STATE OF NEW HAMPSHIRE
BEFORE THE
PUBLIC UTILITIES COMMISSION

Docket No. DE 10-055

Unitil Energy Systems, Inc.

Petition for Approval of Base Rate Increase

DIRECT TESTIMONY

OF

JIM BRENNAN

November 5, 2010

Q. Please state your name, business address and current position.

A. My name is Jim Brennan. I am employed by the New Hampshire Public Utilities Commission as Smart Grid Analyst. My business address is 21 South Fruit Street, Suite 10, Concord, New Hampshire.

Q. Please summarize your educational background and work experience.

A. I graduated in 1978 from Saint Bonaventure with a Bachelor of Science degree in Finance. In 1980, I graduated from Syracuse University with an MBA. In 1981, I completed a nine month Chemical Bank (now JP Morgan Chase) MBA Management Training Program and was ranked third in my class. In private industry I have completed numerous courses in business, finance, software development, electric utility regulation, and Smart Grid. I currently teach finance and business computer applications for a local college.

In my present position as a Smart Grid expert for the NHPUC, I review utility investments aimed at modernizing the electric grid, including automated metering infrastructure, demand response, cyber security, distributed generation and storage. My responsibilities include the review of technical requirements, and the analysis and evaluation of the benefits of Smart Grid technology. I am involved in the National Institute of Standards and Technology (NIST) Cyber Security Working Group (CSWG), and a participating member of the Architecture, Standards and AMI Security subgroups.

From 1980 to 1989, I was First Vice President at Chemical Bank’s commercial lending office in New York City. My experience in technology began in 1995 at Waterhouse Securities, where I ran the third largest statement operation on Wall Street with responsibilities for budget and operations, including overnight processing, monthly production, correspondent new product development, national print expansion, data processing and NYSE compliance. I later managed a series of special projects, including implementation of paperless technology in the security clearing operation, Turbo-Tax integration and launch of an eServices web site providing on-line secure access of brokerage statements to 2.5million clients. My software development experience began in 2003 at Mathematica Policy Research, where I designed relational databases and Microsoft.NET applications including a data collection and reporting system for the U.S. Department of Labor Senior Community Service Employment Program (SCSEP) , which was deployed nationally.

Q. What data did you rely upon to prepare your testimony?

A. I relied on discovery responses provided by UES in Docket No. DE 10-055, including responses to STAFF 3-82 through 3-99 and discussions in a September 17, 2010 Smart Grid meeting held at the PUC with UES officials.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is two-fold:

1) To provide a high-level overview of Smart Grid and how standards are affecting existing and future Smart Grid development and investment.
2) To discuss and evaluate Unitil's Smart Grid projects, its 2008 AMI deployment, and overall Smart Grid strategy.

Q. Please define Smart Grid and its benefits.

A. Because Smart Grid is extensive (it will overlay the entire bulk power system) and, to a large degree, invisible, concise one-line definitions are ineffective. I will, therefore, define Smart Grid using the following four different approaches.

***Approach 1*: Communications + Sensors + Software = Smart Grid (C+S+S=SG).**

Smart Grid is the introduction and integration of three core technologies, including software, communications, and sensors, with today's power grid to form what the U.S. Department of Energy (DOE) calls an "energy internet." Smart Grid is an enabling infrastructure that allows optimizations to occur, often using software algorithms and real time/near time processing and communications capabilities across and within seven Smart Grid domains as defined by the National Institute of Standards and Technology (NIST) – Markets, Operations, Service Providers, Generation, Transmission, Distribution and Customer.[1] Microsoft has stated, "The energy grid becomes 'smart' by injecting software into the various control points in the grid, so that people and businesses have ready access to timely, user-friendly information that can help them make smart choices about their energy use. We can envision a world where thousands of smart appliances can seamlessly plug into homes thanks to common standards and interoperability frameworks, just as the 'plug and play' model allows thousands of devices to seamlessly plug into PCs today."[2]

***Approach 2*: The Fundamental Difference of a Smart Grid.**

According to this approach, three things make the Smart Grid different from today's grid:

[1] NIST Special Publication 1108, NIST Framework and Roadmap for Smart Grid Interoperability Standards Release 1.0, p. 33.

[2] Anoop Gupta, Microsoft Corporate Vice President of Technology Policy and Strategy, summarized Microsoft's contribution to this body shortly after his May meeting at the White House with U.S. Secretary of Energy,Steven Chu, and U.S. Secretary of Commerce, Gary Locke. *See* "Microsoft Smart Energy Reference Architecture," p. 10.

Two-way power flow in distribution;[3]

Two-way communications flow; and

Decentralized power supply and control.

***Approach 3*: Smart Grid Characteristics.**

As organizations innovate and build upon two-way communications networks, two-way power flows and distributed generation/control the Smart Grid will be defined by the following seven capabilities, according to DOE's National Energy Technology Laboratory (NETL):

- Accommodate all generation and storage options;
- Enable active participation by consumers;
- Enable new products, services and markets;
- Provide power quality for the digital economy;
- Optimize asset utilization and operate efficiently;
- Anticipate and respond to system disturbances (self heal); and
- Operate resiliently against attack and natural disaster.

These characteristics offer benefits associated with data and event processing. New products, applications and services, including loosely coupled web services, transform the grid into a high performance transactional platform. As a transactional event-driven platform, the Smart Grid could incorporate advanced proactive security measures. As an example, Homeland Security could theoretically be able to monitor, filter, correlate and

[3] "2030 Distributed Electricity Environment" National Energy Technology Laboratory NETL June 2009, Slide 5

aggregate events in a real-time risk framework to prevent or respond to cyber security threats and attacks.

Smart Grid will be a digitized system of systems designed and built over a large span of time during which several generations of technology will be utilized.

Approach 4: **Value Areas.**

The Smart Grid's new characteristics can create value that can be analyzed in a benefit-cost approach. Smart Grid projects can lead to improvements in the following key value areas:[4]

- Reliability
- Security
- Economics
- Efficiency
- Environment
- Safety

Q. Please discuss the priorities that the Federal Energy Regulatory Commission set out in its July 16, 2009 Smart Grid Policy Statement

A. This policy statement[5] prioritized the development of key interoperability standards to provide a foundation for the development of many other standards. The list below

[4] NETL White Paper, "Understanding the Benefits of the Smart Grid" (June 18, 2010), DOE/NETL-2010/1413, available at http://www.netl.doe.gov/smartgrid/.

[5] 128 FERC 61,060, 74 FR 37098 (7/27/09), Docket No. PL09-4

includes six original FERC priorities and two additional priorities suggested by NIST (#5 Advanced Metering Infrastructure, #6 Distribution Grid Management). Two of the priorities are cross-cutting and pertain to all other standards (#7 Cyber Security and #8 Intra-System Communications). The remaining four priorities represent the four key functionalities of Smart Grid.

1. Demand Response and Consumer Efficiency (key functionality);
2. Wide-Area Situational Awareness (key functionality);
3. Energy Storage (key functionality);
4. Electric Transportation (key functionality);
5. Advanced Metering Infrastructure (key functionality);
6. Distribution Grid Management (key functionality);
7. Cyber Security (cross-cutting)
8. Network and inter-system communications (cross-cutting);

The National Institute of Standards and Technology (NIST) is using the FERC policy statement priorities to coordinate and prioritize the development of interoperability standards.

Q. What is a NIST interoperability standard?

A. Smart Grid, much like the internet, is a complex system of many loosely coupled systems that can work together as one when needed. This is called interoperability.[6] Complex systems require different layers of interoperability. To promote interoperability and

[6] Interoperability is described as exchanging meaningful information between two or more systems and achieving an agreed expectation for the response to the information exchange while maintaining reliability, accuracy and security. See GrideWise Architecture Council Interoperability whitepaper http://www.gridwiseac.org/pdfs/interoperability_path_whitepaper_v1_0.pdf

ensure the entire Smart Grid works together, a national organized effort was formalized under Title XIII, Section 1305 of the Energy Independence and Security Act (EISA) of 2007, in which NIST was granted "primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems." In response to Section 1305, between 2008 and the present, NIST formed Domain Working Groups, launched the Smart Grid Interoperability Panel (SGIP), which contains over 600 organization members, conducted large-scale workshops with over 1500 participants, analyzed and documented requirements and use cases, all of which is leading to formation of upcoming NIST standards. The effort produced an initial list of 75 proposed standards and 15 Priority Action Plans (that lead to standards), most of which are still in the review and modification stage. On October 6, 2010, NIST advised FERC that it had identified five foundational standards ready for regulatory review. Two of the standards define a common information model (CIM).[7] All five initial standards were developed by the International Electrotechnical Commission (IEC) and are low-level object models (tested, proven, and explicit guidelines or instruction sets) that will be the basis for efficient exchanges of information between applications within and across the seven domains, beginning primarily with generation, transmission and distribution. In other words, these initial NIST interoperability standards establish a common ground upon which future waves of standards and applications (meter upgrade, demand response, home area networks, etc) will be built.

Q. Would you briefly address NIST interoperability standards and cyber security?

[7] IEC 61970 Energy Management System Application Program Interfaces(EMS-API); IEC 61968 Application Integration at Electric Utilities;

A. All existing and new NIST interoperability standards must undergo thorough cyber security review. Smart Grid cyber security, noted earlier as cross cutting priority in the FERC 2009 Policy Statement, is centralized with the Smart Grid Interoperability Panel (SGIP) Cyber Security Working Group (CSWG).[8] CSWG has published its Guideline for Smart Grid Cyber Security,[9] which NIST issued on September 2, 2010. The Guideline includes nearly 200 high-level security requirements. The CSWG has reviewed the initial five standards released by NIST.

A full list of all NIST interoperability standards is published in NIST Special Publication 1108.[10]

The use of standards is a best practice in technology systems development. Standards avoid re-inventing the wheel, reduce integration costs, and prevent vendor lock-in. Standards allow and ensure that all the Smart Grid requirements identified by the NIST working groups are, in fact, used across all system wide development. Published standards will also enable a testing and certification process allowing or vendors to "prove", through a certification process, that their system or product will be compatible with the Smart Grid. As an example, standards will allow a homeowner to plug in a smart refrigerator that automatically accepts price signals and participates in demand response events; the refrigerator will be inter-operating with remote Smart Grid applications.

[8] http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/WorkingGroupInfo

[9] NIST IR 7628 http://csrc.nist.gov/publications/PubsNISTIRs.html#N

[10] NIST Special Publication 1108, NIST Framework and Roadmap for Smart Grid Interoperability Standards: Release 1.0

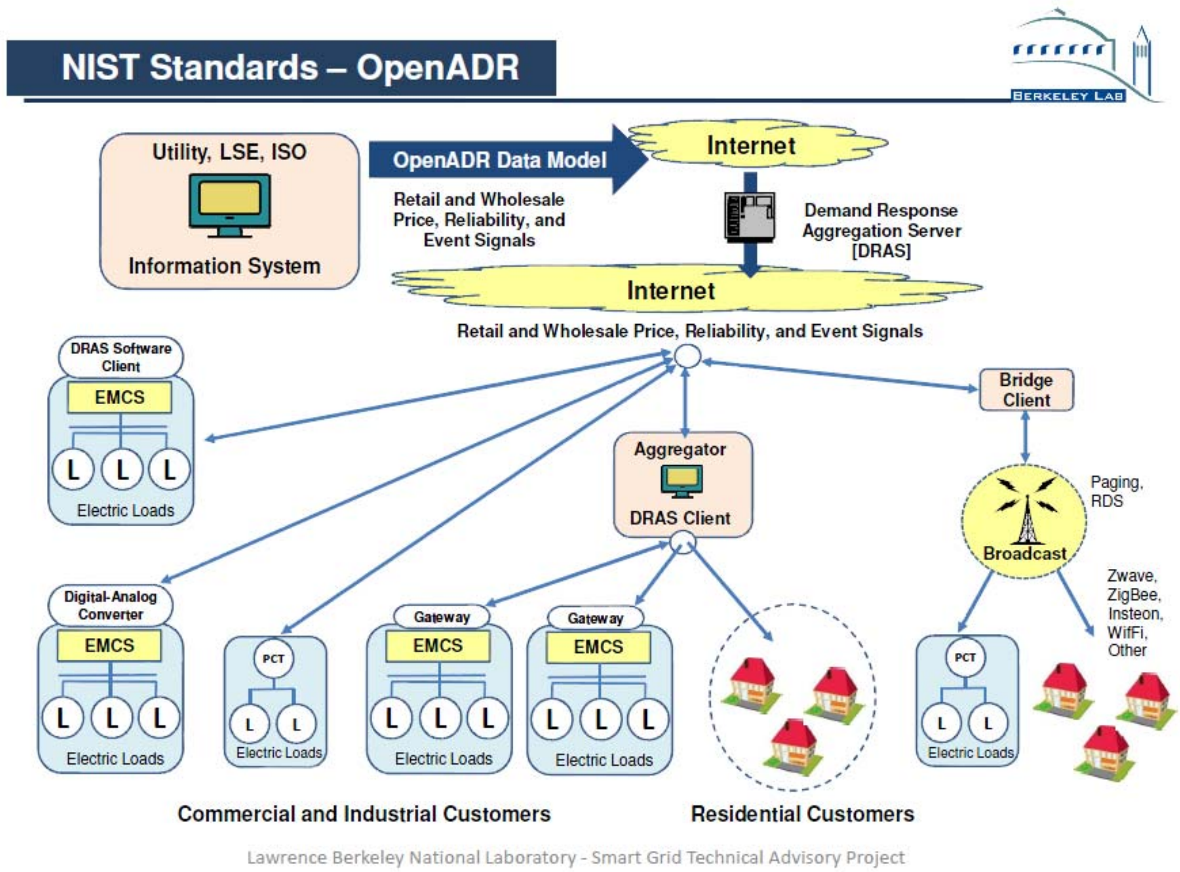
Use of NIST standards was a criterion for DOE Smart Grid Investment Grants and will be mandatory for utilities and vendors designing and building Smart Grid systems.

Q. Can you provide an example of a higher level NIST standard we may see in the future and its potential impact?

A. Yes. An example of a standard prioritized for early release (based on FERC's 2009 Policy Statement priorities) is "OpenADR" which addresses data, communication protocols and business requirements between a utility or an independent system operator (ISO) seeking a demand response resource and a customer who may or may not have the capability to interrupt at a particular moment in time. The goal of the standard is to automate demand response as much as possible until, essentially, it becomes a "set it and forget it" concept. The diversity of Smart Grid applications OpenADR must support includes multiple pricing designs such as Real Time Pricing (RTP) and Critical Peak Pricing (CPP), price response programs including day-ahead and day-of price response, ancillary services, and capacity bids. As the OpenADR standard matures, the demand response capabilities now enjoyed by only large commercial and industrial (C&I) customers using very sophisticated systems, will be achievable by smaller class customers, including residential.

Finally, standards are designed to work with, or not conflict with, other standards. For example, in the case of OpenADR case, data and instructions will flow seamlessly to devices on customer premises over a wide range of communication technologies and protocols.

The diagram below illustrates at a conceptually high level OpenADR architecture. .



In conclusion, NIST interoperability standards are a critical step in making the Smart Grid a highly interconnected environment across and within NIST domains. The NIST interoperability standards are mandatory and are expected to start being released late 2010.

Q. How is the Smart Grid being built and by whom?

A. Building the Smart Grid involves a series of projects, each with its own system development life cycle. The United States is in the early stages of Smart Grid deployment as investor owned utilities and municipal utilities design, buy or build Smart Grid applications and systems. Many utilities are conducting pilot programs and demonstration projects to test functionality and design prior to large-scale deployment, while some utilities have launched full-scale deployments with an emphasis on AMI and communications systems that will eventually support advanced pricing and demand response programs.

Often one Smart Grid project becomes a foundation for advanced projects – for example a communications system may support both AMI projects and distribution automation applications. Most Smart Grid projects today are foundational and will enable more advanced Smart Grid capabilities in the future.

Q. What do you believe are the key areas a utility should analyze and document when seeking regulatory approval to build and deploy a Smart Grid AMI project?

A. The key areas for analysis and documentation for purposes of regulatory approval should include the following:

- Smart Grid Vision;
- Deployment Baseline;
- Smart Grid Strategy;
- Grid security and Cyber Security strategy;
- Smart Grid Roadmap;
- Benefit-cost analysis; and
- Metrics.

Q. What are common misperceptions of a Smart Grid?

A. Smart Grid is not a simple line item on a capital expenditure budget that is purchased, installed and completed. Smart Grid is not a smart meter, a smart car, or a smart phone. These are things that plug into a Smart Grid. Smart Grid is the overall infrastructure built across the seven NIST domains listed above.

UES' SMART GRID PROGRAM

Q. Has Unitil defined a Smart Grid vision or roadmap?

A. In its August 28, 2008 report[11] entitled "Unitil AMI Project Next Phase Implementation Plan D.P.U. 07-71" Unitil defined its Smart Grid strategy specifically around the work of NETL's Modern Grid Strategy. Consistent with NETL's work, Unitil defines Smart Grid not by a list of specific technologies but instead by its capabilities – such as increased reliability and the enabling of demand response and distributed generation. According to Unitil's report, the Company views AMI as "but one element of a larger vision to achieve the functionality of the modern Smart Grid".

Q. What Smart Grid activity has Unitil undertaken?

A. Unitil has initiated activity in four areas –

1. Advanced Meter Infrastructure AMI (2008): Unitil completed a $6.3 million AMI NH deployment in 2008, including smart meters to all customers, utilizing Power Line Carrier (PLC) network, and integrating billing and meter data management systems. Over the same period, Unitil also deployed an identical AMI system in Massachusetts. Total

[11] Staff 3-96 Attachment 1

AMI costs for both New Hampshire and Massachusetts was $11.2 million. In New Hampshire, the AMI system generates solid returns through operational efficiencies; it is now being further integrated to other systems.

2. Smart Grid TOU Pilot (2011): Unitil is scheduled to run a Smart Grid Pilot in the summer of 2011 that will leverage the AMI system's capability to collect time-of-use (TOU) readings across four periods within a day. The pilot will include sample customers in both New Hampshire and Massachusetts. There will be three treatment groups, including a simple TOU rate, a TOU rate with enhanced in-home technology, and a utility-controlled smart thermostat program. In-home technology will include a web portal for access to usage information. The Massachusetts pilot includes a Distribution Automation (DA) proposal. More information on these programs can be found in NHPUC Docket No. De 09-137 and Massachusetts DPU Docket No. 09-31.

3. Outage Management System (OMS) - AMI Integration (2010-2011): Unitil, working with ABB, is currently in the process of designing a new OMS that will integrate with the existing AMI system, Supervisory Control and Data Acquisition (SCADA) system, ESRI Geographic Information System (GIS), Customer Information System (CIS) and Interactive Voice Response (IVR) system. Integration of the AMI system falls within the second phase of this project, which is now underway. AMI systems can be leveraged to determine outages down to the individual customer. This project represents Smart Grid's ability to leverage AMI for other operational uses in addition to Meter Data

Management (MDMS) and billing. The $2.3 million project is expected to be ready for testing in late 2010 or early 2011.

4. Distributed Energy Resources (DER) Docket No. 09-137. The company developed a program to implement N.H. RSA 374-G providing authorization for an electric distribution utility to invest in Distributed Energy Resources. Unitil filed a proposal for implementation in Docket No. DE 09-137, which the Commission approved, with modifications, on June 12, 2010. Pursuant to that order going forward, Unitil will be incorporating Distributed Energy Resources into its Least Cost Resource Planning process.

Q. **Did Unitil receive any government grants for Smart Grid investments?**

A. No, Unitil applied for but did not receive approval for ARRA funding of the OMS/AMI Integration project.

Q. Please summarize the 2008 AMI Deployment project.

A. Unitil deployed a Landis Gyr TS2 (formerly Hunt Technologies Turtle system) to its entire network of 74,639 meters in New Hampshire in 2008. The project included upgrade retrofitting of the majority of existing meters with TS2 meter endpoints, and replacement of a remaining small quantity of non-compliant meters. Communications equipment was installed and configured in substations. The TS2 system utilizes power line communications (PLC) technology. Meter data are transported from the meter over

PLC to substations and routed to existing private wide area networks, or WANs. Full two-way communications exist between the Unitil data center in Concord, New Hampshire to all meters. As part of the project, software was installed and integrated to run the system. Meter data are stored in a database and accessed and integrated to authorized systems including billing and meter data management and other systems.

Q. What benefits did the 2008 AMI Deployment project generate?

A. Financially and operationally, the AMI project appears successful. Unitil's filing of January 2007 estimated O&M savings compared to its original budget.[12] Based on the 2007 assessment, annual O&M savings were estimated at $1,741,103 (vs. an original estimate of $1,564,577). Headcount reduction was estimated at 21 (vs. an original estimate of 19.5). Total project cost including New Hampshire and Massachusetts was $11.2 million (vs. an original budget of $10.5 million). While management did not go back and re-evaluate financial return calculations, Unitil believes the AMI project returns are similar to original estimates - a net present value of $9.4 million, an internal rate of return of 20.7% and a simple payback of 4.5 years, based on the January 2007 analysis. Based on Data Response Staff 3-90, the benefits have been primarily operational and are associated with a reduced head count that resulted in reduced meter reading costs.

System Integration Benefit: Beyond the quantifiable financial benefits of AMI, Smart Grid creates value when systems work together, integrate and reuse common data such as usage and measurement data generated from the AMI system. It is not uncommon to read

[12] 10-055 Staff 3-90 Attachment 1 and Attachment 2

of utilities projecting massive IT systems integration expenditures as part of deploying advanced Smart Grid programs. For example, Gridwise Alliance's list of Smart Grid project types includes integration categories. But the benefits are significant if they make operations more efficient, more reliable, and more automated. Unitil's AMI system rollout in 2008 enables planning, research and work to begin integrating AMI data more effectively into core systems including MDMS, OMS, billing, CIS, etc. It also supports them for more advanced Smart Grid capabilities in the future..

Q. How does Unitil's existing TS2 PLC-based AMI system fit into their Smart Grid strategy and what are the risks of obsolescence?

A. For the immediate future, Unitil's TS2 AMI system should remain a used and useful asset in its present version , including normal upgrades and on-going integration projects with OMS, and should continue contributing operational efficiencies mentioned earlier. It is difficult to estimate exactly how many additional years the AMI system can meet Unitil's needs before investments are required for a major upgrade or replacement. According to Unitil's filing the "next phase of AMI project" is expected to take place in a three to five year period,[13] which would fall into the 2011-2013 period. However, this time frame could get pushed further out during the lengthy NIST standards approval process, including cyber security reviews, and while regulatory policies evolve.

The long-term future role of the TS2 AMI system, as implemented, will need to change. Change could mean upgrading existing vendor platforms or conversion to new ones. In a

[13] Docket No. DE 10-055 - Staff 3-96 Attachment 1, p. 4

data response to Staff, Unitil identified a new business and technical requirement for AMI systems that its current system does not provide. As Unitil stated, "Future evolutions of the AMI system are expected to include hourly meter intervals, bringing metered consumption closer to real time."[14] And according to NETL, distribution utilities such as Unitil will need an AMI capable of supporting dynamic time-of-use pricing, demand response, distributed generation, intra and inter domain interoperability (for example, integrating the customer to energy markets) , as well as compliance with NIST interoperability standards, cyber security requirements and state regulatory requirements on AMI systems.

Risk of obsolescence for legacy AMI systems[15] results from both underperformance (speed, functionality, etc.) and from standards non-compliance. Unitil's potential for financial loss due to AMI obsolescence is minimized by the combination of relatively low AMI project cost, on-going annual cash savings incurred since 2008 and expected to continue in the near term, potentially paying for the system prior to sunset, use of the system in coming years including the 2011 pilot, and use as a stepping stone towards a next generation AMI system. Based on these assumptions, Unitil views the technology obsolescence risk as significantly mitigated and the AMI system as a good fit in its Smart Grid strategy.

[14] Docket No. DE 10-055 - Staff 3-96 Attachment 1, p. 8

[15] For this section the author defines legacy AMI systems as system designs that pre-date the extensive requirements and standards analysis performed by NIST and SGIP collaborative subsequent to Title XIII Section 1305 EISA 2007.

Q. What is your overall assessment of Until's TS2 AMI project?

A. Based on my review, Unitil is executing a conservative, low risk, cost effective, successful Smart Grid strategy. Based on its 2008 deployment (selection process started in 2005), Unitil is an early adopter of Smart Grid technologies. Their vendor/platform selection process and subsequent implementation resulted in a low cost full-scale deployment of smart meters to all customers. Two design features of TS2 system contributed to the low cost rollout. First, the use of PLC for meter communications saved time and avoided a costly build-out of a new communication infrastructure. Second, the TS2 platform design allowed existing meters to be upgraded inexpensively with endpoints (cost of $15-$50 per meter), thus avoiding stranded meter assets.

The TS2 system is not a state-of-the-art AMI platform, however, its functionality is providing the operational savings expected. The current integration efforts adding AMI data into the new OMS system is also a benefit. The company is maximizing value from a relatively lower cost, lower featured system and will look to generate continued operational savings in coming years prior to upgrading to a NIST-compliant AMI system. As savings continue to be realized, the system should be fully paid for in 2012, based on management's original estimate of a 4 ½ year simple payback, as discussed in this testimony. Subject to ongoing vendor upgrades and enhancements, the AMI system could potentially continue to meet Unitil's operational needs for additional years until a next generation NIST-compliant AMI platform is implemented.

Q. Does that conclude your testimony?

A. Yes, it does.