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COMPANY NAME: PORTLAND GENERAL ELECTRIC

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☐ OAR
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☒ Order 11-172
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Key words: PGE Smart Grid Report

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Portland General Electric Company
121 SW Salmon Street • Portland, Oregon 97204
PortlandGeneral.com

September 22, 2011

via Email and US Mail

Oregon Public Utility Commission
550 Capitol Street, NE Suite 215
Salem OR 97308-2148

RE: **UM 1460 - Portland General Electric's Smart Grid Report**

Attn: Commission Filing Center

Pursuant to OPUC Order No. 11-172, enclosed please find an original and two copies of PGE's Smart Grid Report, including PGE's Inventory and the Smart Grid Maturity Model.

On May 25, 2011, the Commission issued Order No. 11-172 for Docket UM 1460, which discusses Utility Smart Grid (SG) Planning. This order directed utilities to file a report on the status of their current and planned smart grid investments, projects and activities, and were provided additional detail on what should be addressed in that report.

If you have any questions or require further information, please call Patrick Hager at (503) 464-7580. Please direct all formal correspondence and requests to the following email address: pge.opuc.filings@pgn.com.

Sincerely,

Randall J. Dahlgren
Director, Regulatory Policy & Affairs

RJD:jlt

Encls.

PORTLAND GENERAL ELECTRIC

UM 1460

SMART GRID REPORT

September 22, 2011

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Executive Summary

Portland General Electric has been working to deliver smart grid solutions to our customers for many years. We began more than 20 years ago with substation automation. Our efforts continue with the recently conducted and successful smart meter installation and our participation in the Salem Smart Grid Project. In addition, PGE launched a significant commercial demand response program in July 2011; we have installed several solar generation sites across our service territory; we have a nationally recognized "virtual power plant" using dispatchable standby generation; and our leadership in rolling out electric vehicle infrastructure provides PGE significant future smart grid opportunities.

Our smart grid efforts are guided by our strategic direction and support our mission to power our customers' potential as the region's trusted energy partner. These smart grid activities support overall objectives to keep electricity reliable, safe and affordable while delivering innovative solutions for our customers. We work to keep it simple and sustainable – making it easy for customers to do business with PGE by simplifying energy solutions and providing power in a sustainable manner.

PGE strives to keep customers at the forefront of smart grid investment planning, ensuring these emerging technologies provide direct and indirect benefits. For example, improvements to our transmission and distribution infrastructure improve reliability, which customers realize through fewer and shorter outages. With the implementation of smart meters, PGE is also beginning to deliver customers expanded pricing options, preferred due dates and energy-monitoring tools such as Energy Tracker, Energy Partner, and Flex Price, which help customers further understand and potentially reduce their usage.

As we move forward with our smart grid planning, PGE will focus on making cost-effective investments that support our generation, transmission and distribution systems, increase reliability, improve system asset utilization and integrate renewables. These efforts and investments will bring a broader set of benefits to our customers. There are abundant opportunities and significant work is underway, but we are still in the early stages of development. The new and emerging smart grid technologies that are not supported by current PGE financial budgets will need funding support from customers.

PGE's management team is committed to the development of smart grid technologies that provide innovative solutions to our customers and improve system performance. In the attached report, we detail our approach to and plan for integrating these emerging technologies into our business practices.

Introduction

PGE's Smart Grid History

Portland General Electric has been working to deliver smart grid solutions to our customers for many years. Projects include ongoing investments in generation, transmission and distribution as well as a successful smart meter installation to over 800,000 customers, which required more than a decade of development between the initial vision and the cost-effective implementation. Another example of a longstanding smart grid initiative within PGE is the automation of our substations, which has been a priority for more than two decades. Below are some examples of other smart grid efforts and accomplishments:

- PGE has one of the most advanced distributed energy resources programs in the US with more than 50 MW of distribution-based solar and back-up diesel generation under the control of System Operations to support peak load requirements.
- PGE has an ongoing program, about 70% complete, to upgrade all substations with SCADA-level telemetry, which improves system reliability.
- After two years of planning, PGE is about to launch a five-year effort to modernize its asset management, mobile workforce, work management, outage management, and geo-spatial information systems to enable advanced distribution automation applications.
- In the Salem test-bed area, PGE has an advanced portfolio of Smart Grid projects under development and in operation.
- With the completion of the smart meter installations, PGE is now poised to deliver customers real value and benefits such as expanded pricing options, preferred due dates and energy monitoring tools.
- PGE and its partners are participating in the largest EV project in US history. PGE is leading the advancement of the EV market in Oregon and establishing the foundation for greater sustainability by bringing electricity and transportation together.

Customer Focus

PGE works to ensure current and planned investments provide benefits to customers, both directly and indirectly. Customer benefits and value are at the forefront of smart grid investment planning; we will continue to listen to our customers through outreach, education and research activities, valuing their feedback.

Our customers have indicated their support for PGE's smart grid investments in several recent surveys. The PGE Parallel E2 (Energy + Environment) Research Program (July 2011) found that after PGE customers read a definition of smart grid, the majority of them are supportive of smart grid technologies: 88% of PGE customers feel smart grid and smart meters are a priority and 83% of customers think that PGE should begin implementing smart grid technologies immediately. In evaluating smart grid applications, PGE customers expect projects to realize one or more key benefits, such as improving energy savings through providing real-time energy usage information and control and/or addressing our use of environmental resources. When asked (in the same survey) about the use of smart meters, PGE customers responded they want meters to enable benefits such as reduced usage, reduced electricity bills, increased information on energy use patterns, and reduced carbon footprint. Based on this customer feedback, when assessing the value and priority of current and future smart grid projects, PGE reviews how the project will address customers' needs and which customer benefits the project will provide.

There is significant work underway related to smart grid, but managing expectations is important given the early stages of smart grid development. There are abundant opportunities, but the smart grid cannot be turned on with the flip of a switch. Many of our smart grid projects are at the pilot or demonstration stage. This allows us to gather information, provide learning to inform future policy decisions and to help determine which products or services are best suited for our system and our customer base. Educating customers on new options for pricing and control of their electric use is a significant task. PGE believes that customer smart grid education is most effective when paced with the availability of our products and services. We discuss this ongoing customer education in the Project Highlights section.

Smart Grid Definition

In Order 11-172, the Commission defined smart grid investments as "utility investments in technology with two-way communication capability... technologies include sensors and remote control switches at the distribution system level, synchrophasors and flexible AC transmission system devices at the transmission level, and information displays and appliance control circuits at the consumer level."

Rather than the implementation of specific technologies, PGE views smart grid as the implementation of numerous projects that change the way we have operated for decades. Benefits of smart grid implementation are achieved when we change business processes and provide customers with more options to control their electricity use. With this approach, the choice of which technology to implement is an outcome of achieving benefits, not an objective by itself.

The Commission's definition also cited smart grid investments "will (1) improve the control and operation of the utility's transmission or distribution system, and (2) provide consumers information about their electricity use and its cost and enable them to respond to price signals from the utility either by using programmable appliances or by manually managing their energy use." PGE agrees with the Commission that smart grid investments should improve the control and operation of our system and provide customers information regarding their energy usage and the costs associated with their usage, enabling them to respond to that information.

In addition to the Commission identified benefits, PGE believes that smart grid investments should include a broader set of benefits. The benefits of smart grid are very similar to the benefits we expect from other company investments. These benefits include, but are not limited to, the following:

- Reduced cost of operations
- Increased system reliability
- Improved system asset utilization
- Reduced cost of integrating renewables
- Informed and directed use of electricity

All of these directly or indirectly benefit customers by providing new tools for customers, more reliable electricity service and detailed intelligence about their energy usage.

PGE's Smart Grid Organization and Responsibility

PGE's strategic direction is to power our customers' potential as the region's trusted energy partner. Our officers, led by Bill Nicholson, the Senior Vice President of Customer Service, Transmission, and Distribution, use this strategic direction to guide smart grid efforts. Operational excellence lies at the core of PGE's business, and smart grid is no exception. PGE continues to watch market signposts, listen to our customers, and remain in the forefront of emerging technology as we evaluate and implement these new technologies.

Due to their complexity, smart grid initiatives typically involve several different departments. This cross-functional nature requires more coordination and communication, since a single project can affect nearly all areas of the organization. To address the need for interdepartmental communication and coordination, PGE formulated the Smart Grid Steering Committee, which includes senior managers and vice presidents from across the company. The committee is a focal point for smart grid strategy, long-term planning, organization, communication, facilitation, and evaluation. The roles and responsibilities of the Smart Grid Steering Committee include:

- Develop and recommend PGE's smart grid vision
- Facilitate and coordinate integration of smart grid priorities with other major PGE initiatives
- Recommend and approve prioritized action items for PGE's Smart Grid Plan
- Coordinate and promote awareness of best practice smart grid efforts by other utilities
- Support creation of cross functional smart grid business cases
- Approve annual report to show current capability/progress of smart grid plan
- Anticipate smart grid skill sets that should developed or acquired for PGE
- Assign resources to smart grid projects

PGE's Smart Grid Process

Smart grid investments usually involve new processes and technologies that have potential benefits but little internal or external experience to guide their development. Consequently, smart grid development follows a path that frequently requires substantially greater development than typical company investments. Smart grid projects, in general, follow the five-phase path outlined below:

Ideation => Research => Pilot => Demonstration => Production Implementation

The first two phases, ideation and research, are typically low cost and completed within existing operations and maintenance budgets. Next is a technology pilot, demonstration, or both. These two phases allow PGE to test new equipment or technologies, gauge customer interest and participation, quantify project benefits for customers and the company, and identify the costs of production. These stages also enable PGE to minimize the risks of unknowns when the project moves to a full implementation stage.

Technology pilots are particularly important for determining how new systems interact with PGE's existing infrastructure and for enabling PGE to address various issues, such as cyber security design, reliable communication paths, and installation procedures in a test environment. Demonstrations are usually customer-facing trials, involving 100-200 customer contacts, with an objective of determining customer acceptance and satisfaction levels. Demonstrations also test the economic benefits of a new system and identify the steps necessary to support the technology.

Technology pilots and demonstrations enable PGE to evaluate investments on a small scale and implement a better-developed product or larger scale system in the future. Although technology pilots and demonstrations are highly beneficial, they rely heavily on IT resources for programming, integrating, and securing new technologies. Since many other areas of the company depend on IT for these same functions, coordinating the timing of IT resources can be challenging.

The production implementation phase of smart grid is a full roll-out of the technology or system and incorporates lessons learned in earlier technology pilots or demonstrations. Although some projects go straight to the production stage, PGE has found that the smaller-scale pilots and demonstrations provide an opportunity for education, training, and evaluation.

Evaluating Smart Grid Projects

Evaluating projects at various stages of the project process ensures that funds are spent on projects that will bring the most economic value and customer benefit. Just like any corporate project, smart grid projects typically go through three stages of evaluation:

- **Company Direction**: Does the project support PGE's strategic direction of delivering value to our customers?
- **Economic Value**: Does the project provide enough value to secure funding in the corporate review process?
- **Achievement of Goals**: Did the project complete and achieve the original scope?

Projects meeting the company's long-term strategic direction will undergo a corporate review and project justification. This includes clear objectives, deliverables, financial analysis and budget, critical resources needed (such as IT), and the project management structure. Cross functional committees review submitted projects and will evaluate elements such as economic value, benefit to customers, risk of taking no action, and legal and regulatory compliance.

Once a project is approved and launched, ongoing evaluations track the project's progress. When the project concludes, a formal evaluation is conducted to assess the degree to which initial objectives are met. This report typically includes recommendations for whether or not project development or implementation should continue.

Smart Grid Project Highlights

PGE has been working on smart grid-related projects for many years. The Smart Grid Project Inventory (included as Attachment A) contains a comprehensive list of these projects. Below, we highlight several of these projects, including those completed, in progress, or planned.

Completed Projects

Energy Management System

PGE's Energy Management System provides supervisory control and data acquisition (SCADA) for PGE's System Control Center over our transmission and distribution system (primarily at the substations). Supervisory control gives the system operators the ability to initiate actions at remote locations. Data acquisition gives the system operators the ability to monitor the real-time condition of the electrical system through continuous updates of status indications and/or data streams for any device connected to the system. In addition, the Energy Management System can run various "advanced applications" that can aid or automate decision making for the system operators. We use the Automatic Generation Control application to help perform the functions of a NERC Balancing Authority.

Advanced Metering Infrastructure – Smart Meter Project

Smart meter deployment completed in 2010 and allowed for several business improvements that led to automated processes. Smart meters lay the foundation for customer offerings and benefits, so PGE will continue to leverage the technology that smart meters provide to introduce new products and services for customers.

Dispatchable Standby Generation

PGE went live with this smart grid application in 2001. The unique GenOnSys platform connects to large (>100kW) distributed resources using high speed secure Ethernet networks. The program started by developing engineering and safety standards for integrating back-up diesel generators with our grid. Ten years later, the program has 75 MW of diesel generators that help provide PGE with valuable generation reserves.

Real-Time Large Scale Solar Integration

PGE's entry into solar development began with a research pilot project - a 104kW array at the intersection of Interstate 5 and Interstate 205. PGE's later solar development effort included 10 warehouse building rooftops for a total capacity of 3.5 MWdc. PGE is now working on a ground-breaking 1.75 MWdc solar project on ODOT property at the I-5 Baldock Rest Area near Wilsonville. PGE is also exploring design and engineering methods that ameliorate the voltage fluctuations caused on the feeder as clouds pass over the solar collector.

Projects In Progress

Customer Education

As noted above in the Customer Focus section, research indicates that our customers want to learn more about the benefits smart grid can provide. To address this need, PGE is developing an overall Smart Grid Communication Plan to build an active dialogue with customers, employees and stakeholders about the evolution of the smart grid. As we implement pilots, demonstrations and projects, we plan to strategically leverage our communications channels and partnerships to educate customers on smart grid features and benefits.

PGE also has communication plans in place for specific initiatives and services that comprise smart grid in Oregon (e.g. Salem Smart Grid Project, Energy Partner, Energy Tracker, and Flex Price). The goal is to help customers, employees and other stakeholders understand how each project fits into the larger picture of smart grid and Oregon's Energy Future.

PGE will continue to modify its communication plans and develop new specific plans as new technologies arise and new projects are implemented.

Substation Automation

Substation Remote Terminal/Telemetry Unit systems, which provide telemetry, alarms and basic remote controls, have been in service at PGE substations beginning in the 1950's. Since then, PGE's substation monitoring system has evolved with changing technology and has gone through several architectures. With the introduction of communication enabled relays and meters, PGE installed the first generation of Substation Integration Systems at several of PGE's substations in the 1990's. This system integrated data from protection relays and meters of different manufactures and protocols and made it available to SCADA and Energy Management System. This system also offered personal computer based operator consoles (called Human Machine Interfaces) at each substation with one-line displays and real-time loading and device status. Human Machine Interfaces provided advanced alarm annunciation, control, and troubleshooting capabilities for substation operators.

More recently, PGE moved to industrial automation products for substation automation. Industrial-based substation automation systems provided inexpensive input-output modules and programmable logic processors. Programmable logic processors were installed on the substation network to support automatic functions such as Substation Transmission Source Transfer Schemes, capacitor bank controls and transformer Load Tap Changer controls. As Ethernet technology developed, many of the traditional industrial and SCADA protocols were also modified to work on Ethernet. PGE decided to make Distributed Network Protocol 3, a protocol developed for utilities and common among US electric utilities, the new standard. Distributed Network Protocol 3 is also well supported by electric utility original equipment manufacturers and is an open standard. PGE also decided to use Substation Gateways, a device that supports multiple protocols and physical layer connectivity, to enable logic processing capability and SCADA Remote Terminal/Telemetry Unit functionality as the center of Substation Automation.

PGE's Substation Automation System, especially the Substation Gateway device, currently serves the function of traditional Remote Terminal/Telemetry Units which provide real time operational information to PGE's System Control Center. This represents only 10-20% of the total data available in the substation automation systems. PGE's plans for the future include the next generation of substation automation protocols, such as the IEC61850 standard, which is currently being developed, and the integration of non-operational data available to enhance our operations and maintenance of the system. The main benefit of this effort is reduced outage time if outages occur. However, through real-time telemetry and automation, substation automation should prevent outages in the first place. A secondary benefit is improving the quality of delivered electricity, such as maintaining better voltage control and reducing line losses.

Energy Tracker

The initial funding for this project was included with the AMI/Smart Meter Project and includes two components: 1) a web portal application that allows customers to view and understand their energy use data and its impacts on their bills, and 2) an interval data store that supports the web portal application and will support additional applications in the future.

Energy Partner

This program was officially launched this past July and enrollment efforts are underway. Under this program, a turnkey contract was awarded to a vendor through an RFP process to acquire 5 MW of load reduction in 2011, increasing to 10 MW by 2012, 30 MW by 2013, and 50 MW by 2014. PGE will send secure signals to our vendor, who in turn will send automated, secure load reduction signals to our customers through a communication and control gateway at the customers' premises. This control gateway is tied to the customers' existing energy management systems; additional control actuators are installed by the vendor.

Salem Smart Grid Project: Battery Transactions

This project, which is part of the Pacific Northwest Smart Grid Demonstration Project, includes a large battery with storage of about 1,300 kWh tied to 5 MW of inverter equipment installed at our Oxford substation in Salem. The purpose of this project is to design and test a number of processes to support power operations. The tests will include: 1) using the battery to provide peak load following capability during daily system peaks, 2) positioning the battery to store wind-based renewable generation at night when insufficient load is available to absorb production, and 3) using the battery to mitigate frequency variation caused by real-time swings in wind and solar generation output. This project develops, implements, and tests the required engineering design in anticipation that battery/inverter prices will drop significantly in the next 5 years.

Salem Smart Grid Project: Micro Grid/Feeder Automation

This project will test running one feeder off the Oxford substation as an independent micro grid in the event of a major system outage. The new system will test our ability to isolate the Oxford feeder from the main grid and allow the battery/inverter system to pick up the feeder load. Within 2 minutes, nearly 5 MW of diesel generators under PGE's Dispatchable Standby Generation program will automatically start powering the feeder for as long as the fuel supply is maintained. Another significant learning opportunity for PGE in this part of the Salem Smart Grid Project is the use of automated switching to isolate the micro grid. The engineering experience gained in this project will enable PGE to build a business case to support the concept of "self-healing" feeders and high reliability power zones.

Salem Smart Grid Project: Demand Response & DRBizNet

This multi-utility project will create and test a new regional control technique called transactive hierarchical control. This is a real-time price signaling model that starts at a regional control center and allows for the price to be adjusted at every node of the grid so the control area operator can increase or decrease the prices depending on their real time situation and specific locations. The price signal then flows to the substation where capacity or operational constraints adjust the price again. In theory, the signal could pass to every utilization transformer and every end-use customer willing to participate. Each consumption node provides a forecast of willingness to increase or decrease load as a function of price and the cumulative signals are passed back up to the regional center. The process repeats every five minutes. PGE's most responsive assets to this test will be residential water heaters and our battery inverter system.

Three significant applications installed as part of this response test will serve PGE beyond the demonstration period. The first is a hardware and software security tool that allows extensive control and monitoring of third parties who provide resources or control signals that affect our power system operations. The second application is the leading back-office software DRBizNet. Used at PJM, CAISO, NV Energy and other utilities, DRBizNet was developed to support demand response transactions in a flexible, automated process at scale. This system becomes the system of record to support every aspect of customer enrollment and operations for any number of unique demand response programs. The third application is the development of a battery management system that will allow PGE to charge and discharge a 5 MW battery storage system to operate for PGE's system benefit and balance renewable resources.

Planned Projects

Enterprise Management Systems

These investments are driven primarily by the need to replace our 15-year-old enterprise systems, including Work Management System, Outage Management System, and Geo-spatial Information Services. PGE has focused on implementing best practices in automated work force management and tools and implementing its first distribution management system. All of these systems represent major investments involving at least one hundred company experts. This system builds on the availability of AMI information to determine the dynamic loading of every conductor in the distribution system. Initially, this enables timelier manual feeder switching to speed power restoration of non-faulted sections of feeder circuits based on the availability of actual substation and conductor capacity. If a business case is approved to justify the replacement of manual switches with automated switches, the distribution management system would be the "brains" to initiate semi-automated feeder switching (replacing switching by field crews) to create "self-healing" feeders. Among other features, this application identifies instances of cost-effective reconductoring and phase balancing.

Home Energy Management System

The purpose of this software is to send frequent and/or periodic price and control signals to smart appliances, either to the appliance directly or through a home energy management system. Pending the successful completion of a pilot in early 2012, the infrastructure and supporting demonstration program (to target 100-200 customers) is scheduled for implementation in late 2012. This project is timed to occur with the retail availability of smart appliances, particularly smart water heaters. The standards for smart appliances, at a minimum, ensure three things:

- Smart appliances will "hear" communication signals.
- The appliance interface allows customers to preset specific actions for various price signals.
- The appliance is engineered to implement some power and/or energy reducing action when the price is high, per the customer's settings.

Until market standards are established, the program design will supply (or rebate) the communication device required to link the customer's smart appliance with the internet (and in a subsequent project via AMI). In the home, we expect the initial smart appliances to be water heaters and thermostats, but we will not exclude other smart appliances that might be available.

The primary function of the home energy management system is to create a single platform to affect energy management of all appropriate devices in the home. These platforms will likely support multiple applications over time. By using a standards-based approach, this program ensures that any smart appliance PGE recommends will be interoperable with future control options.

PGE believes this is the most cost effective approach to demand side management. This approach also enables maximum flexibility for third party products and innovation and makes the customer responsible for the on-going operation and security of the system.

Smart Grid Inventory

To complete the inventory and identify smart grid investments and activities, we met with employees representing departments with smart grid initiatives. For purposes of the inventory, PGE defines a smart grid **investment** as a pilot, demonstration, or production-level project designed to test or implement new or improved smart grid technology in order to achieve one or more benefits, such as reduced costs or improved reliability. PGE defines smart grid **activity** as a small-scale effort that involves behind-the-scenes planning, research, and/or development, prior to a technology pilot, demonstration, or production stage, in order to support future smart grid investments or the company's smart grid position as a whole.

Each area expert described their smart grid projects as completed, in progress, or planned. PGE excluded simple upgrades to existing technologies from this list, focusing primarily on new technologies, actions, and large-scale upgrades. To ensure a systematic review of PGE's Smart Grid Process, PGE used the Smart Grid Maturity Model (included as Attachment B). The Smart Grid Maturity Model grew from the Capability Maturity Model, which was used to identify a process that allows an organization tackle the problem of process automation in a systematic way. Since 1993, the model has been improved and specifically adapted for the implementation of the Smart Grid. PGE used this model to gauge its level of Smart Grid sophistication, specifically in categories such as customer benefits, technology, environmental impacts, and value chain.

PGE's Smart Grid Inventory is included as Attachment A. The inventory is organized in the following order: 1) Operational Area, 2) Type of Project, 3) Status, 4) Estimated Timeframe, 5) Phase, and 6) Benefit.

PORTLAND GENERAL ELECTRIC

UM 1460

SMART GRID PROJECT INVENTORY

ATTACHMENT A

September 22, 2011

UM 1460 - PGE - Smart Grid Report
Smart Grid Project Inventory
Attachment A

Planning Activities	Type of Project*	Status	Estimated Timeframe	Phase	Benefit
Smart Grid Vision	Activity	In Progress	2011-2012	Research	Overall SG
Education/Training for Smart Grid	Activity	In Progress	2011-2012	Research	Overall SG
Smart Grid Roadmap	Activity	Planned	2011-2012	Research	Overall SG
Build Environmental Relationships	Activity	Planned	2011-2012	Research	Overall SG
Research & Develop Environmental Position	Activity	Planned	2011-2012	Research	Overall SG
Smart Grid Environmental Emissions	Activity	Planned	2011-2012	Research	Overall SG
Prep Workforce for Smart Grid	Activity	Planned	2013-2016	Research	Overall SG
Information Technology Aligned with Smart Grid Vision	Activity	Planned	2013-2016	Research	Overall SG
Investments Aligned with Strategy	Activity	Planned	2013-2016	Research	Overall SG
Business Intelligence Platform	Activity	Planned	2013-2016	Research	Cost Reduction
Back Office IT Investments	*Type of Project**	*Status*	*Estimated Timeframe*	*Phase*	*Benefit*
Salem Smart Grid Project: Demand Response Management	Investment	In Progress	2011-2012	Demonstration	Cost Reduction
Security Road Map	Investment	In Progress	2011-2012	Production	Overall SG
Sensus System Security Upgrade	Investment	In Progress	2011-2012	Production	Cost Reduction
Sensus Usability Software Upgrade	Investment	Planned	2013-2016	Production	Reliability
Customer Activities and Investments	*Type of Project**	*Status*	*Estimated Timeframe*	*Phase*	*Benefit*
Smart Meter Customer Research	Activity	Completed	2011-2012	Research	Usage Information
Smart Grid Communication Plan	Activity	In Progress	2011-2012	Research	Overall SG
Smart Grid Corp Comm Research	Activity	In Progress	2011-2012	Research	Overall SG
Program-Specific Communication	Activity	In Progress	2011-2012	Research	Customer Info
Distribution Standby Generation- GenOnSys	Investment	Completed	Pre-2011	Production	Cost Reduction
AMI/Smart Meters	Investment	Completed	Pre-2011	Production	Cost Reduction
Solar Energy Grid Integration Systems	Investment	In Progress	Pre-2011	Technology Pilot	Reliability + Renewable
Energy Partner Implementation	Investment	In Progress	Pre-2011	Production	Cost Reduction
Large Customer Solar	Investment	In Progress	Pre-2011	Production	Renewable Integration
Energy Tracker	Investment	In Progress	Pre-2011	Production	Usage Information
Security for Third Party Demand Response Transactions	Investment	In Progress	2011-2012	Technology Pilot	Overall SG
Fuel Cell Pilot	Investment	In Progress	2011-2012	Technology Pilot	Cost Reduction
Home Battery Backup	Investment	In Progress	2011-2012	Technology Pilot	Renewable Integration
Home Energy Management System Pilot	Investment	In Progress	2011-2012	Technology Pilot	Usage Information
Flex Price (Critical Peak Pricing)	Investment	In Progress	2011-2012	Demonstration	Cost Reduction
Salem Smart Grid Project: Residential Demand Response	Investment	In Progress	2011-2012	Demonstration	Cost Reduction
Home Energy Management Systems Load Control	Investment	Planned	2011-2012	Demonstration	Cost Reduction
Rate Comaprisons	Investment	Planned	2011-2012	Production	Customer Info
Energy Alerts	Investment	Planned	2011-2012	Production	Customer Info
Real Time Meter Data Feed	Investment	Planned	2013-2016	Technology Pilot	Usage Information
Distribution Activities and Investments	*Type of Project**	*Status*	*Estimated Timeframe*	*Phase*	*Benefit*
Solar Power Smoothing	Activity	Planned	2013-2016	Technology Pilot	Reliability
PDX Airport Lighting Project	Investment	Completed	Pre-2011	Production	Cost Reduction
Load Dispatch Emergency Management System	Investment	Completed	Pre-2011	Production	Reliability
Mobile/Temporary Substation Monitoring	Investment	Completed	Pre-2011	Production	Reliability
Tap Line Metering	Investment	In Progress	Pre-2011	Technology Pilot	Cost Reduction
Substation Automation	Investment	In Progress	Pre-2011	Production	Reliability
Substation SCADA	Investment	In Progress	Pre-2011	Production	Reliability
Strategic Fiber Communications	Investment	In Progress	Pre-2011	Production	Reliability +Cost Reductn
Fault Detector	Investment	In Progress	2011-2012	Technology Pilot	Reliability
Recloser Automation	Investment	In Progress	2011-2012	Technology Pilot	Reliability
Salem Smart Grid Project: Microgrid	Investment	In Progress	2011-2012	Technology Pilot	Reliability
Salem Smart Grid Project: Battery Storage	Investment	In Progress	2011-2012	Technology Pilot	Renewable Integration
IT Integrated Roadmap	Investment	In Progress	2011-2012	Demonstration	Overall SG
Inter-Agency Emergency Coordination	Investment	In Progress	2011-2012	Demonstration	Reliability
Distribution Automation	Investment	In Progress	2011-2012	Demonstration	Reliability +Cost Reductn
AMI Bandwidth Expansion	Investment	In Progress	2011-2012	Production	Reliability
Asset Management Software	Investment	Planned	2011-2012	Production	Cost Reduction
Work Management Software	Investment	Planned	2011-2012	Production	Cost Reduction
Multi Ping Enhancement	Investment	Planned	2011-2012	Production	Reliability
Mobile Dispatch	Investment	Planned	2011-2012	Production	Reliability +Cost Reductn
Geo-spatial Information Services	Investment	Planned	2013-2016	Production	Overall SG
Net Metering Process Improvement	Investment	Planned	2013-2016	Production	Cost Reduction
Outage Management System	Investment	Planned	2013-2016	Production	Reliability
Smart Meter Feed to Outage Management System	Investment	Planned	2013-2016	Production	Reliability
Distribution Management System	Investment	Planned	2013-2016	Production	Reliability +Cost Reductn
Transmission Investments	*Type of Project**	*Status*	*Estimated Timeframe*	*Phase*	*Benefit*
Cat-1 Transmission Line Monitors	Investment	Completed	Pre-2011	Technology Pilot	Reliability
Transfer Trip Protection	Investment	In Progress	Pre-2011	Production	Reliability
Obsolete Relay Replacement	Investment	In Progress	Pre-2011	Production	Reliability
Transformer DGA/Controls	Investment	In Progress	Pre-2011	Production	Reliability
Generation Activities and Investments	*Type of Project**	*Status*	*Estimated Timeframe*	*Phase*	*Benefit*
Battery Research	Activity	Planned	2011-2012	Research	Renewable Integration
Salem Smart Grid Project: Transactive Control	Investment	In Progress	2011-2012	Technology Pilot	Renewable Integration
Demand Response Merchant Integration	Investment	Planned	2013-2016	Production	Cost Reduction

*Projects categorized based on PGE's definitions of "activity" and "investment" as described in PGE's Smart Grid Report.

PORTLAND GENERAL ELECTRIC

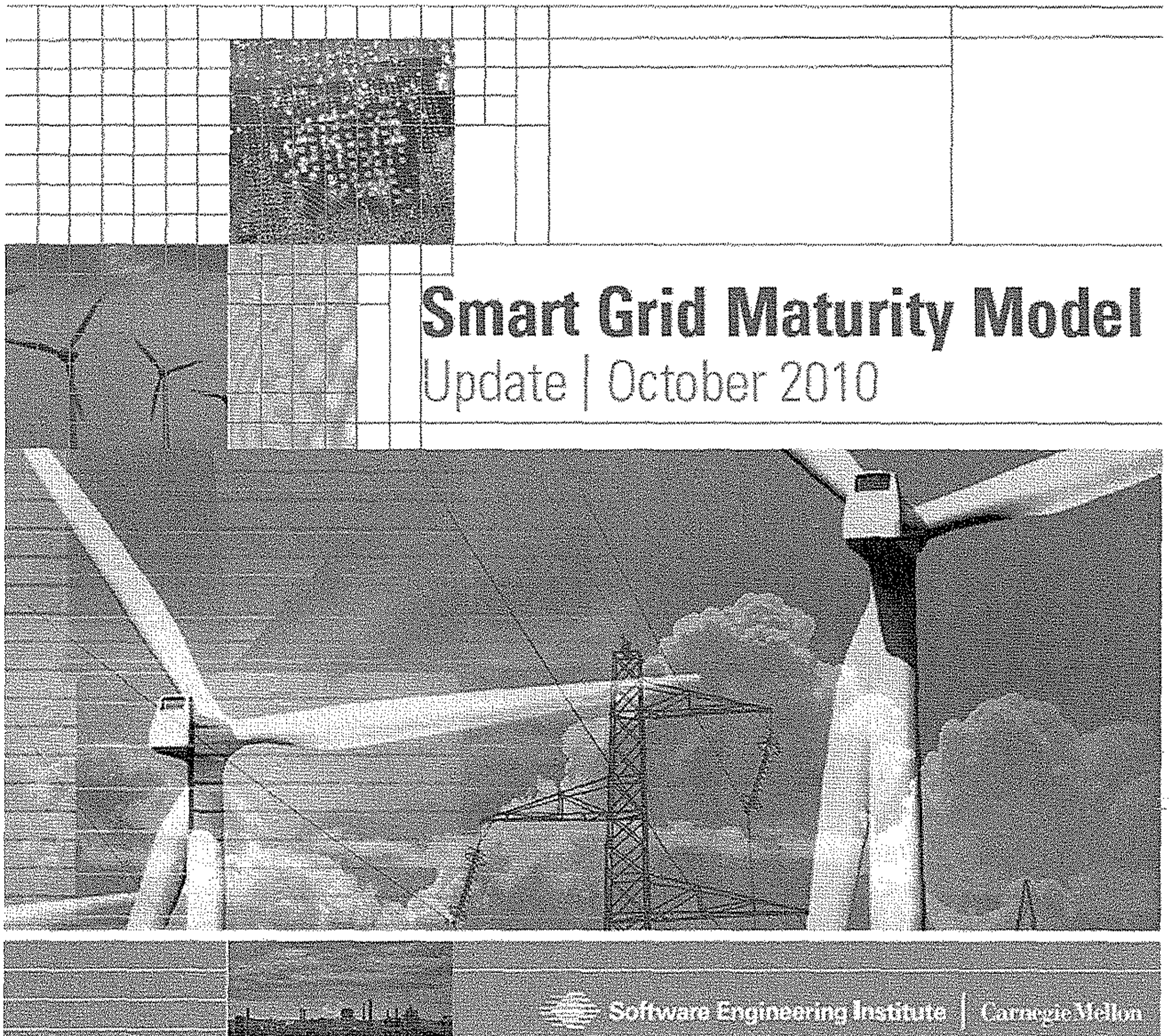
UM 1460

SMART GRID MATURITY MODEL

ATTACHMENT B

September 22, 2011

Smart Grid Maturity Model

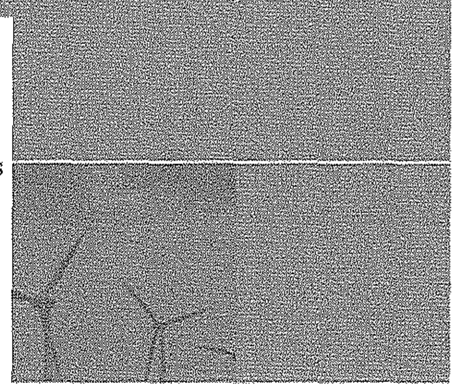


About the Software Engineering Institute

In 2009, Carnegie Mellon University's Software Engineering Institute (SEI) became the steward of the SGMM. A global leader in software and systems engineering, security best practices, process improvement, and maturity modeling, the SEI is partnering with government and industry to improve the security, resiliency, and interoperability of the grid. With the support of the Department of Energy and the National Energy Technology Laboratory, the SEI and its collaborator APQC are maintaining and evolving the SGMM as a resource for industry transformation.

About APQC

APQC is a non-profit member-based research organization with more than 30 years of systematic quality and process improvement research experience. APQC is working in collaboration with the SEI to evolve the SGMM and to analyze and maintain the data collected from organizations that use the SGMM.



Smart Grid Maturity Model: Matrix

The Matrix offers a summary view of the Smart Grid Maturity Model. It has an easy-to-access format with shortened versions of the expected characteristics contained in the model and is an excellent reference for SGMM users.

	Technology (TECH) IT architecture, standards, infrastructure, integration, tools	Customer (CUST) pricing, customer participation and experience, advanced services
PIONEERING 5	1 Autonomic computing and machine learning are implemented. 2 The enterprise information infrastructure can automatically identify, mitigate, and recover from cyber incidents.	1 Customers can manage their end-to-end energy supply and usage levels. 2 There is automatic outage detection at the premise or device level. 3 Plug-and-play, customer-based generation is supported. 4 Security and privacy for all customer data is assured. 5 The organization plays a leadership role in industry-wide information sharing and standards development efforts for smart grid.
OPTIMIZING 4	1 Data flows end to end from customer to generation. 2 Business processes are optimized by leveraging the enterprise IT architecture. 3 Systems have sufficient wide-area situational awareness to enable real-time monitoring and control for complex events. 4 Predictive modeling and near real-time simulation are used to optimize support processes. 5 Performance is improved through sophisticated systems that are informed by smart grid data. 6 Security strategy and tactics continually evolve based on changes in the operational environment and lessons learned.	1 Support is provided to customers to help analyze and compare usage against all available pricing programs. 2 There is outage detection and proactive notification at the circuit level. 3 Customers have access to near real-time data on their own usage. 4 Residential customers participate in demand response and/or utility-managed remote load control programs. 5 Automatic response to pricing signals for devices within the customer's premise is supported. 6 In-home net billing programs are enabled. 7 A common customer experience has been integrated.
INTEGRATING 3	1 Smart grid-impacted business processes are aligned with the enterprise IT architecture across LOBs. 2 Systems adhere to an enterprise IT architectural framework for smart grid. 3 Smart grid-specific technology has been implemented to improve cross-LOB performance. 4 The use of advanced distributed intelligence and analytical capabilities are enabled through smart grid technology. 5 The organization has an advanced sensor plan. 6 A detailed data communication strategy and corresponding tactics that cross functions and LOBs are in place.	1 The organization tailors programs to customer segments. 2 Two-way meter communication has been deployed. 3 A remote connect/disconnect capability is deployed. 4 Demand response and/or remote load control is available to residential customers. 5 There is automatic outage detection at the substation level. 6 Residential customers have on-demand access to daily usage data. 7 A common experience has been implemented across two or more customer interface channels. 8 Customer education on how to use smart grid services to curtail peak usage is provided. 9 All customer products and services have built-in standards based on security and privacy controls.
ENABLING 2	1 Tactical IT investments are aligned to an enterprise IT architecture within an LOB. 2 Changes to the enterprise IT architecture that enable smart grid are being deployed. 3 Standards are selected to support the smart grid strategy within the enterprise IT architecture. 4 A common technology evaluation and selection process is applied for all smart grid activities. 5 There is a data communications strategy for the grid. 6 Pilots based on connectivity to distributed IEDs are underway. 7 Security is built into all smart grid initiatives from the outset.	1 Pilots of remote AMI/AMR are being conducted or have been deployed. 2 The organization has frequent (more than monthly) knowledge of residential customer usage. 3 The organization is modeling the reliability of grid equipment. 4 Remote connect/disconnect is being piloted for residential customers. 5 The impact on the customer of new services and delivery processes is being assessed. 6 Security and privacy requirements for customer protection are specified for smart grid-related pilot projects and RFPs.
INITIATING 1	1 An enterprise IT architecture exists or is under development. 2 Existing or proposed IT architectures have been evaluated for quality attributes that support smart grid applications. 3 A change control process is used for applications and IT infrastructure. 4 Opportunities are identified to use technology to improve departmental performance. 5 There is a process to evaluate and select technologies in alignment with smart grid vision and strategies.	1 Research is being conducted on how to use smart grid technologies to enhance the customer's experience, benefits, and participation. 2 Security and privacy implications of smart grid are being investigated. 3 A vision of the future grid is being communicated to customers. 4 The utility consults with public utility commissions and/or other government organizations concerning the impact on customers.

Smart Grid Maturity Model: Matrix

	Strategy, Management, and Regulatory (SMR) vision, planning, governance, stakeholder collaboration	**Organization and Structure (OS)** culture, structure, training, communications, knowledge management
PIONEERING **5**	1 Smart grid strategy capitalizes on smart grid as a foundation for the introduction of new services and product offerings. 2 Smart grid business activities provide sufficient financial resources to enable continued investment in smart grid sustainment and expansion. 3 New business model opportunities emerge as a result of smart grid capabilities and are implemented.	1 The organizational structure enables collaboration with other grid stakeholders to optimize overall grid operation and health. 2 The organization is able to readily adapt to support new ventures, products, and services that emerge as a result of smart grid. 3 Channels are in place to harvest ideas, develop them, and reward those who help shape future advances in process, workforce competencies, and technology.
OPTIMIZING **4**	1 Smart grid vision and strategy drive the organization's strategy and direction. 2 Smart grid is a core competency throughout the organization. 3 Smart grid strategy is shared and revised collaboratively with external stakeholders.	1 Management systems and organizational structure are capable of taking advantage of the increased visibility and control provided by smart grid. 2 There is end-to-end grid observability that can be leveraged by internal and external stakeholders. 3 Decision making occurs at the closest point of need as a result of an efficient organizational structure and the increased availability of information due to smart grid.
INTEGRATING **3**	1 The smart grid vision, strategy, and business case are incorporated into the vision and strategy. 2 A smart grid governance model is established. 3 Smart grid leaders with explicit authority across functions and lines of business are designated to ensure effective implementation of the smart grid strategy. 4 Required authorizations for smart grid investments have been secured.	1 The smart grid vision and strategy are driving organizational change. 2 Smart grid measures are incorporated into the measurement system. 3 Performance and compensation are linked to smart grid success. 4 Leadership is consistent in communication and actions regarding smart grid. 5 A matrix or overlay structure to support smart grid activities is in place. 6 Education and training are aligned to exploit smart grid capabilities.
ENABLING **2**	1 An initial smart grid strategy and a business plan are approved by management. 2 A common smart grid vision is accepted across the organization. 3 Operational investment is explicitly aligned to the smart grid strategy. 4 Budgets are established specifically for funding the implementation of the smart grid vision. 5 There is collaboration with regulators and other stakeholders regarding implementation of the smart grid vision and strategy. 6 There is support and funding for conducting proof-of-concept projects to evaluate feasibility and alignment.	1 A new vision for a smart grid begins to drive change and affect related priorities. 2 Most operations have been aligned around end-to-end processes. 3 Smart grid implementation and deployment teams include participants from all impacted functions and LOBs. 4 Education and training to develop smart grid competencies have been identified and are available. 5 The linking of performance and compensation plans to achieve smart grid milestones is in progress.
INITIATING **1**	1 Smart grid vision is developed with a goal of operational improvement. 2 Experimental implementations of smart grid concepts are supported. 3 Discussions have been held with regulators about the organization's smart grid vision.	1 The organization has articulated its need to build smart grid competencies in its workforce. 2 Leadership has demonstrated a commitment to change the organization in support of achieving smart grid. 3 Smart grid awareness efforts to inform the workforce of smart grid activities have been initiated.

Smart Grid Maturity Model: Matrix

	Value Chain Integration (VCI) demand and supply management, leveraging market opportunities	**Societal and Environmental (SE)** responsibility, sustainability, critical infrastructure, efficiency
PIONEERING 5	1 The optimization of energy assets is automated across the full value chain. 2 Resources are adequately dispatchable and controllable so that the organization can take advantage of granular market options. 3 Automated control and resource optimization schemes consider and support regional and/or national grid optimization.	1 Triple bottom line goals align with local, regional, and national objectives. 2 Customers control their energy-based environmental footprints through automatic optimization of their end-to-end energy supply and usage level (energy source and mix). 3 The organization is a leader in developing and promoting industry-wide resilience best practices and/or technologies for protection of the national critical infrastructure.
OPTIMIZING 4	1 Energy resources (including Volt/VAR, DG, and DR) are dispatchable and tradable. 2 Portfolio optimization models that encompass available resources and real-time markets are implemented. 3 Secure two-way communications with Home Area Networks (HANs) are available. 4 Visibility and potential control of customers' large-demand appliances to balance demand and supply is available.	1 The organization collaborates with external stakeholders to address environmental and societal issues. 2 A public environmental and societal scorecard is maintained. 3 Programs are in place to shave peak demand. 4 End-user energy usage and devices are actively managed through the utility's network. 5 The organization fulfills its critical infrastructure assurance goals for resiliency, and contributes to those of the region and the nation.
INTEGRATING 3	1 An integrated resource plan is in place and includes new targeted resources and technologies. 2 Customer premise energy management solutions with market and usage information are enabled. 3 Additional resources are available and deployed to provide substitutes for market products to support reliability or other objectives. 4 Security management and monitoring processes are deployed to protect the interactions with an expanded portfolio of value chain partners.	1 Performance of societal and environmental programs are measured and effectiveness is demonstrated. 2 Segmented and tailored information that includes environmental and societal benefits and costs is available to customers. 3 Programs to encourage off-peak usage by customers are in place. 4 The organization regularly reports on the sustainability and the societal and environmental impacts of its smart grid programs and technologies.
ENABLING 2	1 Support is provided for energy management systems for residential customers. 2 The value chain has been redefined based on its smart grid capabilities. 3 Pilots to support a diverse resource portfolio have been conducted. 4 Secure interactions have been piloted with an expanded portfolio of value chain partners.	1 Smart-grid strategies and work plans address societal and environmental issues. 2 Energy efficiency programs for customers have been established. 3 The organization considers a "triple bottom line" view when making decisions. 4 Environmental proof-of-concept projects are underway that demonstrate smart grid benefits. 5 Increasingly granular and more frequent consumption information is available to customers.
INITIATING 1	1 Assets and programs necessary to facilitate load management are identified. 2 Distributed generation sources and the capabilities needed to support them are identified. 3 Energy storage options and the capabilities needed to support them are identified. 4 There is a strategy for creating and managing a diverse resource portfolio. 5 Security requirements to enable interaction with an expanded portfolio of value chain partners have been identified.	1 The smart grid strategy addresses the organization's role in societal and environmental issues. 2 The environmental benefits of the smart grid vision and strategy are publicly promoted. 3 Environmental compliance performance records are available for public inspection. 4 The smart grid vision or strategy specifies the organization's role in protecting the nation's critical infrastructure.

Smart Grid Maturity Model: Matrix

	Grid Operations (GO) reliability, efficiency, security, safety, observability, control	Work and Asset Management (WAM) asset monitoring, tracking and maintenance, mobile workforce
PIONEERING **5**	1 Self-healing capabilities are present. 2 System-wide, analytics-based, and automated grid decision making is in place.	1 The use of assets between and across supply chain participants is optimized with processes defined and executed across the supply chain. 2 Assets are leveraged to maximize utilization, including just-in-time asset retirement, based on smart grid data and systems.
OPTIMIZING **4**	1 Operational data from smart grid deployments is being used to optimize processes across the organization. 2 Grid operational management is based on near real-time data. 3 Operational forecasts are based on data gathered through smart grid. 4 Grid operations information has been made available across functions and LOBs. 5 There is automated decision-making within protection schemes that is based on wide-area monitoring.	1 A complete view of assets based on status, connectivity, and proximity is available to the organization. 2 Asset models are based on real performance and monitoring data. 3 Performance and usage of assets is optimized across the asset fleet and across asset classes. 4 Service life for key grid components is managed through condition-based and predictive maintenance, and is based on real and current asset data.
INTEGRATING **3**	1 Smart grid information is available across systems and organizational functions. 2 Control analytics have been implemented and are used to improve cross-LOB decision-making. 3 Grid operations planning is now fact-based using grid data made available by smart grid capabilities. 4 Smart meters are important grid management sensors. 5 Grid data is used by an organization's security functions. 6 There is automated decision-making within protection schemes.	1 Performance, trend analysis, and event audit data are available for components of the organization's systems. 2 CBM programs for key components are in place. 3 Remote asset monitoring capabilities are integrated with asset management. 4 Integration of remote asset monitoring with mobile workforce systems, in order to automate work order creation, is underway. 5 An integrated view of GIS and asset monitoring is in place. 6 Asset inventory is being tracked using automation. 7 Modeling of asset investments for key components is underway.
ENABLING **2**	1 Initial distribution to substation automation projects are underway. 2 Advanced outage restoration schemes are being implemented, which resolve or reduce the magnitude of unplanned outages. 3 Aside from SCADA, piloting of remote asset monitoring of key grid assets to support manual decision making is underway. 4 Investment in and expansion of data communications networks in support of grid operations is underway.	1 An approach to track, inventory, and maintain event histories of assets is in development. 2 An integrated view of GIS for asset monitoring based on location, status, and interconnectivity (nodal) has been developed. 3 An organization-wide mobile workforce strategy is in development.
INITIATING **1**	1 Business cases for new equipment and systems related to smart grid are approved. 2 New sensors, switches, and communications technologies are evaluated for grid monitoring and control. 3 Proof-of-concept projects and component testing for grid monitoring and control are underway. 4 Outage and distribution management systems linked to substation automation are being explored and evaluated. 5 Safety and security (physical and cyber) requirements are considered.	1 Enhancements to work and asset management have been built into approved business cases. 2 Potential uses of remote asset monitoring are being evaluated. 3 Asset and workforce management equipment and systems are being evaluated for their potential alignment to the smart grid vision.

Highlights from the Aspiration Workshops Conducted in 2010

SGMM Domains	Motivations What motivates your aspirations?	Actions What actions must happen?	Obstacles What obstacles must be overcome?
SMR	• improved business performance, success, and growth • improved productivity and profitability	• integrate with existing strategy • secure funding • prioritize and plan • educate stakeholders	• budget constraints and justification • skepticism of value • scale, scope, and pace of change
OS	• empowered and involved workforce • improved decision making • addressed aging workforce	• create a unified vision, strategy, goals, and plan • provide training • transform policies and processes	• resistance to change • culture • skill gaps
GO	• supported distributed generation (DG) cost savings • resiliency and reliability	• deploy the necessary infrastructure • implement plan • develop improved analytic capabilities	• interoperability and availability of technology • risk and complexity • security and privacy
WAM	• decreased recovery time • increased asset utilization and extend asset life	• improve GIS systems • develop standards for new technologies	• high-risk environment • managing large amounts of data • perceived ROI
TECH	• systems integration and compatibility • security and critical infrastructure protection • complex grid operations management	• enforce architecture and standards • fill application gaps • devise IT master plan • develop dynamic data distribution model	• cyber security risks • regulatory and statutory issues • increased systems complexity • technology lifespan
CUST	improved customer • satisfaction • choice • quality of service • empowerment	• develop customer enabling technologies and programs • understand customer wants/needs • educate customers	• customer willingness, acceptance, and adoption • privacy issues • customer attitudes and behaviors
VCI	• market demand for DG • enabled supply and demand management • fuel diversity • reduced emissions	• obtain regulatory approvals • create new rate structures • promote adoption of enabling technologies • develop DG incentives	• tariff structure • reduced revenue from reduced use • marketplace readiness • cross company pricing
SE	• meeting public policy objectives • being socially responsible • sustainability • improved image	• develop clear direction • define and report metrics and measures • support technological advancements	• ability to make it cost effective • balancing conflicting goals among stakeholders

Figure 10: Data points gathered during aspirations workshops conducted in 2010 with 20 utilities

CERTIFICATE OF SERVICE

I hereby certify that I have this day caused **PORTLAND GENERAL ELECTRIC SMART GRID REPORT** to be served by electronic mail to those parties whose email addresses appear on the attached service list, and by First Class US Mail, postage prepaid and properly addressed, to those parties on the attached service list who have not waived paper service from OPUC Docket No. UM 1460.

Dated at Portland, Oregon, this 22nd day of September, 2011.

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