

ATTACHMENT A

Impact Evaluation Literature Review

During on-peak or critical peak periods, load is reduced from a level it would have reached without the price signal or demand response measure. The actual metered data includes the demand savings. Therefore, to measure the amount of demand reduction, Unitil must estimate the level the load would have reached and then net the metered data from the estimate to determine the load response. The estimated load is called the baseline.

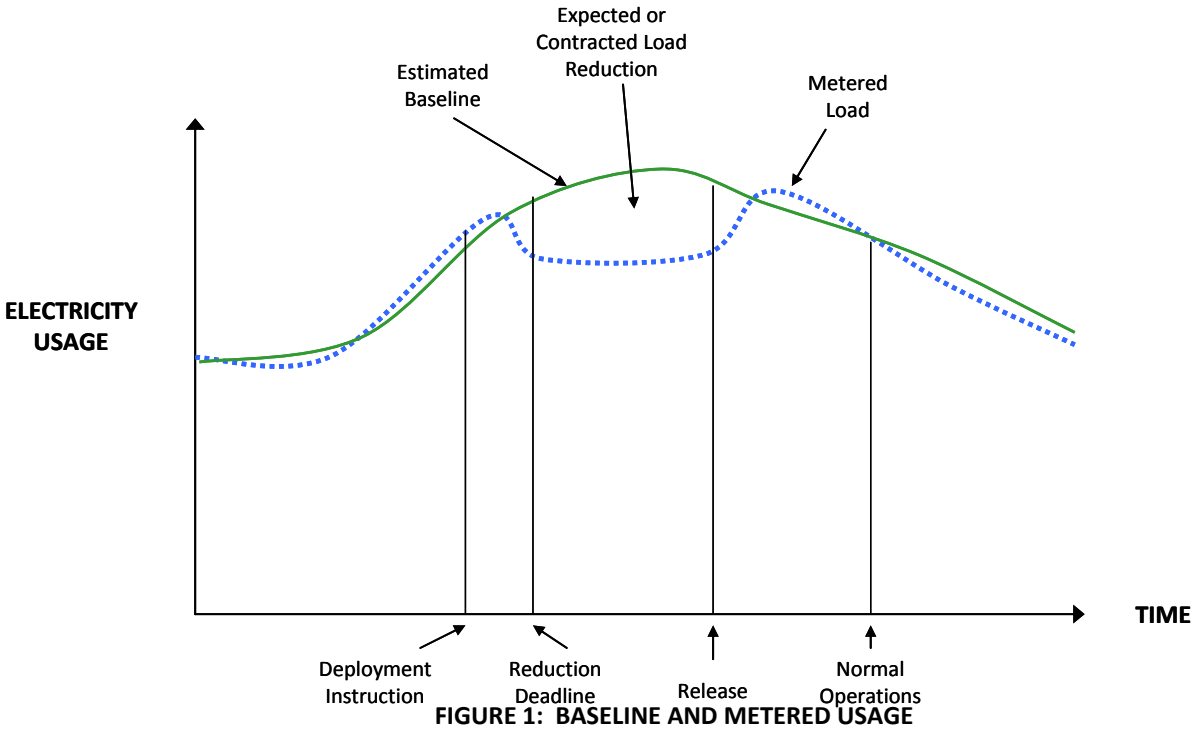


FIGURE 1: BASELINE AND METERED USAGE

There are competing criteria that must be balanced when selecting a baseline estimation methodology. Simplicity is desirable because it increases ease of use and understanding, and it provides for lower costs for evaluators to implement on a large scale. Accuracy is another important component, which includes lack of bias[8] (no systematic tendency to over- or under-state the demand reductions), appropriate handling of weather-sensitivity if applicable, and verifiability. In programs where advanced notice is given prior to a control event (e.g., interruptible rate program), there exists the potential for customers to game the system by adjusting their loads that would impact the baseline. Finally, an important macro goal is consistency within the industry.

[8] A statistical definition of bias is the amount by which the expected value of an estimate of a parameter θ is higher or lower than the true value of the parameter θ. $\text{Bias} = E(\hat{\theta}) - \theta$

There are two basic approaches to estimating the baseline, with variations on both. All these methodologies attempt to balance the criteria of simplicity, accuracy, minimization of gaming, and consistency. The simpler approach is to look at some average of prior days' loads. The more complex approach is a statistical modeling approach that accounts for characteristics that impact load such as weather and takes data collected from the control group into account.

Prior Day Averaging - These techniques assume the existence of one or more "non-event" days whose hourly load values can be averaged to provide a baseline load profile. The goal is to collect a set of data for which: i) the actual loads without control are known; and, ii) the days are similar in some sense to the actual days during which control was implemented. Usually, a set of admissible days is selected from the set of many recent days. In most methodologies, admissible days exclude weekends, holidays, and days with control events. Some selected number (e.g., three, five, or ten) of the most recent admissible days are then averaged for every hour to create a 24-hour profile. This profile becomes the baseline for the day of the control event. This simple methodology ignores what could be differences in weather or other operating conditions between the admissible days and the day of the event. To correct for this shortcoming, Goldberg and Agnew recommend applying an adjustment to the baseline based on the morning hours of the day of control[9].

The prior day averaging approach is easy to implement and provides intuitive results for a single event day. However, evaluation across a season would require more complex calculations. Furthermore, with advanced notice, pre-cooling strategies or other pre-event baseline adjustment behaviors by the customer can increase the bias in the estimate. This potential bias can be corrected by using prior-day baselines that exclude any hours after notification; however, this approach sacrifices simplicity and intuitiveness.

Statistical Modeling – There are two basic statistical models employed for estimating the baseline. Regression modeling is the simpler technique and easiest to interpret. Analysis of covariance (ANCOVA) is a more advanced model that can also be used.

Using the regression approach, a statistical model is developed to quantify a relationship between historical loads, weather conditions, price of electricity (where applicable), and a series of calendar identifiers. Weather data and calendar variables representing the day of the event can be input into the model to project the baseline. A single regression model can be estimated for aggregated load, or individual models for each residence can be constructed. When possible, the individual models are preferable because the coefficients capture the high degree of variability in customer behaviors and demographics. For a single model, it is preferable to include demographic information,

[9] Goldberg, Miriam L and G. Kennedy Agnew. *Protocol Development for Demand Response Calculation – Findings and Recommendations*. Consultant report to California Energy Commission. Report # 400-022-017F. February 2003.

but such information is usually missing for some or all of the accounts. Missing demographic data may lead to bias in the model estimate if those accounts are excluded from model estimation[10]. A fixed-effects model can also be estimated that includes an indicator variable for each individual consumer in the aggregated model. This indicator variable would control for unknown individual load characteristics.

Although more complex than the prior-day averaging method, regression estimation is relatively straightforward using a least squares procedure that is available in all statistical software and spreadsheets. Second, regression is theoretically less biased than prior-day average for weather-sensitive loads because weather is explicitly quantified, as are differences in calendar day load shapes. The relationship is measured without the somewhat laborious process of identifying historical matching weather days for the weather-based matching technique. Finally, the regression techniques produce estimates that are statistically unbiased and consistent[11], which is desirable for a statistical estimator[12]. Consistency is especially important because it means the estimate's validity increases over time as more data is collected. The major drawback of regression modeling is the cost and time associated with developing the models. The underlying statistics are less intuitive and building a good regression model is part science and part art. Furthermore, it has been noted that time series data such as hourly loads tends to have first order serial correlation[13]. This can be corrected with the use of autoregressive parameters at a cost of increasing the complexity of calculating an estimate.

Analysis of covariance combines some of the features of both regression and analysis of variance. It is a more powerful model than the regression approach because it allows for the control of a variable other than the variable of interest (called the concomitant variable or the covariate). For instance, ANCOVA can be used to generate a single model to account for the average reduction per house but still control for each home's individual behavioral characteristics.

ANCOVA has the same benefits as regression, and it automatically controls for individual consumer characteristics. However, the procedure is more complex and less intuitive than regression. Developing ANCOVA estimates usually requires special statistical software and training for model development and interpretation.

---

[10] For instance, if higher-usage customers tend not to report their income and customers without income are excluded, the coefficient for income would exhibit sample selection bias.

[11] Estimates are unbiased when the difference between the estimate and the true but unobserved value has an expected value of zero. A consistent estimate converges to its true but unobserved value as the sample size increases.

[12] Woo, C.K. and K. Herter. *Residential Demand Response Evaluation: A Scoping Study*. Ernest Orlando Lawrence Berkeley National Laboratory, June 2006.

[13] Serial correlation is when the errors associated with observations in a given time period carry over into future time periods. In other words, if the model is over-predicting in period 1, it is highly likely to over-predict in period 2 as well.

ISO New England[14]

As a member of ISO New England, it is instructive for Unitil to understand how the ISO measures demand response impacts for the purposes of transacting in their market. ISO New England has detailed standards on their demand response program, dating back to December 2002. Their program includes both day-ahead and real time demand response programs. The day-ahead program allows Real-Time program participants to offer energy reductions (100 kW minimum) of curtailment concurrent with the Day-Ahead Energy Market, paid at the Day-Ahead Zonal Price. The Real Time programs allow real time response for either 30 minutes notice or for 2 hours notice. The Real Time participants receive payment at the Real-Time Zonal Price. Load aggregation is allowed in all of the programs offered, as long as the ISO can treat the aggregated load as a single entity (i.e., they all must be able to respond in 30 minutes on that Real Time plan).

For estimating a baseline, ISO New England uses the prior day-averaging with morning adjustment methodology. The most recent five admissible days are used to estimate the baseline, and then an adjustment is made based on the two hours prior to the interruption. Holidays and prior load response event days are excluded from the list of admissible days in the calculation.

[14] This section based on *ISO New England Load Response Program Manual*. 12th Revision. October 1, 2007. This was the most recent version of this manual available on ISO-NE's website.

ATTACHMENT B

DRAFT Pre-Pilot Survey

ENERGY$AVINGS MANAGEMENT

Customer Survey

Unitil

Thank you for participating in Unitil's *Energy Savings Management* Program. Please fill out this survey which will help us gauge the impact of the pilot program. The information collected will be used to compare answers to other program participants and will not be used for any other purpose. We will also be asking you to complete a brief survey at the conclusion of the pilot which will help us to better understand your experience and how it could be improved. Thank you for your time and for participating in the pilot.

_____
Name

_____
Date

_____
Address

_____
Unitil Account #

How aware would you say your household is of energy usage and the impacts of energy use on the environment? **On a scale of 1 to 10, please circle the number that best represents your answer.**

1 = not at all aware; 10 = extremely aware

1 2 3 4 5 6 7 8 9 10

How would you rate your household in terms of Energy Conservation *(e.g turning off lights when leaving a room, unplugging phone chargers when not in use, etc.)?* **On a scale of 1 to 10, please circle the number that best represents your answer.**

1 = needs improvement; 10 = excellent

1 2 3 4 5 6 7 8 9 10

How would you rate your household in terms of Energy Efficiency *(e.g. replacing incandescent lights with CFL's, purchasing high efficiency appliances, etc.)?* **On a scale of 1 to 10, please circle the number that best represents your answer.**

1 = needs improvement; 10 = excellent

1 2 3 4 5 6 7 8 9 10

Prior to hearing about this program, how aware were you that the cost to generate electricity varies throughout the day, peaking in the early afternoon? **On a scale of 1 to 10, please circle the number that best represents your answer.**

1 = not at all aware; 10 = extremely aware

1 2 3 4 5 6 7 8 9 10

On a typical summer weekday (Monday-Friday), how frequently would you say someone is at home during the day?

- ❑ almost never
- ❑ occasionally
- ❑ almost always

Approximately how many days during the summer would you say you run your central air conditioning system?

- ❑ never
- ❑ just the hottest days
- ❑ several days a week
- ❑ almost every day
- ❑ every day

continued, page 2

In the summer, what temperature do you typically set your thermostat to when you are home?

- ❑ 66°F or lower
- ❑ 67°F - 69°F
- ❑ 70°F - 72°F
- ❑ 73°F - 75°F
- ❑ 76°F or higher

What is the approximate range of your household income?

- ❑ less than $50
- ❑ $50K - $80K
- ❑ $80K - $120K
- ❑ $120K - $150K
- ❑ more than $150K

What is the highest level of education you have completed?

- ❑ Did not graduate high school
- ❑ High School / GED
- ❑ Some College
- ❑ College Graduate
- ❑ Postgraduate degree

In regards to your motivations for participating in the pilot program, **please rank the following on a scale of 1 to 10:**

1 = very unimportant; 10 = very important

◢ Saving money on your electric bill

1 2 3 4 5 6 7 8 9 10

◢ Conserving energy

1 2 3 4 5 6 7 8 9 10

◢ Environmental benefits, including greenhouse gas reductions

1 2 3 4 5 6 7 8 9 10

◢ Interested in the technology

1 2 3 4 5 6 7 8 9 10

For each age group below, please identify how many people are currently living in this household

◢ 5 yrs old and under

❑ *0* ❑ *1* ❑ *2* ❑ *3* ❑ *4 or more*

◢ 6-18 yrs old

❑ *0* ❑ *1* ❑ *2* ❑ *3* ❑ *4 or more*

◢ 19-34 yrs old

❑ *0* ❑ *1* ❑ *2* ❑ *3* ❑ *4 or more*

◢ 35-54 yrs old

❑ *0* ❑ *1* ❑ *2* ❑ *3* ❑ *4 or more*

◢ 55-64 yrs old

❑ *0* ❑ *1* ❑ *2* ❑ *3* ❑ *4 or more*

◢ 65 yrs old and over

❑ *0* ❑ *1* ❑ *2* ❑ *3* ❑ *4 or more*

How many times per week would you estimate you currently run the following high energy use appliances between the hours of 12pm to 6pm on weekdays?

◢ dishwasher

❑ *0* ❑ *1-2* ❑ *3-4* ❑ *5-6* ❑ *7 or more*

◢ clothes washer

❑ *0* ❑ *1-2* ❑ *3-4* ❑ *5-6* ❑ *7 or more*

◢ clothes dryer

❑ *0* ❑ *1-2* ❑ *3-4* ❑ *5-6* ❑ *7 or more*

How effectively do you feel your household will be able to manage and shift energy usage to take full advantage of the program incentives? **On a scale of 1 to 10, please circle the number that best represents your answer.**

1 = not effectively; 10 = highly effectively

1 2 3 4 5 6 7 8 9 10

continued, page 3

Please rank the following by checking the box that you think best corresponds to the amount of energy that appliance consumes relative to the others:

◀ ***uses LEAST energy*** • • • • • • • • • • • • ***uses MOST energy*** ▶

										central air conditioning system
										plasma TV
										clothes washer
										clothes dryer
										dishwasher
										toaster oven
										electric oven
										refrigerator
										electric water heater
										microwave
										well pump
										pool pump
										60 watt incandescent light bulb
										15 watt compact fluorescent (CFL) light bulb

Have you incorporated any significant energy efficiency measures in your household in the last 10 years? Check all that apply:

- ❑ Added/replaced insulation
- ❑ Added air sealing
- ❑ Had a home energy audit
- ❑ Installed energy efficient windows or storm windows
- ❑ Purchased ENERGY STAR heating or cooling systems
- ❑ Purchased ENERGY STAR appliance(s)
- ❑ Other _____

This information will be used to compare your answer to other demographic groups and will not be used for any other purpose.

ATTACHMENT C

DRAFT Post-Pilot Survey

Unitil Logo

Thank you for participating in our Unitil's Energy Savings Management Pilot Program. Please complete the attached questionnaire which will help us to better understand your experience with the program and how we could improve it. The information collected will be used only to compare your answers to other program participants and will not be used for any other purpose.

Name _____
Date _____
Address _____
_____

1) On a scale of 1-10, how would you rate your overall experience with the program?

   1 = Extremely Dissatisfied
   10 = Extremely Satisfied

2) If this program were offered on a full time basis, would you be interested in participating?

   - ☐ Yes
   - ☐ No
   - ☐ Don't Know

3) Did your monthly electric bills increase, decrease, or stay the same during the pilot program?

   - ☐ decreased significantly
   - ☐ decreased slightly
   - ☐ stayed the same
   - ☐ increased slightly
   - ☐ increased significantly

4) How clear and easy to understand were your monthly electric bills?

   - ☐ Extremely confusing
   - ☐ Somewhat confusing
   - ☐ Same as before
   - ☐ Somewhat clear and easy to comprehend
   - ☐ Extremely clear and easy to comprehend

5) What specifically, if anything did you find confusing about your monthly bills that could be changed to make them easier to understand?

   _____
   _____

6) After participating in the pilot, how aware would you say your household is of energy usage and the impacts of energy use on the environment? On a scale of 1 to 5, please circle the number that best represents your answer.

   1 = not at all aware; 5= extremely aware

7) After participating in the pilot, wow would you rate your household in terms of Energy Conservation (e.g turning off lights when leaving a room, unplugging phone chargers when not in use, etc.)? On a scale of 1 to 5, please circle the number that best represents your answer.

1 = needs improvement; 5 = excellent

8) After participating in the pilot, how would you rate your household in terms of Energy Efficiency (e.g. replacing incandescent lights with CFL's, purchasing high efficiency appliances, etc.)? On a scale of 1 to 5 please circle the number that best represents your answer.

1 = needs improvement; 5 = excellent

9) How would you rate your experience with the installation contractor who initially visited your home, installed the equipment and explained the program to you? On a scale of 1 to 5 please circle the number that best represents your answer.

1 = poor; 5 = excellent

10) Did you or your family access the web portal at myunitil.com to view your daily energy usage and energy saving tips?

- ☐ Yes
- ☐ No
- ☐ Don't know

11) If so, did you find it useful?

- ☐ Yes
- ☐ No
- ☐ Did not access

12) Do you have any recommendations for making the web portal more useful or easier to navigate?

_____

_____

13) The program was designed so that you would be made aware of Critical Peak Periods (CPP's) one day in advance. Based on your experience, how clearly did Unitil communicate that a CPP would be declared the following day?

- ☐ Very clearly
- ☐ Somewhat clearly
- ☐ Neither clearly nor unclearly
- ☐ Somewhat poorly
- ☐ very poorly

14) Please circle the number of Critical Peak Periods (CPP's) you believe were declared during the course of the pilot?

List numbers: 0-8

TECHNOLOGY

Simple TOU	**Enhanced Technology**	**Smart Thermostat**
How easy to understand were the time-of-use rates? On a scale of 1-5, please circle the number that best represents your answer: 1 = very complicated; 5 = very simple 1 2 3 4 5	How easy to understand were the time-of-use rates? On a scale of 1-5, please circle the number that best represents your answer: 1 = very complicated; 5 = very simple 1 2 3 4 5	Did you experience a noticeable change in the comfort of your home during these critical peak periods? ☐ Yes ☐ No ☐ Don't Know
How effectively did the educational materials explain the time-of-use rates? On a scale of 1-5, please circle the number that best represents your answer: 1 = not at all effectively; 5 = very effectively 1 2 3 4 5	How effectively did the educational materials explain the time-of-use rates? On a scale of 1-5, please circle the number that best represents your answer: 1 = not at all effectively; 5 = very effectively 1 2 3 4 5	Did you override the temperature set point of your central air conditioning system during any critical peak periods? ☐ Yes ☐ No ☐ Don't Know
	How effectively were the time-of-use rates shown and/or explained in the energy management system web portal? On a scale of 1-5, please circle the number that best represents your answer: 1 = not at all effectively; 5 = very effectively 1 2 3 4 5	
On a scale of 1-5, with 1 being "strongly disagree" and 5 being "strongly agree", please rate your response to the following	On a scale of 1-5, with 1 being "strongly disagree" and 5 being "strongly agree", please rate your response to the following statements:	On a scale of 1-5, with 1 being "strongly disagree" and 5 being "strongly agree", please rate your response to the following statements:

statements: • I made active efforts to shift energy usage from high price (on-peak) periods to low price (off-peak) periods (1-5) • The educational materials provided by Unitil provided useful tips on how to shift usage to off-peak hours. (1-5) • The educational materials provided by Unitil provided useful tips on how to incorporate energy efficiency and reduce overall energy consumption in my home. (1-5) • I will continue to incorporate energy conservation and efficiency in my household. (1-5)	• The home energy management system was easy to use and understand. (1-5) • The home energy management system increased my understanding of how energy is used in my home. (1-5) • The home energy management system encouraged me to conserve energy in my home. (1-5) • The home energy management system clearly and effectively communicated that Critical Peak Periods were occurring. (1-5) • I made active efforts to shift energy usage from high price (on-peak) periods to low price (off-peak) periods (1-5) • I used the enhanced programming features of my home energy management system to minimize the use of central air conditioning or other high energy use appliances during high price (on-peak and critical peak) periods. (1-5) • I will continue to incorporate energy conservation and efficiency in my household. (1-5) • I would be more likely to continue incorporating energy efficiency and awareness if I were allowed to keep the Tendril system. (1-5)	• The thermostat was easy to use and understand. (1-5) • The educational materials provided by Unitil made me more aware of my energy use habits. (1-5) • I incorporated some of the energy efficiency tips included in the educational materials I received. (1-5) • I will continue to incorporate energy conservation and efficiency in my household. (1-5)

	On a scale of 1-5, with 1 being “strongly disliked” and 5 being “strongly liked”, please rate your perception of the following components of your home energy management system: • In-home display (1-5) • Programmable thermostat (1-5) • Volt controllable outlet (1-5) • Tendril Vantage web portal (1-5) • Unitil Web portal (myunitil.com) (1-5)	
What kinds of specific actions did you take to shift energy use to off-peak periods? Check all that apply: ☐ washed clothes off peak ☐ dried clothes off peak ☐ hung dry clothes instead of machine drying ☐ used timer on my water heater ☐ used my dishwasher off-peak ☐ avoided drying cycle of my dishwasher and let air dry ☐ washed my car off-peak ☐ Other _____	What kinds of specific actions did you take to shift energy use to off-peak periods? Check all that apply: ☐ Set rules in the web portal to minimize usage during high price periods ☐ washed clothes off peak ☐ dried clothes off peak ☐ hung dry clothes instead of machine drying ☐ used timer on my water heater ☐ used my dishwasher off-peak ☐ avoided drying cycle of my dishwasher and let air dry ☐ washed my car off-peak ☐ other _____	
What kinds of specific actions did you take to minimize energy during peak and critical peak periods? Check all that apply:	What kinds of specific actions did you take to minimize energy during peak and critical peak periods? Check all that apply:	

☐ Increased temperature of thermostat ☐ Conserved water ☐ Minimized the use of home electronics ☐ Turned off lights ☐ minimized use of appliances ☐ Reduced phantom loads by turning off power strips when electronics not in use ☐ Other _____	☐ Increased temperature of thermostat ☐ Conserved water ☐ Minimized the use of home electronics ☐ Turned off lights ☐ minimized use of appliances ☐ Reduced phantom loads by turning off power strips when electronics not in use ☐ Other _____	
Did you incorporate any of the tips for energy efficiency? Check all that apply: ☐ Turned off lights when a room is not being used ☐ Replaced incandescent lights with CFL's or LED's ☐ Turned up temperature set point of thermostat ☐ Shut off AC and used fans instead ☐ Closed shades to keep sun out ☐ Air dried dishes ☐ Ran clothes washer using only cold water ☐ Washed only full loads of dishes ☐ Installed aerators on faucets or showerheads ☐ Installed timer on electric water heater ☐ Increased refrigerator temperature ☐ Other _____	Did you incorporate any of the tips for energy efficiency? Check all that apply: ☐ Turned off lights when a room is not being used ☐ Replaced incandescent lights with CFL's or LED's ☐ Turned up temperature set point of thermostat ☐ Shut off AC and used fans instead ☐ Closed shades to keep sun out ☐ Air dried dishes ☐ Ran clothes washer using only cold water ☐ Washed only full loads of dishes ☐ Installed aerators on faucets or showerheads ☐ Installed timer on electric water heater ☐ Increased refrigerator temperature ☐ Other _____	Did you incorporate any of the tips for energy efficiency? Check all that apply: ☐ Turned off lights when a room is not being used ☐ Replaced incandescent lights with CFL's or LED's ☐ Turned up temperature set point of thermostat ☐ Shut off AC and used fans instead ☐ Closed shades to keep sun out ☐ Air dried dishes ☐ Ran clothes washer using only cold water ☐ Washed only full loads of dishes ☐ Installed aerators on faucets or showerheads ☐ Installed timer on electric water heater ☐ Increased refrigerator temperature ☐ Other _____
During the program, what temperature did	During the program, what temperature did you	During the program, what temperature did you

you typically set your thermostat to during the following periods: • 12pm-6pm weekdays (on-peak) ___ • 12pm-6pm weekdays (critical-peak) ___ • All other times (off-peak) _____	typically set your thermostat to during the following periods: • 12pm-6pm weekdays (on-peak) ___ • 12pm-6pm weekdays (critical-peak) ___ • All other times (off-peak) _____	typically set your thermostat to during the following periods: • 12pm-6pm weekdays (on-peak) ___ • 12pm-6pm weekdays (critical-peak) ___ • All other times (off-peak) _____
Did you have any problems with any of the technologies? If so, please describe briefly: (blank lines for write-in)	Did you have any problems with any of the technologies? If so, please describe briefly: (blank lines for write-in)	Did you have any problems with any of the technologies? If so, please describe briefly: (blank lines for write-in)
What recommendations would you have for improving the program in the future? (blank lines for write-in)	What recommendations would you have for improving the program in the future? (blank lines for write-in)	What recommendations would you have for improving the program in the future? (blank lines for write-in)

Unitil Energy Systems, Inc.
Docket No. DE 10-055
PUC Staff Information Requests – Set 3

Received: July 1, 2010 Date of Response: July 15, 2010
Request No. Staff 3-90 Witness: Thomas P. Meissner, Jr.

Request:

3-90. Reference response to question 3-88a. If response is "yes," using actual historical results on the AMR solution implemented please provide analytical results on the Hunt AMR solution, including:

a. Analysis and calculation of actual Simple Payback, NPV and IRR of the AMR solution implemented;
b. Please discuss and compare actual Simple Payback, NPV, IRR results to the forecasted results summarized in the June 17, 2005 Executive Summary of attachment 1 Page 6 of 30;
c. Whether an internal performance review has been performed documenting actual financial results (Simple Payback, NPV, IRR) of the Hunt system post implementation. If so, please provide to Staff.

Response:

a. In the Company's June 17, 2005 AMR Project Recommendation ("Recommendation"), the Company provided a NPV of $9.4 million, IRR of 20.7%, and simple payback of 4.5 years. In the Recommendation, the Company provided a break-down of the expected Cash, Productivity and One-time Benefits which support the project economics. Please see Staff 3-90 Attachment 1 for the break-down of these benefits organized by savings category (O&M, Revenue or Capital).

In January 2007, the Company assessed its O&M savings. Please see Staff 3-90 Attachment 2. The Company's original assumption of annual O&M savings in the Recommendation was $1,564,577 and total headcount reduction of 19.5. In Staff 3-90 Attachment 2, the Company estimated annual O&M savings achieved of $1,741,103 and total headcount reduction of 21.

Furthermore, in the Company's recommendation, the Company estimated a total project cash cost (excluding fixed overheads) of $10.5 million. The actual project cash cost was $11.2 million, or a difference of approximately $0.7 million.

In conclusion, the actual cash cost for the project was very close to the original estimate in the Recommendation and came within $0.7 million. Furthermore, the actual O&M savings the Company achieved were greater than that outlined in the Recommendation. As a result, the Company assessed that the actual AMR project economics would be similar to the

economics provided in the Recommendation and did not formally perform any further detailed look-back analyses to calculate actual project economics.

b. Please see response in part a.

c. Please see response in part a.

Unitil Corp.
Automated Meter Reading Project
Original Estimate of Benefits
June 2005

			Itron Total	Hunt Total	Savings Category
Cash Benefits					
C	Meter Reading Labor Revised		$ 1,066,170	$ 1,131,167	O&M
C	Tamper Detection		296,815	296,815	Revenue
C	Mtr Rdg Vehicles		143,964	173,613	O&M
C	On Demand Read (C)		-	171,146	O&M
	All Other Cash Benefits				
C	Accuracy		161,137	161,137	Revenue
C	Line Loss Reduction		-	91,100	Revenue
C	Phase Detection		77,496	77,496	Revenue
C	Mtr Rdg Application (C)		67,526	67,526	O&M
C	Load Profile Setup (C)		-	13,023	O&M
C	Distribution Project Deferral		-	8,487	Capital
C	Outage Restoration (C)		-	6,447	O&M
C	Cancel Rebill (C)		1,656	1,656	O&M
	Total All Other Cash Benefits		307,815	426,871	
	Total Cash Benefits		$ 1,814,764	$ 2,199,613	
Productivity Benefits					
P	Virtual Disconnect (P)		-	$ 67,366	
P	Mtr Rdg Application (P)		37,945	37,946	
P	On Demand Read (P)		-	36,175	
P	Cancel Rebill (P)		29,178	29,178	
P	Reduced Call Center		28,929	28,928	
P	Outage Restoration (P)		-	12,572	
P	Meter Changeout Deferred (P)	FGE	8,589	8,589	
P	Distribution Control		-	5,305	
P	Load Profile Setup (P)		-	1,824	
	O&M Productivity Costs		(80,000)		
	Total Productivity Benefits		$ 24,640	$ 227,882	
	Total Benefits			2,427,495	
				-	
	One time Benefits			221,885	

Cash Benefits by Savings Category

O&M	**$ 1,279,316**	**$ 1,564,577**
Capital	**-**	**8,487**
Revenue	**535,448**	**626,548**
Total	**1,814,764**	**2,199,613**

Unitil Corp.
Automated Meter Reading Project
Reconciliation of Project Savings
January 2007

Original Assumptions

O&M Savings	$ 1,564,577
Headcount Reduction	19.5

Actual Results

	Pre-2006	2006	2007	2008
Incremental Savings Each Year				
Operations	134,082	226,000	500,000	400,000
Customer Service			33,000	
Payroll Taxes & Benefits (40%)	53,633	76,508	182,467	135,413
Budgeted Savings	187,715	302,508	715,467	535,413
Headcount Reduction				
Operations	2	8	10	
Customer Service			1	
Total Positions	2	8	11	
Cumulative Annual Savings --->	187,715	490,223	1,205,690	1,741,103
Cumulative Staffing Impact --->	2	10	21	