BEFORE THE STATE OF NEW HAMPSHIRE

PUBLIC UTILITIES COMMISSION

In the matter of:)
DE 13-177)
Public Service Company of New Hampshire)
2013 Least Integrated Resource Plan)

Direct Prefiled Testimony

Of

Jim Brennan
Finance Director

On behalf of
The New Hampshire Office of the Consumer Advocate

Dated: **February 21, 2014**

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

A. My name is Jim Brennan. I am the Finance Director at the New Hampshire Office of the Consumer Advocate (OCA). 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.

In my present position at the OCA I perform economic and financial analysis of utility filings across all industries, participate in dockets, draft discovery and testimony, and provide guidance on financial policy and regulatory issues.

I have experience in Smart Grid as an analyst for the NHPUC, 2009-2011, where I reviewed utility investments aimed at modernizing the electric grid, including automated metering infrastructure, demand response, cyber security, distributed generation and storage. During that assignment I was involved in the National Institute of Standards and Technology (NIST) Cyber Security Working Group (CSWG) participating in the Architecture, Standards and Advanced Metering Infrastructure (defined on page 7 of testimony) Security subgroups.

My business career began in banking as First Vice President at Chemical Bank,1980-1989, with responsibilities as analyst, credit department manager, and course designer and instructor of risk assessment training. I have experience managing business and technology operations. At TD Waterhouse Securities, 1995-2001, I ran the third largest brokerage statement operation on Wall Street during a period of 400% growth with responsibilities for budget, operations, Information Technology (IT) data processing and New York Stock Exchange compliance (Waterhouse's statement was awarded #1 ranking by Smart Money during this assignment). I have experience in IT project management and software design. Experience includes: implementation of paperless technology in Waterhouse Security National Investor Clearing Corporation clearing operation 2000; managing launch of an eServices web site providing on-line secure access of brokerage statements to 2.5 million Waterhouse clients (2001); designing Microsoft.NET and SQL Server based software systems for Mathematica Policy Research 2003-2006; directing design testing and launch of cloud based Microsoft Customer Relationship Management (CRM) applications for Southern New Hampshire University 2012-2013. As an Adjunct Instructor I have taught courses in Corporate Finance, Microsoft applications and the .NET C# programming language.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to recommend modifications to PSNH's distribution planning process to include analysis of current technology known as Smart Grid.

Q. Summary and recommendation.

A. Following years of work by federal and state regulators, stakeholders (including NIST[1], Smart Grid Interoperability Panel's (SGIP) twenty one stakeholder groups[2], Electric Power Research Institute (EPRI)[3], coupled with early adopter utilities), Smart Grid is redefining the planning process and architecture of the electric distribution system. Over the past 5 years distribution utilities have planned, piloted, and incrementally deployed Smart Infrastructure that will enable Smart Grid Applications with potential positive benefits to customers.

PSNH's distribution planning process should evolve to include Smart Grid in its strategic plan. Please see attached Exhibit 1 flow chart of the existing distribution planning process provided by PSNH at 1/27/2014 technical session.

Currently new capital projects and long term distribution assets deployed by PSNH undergo formal steps that analyze, approve and are implemented

[1] http://www.nist.gov/
[2] http://www.sgip.org/stakeholder-categories/#sthash.SAr5KMLu.dpbs
[3] http://www.epri.com/Pages/Default.aspx

according to the distribution planning process discussed in this docket. However in the event of a future PSNH Smart Grid Infrastructure deployment some legacy devices and legacy systems that were designed to meet current architecture needs will also need to integrate into a new architecture with potential new requirements. At a minimum PSNH's distribution planning process should be aware of and able to identify decision points where investment decisions made today may also affect future Smart Grid Infrastructure projects. Including Smart Grid in the context of long term planning is efficient and prudent. Assets deployed today that cannot efficiently meet future integration and interoperability requirements may become less useful in the event of a Smart Grid deployment.

OCA Recommendations:

1) Include a Smart Grid Infrastructure plan as part of PSNH's distribution planning process. Map high level gaps that exist between existing distribution system and Smart Grid distribution architectures.

2) Move customer meters into PSNH's distribution planning process.

3) Include communications system architecture and related IT functions (for example data storage) into PSNH's distribution planning process.

Q. Please define the term Smart Grid as it is used in your testimony.

A. Smart Grid is the introduction and integration with today's power grid of three core technologies: software, communications, and sensors. For this testimony I use the definition from EPRI which is as follows: "Smart Grid is a high level concept that infuses information and communications technologies with the electricity grid to increase performance and provide new capabilities. The Smart Grid vision includes the idea that the utility's meters, sensors, control devices, and software applications will be able to exchange information, and do this with sufficient timing and data volume to enable a wide range of applications."[4]

Q. Please describe Smart Grid's 10 year history in the U.S.

A. Over the past 10 years Smart Grid has been envisioned and deployed in many contexts throughout the US. Smart Grid has been analyzed for cost and benefit, litigated in Public Utility Commission dockets, test piloted and recently deployed to varying levels in portions of New England and New Hampshire. A brief history follows:

2003 "Early Visionary Efforts" - EPRI partnered with The Consortium for Electrical Infrastructure to Support a Digital Society (CEIDS) in a 2003 paper "The Power Delivery System of the Future", by Clark W. Gellings.[5] Page 15 of this research (provided as Exhibit 2 "CEIDS Descriptive Framework") provides a descriptive framework that includes Integrated Energy and Communications System Architecture that enables increases of "efficiency and value of electricity using enabled digital devices."

2004 "Start of Major Collaboration Efforts" Important collaborative efforts begin including formations of GridWise Alliance.[6] GridWise is a group of utilities, academia, technology firms and investors dedicated to promoting Smart Grid. The

[4] http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002002137
[5] http://www.intelligrid.info/IntelliGrid_Architecture/Marketing_IntelliGrid/System_of_the_Future.pdf
[6] http://www.gridwise.org/

Alliance states “The underlying premise of the Smart Grid is that it not only delivers power, but information.”

2007 “Federal Legislation" Title XIII of the Energy Independence and Security Act of 2007 (EISA) is enacted. The Smart Grid section launched many activities including the mandate directing NIST to set up a Smart Grid interoperability Framework.[7]

2009 "Begin Large Scale Federally Funded Smart Grid Investments" The American Restructuring and Reinvestment Act (ARRA) was enacted and provided $4 billion in federal funds to finance Smart Grid investments and demonstration projects. These projects are at or near completion today. The status of projects may be tracked on Smartgrid.gov.[8]

2009 "Emergence of Project Planning Maturity Model for Smart Grid" IBM collaborated with Carnegie Mellon University to quantify methods for project planning and measurements of Smart Grid projects. Today the Smart Grid Maturity Model is referenced and maintained by CarnegieMellon Software Engineering Institute.[9]

2009 - "Federal Priorities Established for Smart Grid" Federal Energy Regulatory Commission (FERC) issues Smart Grid Policy Statement defining eight Priority Areas listed below:

- Demand response and consumer energy efficiency
- Wide-area situational awareness
- Energy storage
- Electric transportation
- Network communications
- Advanced Metering Infrastructure (AMI
- Distribution grid management
- Cybersecurity

[7] http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/WebHome Smart Grid Collaboration Wiki for Smart Grid Interoperability Standards
[8] https://www.smartgrid.gov/recovery_act/project_information
[9] http://www.sei.cmu.edu/library/assets/brochures/SGMM-1010.pdf “Smart Grid Maturity Model ”

2009 "Bumps Along the Road" California utility PGE hits technical and public relations issues and challenges associated with its ARRA multi-billion dollar AMI deployment. Utilities can learn from the experiences of early adopters.

2010 "Smart Grid Standards Developed / Priority Gaps Identified" The SGIP facilitates standards development and priority actions such as Meter Upgradability standards[10]. SGIP is composed of 22 different stakeholder groups including utilities, government, consumers and industry.[11]

2010, "State regulatory focus on Smart Grid" The National Association of Regulatory Utility Commissioners (NARUC) formed a Smart Grid Working Group comprised of seven state commissioners with the intent to bring focus to many Smart Grid Issues between stakeholders including industry, regulators, and consumers.

2010 "Smart Grid Planning Model from Early Adopters" California Public Utility Commission (CPUC) approved a common model for designing a Smart Grid Roadmap, providing guidance to future utilities and regulators planning smart grid investments.

2012 "Refinements of Smart Grid Architecture Road Maps Published" NIST undertakes its EISA Title VIII mandate to coordinate development of Smart Grid framework using protocols, models, and standards of information management required to achieve interoperability of smart grid devices and systems. NIST releases version 2.015 "Special Publication 1108R2 NIST Framework and Roadmap for Smart Grid Interoperability Standards" (NISTIR v2). This publication presents the US electric grid as 7 interconnected domains linked by Smart Grid infrastructure. Please refer to Exhibit 3, "NIST 8 Domains".

2013 "Emergence of Smart Grid Planning Post ARRA Funding" - Massachusetts DPU Order 12-76-A 12 initiates a state-wide Smart Grid planning effort. Independently Owned Utilities (IOU) are mandated to submit a 10 grid modernization plan by June 2014. Planning will cover a range of technologies and use cases (requirements) including meter infrastructure, Outage Management Systems (OMS), appliance communication & control, power quality, conservation & voltage reduction and time varying rates. Other long term objectives are outage

[10] http://www.nist.gov/smartgrid/priority-actions.cfm
[11] http://www.sgip.org/stakeholder-categories/#sthash.SAr5KMLu.dpbs
[12] http://www.mass.gov/eea/docs/dpu/electric/12-76-a-order.pdf

reduction, demand optimization, integration of distributed resources and improved asset management.

2014 "Positive Results Reported on Completed ARRA AMI Project" Central Maine Power (CMP) release positive results[13] on completion of their ARRA funded Smart Grid Infrastructure project which included communication network and smart meters. The completed Smart Grid infrastructure enables CMP to consider two potential cost-effective Smart Grid applications - distribution automation and time based rates.

Q. What is the role of the distribution utility in context of Smart Grid?

A. Distribution utilities will build much of Smart Infrastructure needed to support Smart Grid Applications. Smart Grid organizes the power system into 7 domains. A NIST domain is a logical grouping. Each NIST domain and sub-domain encompass Smart Grid actors and applications. These include devices, systems, programs, and stakeholders that make decisions, exchange information and perform tasks. Below is Diagram 1 "Distribution domain" from NISTIR v2. This diagram shows the integration of the distribution system with four other domains including Operations domain, Markets domain, Transmission domain, and customer domain.

[13] https://www.smartgrid.gov/sites/default/files/doc/files/Central%20Maine%20Power%20Case%20Study_0.pdf

Diagram 1 – Distribution Domain

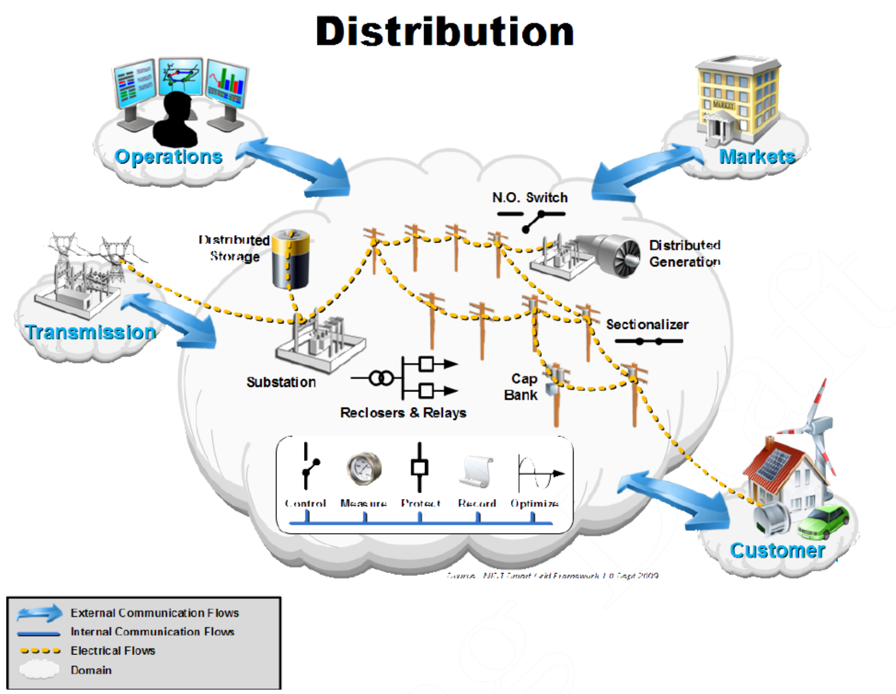

Figure 10-8. Overview of the Distribution Domain

Q. What is the difference between Smart Grid Infrastructure built by the utility and Smart Grid Applications?

A. Smart Grid Infrastructure enables Smart Grid Applications to exist. Conversely Smart Grid Applications are highly dependent on existence of Smart Grid Infrastructure. Distribution Domain Diagram 1 is an illustration of Smart Grid Infrastructure. Smart Grid Infrastructure is the complex collections of (regulated) assets including communications networks (data com lines, routers, firewall, network operating systems, etc.) and the increasing quantities of network connected smart digital devices (meters, sensors, etc.). Smart Grid Applications are built by the utility or 3rd parties and are implied domain diagrams. They include well know systems such as Time of Use rates (TOU), Voltage management, Demand Response (DR), Electric Vehicle (EV) programs, etc. Smart Grid Applications run on top of the infrastructure similar to the internet. Therefore it is important that infrastructure is planned and designed with a long term view including application requirements. An argument can be made that Smart Grid is the Smart Grid Infrastructure (not the applications), which the utility plans and builds.

Q. What is AMR?

A. Automated Meter Reading (AMR) technology has been deployed to residential meters since the 1980's. It is a laborsaving solution that replaces the meter reader. AMR technology evolved over time with new capabilities and became a forerunner to Smart Grid technology called AMI. Scenarios exist where AMR is replaced or is upgraded to AMI based on project need. In docket DE 13-215 PSNH indicates it is upgrading residential meters to AMR. PSNH anticipates the upgrade to extend into 2017 based on information provided at the 1/27/2014 technical session.

Q. What is AMI, and is it an application or infrastructure?

A. Advanced Meter Infrastructure (AMI) refers to portions of a Smart Grid Infrastructure that may include smart meter (digital end device) communication network (ex. Wire-less, 2X, back haul); Meter Data Management System (MDMS) and back office capability for handling very large volumes of interval data collected by meter for use in billing systems. AMI enables and supports Smart Grid Applications such as TOU rate applications, outage management enhancements (real-time awareness of individual outages), and remote turn on/off applications. I mentioned earlier that infrastructure enables application. For example Central Maine Power recently completed construction of an ARRA Smart Grid Investment Grant funded AMI system. In January 2014 CMP announced plans to leverage its AMI with cost-effective TOU application and Distribution Automation project using capabilities of AMI[14].

Q. What guidance is available to utilities to plan Smart Grid infrastructures?

A. In addition to many other resources SGIP and NIST have published reference architecture[15] and educational material useful for planning Smart Grid Infrastructure and applications.

[14] https://www.smartgrid.gov/sites/default/files/doc/files/Central%20Maine%20Power%20Case%20Study_0.pdf
[15] http://www.nist.gov/smartgrid/upload/NIST_Framework_Release_2-0_corr.pdf

Q. Please give an example where Smart Grid Infrastructure differs from traditional distribution infrastructure.

A. The Conceptual Network Diagram 2 below is taken from NISTIR Figure 3-2. It presents the Distribution Domain in bottom center, the Customer Domain in bottom right and a Distributed Energy Resources (DER) sub-domain joining the distribution and customer domains. Using this diagram I will point out three differences between Smart Grid Infrastructure and a more traditional utility infrastructure; First – robust communication networks overlay the entire power grid forming what is often referred to as "internet of energy". The network allows data and messages from components to flow within and across domains as shown by dotted and solid lines; Second - the meter will become a cross domain device interacting with other domains; Third - the diagram reflects emergence of DER such as Distributed Generation (DG) in the distribution domain and customer domain (primarily rooftop solar).

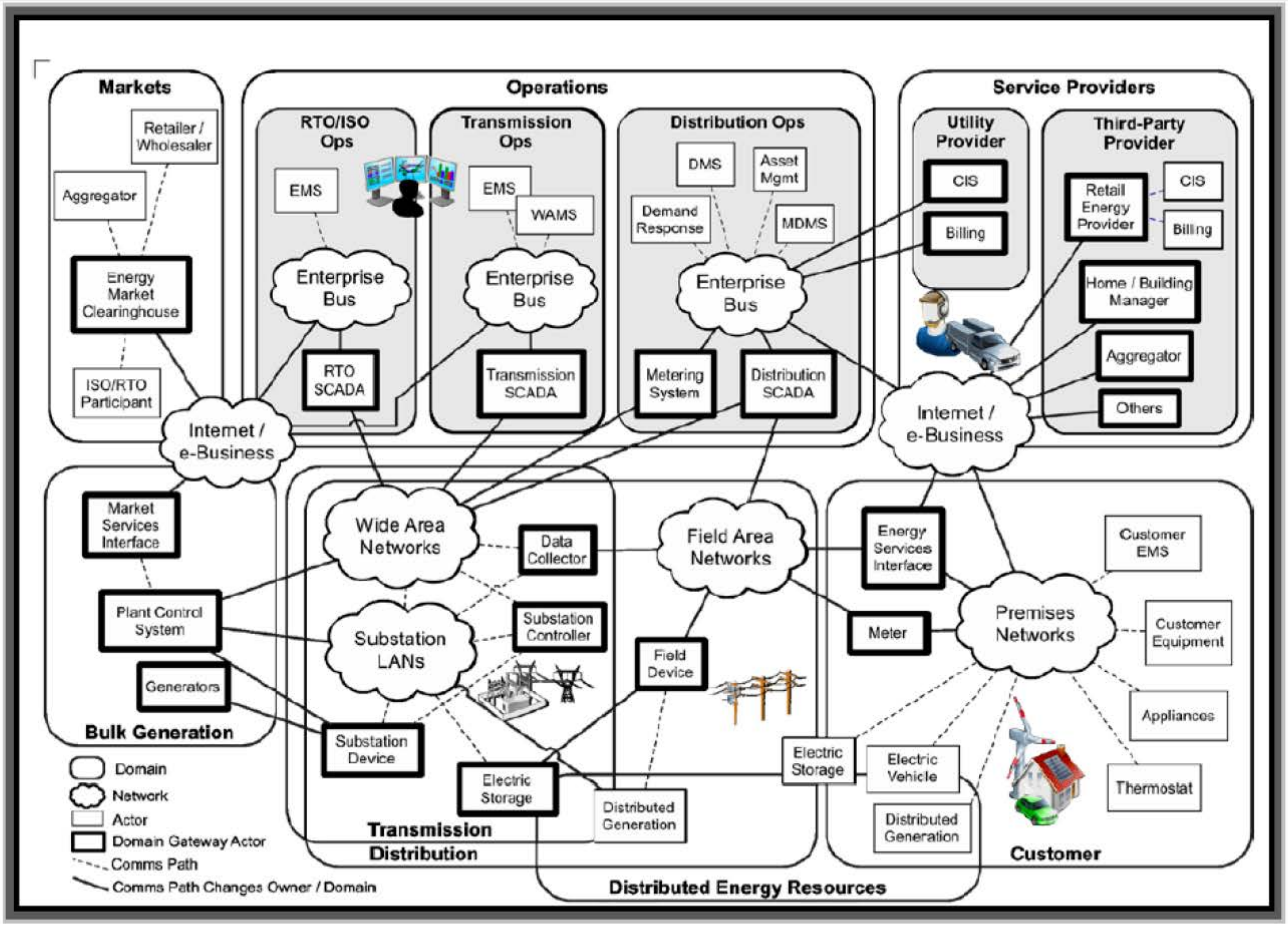

Figure 3-2. Conceptual Reference Diagram for Smart Grid Information Networks

Q. Does PSNH's existing distribution planning process include long term strategic planning of meters and communication networks?

A. No. Meters are not included in the existing distribution planning process. Meter decisions are made elsewhere. Network architecture is handled by an affiliated entity and is not included in PSNH's distribution plan[16].

Q. Do you have a final comment relative to Smart Grid in the strategic planning process?

A. Smart Grid is complex and can bring transformative change. Major challenges exist as disruptive technologies are injected into the existing live power grid. Years of planning are required prior to designing and deploying Smart Grid Infrastructures which will occur incrementally over time. Strategic planning can benefit from two areas: first- documents, analysis and guidance from government and industry collaborative groups as described in this testimony; second – current research, results and lessons learned from the first wave (early adopters) of Smart Grid projects nearing completion across the US including New Hampshire, Vermont and Maine.

Q. Does this conclude your testimony?

A. Yes

[16] A project list from the planning process was not available, answers are based on diagram and verbal responses from Russel Johnson during 1/27/2014 technical session.