AVISTA

Smart Grid Technology Report

August 28, 2014

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Executive Summary

Avista Utilities "Smart Grid" or "Grid Modernization" technology is designed to improve the power grid's reliability and performance by optimizing the push and pull from supply and demand. Electricity generators, suppliers and consumers are all part of the equation and need to understand the value they receive from these investments. A significant portion of the Company's smart grid investment consists of rebuilding distribution feeders, as discussed in detail further in this report. A smart grid also enhances power delivery and use through intelligent, two-way communication between suppliers and consumers. Interactive appliances in homes, improved substation automation, and sensors on transmission lines monitor activities in real time, exchange information about supply and demand, and adjust power use based on instantaneous data.

Ultimately, these types of projects will move the region and nation closer to establishing a more efficient and effective electricity infrastructure that's expected to help contain costs, reduce emissions, incorporate more wind power and other types of renewable energy, increase power grid reliability and provide greater flexibility for consumers.

As part of the utility planning process, Avista continually evaluates new technologies and approaches to improve reliability, capacity, operational efficiency and operation and maintenance (O&M) expense reduction, energy efficiency, customer education and participation. This planning process evaluates the system as a whole and utilizes life cycle economics which includes all the key elements of the Smart Grid as typically defined. Smart Grid could be characterized as more of a strategy that is incorporated into the planning process rather than as a technology subset. Technology should be deployed to meet strategic objectives and may be applied differently depending on circuit configuration, load profile, or customer interest for example.

Avista has learned a great deal about the complexity and benefits of implementing the 'system of systems' that comprise any smart grid initiative. The benefits of installing Smart switch, breaker, capacitor, regulator, and transformer technology, the radio networks which tie them together, distribution management software systems, advanced meter infrastructure (AMI) and more, implemented for the Smart Grid Investment Grant (SGIG) and the Smart Grid Demonstration Project (SGDP), are currently evaluated as infrastructure is replaced and expanded in other areas of the Avista service territory to ensure the best operational efficiencies and customer benefit for each situation.

History

By way of background, the Company began an increased effort on asset management in 2004 with a focus on analysis of equipment life and maintenance costs. Specific equipment classes were prioritized based on need. These efforts led collectively to the creation of a systemic feeder rebuild program.

The feeder rebuild program focused on three objectives; reducing maintenance expenses, reducing losses, and increasing reliability. The program included the placement of automated capacitor banks, and the replacement of small high loss conductor, and high loss distribution transformers (pre 1981 manufacture date). The feeder was then rebuilt and measures collected to determine effectiveness. Plans were made to facilitate the rebuild of 5 feeders in year one of the program followed by 10 in year two and 15 in years 3 and beyond.

Avista engineers in late 2007 began leveraging a program called Distribution Reliability and Energy Efficiency or DREE. The DREE program could be considered the first specifications for a smart grid system derived from the culmination of previous efforts.

The American Recovery and Reinvestment Act of 2009 (ARRA) was signed into law February 17th, 2009. The Recovery act provided the U.S. Department of Energy with $4.5 billion to modernize the electric power grid and to implement Title XIII of the Energy Independence and Security Act of 2007.

Per section 3 of the ARRA, the purposes of this Act included the following:

1. To preserve and create jobs and promote economic recovery.
2. To assist those most impacted by the recession.
3. To provide investments needed to increase economic efficiency by spurring technological advances in science and health.
4. To invest in transportation, environmental protection, and other infrastructure that will provide long-term economic benefits.
5. To stabilize State and local government budgets, in order to minimize and avoid reductions in essential services and counterproductive state and local tax increases.

The ARRA was comprised of four Smart Grid programs: Smart Grid Investment Grant (SGIG), Smart Grid Demonstration Projects (SGDP), Standards Interoperability and Cybersecurity, and Workforce Training. The two largest initiatives of the ARRA Smart Grid programs were the Smart Grid Investment Grant Program (SGIG) and the Smart Grid Demonstration Program (SGDP). SGIG's focus was on deployment of existing smart grid technologies, tools, and techniques. SGDP's focused was on demonstrating advanced concepts and innovative applications in regional smart grid and energy storage demonstrations. Through an open application process, the U.S. Department of Energy (DOE) selected and announced competitive awards for 99 SGIG projects and 32 SGDP projects.

In October 2009, Avista was chosen to receive a matching grant in the range of $20 million from the DOE for a Smart Grid Investment Grant project to upgrade portions of its electric distribution system to smart grid standards. At the time, the Company committed approximately $22 million to the project cost. The upgrade would dramatically improve 58 electric distribution facilities known as "feeders" in the Spokane area. The project was intended to reduce energy losses from electric lines, improve reliability and increase efficiency to the feeder system. The result of this work includes a reduction in the need for new energy sources and a reduction in greenhouse gas emissions. Specifically, the project included installation of modern equipment and software to enable Smart Grid capabilities and increase reliability and efficiency. The distribution feeder systems upgraded are primarily in higher population density areas of north and south Spokane. The entire project was scheduled for completion in three years.

Avista also lead a Smart Grid Demonstration Project that created the first "smart community" in the Pacific Northwest. The matching funds for the $38 million project were a part of a DOE grant for a larger $178 million regional project which was administered by Battelle[1]. Avista teamed up with several regional entities for the Pullman, Washington project including Itron, Hewlett-Packard, Spirea, and Washington State University. Avista's portion of the matching funds was approximately $13.1 million.

This project, also expected to help move the region and the nation closer to establishing a more efficient and effective electricity infrastructure, is intended to help contain costs, reduce emissions, incorporate more wind power, and other types of renewable energy as well as increase power grid reliability and provide greater information and flexibility for consumers. The project completion date is set for December 2014. Battelle will then begin analysis and reporting on data gathered from all participating utilities to determine the value derived from the smart grid projects and put forth recommendations to the DOE on expanded Smart Grid deployments.

[1] *Battelle is an international science and technology enterprise that explores emerging areas of science, develops and commercializes technology, and manages laboratories for customers. Battelle supports community and education programs to promote an enhanced quality of life for its community neighbors.*

The American Reinvestment and Recovery Act of 2009 provided the Company with the opportunity to achieve the DREE objectives by quickening the pace of the Feeder Rebuild program.

One hundred percent of the SGIG Spokane project costs and approximately 60% of the SGDP Pullman project costs would have been expended under the feeder rebuild program. The ARRA grants allowed these investments, which the Company would already be doing, to be made with a 50% discount to Avista customers.

In addition to the SGIG and SGDP awards, Avista also received $1.3 million of the $5 million grant to develop a smart grid work force training program in partnership with several utilities and colleges in the region. The goals of the smart grid workforce training program were to:

- Create and deliver curriculum, programs, and training for smart grid technologies and applications to utility workers in a five-state region that includes Washington, Idaho, Oregon and Montana;
- Create an online smart grid training and information portal to be shared by utilities, businesses, and consumers through these four states; and
- Share best practices on smart grid training using a regional approach.

The project specifically targeted ten supply and demand side occupations that required workforce training to prepare the labor force for emerging smart grid technologies such as:

- Supply side: Instrument Control/Relay Specialist (Generation and Load Dispatchers); Generation, Load and Substation Operators; Line Workers; Substation Wireman/Mechanics; and Ground Crews; and
- Demand side: Customer Service Representatives; Meter Technicians; Energy Advisors; Energy Conservation Program Administrators; Resource Conservation Managers.

As part of the work force training project, Avista upgraded the Jack Stewart Training Center with a substation and distribution circuits equipped with smart grid technology, to serve as a regional training center for the delivery of smart grid field training. The connected facilities create an authentic training environment that simulates real life work situations for field personnel.

In addition, Avista training programs for apprentices, journeymen and pre-line school students were updated to incorporate smart grid technology.

Goal or Purpose of the Smart Grid Technologies Described in This Report

1. Increased energy delivery information,
2. Reducing energy losses,
3. Increasing reliability,
4. Improved energy information,
5. Voltage Optimization,
6. Integrating distributed renewable generation and
7. Extending the life of existing infrastructure.
8. Measure and Validate
9. Operations efficiency

Project Updates

Smart Grid Investment Grant (SGIG)

Upgrades to 58 electric distribution circuits known as “feeders” in the Spokane area, and 14 substations that serve approximately 110,000 electric customers are complete. The project reduced energy losses from electric lines improved reliability and increased efficiency in these feeders. This work also reduced the need for new energy sources and cut greenhouse gas emissions. Specifically, the project included installation of modern equipment and software to enable Smart Grid capabilities and increase reliability and efficiency. The distribution feeder system upgrades are primarily in higher population density areas of north and south Spokane. This project allows Avista to remotely control and operate the distribution reclosers, capacitor banks, and voltage regulators.

The construction phase of the distribution line work associated with the SGIG project is complete, as well as the installation of 380 line devices, 29-miles of primary conductor, and 14 substations. In addition, the Distribution Management System (DMS) is fully installed and is currently running Fault Detection Isolation and Restoration (FDIR) and Integrated Voltage / Reactive Power Control (IVVC) for 59 Smart Grid Feeders (*one more feeder than the original plan due to splitting a heavily loaded feeder into two*). The DMS deployment has provided a significant amount of real-time data reflecting the distribution system’s operational behavior. This level of intelligence enables more visibility into the distribution network via configuration management, performance monitoring and network fault monitoring. One big advantage of this intelligence is the grid can be automatically reconfigured for reliability. This is achieved during an outage when the system determines which section needs to be isolated and then restores power to both the upstream and downstream customers. This reduces the number of customers affected by an outage and reduces the length of outages for customers on these feeders.

By way of example, on August 13, 2013, while the Company was in the training and implementation phase of FDIR, we experienced an outage in north Spokane at approximately 10:18 am, where a garbage truck hit a pole causing a fault on the Company's Lyons and Standard feeder. The incident affected 897 customers, including the North Town Shopping Mall. The DMS correctly performed upstream restoration of 811 customers at 10:19 am; and Avista's Distribution Dispatchers correctly performed downstream restoration of an additional 72 customers by 10:33 am. The Company sent a crew to the isolated incident to replace the power pole and restore power to the remaining 14 customers. The Company estimates the total customer outage minutes saved during this one outage to be 36,374. Ultimately, the benefits of the system include a more reliable and efficient grid, along with improved customer service.

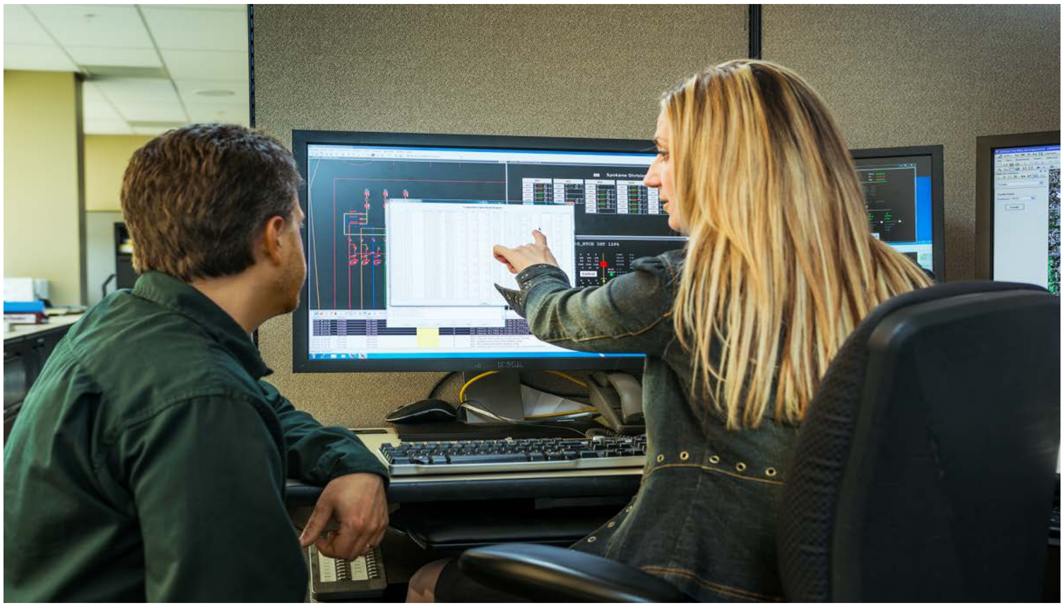
The Smart Grid Demonstration Project (SGDP)

The demonstration project involved the automation of many parts of the electric distribution system using advanced metering, enhanced utility communication and other elements of smart grid technologies[2]. This project also includes some of the same technology as the Spokane project -for example, the use of a distribution management system (DMS) which controls smart switches, smart capacitor banks, smart fault indicators, and smart voltage regulators for fully automated restoration, fault identification, integrated voltage and reactive power compensation, conservation voltage reduction, and automated switching. The DMS portion of both SGIG and SGDP projects was fully implemented in fourth quarter 2013.

In June 2014, through the use of the DMS system and the smart devices it controls, Avista recently met and passed the 1 million customer minutes saved since the inception date of the SGIG and SGDP projects.

Smart Grid Reliability Improvements	June	YTD	ITD
Customer Minutes Saved	53,372	270,044	1,067,880

[2] Smart grid technology includes everything from interactive appliances in homes to substation automation and sensors on transmission lines. It is a system that uses various technologies to enhance power delivery and use through intelligent two-way communication. Generators of electricity, suppliers and users are all part of the equation. With increased communication and information, smart grid implementations can monitor activities in real time, exchange data about supply and demand and adjust power use to changing load requirements.



DMS Software

Smart transformers with internal and ambient temperature sensing, as well as low side bushing measurement devices, were installed as part of SGDP. These transformers were intended to be utilized to attain customer loading information to better size future transformer installations and determine transformer useful life by scanning oil and winding temperature. These transformers were extremely useful in the DMS commissioning of the voltage control portion of the integrated volt var control. The DMS power flow output results were compared to the telemetered values from the smart transformers in order to verify the power flow accuracy. The smart transformers were also used to determine correct phasing as documented on Avista's GIS system.

The Pullman SGDP has completed its fourth year of construction and operation. In addition to line switches, capacitor bank, primary conductor and smart transformers previously discussed, contract crews, in 2011, installed approximately 13,000 digital electric meters and 5,000 natural gas "Encoder Receiver Transmitters" (ERT's) to Pullman and Albion customers.

Avista crews have completed upgrading all three substations in the project. The most recent year focused on the integration of new intelligent transformers, line devices, and substation controls into the control system.

Substation Voltage Regulators

Capacitor – Line Device

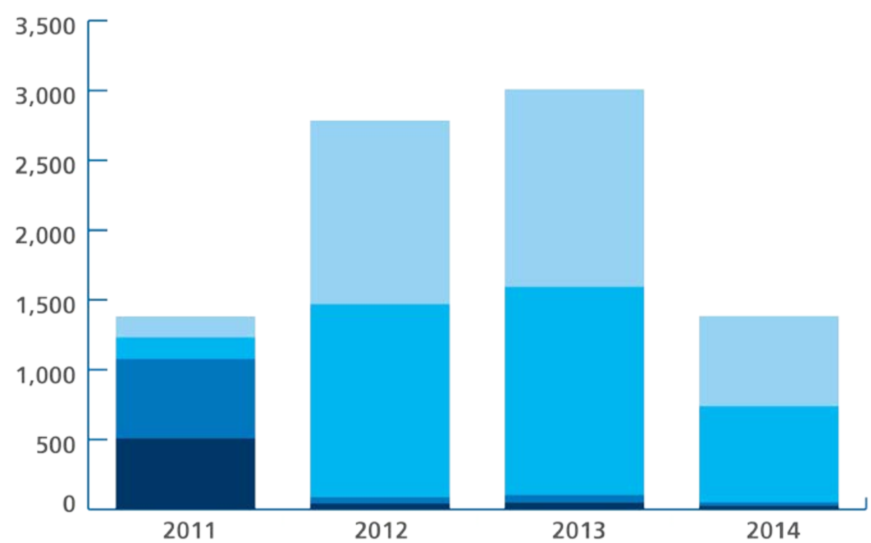
Smart Transformer

The Company provided a web portal in the second quarter of 2012 that allowed 6,500 targeted customers in Pullman access to their energy data. The remaining 6,500 customers were offered the web portal as part of a control group, in an effort to achieve valid customer statistics around web portal effectiveness. These control and target groups were selected randomly. Additionally, by the end of 2013, a subgroup of 75 volunteer customers had received advanced thermostats that provide in-home, near real-time (5 minute interval readings), energy consumption feedback.

The project entered a demonstration phase in the fall of 2013 and will end in January 2015. During this time, transactive functionality and customer feedback will be monitored. Reporting in the final six-months of 2014 will help with program assessment in the areas of system efficiencies, transactive control signal, reliability, and customer behavior.

Since the advanced meters were installed in Pullman and Albion, manual connects and reconnects has been significantly reduced. Remote connects and disconnect are accomplished via the OpenWay AMI system.

Pullman/Albion Collection Connect and Disconnect Activity



	2011	2012	2013	2014
Remote Reconnect	152	1,317	1,419	646
Remote Disconnect	155	1,384	1,490	691
Manual Reconnect	568	45	55	22
Manual Disconnect	508	41	47	26

2011 was estimated for first 6 months, 2014 is year to date through July 2014.

Billing disputes are more easily addressed by our customer service representative using real time and historical AMI meter reading data.

In the spring of 2011, a SGDP customer called to discuss a 'high bill'. Working with the meter shop the customer service representative was able to obtain a graph of meter consumption for the billing period in question. Standing out very clearly was a near vertical rise from their historical consumption to a point where the consumption leveled off for many hours then dropped to a 'normal' consumption level as rapidly as it had risen. With this information the customer was able to ascertain that a contractor, doing sheet rock work in the home, had opened all of the doors and windows and then turned up the thermostat to facilitate the drying of the sheet rock 'mud'.

Communication and Cyber Security

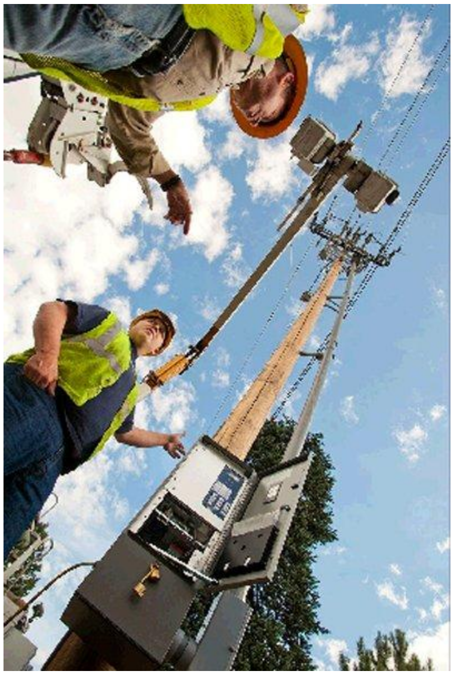
Integral to the success of both the Smart Grid Investment Grant project and the Smart Grid Demonstration project were the construction of state-of-the-art radio systems and the diligent exercise of applying cyber security rules and oversight.

Pullman and Spokane Radio Network

Smart grid enabling communications infrastructure and services that interconnect Intelligent Electrical Devices (IEDs) within Avista's electrical transmission and distribution system to Avista's Energy Management System (EMS) and Distribution Management System (DMS) and Control Centers are considered core underlying services for enabling Avista's current and future-state smart grid technology capabilities and function.

In addition to the extension of fiber infrastructure and deployment of a private Multi Protocol Label Switching (MPLS) network, between 2010 and 2013, the SGIG projects built an 802.11 wireless mesh network in Spokane. During that same time, SGDP supported the build of a wireless mesh network and Advanced Metering Infrastructure (AMI) in the Pullman and Albion areas to gather data from several thousand smart meters and gas ERT modules.

Included in this report is a comprehensive, detailed report on the communications technology required to successfully operate the smart grid systems.



Cyber Security

With the introduction of thousands of devices able to communicate digitally, the need existed to understand each component and insure that equipment design included cyber security standards acceptable to Avista. To that end, Avista created a Cyber Security oversight committee that applied risk assessments and implementation of controls following the guidelines of NISTIR 7628. Each smart device was dissected to ensure data integrity and the protection of customer information.

Summary of Installed Technology and Goals Met

	Function	QTY	Go Live	Increase Energy Delivery Information	Reduce Energy Losses	Increase Reliability	Improved Energy Information	Voltage Optimization	Integrating Distributed Renewable Generation	Extend Life of Existing Infrastructure	Operations Efficiency
Smart Grid Investment Grant Components											
Distribution Management System (DMS)	Hard/Software	1	2013	✓	✓	✓	✓	✓		✓	
Scada Mate Smart Switches and Viper Reclosers	IVVC/FDIR	263	2013	✓		✓	✓	✓	✓	✓	
Capacitors	IVVC	123	2013		✓						
Voltage Regulators	IVVC	174	2013		✓			✓		✓	
Fault Detection, Isolation & Restoration	FDIR	72	2013			✓					✓
Fault Circuit Indicators	FCI	3	2013			✓					✓
Smart Grid Demonstration Project Components											
Distribution Management System (DMS)	Noted Above										
Viper Reclosers	IVVC/FDIR	34	2013	✓		✓	✓	✓	✓	✓	
Capacitors	IVVC	30	2013		✓						
Voltage Regulators	IVVC	39	2013		✓			✓		✓	
Fault Circuit Indicators	FCI	130	2013			✓					✓
Smart Transformers	Load Reporting	360	2012	✓	✓	✓	✓	✓		✓	
Advanced Meter Infrastructure (AMI)											
Open Way AMI Meter Reading System	Hard/Software	1	2011	✓			✓	✓			✓
AMI Smart Meters	Smart Meters	13,000	2011	✓			✓	✓			✓
Gas ERTS	w/900mh Radio	5,000	2011	✓			✓	✓			✓
Customer Experience											
AMI Web Portal	AMI Data Access	13,000	2012	✓			✓				✓
Demand Response - Residential	Thermostats	75	2012								✓
Demand Response - Commercial WSU Partner	Signal	0	2012								✓
Communication Network											
Spokane 802.11 Mesh Radios	Data Collection	485	2012	✓		✓	✓				
Pullman Mesh Radios	Data Collection	90	2010	✓		✓	✓				
Pullman Gateway Radios	Data Collection	20	2010	✓		✓	✓				
Fiber Optic Network	Data Transport	1	2013	✓		✓	✓				

Measure and Validate: A major objective of the two projects was to measure and validate smart grid costs and benefits, thereby laying the foundations for business cases for future smart grid investments, please see Appendix A.

Future Smart Grid Initiatives

Smart City: Avista is currently evaluating the opportunities that may exist for a "Smart City" demonstration in the University District in Spokane, WA. The University District, adjoining downtown Spokane Washington, is at the core of a higher education and health care cluster and is the focus of redevelopment efforts targeting economic development and attracting new economy, workers, and businesses. The District already has a base system of smart circuits, and there is an opportunity to build on smart grid experience gained in Pullman Washington, to position the University District as a smart city proving ground. The emerging smart city vision includes a profound shift in the way electricity and other resources (e.g., water, natural gas, transportation, etc.) are used and supplied. The project is currently in the preliminary planning phase, project scope, costs, and benefits are not available at this time.

Vanadium Flow Battery: Energy efficiency is a top business objective for both Avista and Washington State University (WSU). The systems in Pullman, WA provide combinational power factor correction and voltage regulation while lowering the voltage to reduce both losses and loads. The stated business case for the SGDP was for a 1.86% reduction overall. The early results imply as much as 4% savings is possible. However, of the 6 feeders that supply WSU, one is subjected to cyclical loads that cause a 4 volt drop, negating the savings potential. A battery is an ideal solution to flatten the peak and minimize the number of operations for voltage regulators. Additionally, a four-quadrant inverter can maintain unity power factor which allows for maximum voltage reduction while in discharge mode. The Company suggests a Vanadium Flow Battery (VFB) and associated inverter with 1 MW of power and energy capability of 3.2MWh.

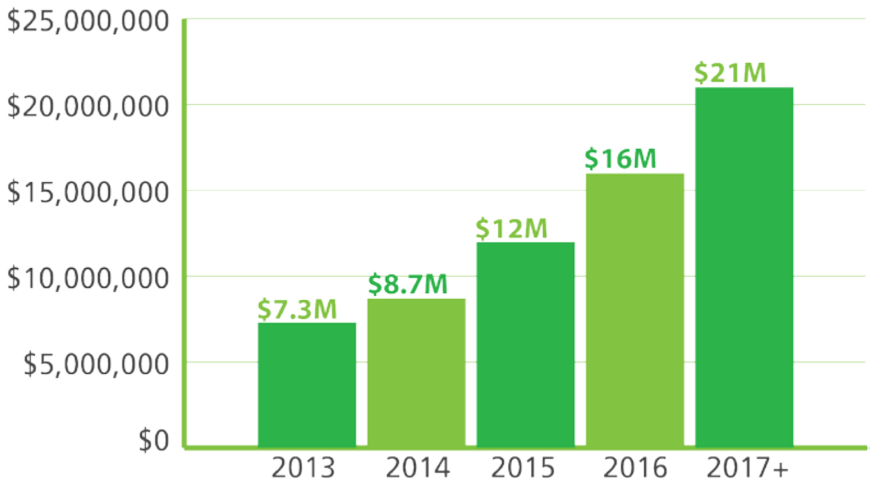
Automated Meter Infrastructure (AMI): The benefits associated with AMI have lead Avista to consider the broad deployment throughout Washington. Avista is currently in the process of finalizing an AMI deployment plan for the state of Washington. If approved, deployment of Washington AMI would begin in 2015 and work towards integrating 253,000 electric and 155,000 gas meters by 2018. AMI will allow Avista and its customers to save energy, provide a means for remote meter reads, connects and disconnects, report outage status, and allow for customer load models for system planning.

Grid Modernization: The success of both the SGIG and SGDP projects has led the Company to develop a program expansion taking a systematic approach. The premise of this program is to make all necessary upgrades to the feeder infrastructure at one time. In essence, it optimizes our investments by merging objectives of several independent programs including, Wood Pole Management, Smart Grid, and the Feeder Rebuild programs. Avista has over 340 feeders in its service territory in Washington and Idaho. The Grid Modernization program will upgrade six feeders annually. Each feeder will be individually assessed to determine the applicable level of automation. Smart technologies, like those deployed through SGIG and SGDP projects, will be installed while we continue to monitor the market for new technologies that could assist in meeting our grid modernization goals. In addition to expanding Avista's smart grid footprint, the program will meet several other intentional objects.

Program Objectives

- **Safety: Focus on public and employee safety through smart design and work practices.**
- **Increase System Reliability: Replacing aging & failed infrastructure that has a high likelihood of creating a need of an unplanned crew call-out;**
- **Avoided Costs: Replace equipment that has high energy losses with new equipment that is more energy efficient and improve the overall feeder performance;**
- **Operational Ability: Replace conductor and equipment that hinders outage detection and install Automation Devices and feeder ties that enable isolation of outages;**
- **Capital Offset of Future O&M: Avoid future equipment O&M costs with programmatic capital investment.**

Proposed Capital Spend



Reporting: The Company is working on developing metrics and reports to support the requirements of the Department of Energy (DOE) for the SGIG grant. The reporting program is being submitted to a DOE data clearing house and will help the DOE assess the effectiveness of the program. The data reporting period goes through March 2015, which will then conclude the project. See Appendix D for latest SGIG project filing.

Conclusion: This is an exciting time for the Company as we provide our customers with a system worthy of the 21st century. While we are committed to piloting new technologies, we are also very proud to be doing larger scale deployments of proven smart grid equipment. As the Spokane and Pullman projects demonstrated, an adequately designed, tested and deployed Smart Grid system will reduce energy losses from electric lines, improve reliability and increase efficiency in the feeder system. The process of proving out this technology would not have been possible without the assistance from our region partners and cost share partners, Itron, Hewlett-Packard, Spirea, and Washington State University and the dedicated men and women of Avista. We also would like to pay a special tribute to the Pullman and Albion customers for listening and learning about our project which enabled the implementation, in all technology areas, to go nearly issue free.

Advanced Metering Infrastructure (AMI)

Description

Avista deployed Advanced Metering Infrastructure (AMI) in Pullman, WA as part of SGDP. The goal of the AMI deployment was to demonstrate the benefits, both operational and customer related, of deploying advanced metering technology. Today AMI is operational on approximately 13,000 electric meters and 5,000 gas meters in Pullman.

AMI provides the information necessary to understand consumer behavior when coupled with energy consumption education, ultimately providing consumers with the ability to manage their energy costs. Without AMI consumers will lack timely information to understand their energy consumption. Real-time information will allow Avista to study the impact of active customer participation.

Smart meters are key to deriving the maximum amount of electrical efficiency from the electric distribution system. Smart meters provide the calibration for managing system efficiency.

Smart meters provide outage information at an individual service. The customer no longer needs to place a call to Avista in order for “out-of-power” status to be known. This outage information, when coupled with Avista’s existing outage management system, allows for a level of restoration service and crew efficiency that has never been possible. Additionally, individual service outages will not be missed after restoration of large portions of circuits.

Operational efficiency also comes in the form of reduced labor, vehicle miles and timely response to system issues. The Pullman project has reduced the need for meter readers due to remote read capability. Account open and close reads are made remotely. Power status at the meter is validated without crew trips to a customer premise. System outage status is better understood for efficient routing of crews and resources. These are but a few of the potential operational efficiency gains that can be realized.

Smart meters also provide the information necessary to understand the automated response of the electrical distribution system with respect to a regional signal which allows for automated response to intermittent energy sources and loads. Moreover, AMI meters can be configured for net metering.

Building on the lessons of the SGDP Pullman AMI deployment, Avista is interested in pursuing a larger AMI project which would encompass every Washington customer. The Washington AMI project would include approximately 253,000 electric meters and 155,000 gas meters. Electric meters will collect usage data in the range between 5 and 15-minute intervals, and gas will collect data in one hour intervals.

The Washington AMI project goal will be to build on Avista's past experiences with Advanced Meter Reading (AMR) (Idaho and Oregon) and AMI (Pullman), to provide customer and operational benefits to Avista's Washington service territory. Advanced Metering will become the enabling system for current and future technology which will help Avista customers understand and manage their energy usage. Technology features will include secure two-way communications, interval meter data for gas and electric meters, remote connect/disconnect for electric meters, and voltage alarming for Conservation Voltage Reduction (CVR). The technology will provide a foundation for innovation in the ways Avista interacts with our customers and operates our distribution system.

Funding Source

The AMI project in Pullman, WA was funded as part of SGDP.

If approved, the future Washington AMI project would be funded by Avista's Capital Budget. The preliminary capital cost estimate for Washington AMI is approximately $131.6 million.

Status/Timeline

The Pullman AMI system was fully deployed in 2011. The Washington AMI project, if approved, would begin in 2015, be mostly operational by 2018, and completed by 2020. The timing for the Washington Project is dependent on what AMI technology is deployed in specific areas of the Washington service territory. The scoping analysis has begun as part of the Company's AMR Business Case.

Update on Pullman AMI (SGDP)

The Pullman AMI deployment has given Avista valuable experience and insight into what it takes to create an AMI system that provides benefits beyond traditional meter reading systems. Avista has been able to integrate the meter data into several systems which provide customer insight on energy usage, in addition to providing accurate and timely billing information and operational efficiencies.

The AMI deployment in Pullman was smaller in scale than most deployments throughout the United States, and Avista will benefit from the demonstration project by applying lessons learned to future installations. AMI systems are more complex than traditional AMR due to the two-way communications infrastructure and an abundance of data, among other considerations. Avista learned how the additional complexities translate into challenges, and we have been able to successfully overcome those challenges while examining the benefits such a system can provide. When pursuing future projects, Avista will have a better grasp on what it will take to get the most out of AMI systems. We are experienced with the technology, and understand the value it can bring.

Benefits Description

Installing AMI will help Avista become more efficient, allow customers to be more informed about their energy use, and provide a foundation for future applications. Specifically, the following list of benefits can be attributed directly to Avista's current and future AMI projects:

Cost Effectiveness: AMI will help save energy for Avista and its customers. Voltage alarming from AMI systems can be integrated with Conservation Voltage Reduction (CVR) in order to allow greater energy reductions due to access to voltage information at more points on the feeder. Customers can also choose to use their more real-time, higher interval usage information to learn about ways to save energy.

- **Operational Savings:** AMI provides on demand open and close reads and remote service disconnects/reconnects. These features will reduce Customer Service expense in outside collections, inactive use, call reduction, and write offs.

Installing automated meter reading eliminates the need to manually read each meter once per month.

Below is a summary of estimated AMI costs and benefits associated with installing AMI in Washington. *The calculations are very preliminary, forward looking, and subject to change.*

- Capital Expense = $131.6 Million (408,000 meters plus communications and head end systems)
- Annual O&M Cost = $5.0 Million
- Annual Operational Savings = $7.9 Million
- Annual Energy Savings = $2.0 Million (in addition to CVR savings due to grid modernization)
- Net Annual savings = $4.9 Million
- Customer Bill Impact = $1.50 per month
- **Effects on System Capability to Meet or Modify Peak Loads:** AMI data can be used to build accurate load models for customers. These load models will provide a means to determine an accurate load growth within our system. This predictive capability allows for more accurate system planning ensuring the system meets customer load requirements.

- **Effects on Reliability:** Avista will explore how meter status information can be utilized to identify outages more rapidly. This early identification of power outage could have a positive effect on system restoration times. Avista is currently investigating the value AMI data can bring to distribution dispatch by manually querying the Pullman AMI system during outages. The next step will be to decide how to integrate the data between AMI and OMT systems, which would likely be in scope for our next large AMI deployment.

- **Effects on Integration of New Loads:** As customer usage patterns change with new technology, AMI data can be used to better understand how electricity is being used. This data will help with rate studies, system planning, distribution engineering, and asset management.

- **Cyber and Physical Security Of Utility Operational and Customer Information:** Avista is committed to keeping private customer information safe. AMI systems today incorporate modern cyber security methods to ensure data is protected from the meters to the secure data center. AMI data is encrypted at the meter, and any access to metering systems must be authorized and authenticated. As mentioned in the Cyber Security Plan technology report, the Smart Grid AMI System Security Plan is evaluated annually by the Enterprise Security Working Group to update the plan as needed.

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** When designing an AMI system, Avista makes security and interoperability top priorities. Avista recognizes that the grid of the future will be heavily reliant on the ability for multiple systems to provide information to multiple applications. With interoperability and security in mind, Avista's next AMI deployment will use IPv6 protocol, and other interoperable technologies where possible, allowing for multiple communications technologies and suppliers to be used.

- **Non-quantifiable Societal Benefits:** It is important to note that some of the most important benefits of AMI, such as customer choice, customer engagement, or greenhouse gas reduction, are not financial. Avista considers financial benefits of AMI as well as customer and societal benefits when deciding to pursue further AMI deployments.

Interval meter data can be accessed by customers to help them understand and manage their energy usage. Avista customers in Pullman can already download their interval data via the avistautilities.com web portal. In the future, Avista will work to provide customer data in the standardized Green Button format.

AMI enables customer engagement tools to help Avista connect in ways customers want. One example is text alerts, where a customer can set a budget and receive a message when their energy usage is trending over their budget. Text alert technology was demonstrated in Pullman, and will be included in future AMI deployments.

The list of AMI benefits would not be complete without acknowledging potential future uses of AMI infrastructure. Not all of these are applicable or feasible for Avista today, but they are being implemented in other areas of the U.S. already. Future benefits include: time of use pricing, critical peak pricing, demand response, pre-pay, flexible billing schedules, theft detection, advanced outage management integration, electric vehicle integration, and distributed energy resource integration.

Deployment and Evaluation of Energy Storage

Description

Energy efficiency is a top business objective for both Avista and WSU. The systems in Pullman, WA provide combinational power factor correction and voltage regulation while lowering the voltage to reduce both losses and loads. The stated business case for the SGDP was for a 1.86% reduction overall. The early results imply as much as 4% savings is possible. However, of the 6 feeders that supply WSU, one is subjected to cyclical loads that cause a 4 volt drop, negating the savings potential. A battery is an ideal solution to flatten the peak and minimize the number of operations for voltage regulators. Additionally, a four--quadrant inverter can maintain unity power factor which allows for maximum voltage reduction while in discharge mode. The Company suggests a Vanadium Flow Battery (VFB) and associated inverter with 1MW of power and energy capability of 3.2MWh.

This battery can be leveraged for not only this localized load problem on the feeder, but can be "dispatched" for power supply use. There are numerous "use cases" listed in the business case for this project. Each use case will be evaluated for effectiveness, coincident opportunity, constraints, and performance. The battery will be commanded through Avista's distribution management system (DMS) and Energy Management System (EMS) as "dispatched" events. Day--ahead schedules, renewable energy availability, anticipated power costs, local constraints, local loads, battery management and system needs will be evaluated in a multi---variant set of equations to determine battery operation. This approach is unique in that transmission and distribution operations can both command the distributed resource installed on the distribution system with prioritization based on optimal value achieved.

The EMS and DMS will be configured, and if necessary, code modified by the respective vendors to provide modeling, simulation and operating tools for use with energy storage systems. Budget has been reserved for this effort to insure automated operation is not only possible but implemented for this solution.

The consortium intends this battery to integrate with renewable energy projects, both solar and wind, so that unanticipated changes in supply or prediction of such changes can be mitigated with this battery. We intend to demonstrate the dispatch of the energy storage resource from our distribution and bulk power operation centers with sophisticated valuation and control methodologies. Finally, this battery installation will improve reliability on the intended substation and feeder while reducing the cost of intermittent or distributed energy resources.

The project, as designed, will establish engineering standards that allow for deployment at other substation or line locations throughout the Avista service territory. The project site location can accommodate additional battery strings for higher energy and capacity as results indicate the need. Additionally, the project will create assessment tools that can be used to evaluate one or more use cases either singularly or coincidently. Coupled with previous infrastructure upgrades, the project provides for development, integration and testing of most any use cases imaginable.

Consortium partners are Pacific Northwest National Laboratory (PNNL), Washington State University (WSU), and UniEnergy Technologies (UET), all located in Washington.

Funding Source

Avista Corp ($3.7M), Washington State Department of Commerce Grant ($3.2M)

Status

Funding is in the approval process. Beginning implementation analysis.

Benefits Description

- **Cost Effectiveness:** The participation in seven use cases justifies the cost effectiveness of this project. Avoided Cost, Ancillary Services, Conservation Voltage Reduction (CVR), Flex Market Ramping, Negative Pricing, Operations and Maintenance and Energy Sales make up the benefit savings seen in Table 1.
- **Operational Savings:** Large swings in generator output cause wear and tear and ultimately premature failure of components. Operational Savings can be realized if larger generation assets can remain in base mode operation or closer to optimal output levels due to the flexibility of this resource.
- **Effects on System Capability to Meet or Modify Peak Loads:** Enhanced CVR, both on peak and off peak is possible as the energy storage provides a peak flattening service, while correcting power factor which keeps voltage sags from limiting CVR operation during peak periods. Off peak is also affected as voltage rises during low load periods.
- **Effects on Reliability:** This project will not initially impact reliability. However, as a phase 2 this project could be integrated into a micro-grid application, useful for supporting local critical load in a major outage event.
- **Effects on Integration of New Loads:** The effects of new loads added to the same distribution feeder as this Energy Storage Project, will be more clearly quantified. The nature of the Energy Storage Projects hour by hour analysis and justification of Use Case details the existing load profile in much finer detail than previously. This load detail

can be used to better anticipate the impacts of new loads both at a local level and a system level.

- **Cyber and Physical Security Of Utility Operational and Customer Information:** The Enterprise Security Working Group meets monthly and annually reviews the Smart Grid Vulnerability Assessment to assess both customer and utility vulnerability.

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** N/A

- **Non-quantifiable Societal Benefits**

This Energy Storage Project through "peak shifting"[3] and energy efficiency gains through Enhanced CVR not only has cost savings components but also reduces CO_2 emissions.

Cost Effectiveness

	Avoided Cost		Balancing	CVR		Ramping	Negative	O&M	Energy			
	Capacity	Risk	Ancillary	On-Peak	Off-Peak	Flex Market	Pricing	Operations	Energy	Capacity	Risk	
Year	$/KW-Yr	$/KW-Yr	$/KW-Yr	$/KW-Yr	$/KW-Yr	$/KW-Yr	$/KW-Yr	$/KW-Yr	$/KW-Yr	$/KW-Yr	$/KW-Yr	Totals
2014	$0	$0	$15.18	$9.46	$15.43	$0	$6.60	$2.06	$10.34	$0	$0	$59,061.60
2015	$0	$0	$15.46	$9.64	$15.71	$0	$6.60	$2.09	$11.02	$0	$0	$60,517.98
2016	$0	$0	$15.74	$9.81	$16.00	$14.93	$13.87	$2.13	$11.30	$0	$0	$83,794.73
2017	$0	$0	$16.02	$9.99	$16.28	$15.20	$14.11	$2.17	$11.38	$0	$0	$85,161.94
2018	$0	$0	$16.32	$10.17	$16.58	$15.48	$14.37	$2.21	$12.06	$0	$0	$87,181.86
2019	$0	$0	$16.62	$10.36	$16.89	$15.76	$14.64	$2.25	$12.76	$0	$0	$89,273.54
2020	$122.10	$4.60	$16.91	$10.54	$17.19	$16.04	$14.90	$2.29	$13.78	$5.05	$0.19	$223,591.79
2021	$127.10	$4.80	$17.22	$10.73	$17.50	$16.33	$15.17	$2.33	$14.57	$5.26	$0.20	$231,207.99
2022	$132.30	$5.00	$17.52	$10.92	$17.81	$16.62	$15.44	$2.37	$15.35	$5.47	$0.20	$239,019.28
2023	$137.70	$5.20	$17.83	$11.11	$18.12	$16.91	$15.70	$2.42	$16.28	$5.69	$0.21	$247,182.55
2024	$143.30	$5.40	$18.13	$11.30	$18.43	$17.20	$15.97	$2.46	$16.51	$5.93	$0.22	$254,849.62
2025	$149.10	$5.60	$18.44	$11.50	$18.74	$17.49	$16.25	$2.50	$16.45	$6.17	$0.23	$262,473.36
2026	$155.20	$5.80	$18.76	$11.70	$19.07	$17.80	$16.53	$2.54	$17.35	$6.42	$0.24	$271,394.13
2027	$161.50	$6.10	$19.09	$11.90	$19.40	$18.11	$16.82	$2.59	$17.79	$6.68	$0.25	$280,230.07
13 Year Totals												$2,474,940.44
2028	$168.10	$6.30	$19.44	$12.11	$19.75	$18.44	$17.12	$2.63	$18.55	$6.95	$0.26	$289,653.94
2029	$174.90	$6.60	$19.79	$12.34	$20.11	$18.77	$17.43	$2.68	$19.31	$7.24	$0.27	$299,440.74
2030	$182.10	$6.80	$20.15	$12.56	$20.48	$19.11	$17.75	$2.73	$20.46	$7.53	$0.28	$309,942.62
2031	$189.50	$7.10	$20.51	$12.78	$20.84	$19.45	$18.06	$2.78	$21.02	$7.84	$0.29	$320,162.02
2032	$197.20	$7.40	$20.87	$13.01	$21.21	$19.79	$18.38	$2.83	$21.88	$8.16	$0.30	$331,023.45
2033	$205.20	$7.70	$21.24	$13.24	$21.59	$20.15	$18.71	$2.88	$22.32	$8.49	$0.32	$341,836.24
IRP 20 Year Totals												$4,366,999.45

[3] *Taken here to mean storage in off-peak and discharge in on-peak. The difference between the emissions of an on-peak resource mix and an off-peak is variable, but generally on-peak is more likely to be comprised of higher emissions resources.*

Substation Integration and Smart Grid Communications Backhaul

Description

Avista's smart grid data and communications backhaul in the Spokane metropolitan area is primarily supported by a private high speed and high bandwidth fiber infrastructure MPLS backbone that also supports substation integration and corporate network data and voice communications to Avista offices and generation facilities. Gateway radios for the Spokane area wireless mesh network reside at substation locations where IEDs were installed or planned for installation on the electrical distribution network served by that substation.

Avista's smart grid data and communications backhaul in the Pullman region is primarily supported by a private high speed and high bandwidth MPLS over fiber infrastructure backbone that also supports substation integration and IP telephony to three substations, in addition to corporate network and IP telephony to the Pullman local construction office. Spokane and Pullman private MPLS networks are linked via fiber, as well as bonded leased services utilized as a secondary connection in the event of fiber interconnect failures.

Primary goals and decision point for an MPLS architecture included the following:

- Avista wanted to best leverage the fiber network for other use cases in addition to smart grid
- Avista wanted to provide network virtualization and segregation of services across use cases
- Avista wanted to utilize a standards-based protocol overlay to the fiber network

Avista's private MPLS network provides a secure, reliable, scalable network backbone for smart grid communications that supports IP addressable wide area wireless network for smart grid and metering telemetry.

Funding Source

Funding for MPLS backbone in Spokane and Pullman regions were primarily provided through the Smart Grid Investment Grant and Smart Grid Demonstration Project.

Status/Timeline

The bulk of the smart grid communications backhaul infrastructure installation in Spokane and Pullman regions were completed between 2010 and 2012. Projects that are currently or planned to leverage or extend backhaul capability or MPLS network reach include a business continuity project that is currently active with planned completion date of 2015 that will increase the availability and resiliency of the MPLS fiber interconnect between Spokane and Pullman by providing alternate path redundancy. Avista smart grid communications roadmap includes further integration and leveraging of the MPLS backbone to provide network services over a common platform that provides resilient, multi-tenant, multi-use, secure, reliable, scalable, and low latency communications.

Update

In parallel with Avista smart grid initiatives, a telecommunications High Voltage Protection (HVP) initiative mandated the refresh of end of life telecommunications protection equipment protecting leased wire-line services to substations serving substation SCADA and phone in 2010. This provided an opportunity to leverage and extend Avista's private MPLS network by migrating leased wire-line services to services provided over Avista's private MPLS backbone. Because fiber is a dielectric medium and non-conductive, this was a more suitable option for the delivery of communication services into substation high voltage environments versus leased wire-line. During 2012 and 2014, HVP project have extended the MPLS network to an additional 10 substations in the Spokane and Coeur d' Alene region. Avista's current MPLS network interconnects 52 Avista facilities to include substations, local offices, call centers, and corporate; and covers regions in Spokane, Lewiston, Pullman, Moscow, Post Falls, and Coeur d' Alene.

Lessons learned from the current-state backhaul engineering and deployment include the following:

- Relatively limited product offerings and environment-related equipment standards can drive sub-optimal network design. Grid network designers should keep up on vendor offerings and consider planning relatively short infrastructure equipment refresh cycles for the time being.
- Combining layer two VPN architecture and MPLS L3 VPN architecture can prove challenging. Backbone designers should consider using solely L3 VPN architecture.
- Flexible, open Network design has proven to be the right approach for Avista. It has made broader use of the MPLS network relatively easy, allowing expansion of services and integration with other enterprise network backbone segments less complicated than it would have been had a closed system design base been used.
- Network provision tools specific to MPLS should be considered from onset as early adopted design requirement.
- Comprehensive network monitoring and management tools that support end-to-end (wired and wireless) are critical for effective network operations.

Avista continues to architect network capabilities that leverage or extend the MPLS network. Avista's future-state smart grid communications roadmap includes:

- Addressing future security needs
- Supporting increased availability and fault tolerance
- Supporting low-latency applications
- Enhancing network management capabilities
- Network convergence to a single coherent architecture

Benefits Description

Benefits realized (not including benefits of enabling smart grid technologies) of the backhaul architecture are described below for the following categories.

- **Cost Effectiveness:** The cost effectiveness of the communications infrastructure enabling smart grid functions is a contributor to the overall cost effectiveness of Avista's smart grid system. Avista has leveraged and extended parts of its existing privately owned fiber infrastructure for a large percentage of its smart grid communications backhaul. In addition to smart grid communications, Avista leverages its backhaul infrastructure for multiple use-cases; including but not limited to, corporate network communications, and IP telephony. This makes it difficult to quantify the cost effectiveness supporting smart grid communications; however, it is believed to be lower a lower cost model than other available options for providing communications backhaul services including wireless and wired leased services. Wire-line based leased services into substation high voltage environments require high voltage protection and isolation equipment, whereas private fiber-optic services to substations are non-conductive and immune to the effects of high voltage. Wireless services are typically lower bandwidth point to point communications between the customer and the carrier and Avista's head end; are not available in all services regions; and do not provide the reliability and scalability that leased wire-line or private fiber infrastructure can provide.

- **Operational Savings:** The communications infrastructure enabling smart grid functions is a contributor to the overall operational savings observed with Avista's smart grid system. The operational costs of the communications infrastructure are a factor to the achievable operational savings that can be provided by Avista's smart grid system.

- **Effects on System Capability to Meet or Modify Peak Loads:** Smart grid communications infrastructure supports smart grid device functions that enable electric system capability to meet or modify peak loads. The effects on system capability are quantified in other sections of the report not specific to communications infrastructure.

- **Effects on Reliability:** The availability of smart grid communications infrastructure services supports smart grid device functions that enhance the reliability of the electric system. The effects on the reliability of the electric system are quantified in other sections of the report not specific to communications infrastructure.

- **Effects on Integration of New Loads:** Smart grid communications infrastructure supports smart grid device functions that enable electric system capability to integrate new loads. The effects on integration of new loads are quantified in other areas of this report not specific to communications infrastructure.

- **Cyber and Physical Security Of Utility Operational and Customer Information:** Avista's private MPLS backbone that supports smart grid communications provides a more secure method for transport of utility operational and customer information by providing network segregation and packet encapsulation. In addition, secure socket layer (SSL) encryption techniques are used for transport of SCADA communications and data that is classified sensitive. The smart grid MPLS network was able to be leveraged to provide communications for IP-based access card readers, allowing enhanced physical security at certain substations and switchyards.

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** Avista's MPLS network supports interoperability and transport of multi-protocol communications believed to support future use-cases for smart grid functions.

- **Non-quantifiable Societal Benefits:** Smart grid communications infrastructure supports smart grid device functions that provide societal benefits that are difficult to quantify such as energy efficiency leading to reduced atmospheric pollution and the societal benefits of reduced outage durations. These non-quantifiable societal benefits are described in other areas of this report not specific to communications infrastructure.

- **Other Benefits Realized:** The following benefits are:
  - **EBC – Utilization of MPLS for Redundant Network Paths:** Enterprise Business Continuity plans will be able to utilize the future expansion of the original Smart Grid MPLS network to support Avista remote sites connectivity to the disaster recovery data center as well as a secondary path to Internet services supporting existing business functions and future initiatives.

  - **Leverage Interoperability and Services for HVP:** The MPLS network was leveraged for replacement of two- and four-wire circuits for telephone and DMS at certain substations with IP network transport.

  - **Trunked Radio System Backhaul:** The MPLS network transport supports reliable IP communications linking radio base station sites to the control nodes enhancing Avista's next generation 2-way radio system. The network provides communication resiliency that could not be achieved in the original point-to-point communication design.

- **Lewiston Call Center:** The Lewiston Call Center Data traffic for customer support and corporate communications was moved from conventional WAN circuits to the MPLS backbone, resulting in far higher bandwidth and better customer support.

- **Automated DNX Control:** The MPLS network was leveraged to provide a network for automated reconfiguration of DNXs resulting in much faster restoration of SCADA circuit failures between three key substations.

- **Pullman Service Center Network:** The Lewiston Call Center Data traffic for customer support and corporate communications was moved from conventional WAN circuits to the MPLS backbone, resulting in far higher bandwidth and better customer support.

- **Generation Control Locations:** The MPLS network was leveraged to provide high-speed backhauls for segregated corporate networks to two of Avista's generation facilities (BPKCT and NECT). The result was better performance for general network connectivity. Control Network traffic (generation control and monitoring) for a combustion turbine generating facility was also moved to the MPLS backbone-migration from SONET.

- **IP Telephony to Substations:** The MPLS network was leveraged to for replacement of telephone circuits, replacing them with Voice over IP.

Cyber Security Plan

Description

At the outset of the Smart Grid projects, Avista created a Cyber Security Plan to outline management's intentions for the secure implementation of Smart Grid technologies. The goal of this plan was to follow a cyclical strategy with the following components:

- Risk Assessment
- Selection of Controls
- Implementation of Controls
- Assessment of Controls
- Authorize the System of Controls
- Monitor the Controls

This strategy has been dubbed the "Security Life Cycle Approach" and is intended to be repeated over time as technologies and their respective risk profiles change and evolve. This life cycle will help Avista ensure that technologies are deployed in a secure fashion and remain secure during their use.

The Enterprise Security Committee is responsible for oversight of the plan and related activities. Avista formed a Smart Grid Security Working Group to perform the steps outlined in the plan and report to the Enterprise Security Committee, and senior management when appropriate. The Smart Grid Security Working Group was made up of a representative cross-section of people from all areas related to the Smart Grid Projects including representatives from the Meter Shop, System Protection, Transmission and Distribution, Network Operations, IT Security Operations, Web Application Development, and others as necessary.

Funding Source

SGIG and SGDP Projects

Status/Timeline

The Cyber Security Plan was originally created in March of 2010 in preparation for the project to begin and has been updated a number of times since. The most recent revision is dated November 11, 2011. The plan, as well as system-specific security plans, are reviewed once per year and updated as necessary.

The Smart Grid Security Working Group was formed in 2010 as well and met weekly to address any new or upcoming issues and perform the evaluations of the effectiveness of controls and make recommendations to the Enterprise Security Committee. Items such as data integrity and the protection of customer information were considered each time a particular technology was assessed for Smart Grid implementation. Initially, industry best practices, based on a variety of guidelines and standards, were used in this evaluation. It quickly became apparent that the guideline known as NISTIR 7628 would be the most appropriate for our scenario as it deals directly with "Guidelines for Smart Grid Cyber Security." This became the standard by which Smart Grid security was measured at Avista.

As the solutions and control structures became solidified and the installations of new equipment began to wane, the group met only once per month (beginning in May of 2012). In January 2014 the Smart Grid Security Working Group was combined with a newly-forming Enterprise Security Working Group to carry out similar functions to those related to the Smart Grid, but in the greater context of security for the entire company. This group continues to meet monthly.

For all intents and purposes the Smart Grid projects are complete, yet the cyber security aspects continue on an on-going basis. Smart Grid security has been folded into the overall security control structure for the enterprise.

Update

As stated above, the Enterprise Security Working Group meets once per month and is responsible for handling any security-related issues or reoccurring Smart Grid security tasks. The following list is not all-inclusive, but provides a few examples of the kinds of things the group does:

- Review the Smart Grid AMI System Security Plan (annual)
- Review the Smart Grid DMS System Security Plan (annual)
- Review the Annual Smart Grid Vulnerability Assessment (annual)
- Review Exceptions to the Smart Grid Security Policy (annual)
- Perform Incident Response drills (annual)
- Assess and monitor the security of customer information (on-going)
- Other

Benefits Description

The benefits of having a Cyber Security Plan are numerous, especially if one considers what could occur in the absence of one. Here are a few of the benefits:

- **Cost Effectiveness:** N/A

- **Operational Savings:** N/A

- **Effects on System Capability to Meet or Modify Peak Loads:** N/A

- **Effects on Reliability:** Ensuring the security of Smart Grid devices helps to ensure the availability (i.e., reliability) of systems and services.

- **Effects on Integration of New Loads:** N/A

- **Cyber and Physical Security Of Utility Operational and Customer Information:** The Enterprise Security Working Group is made up of representatives from multiple areas of the company. Monthly meetings are an opportunity to share what is going on from a security perspective, keep everyone up to date, nurture a shared vision, and continually monitor the security of customer information and utility system integrity.

The cyclical nature of the life cycle ensures that systems remain in a secured state over time. Periodic testing of controls identifies new vulnerabilities or potential compromises and allows for evaluation of controls for potential improvements.

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** As mentioned above, the primary compliance standard used for this project was the NISTIR 7628, Guidelines for Smart Grid Cyber Security. The guidelines are currently in their 1st revision, made up of 3 volumes. The first volume contains a section describing high-level security requirements. These requirements are those that were built into our Smart Grid Security Framework from the start. Volume 2 focuses on privacy. As stated above, privacy has also been a key focus as the Smart Grid projects progressed. (Note: Volume 3 is a report on Supportive Analyses and References. Good information, more useful in a “what-not-to-do” exercise).

- **Non-quantifiable Societal Benefits:** It is not possible to quantify the absence of a security breach. When such breaches do occur, the lost time and money can be counted in hours, minutes, dollars and cents. The immeasurable benefits of deploying smart grid technologies in a safe and secure fashion include efficient and consistent operation of the electrical system, the protection of customer privacy and personal information, and public confidence in Avista’s competency, integrity, and ability to consistently and reliably keep the lights on.

Demand Response – Residential/In-Home Display

Description

As a part of the Smart Grid Demonstration Project, Avista implemented a residential demand response program using Smart Thermostats and advanced predictive analytics to initiate automated direct load control events for electric space heating and/or cooling loads in the Pullman/Albion Washington Community. The purpose is three-fold. First, Avista is required at a project level to automatically respond to the regional value signal to curtail loads. Second, Avista is testing residential demand response cost effectiveness. The third purpose is to learn the value predictive analytics provides to demand response event planning in comparison to the traditional command/control of demand response programs.

In addition, the enabling technology for demand response, the smart thermostat, serves as an In-Home-Display for participating Demand Response customers to view near real time electric usage. This too is a project level requirement. Avista is interested in learning the current and persistent values customers have for In-Home-Displays.

The program began June 2012 and will continue through December 31st, 2014.

Funding Source

Funding for this program was provided under the Smart Grid Demonstration Project (SGDP)

Status/Timeline

Smart thermostats were installed in customer homes between June 2012 and October 2013. Demand Response events have operated regularly as needed since installation and will continue through July 31st, 2014. Customers will then be given the option to keep the Smart thermostat or have their old thermostat reinstalled.

Update

Program results will be thoroughly evaluated Q4 2014.

Benefits Description

This program is available to customers with an AMI meter (Advanced Metering Infrastructure). Benefits from this program will be evaluated Q4 2014 to determine cost effectiveness and if a similar program should be implemented when AMI is deployed to customers throughout the Avista service territory.

- **Cost Effectiveness:** Quantification of results to be complete by the end of 2014.

- **Operational Savings:** the system provides savings by allowing operation of assets with minimal human intervention. Quantification of operational savings to be reported at end of 2014.

- **Effects on System Capability to Meet or Modify Peak Loads:** the scale of assets influenced by the transactive system is small, but the system is expandable and at a larger scale can provide demand response of sufficient size to help meet or modify the energy of peak loads. Avista is actively analyzing potential for the system beyond the current installation with quantification by the end of 2014.

- **Effects on Reliability:** the system has proven it can respond to the transactive signal as well as an internal signal for immediate response to grid needs, potentially increasing reliability.

- **Effects on Integration of New Loads:** the system has been designed for prediction and operation of distributed assets regardless of type. Accordingly, new types of loads such as electric vehicle chargers can be managed for DR, load balancing, and time of use scheduling. Recommendations and quantification of capability to be completed by the end of 2014.

- **Cyber and Physical Security Of Utility Operational and Customer Information:** Protection of customer privacy and customer data is paramount in the design of this program. Pairing of the thermostat to the electric meter is performed by Avista using pre-gathered data from the thermostat manufacturer. Once the thermostat is installed, it utilizes Zigbee SEP to communicate with the meter. Proximity must be close without much obstruction for communications to be complete between the thermostat and meter.
    - Avista follows strict security practices for data transfers.

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** the system utilizes available interoperability and communication standards.

- **Non-quantifiable Societal Benefits:** the system can provide customer feedback for enhanced lifestyle benefits and can also provide diagnostics of customer systems via utility analysis. Final reports due at the end of 2014.

Distribution Management System (DMS)

Description

As part of both the SGIG and SGDP smart grid projects, Avista elected to purchase a centralized Distribution Management System (DMS). The DMS system controls all smart field devices remotely and performs automated restoration, conservation voltage reduction, and power factor correction. Avista selected Efacec ACS's DMS system for implementation. This system is a distribution SCADA system with add-on predictive applications to perform Fault Detection, Isolation and Restoration (FDIR) as well as Integrated Volt VAR Control (IVVC).

The hardware for the DMS deployment includes 6 physical servers – a redundant set of 3 systems – along with a single virtual machine for non-operator views. This year the DMS will transition to running entirely on virtual servers to provide greater reliability.

Deployment of this system involved extracting a distribution model from Avista's GIS that would provide a graphical representation of the feeders and all its components in the DMS. Given that the predictive applications are model based, the DMS model needed to clearly represent all electrical components, smart and non-smart. Focus was given to insure the model export process was repeatable given that new equipment is frequently added in the field and thus our GIS model.

An important piece of DMS deployment was to ensure a real time device status syncing of all devices (smart and non-smart) between the DMS and GIS based Outage Management System. In order to ensure the safety of crews and the safe operation of our system, it is important that any topology changes that occur in OMS or DMS get shared to the other system in a near real time manner. Tools were developed internally and with the DMS vendor to pass devices states between the DMS and OMS.

Funding Source

SGIG and SGDP projects

Status

DMS deployment is completed 2013.

Update

72 feeders are currently modeled in the DMS system for use with the DMS predictive

applications of FDIR and IVVC.

Additional feeders are being added as part of the Grid Modernization Program.

Although the initial plan was to perform a GIS to DMS model extraction nightly, this frequency proved to be too cumbersome. GIS to DMS model extraction is presently performed weekly to capture any new equipment. This frequency is modified if switching operations require devices which were recently added during design process.

Real time syncing of device states between DMS and OMT is running 24/7 to pickup and share device state changes between the two systems.

Benefits Description

The DMS systems predictive applications improve reliability and energy efficiencies. The DMS systems automated reliability application is referred to as Fault Detection Restoration Isolation and Restoration (FDIR). The Integrated Volt Var Control (IVVC) application is the automated application used to improve energy efficiencies. The DMS predictive application benefits are summarized in their corresponding sections. In addition to the predictive applications, the DMS system provides operational benefits by automated switching and tagging operations as well as the opportunity to remotely operate station and line regulators. The summary of these benefits are summarized in their corresponding sections also.

Energy Alerts and Notifications

Description

The Avista Smart Grid Demonstration Project (SGDP) alerts and notifications program notifies customers when they reach a bill target set by them, or daily and weekly usage messages. These messages also provide customers an estimated range of their next bill based on their usage history and current and forecasted weather. Residential customers in the SGDP Pullman/Albion Washington Community are eligible to participate and can receive alerts/notification messages by text on their mobile device, email or both. This tool delivers a direct value of the Smart Meter to customers who choose to use it by giving customers a way to see near real time usage and its impact on their bill early enough in their bill cycle to make choices that will affect their overall bill.

Funding Source

Funding for this program was provided under the Smart Grid Demonstration Project (SGDP)

Status/Timeline

In-progress. Fully implemented early Q2, 2014.

Update

Program results will be thoroughly evaluated Q4 2014.

Benefits Description

- **Cost Effectiveness:** alerts and notifications are being successfully delivered to customers as designed. Quantification of results to be complete by the end of 2014.
- **Operational Savings:** Quantification of results to be complete by the end of 2014.
- **Effects on System Capability to Meet or Modify Peak Loads:** Quantification of results to be complete by the end of 2014.
- **Effects on Reliability:** Quantification of results to be complete by the end of 2014.
- **Effects on Integration of New Loads:** Quantification of results to be complete by the end

of 2014.

- **Cyber and Physical Security Of Utility Operational and Customer Information:** Customers must authenticate on Avista's website to enroll. Then enrollment is complete when a customer responds positively, "YES" to the enrollment text message on their phone. All data transfers are done through an SFTP process w/proper encryption.

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** the system utilizes available interoperability standards.

- **Non-quantifiable Societal Benefits:** Customers interested in viewing this data are more engaged in managing their energy usage and controlling costs.

Fault Circuit Indicators (FCI)

Description

Avista has deployed smart Fault Circuit Indicators (FCI) to further enhance the capabilities of the DMS and the Outage management System (OMS) in the City of Pullman and at some test sites in the Spokane. The 130 FCIs have been installed at primary fuse locations and main feeder junctions on 8 of the 13 Smart Grid feeders within the SGDP project.

The FCIs will be located at key junction points to detect fault current and help identify the actual location of the fault. The information gathered from the Fault Circuit Indicators will be transmitted using On-Ramp communication technology. The On-Ramp technology has a much greater range than the current Tropos communications technology but less data bandwidth. So it is expected to work well with smart equipment that does not require continual data transfers, such as Fault Circuit Indicators.

On-Ramp also provides a web-based application called Total View that manages and monitors the Fault Circuit Indicators. The Total View application enables real-time monitoring and management and provides remote configuration as well as a breadth of alarms to ensure complete operational visibility. As part of this project, Avista has contracted with On-Ramp to be the system administrator for a period of 1 year. This enables Avista to become familiar with this technology under the tutelage of the manufacturer.

Funding Source

SGDP Project.

Status/Timeline

The project is in progress. All Fault Circuit Indicators have been installed. Integration with the DMS and OMS is currently under way.

Benefits Description

- **Cost Effectiveness:** The installation of smart Fault Circuit Indicators will help to identify the location of faulted equipment faster by reducing the potential area where the fault has occurred and reducing the time to locate a fault.

- **Operational Savings:** Minimizing the area of the potential fault will reduce the time spent by First Responders patrolling in their vehicles to locate the fault. In areas of underground facilities the time spent can be substantial.

- **Effects on System Capability to Meet or Modify Peak Loads:** Data from the Fault Circuit Indicators will be used help analyze the loading on feeders and support load balancing to achieve system optimization objectives to maximize loss reduction.

- **Effects on Reliability:** The addition of Fault Circuit Indicators to the existing switch assets controlled by the DMS will facilitate better location of feeder lateral faults and quicker crew response thereby reducing the overall outage time. The company's response to outages and overall system reliability indices will improve with this technology.

- **Real Time Email Notifications will Alert Operations that a Fault Has Occurred:** Currently, faults that trip protective devices downstream of the DMS smart devices must be identified by a customer outage call.

- **The Integration of the Data from the FCIs May Allow for Automated Damage Assessment:** Further analysis and development of this enhancement will be explored as part of this project.

- **Effects on Integration of New Loads:** Fault Circuit Indicators data can be used to better understand where and when electricity is being used and help with system planning and identifying load growth.

- **Cyber and Physical Security Of Utility Operational and Customer Information:** Fault Circuit Indicators do not directly provide customer information. Information collected by Fault Circuit Indicators is used to manage Avista's electric distribution Grid. The Fault Circuit Indicators are part of the Smart Grid Vulnerability Assessment plan. The Enterprise Security Working Group meets monthly to assess both customer and utility vulnerability.

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** N/A

- **Non-quantifiable Societal Benefits:** The Fault Circuit Indicators minimizes the area of the potential fault will reduce the time spent by First Responders patrolling in their vehicles to locate the fault. The reduced patrolling will provide a reduction in $CO2$.

Fault Detection Isolation and Restoration (FDIR)

Description

One of the predictive applications of the DMS system Avista integrated is Fault Detection Isolation and Restoration (FDIR). Avista chose to deploy FDIR for all 72 feeders included in the SGIG and SGDP projects. FDIR allows for increased reliability for customers with rapid restoration (under 3 minutes) when a feeder breaker has opened due to a fault on the feeder.

FDIR analyzes all the fault targets that it received from the switches and breakers along that feeder to determine which section the fault is located in. Once the application determines where the fault is located, FDIR sends a command to the switches or breakers both upstream and downstream of the fault. This isolates the fault from being reenergized during the restoration of customers outside of the faulted area. With the fault isolated, FDIR then restores customers upstream of the fault by closing in the breaker that original opened and triggered FDIR. Upstream restoration reenergizes the customers with the same source they were on before. There is no risk for overloading equipment along the feeder given that this load was on the feeder prior to the fault.

However, downstream restoration requires FDIR to consider which adjacent feeders could handle the transfer of load without overloading equipment. FDIR determines adjacent feeder capacity by running a power flow analysis of the feeder. The power flow analysis leverages the real-time telemetry to determine feeder loading prior to the fault. If an adjacent feeder has the capacity to support the customers downstream of the isolated fault, FDIR sends a close command to a normally open tie switch. The full FDIR process takes place in under 3 minutes. Prior to implementing FDIR on a feeder, this process would take 1-3 hours.

Funding Source

SGIG and SGDP projects

Status

Actively deployed in upstream and downstream mode on the 72 SGIG and SGDP feeders.

Update

Safety was of the utmost concern during FDIR commissioning. Avista wanted to safeguard against any misoperation of FDIR's switching operations. To demonstrate the securities embedded in the FDIR application, Avista utilized a simulation environment to evaluate a variety of use case scenarios. Use case scenarios were able to address many questions that field personal had regarding the conditions for which FDIR would and perform restoration. The use case scenarios were also very useful tools for training Distribution Dispatchers that would be manning the DMS system.

As a part of the commissioning process, field tests were done to demonstrate the capability of FDIR in a real world environment. Field devices were bypassed to prevent customer outages as switches were requested to open from an FDIR event. A fault was simulated by a relay technician by injecting current at the Current Transformer (CT) at a substation breaker to mimic a downstream fault. In addition, the relay technician initiated fault targets to simulate a fault at a predetermined section. FDIR was allowed to perform upstream restoration and downstream restoration on this feeder.

This test was repeated on several feeders. The test provided validation to operation staff of FDIR as well as coordination with distribution protection settings.

Once FDIR simulations and demonstrations were complete, the FDIR was deployed on 72 feeders in a supervised mode. In this mode, FDIR performed the fault detection and created a switching notice for isolation of the fault and upstream restoration without actually implementing the notice. These switching notices were stored in the DMS SWORDER tool for the Distribution Dispatchers to review prior to being executed. After several months in this mode, FDIR was set to Auto Upstream mode. In this mode, FDIR would perform the fault detection, isolation and upstream restoration and generate a downstream switching notice in SWORDER for the Distribution Dispatcher to review prior to implementation. After several additional months in this mode, FDIR was set to full upstream and downstream restoration mode.

Given the success of the FDIR deployment for the SGIG and SGDP project, FDIR will be considered for deployment on each of the 6 Grid Modernization feeders upgraded annually.

Benefits Description

- **Cost Effectiveness:** Both the Spokane project (SGIG) and Pullman project (SGDP) grants require Avista to report the reduction in customer outage minutes. The reduction is attributable to remote switching capability as well as the automated distribution management system (DMS) application that is responsible for fault detection, isolation and restoration (FDIR). The table below provides the to-date savings in customer outage minutes and an assumed value to the customer of $100/customer outage hour. Avista did not assume a revenue benefit for higher reliability.

Task	Number of Events	Minutes	Energy Savings ($100/Customer Outage Hour)
FDIR	7	389,070	$648,450
Remote Switching to Restore Outages	5	83,155	$138,592

- **Operational Savings:** N/A
- **Effects on System Capability to Meet or Modify Peak Loads:** N/A
- **Effects on Reliability:** Prior to smart grid, when a feeder breaker locked open, a serviceman would have to patrol the entire main feeder trunk to determine where the fault was. This was not only time consuming but also left our customers in the dark until the problem could be found and isolated for restoration of customers not in the faulted section. FDIR's ability to rapidly determine the location of the fault, isolate the fault, and restore customers up and downstream of the faulted area has had positive effects on our reliability indices

Smart Grid Reliability Improvements	June	YTD	ITD
Customer Minutes Saved	53,372	270,044	1,067,880
SAIFI Improvement	6.51%	3.51%	3.55%
SAIDI Improvement	1.73%	1.70%	1.45%
CAIDI Improvement	-5.11%	-1.87%	-2.18%

Note: CAIDI is a negative number because FDIR reduces the number of short customer outages. In affect it reduces the base of short outages. It doesn't actively make CAIDI worse, rather the average time a customer is out must increase as the quicker outages are eliminated. (Less than 5 minutes eliminates it as a sustained outage).

- **Effects on Integration of New Loads:** N/A
- **Cyber and Physical Security Of Utility Operational and Customer Information:** N/A
- **Interoperability and Upgradability of Technology and Compliance with National Standards:** N/A
- **Non-quantifiable Societal Benefits:** N/A

Green Button Initiative

Description

Currently Avista provides residential customers through rate schedule 22 and business customers through rate schedule 21 the ability to download 24 months of energy usage and billing data through the on-line Bill Analyzer tool. Large Commercial and Industrial customers, rate schedule 25, have access to their data on a daily or greater frequency of their choice by means of a manual report generation process done in the Avista meter shop. In addition, Smart Grid Demonstration Project (SGDP) customers in the Pullman/Albion community (residential and small/medium business) can download five-minute electric interval usage data and daily gas usage data.

The Green Button initiative is becoming more widely recognized by consumers. While Avista is already securely providing our customers with energy usage and billing information online, we are proponents of having a standardized format for customer to downloads. In the future, Avista will work to provide customer data in the standardized Green Button format.

Funding Source

This project is not yet funded.

Status/Timeline

Avista is currently evaluating Green Button implementation options with the goal to roll-out the Green Button tool after Avista’s new customer service system is fully implemented.

Update

N/A

Benefits Description

The Green Button Initiative will help Avista more effectively communicate energy usage customers in order to keep them informed about their energy use, and provide a foundation for future applications. Specifically, the following list of benefits can be attributed directly to Avista's future implementation of the Green Button standard.

- **Cost Effectiveness:** N/A
- **Operational Savings:** While Avista cannot currently quantify the amount of operational saving, adoption of the Green Button standard could potentially mitigate some customer inquiries regarding explanation of their billing statement and usage.
- **Effects on System Capability to Meet or Modify Peak Loads:** N/A
- **Effects on Reliability:** N/A
- **Effects on Integration of New Loads:** N/A
- **Cyber and Physical Security Of Utility Operational and Customer Information:** Protection of customer privacy and customer data is paramount in the design of this program.
- **Interoperability and Upgradability of Technology and Compliance with National Standards:** N/A
- **Non-quantifiable Societal Benefits:** The value of the Green Button tool is to help customers better understand their energy use and support an elevated level of customer engagement. With a better understanding of their energy use, customers manage their energy use more effectively and save on their energy bills.

Integrated Volt Var Control (IVVC)

Description

Integrated Volt Var Control (IVVC) is one of the applications embedded in the DMS system that Avista elected to deploy. This IVVC system has two main components: Capacitor Bank Control (CBC) and Voltage Control).

Capacitor Bank Control (CBC) is the application for power factor correction in the DMS. CBC allows remotely controllable capacitor banks to be operated based on predetermined and defined KVAR parameters. 153 remotely controllable capacitors were installed across the 72 SGIG and SGDP feeders. Capacitors ranged from 300KVAR to 1200KVAR in size. Telemetered KVAR values along the feeder are used to determine where KVARs are or aren't needed. Every 30 seconds (a time increment chosen by Avista), CBC checks the telemetry along the feeder to determine if the KVAR is within the desired band of approximately -360 to 360KVAR. If the telemetry indicates that the 3 phase KVARS are not within the desired band, the DMS issues a control command to the capacitor to correct the feeder KVAR. CBC can operate multiple capacitors in one 30 second iteration.

Voltage Control (VC) is the second application embedded in the IVVC application. The VC remote regulator control initiates tap operations based on results of a power flow calculation. Real time telemetered values are polled every 30 seconds and used in a power flow to determine what the lowest and highest voltages are at distribution transformers along the feeder. If the low voltage is outside of the desired predetermined band, then a tap control is issued from VC to the regulator. Given then the accuracy of the telemetry and power flow, Avista was able to implement a conservation voltage reduction (CVR) scheme and lower the voltage along the feeder approximately 2%.

As part of the IVVC deployment, Avista partnered with Washington State University to develop a methodology to quantify the real-time savings of both CBC and VC. The initial focus of WSU's project was to determine the load response to a day when IVVC was running versus a day where IVVC was not running. As the study progressed, WSU discovered that the nexus of the load response were the ZIP parameters of the load. The ZIP parameters are the percent of load that is constant impedance (Z), constant current (I) and constant power (P). As the voltage is lowered for CVR, each load responds differently according to whether it is a Z, I, or P type load. WSU discovered that not only do the loads differ in their response, but also that the ZIP parameters of a feeder are dynamic throughout the day. Presently, Avista is developing a tool to determine the ZIP parameters throughout the day for each feeder. With these values, the actual IVVC savings can be calculated.

Given the successful implementation of IVVC for both the SGIG and SGDP project, Avista has expanding the smart grid foot print through its Grid Modernization Program. The Grid Modernization program is a programmatic 60-year program intended to address our distribution infrastructure while finding the right size of feeder automation for each feeder.

Funding Source

SGIG and SGDP projects
Grid Modernization- Capital

Status/Timeline

IVVC is currently running on the 72 SGIG and SGDP feeders.
IVVC will be considered for deployment as part of ongoing Grid Modernization project on 6 feeders per year.

Update

The next stage of the SGIG and SGDP IVVC projects is the tuning phase. In this phase we are looking at lowering the voltage further where possible and placing additional capacitors on feeders that still need additional KVAR support.

The Smart Grid footprint will be expanded through our Grid Modernization Program 6 feeders will be considered for IVVC automation a year.

Benefits Description

As part of the SGIG and SGDP project, the Utilities and Transportation Commission (UTC) required Avista to provide a third-party verification of the IVVC savings attained across the 72 feeders. Navigant Consulting, Inc. performed the required third-party verification by developing a methodology that relied on direct regression modeling to estimate energy savings.

- **Cost Effectiveness:** The Navigant analysis projected Avista's annual CVR to be about 43,000 MWH annually. To understand how variably this relates to customer billing a more detailed explanation is needed. Per the Navigant report (appendix c) the weighted average voltage reduction factor (CVRf) created using IVVC was 0.883. This factor translates how much the power reduction would be for the 2.02% weighted average voltage reduction IVVC delivered. Multiplying them shows that the average customer should see a reduction in their power use of 1.78% with commensurably lower bills. However, the averages smooth out a wide spread; voltage reduction from 2.6% to 0.84%, CVRf factors from 1.9 to 0.106. This implies that some customers are likely to see power use reduction above 1.78% and some could see reductions well below that. Comparison to prior year bills may or may not demonstrate the savings as one year can be hotter or colder than another or have other local variations outside Avista's control.

- **Operational Savings:** In accordance with the RTF Automated CVR protocol No. 1, Avista was asked to run IVVC only every other day. Navigant utilized the telemetry data from Avista's line devices during this on/off cycling to quantify the energy savings of SGIG and SGDP. Navigant estimated that across the 72 feeders that Avista was attaining 42,374 MWh annually.

- **Effects on System Capability to Meet or Modify Peak Loads:** The peak load relief due to IVVC has to be evaluated on a feeder by feeder basis. During peak load, the quantity of CVR benefits are bounded by two conditions. One is the absolute loading on the line. Heavily loaded lines have more line losses hence a bigger difference between the source voltage and the voltage at the low point. Consequently, heavily loaded lines reduce the amount voltage bandwidth available for voltage reduction. The second bound is by the load composition or ZIP parameters. Initial models from Washington State University suggest the constant impedance loads contribution to total load for some feeders may reduce during peak periods. The constant impedance load is the component of load composition which is significantly influenced by voltage variation.

- **Effects on Reliability:** N/A

- **Effects on Integration of New Loads:** The dynamic ability of capacitor bank control (CBC) allows for immediate response to new inductive added to the distribution system.

- **Cyber and Physical Security Of Utility Operational and Customer Information:** N/A

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** N/A

- **Non-quantifiable Societal Benefits:** N/A

Deployment of Smart Devices

Description

As part of the SGIG and SGDP projects, Avista endeavored to install remotely operable devices on 72 of its distribution feeders. Between 4th quarter 2009 and July 2013, Avista installed 4 types of devices in Spokane and Pullman that would be integrated into an overall Smart Grid system. These devices included 297 reclosers and switches, 153 capacitors, and 216 voltage regulators. All of these smart devices can be operated remotely by either an operator or the predictive applications of the DMS (FDIR and IVVC).

Approximately three hundred, smart switches (S&C SCADA-Mate®) and breakers (G&W VIPER-ST Reclosers®) were strategically placed along feeder trunks with the intent of sectionalizing the load into four nearly equal sections. In addition, smart switches were also placed between feeders as “normally open” points to allow remote load transfers between feeders.

This sectionalizing scheme supports FDIR by allowing for fault isolation and a rapid remote restoration for customers. In addition to supporting FDIR schemes, the smart switches and breakers are used for daily planned switching and tagging procedures. The remote switching and tagging capability has reduced the once manual process from hours to minutes.

As a part of the sectionalizing scheme, a midline recloser was installed with each smart feeder. The midline recloser is a coordinated protection device which will run through a trip and reclose event in response to a downstream fault. The midline recloser device effectively reduces line exposure to events (i.e. customer outages) by approximately fifty percent.

The one hundred and fifty three smart capacitor banks and two hundred thirteen smart voltage regulators were installed as a part of the integrated volt var control (IVVC) component of the DMS. In addition to being controlled by IVVC, these devices are remotely control by a Dispatcher should additional voltage or var support be required on either the transmission or distribution systems. In addition, smart voltage regulators can now be controlled remotely by locking the regulator on step. A procedure once done manually by a serviceman is required to parallel feeders.

Given the successful implementation of these smart devices for both the SGIG and SGDP project, Avista has expanding the smart grid footprint through its Grid Modernization Program. The Grid Modernization program is a programmatic 60-year program intended to address our distribution infrastructure while finding the right size of feeder automation for each feeder.

Funding Source

SGIG and SGDP projects – Capital and DOE Grant
Grid Modernization- Capital

Status/Timeline

Smart device deployment under the SGIG and SGDP projects is complete. All devices are energized and in use.

Smart devices will be deployed as part of ongoing Grid Modernization project on 6 feeders per year.

Update

Deployment and remote capability of these devices has proven to be a success. Remote operations are becoming the norm for Avista and expanding the smart grid footprint is now an ongoing piece of the Grid Modernization program.

Benefits Description

- **Cost Effectiveness:** Given that the midline breakers reduced the number of customers subjected to a main truck fault and subsequent power outage, our customers will benefit from the avoid outages. The table below provides the to-date savings in customer outage minutes and an assumed value to the customer of $100/customer outage hour. Avista did not assume a revenue benefit for higher reliability.

Savings Since Q1 2013

Task ($100/Customer Outage Hour)	Number of Events	Minutes	Energy Savings
Midline Operation	5	510,937	$851,562

- Operational Savings: Remotely controllable smart devices have reduced the number of crew hours required to perform switching operations and to place “Hot Line Hold” (HLH) status on devices. The number of remote switching and (HLH) procedures performed since the deployment in 2013 is summarized in the table below (*valid through 7/28/14*). The labor rate reduction was determined by assuming a loaded serviceman rate of $90.00 hour and trip time of one hour and half. This technology is pertinent to both Spokane (SGIG) and Pullman (SGDP).

Savings Since Q1 2013

Task	Number of Operations	Savings
HLH	1,080	$145,800
Remote Switching	281	$37,935

- **Effects on System Capability to Meet or Modify Peak Loads:** The additional smart devices along the feeder (switches and reclosers) allow for more telemetered data to determine loading and voltage all along the feeder. This information can be utilized for optimizing feeder configuration and system planning. During peak loading, load can remotely be transferred from heavily loaded feeders in order to prevent damage to utility infrastructure.

- **Effects on Reliability:** In addition to the benefit of reduced customer outage minutes mentioned above, the smart devices also allow Avista’s operators to transfer large customers and sensitive loads to adjacent feeders remotely during construction on their primary feed. Given that more sensitive trip settings are applied to the feeder breakers upstream of crew construction, these transfers minimize the susceptibility to outages for these customers.

- **Effects on Integration of New Loads:** With the increased telemetry data along the feeder, capacity constraints for future loads along that telemetered section can more accurately be deduced. As new loads come on to the system, planning predictions can be compared to actual load for refinement of future projections.

- **Cyber and Physical Security Of Utility Operational and Customer Information:** The Enterprise Security Working Group meets monthly and annually reviews the Smart Grid Vulnerability Assessment to assess both customer and utility vulnerability.

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** N/A

- **Non-quantifiable Societal Benefits:** The DMS provides the ability to perform remote switching and tagging which results in a reduction in the number of crew trips for both Spokane (SGIG) and Pullman (SGDP). These trip reductions provide a reduction in CO_2. The trip reduction was calculated in miles by assuming an average trip mileage to be 10 miles.

CO_2 Reduction Since Q1 2013

Task	Number of Operations	Trip Mileage	CO_2 Reduction
HLH	1,080	10,800	720
Remote Switching	281	2,810	187

Smart Transformers

Description

As a part of the Smart Grid Demonstration Project three hundred and sixty transformers with enhanced wireless data collection electronics ("Smart Transformers" or ST) have been installed in Pullman since 2012. The three major goals of the installation of smart transformers are as follows: 1) Obtain additional customer loading information to better size future transformer installations, 2) Utilize the smart transformer voltage reads to enhance IVVC model calibration, and 3) Determine transformer useful life by scanning oil and winding temperature.

Funding Source

Smart Grid Demonstration Project

Status/Timeline

To date, three hundred and eighty smart transformers have been installed in Pullman as part of the SGDP. However, due to the complexity of the transformer radio to backbone interface, some 64 +/- are not communicating at this time. Work is underway to determine next best steps. For some ST's, radio upgrades may be warranted. For others leaving them as non-communicating units and avoiding replacement, which would cause an additional customer outage, may be the best option. A working group has been formed to look at all available options to determine the right course of action.

Update

ST data is now available as historical information and can be used for engineering analysis. To date this information has been used to determine actual customer loading for pending customer load additions. This allows accurate loading to be used to size replacement transformer(s).

Further, ST voltage information has been utilized to verify IVVC accuracy. By using models and integrating ST voltage information, our engineers have been able to verify and predict with reasonable accuracy the loss savings and effective implementation of IVVC on various feeders. Using a feeder model with node data provided by ST's, helps to authenticate that the IVVC computer program operates as designed. The ST data was integral to our acceptance testing with the IVVC model provider.

Smart Transformers include custom electronics and design of a new 'mini' communications radio that attaches to each transformer. This causes problems with radio replacement and/or repair if the radio does not communicate properly. Reliable radio communications has been an issue for these ST's. If Avista pursues future purchase and installation of additional ST's, we will require assurances from manufacturers and suppliers that the communications systems have been fully tested, and can be replaced in the field without causing a customer outage.

Benefits Description

- **Cost Effectiveness:** Additional side benefits to ST installations have been installation of newly designed low loss transformers, removal of possible PCB transformers, and replacement of old adjacent facilities. These benefits will be seen by customers as lower lifetime costs for each transformer, elimination of PCB's in the Pullman area, and improved reliability due to replacement of old plant.

- **Operational Savings:** The data provided by each ST will be accumulated and create a historical trend for various customer types. For instance, information about load factor, usage, etc. is expected to be different for commercial customers vs. residential customers. The data must accumulate for several seasons and then will be analyzed by our distribution engineering department. We expect the results will be new methodologies for accurate transformer sizing. Accurate transformer sizing will create direct customer savings due to less cost by utilizing smaller Kva sized transformers for service to new customers. In addition, smart transformers when paired with smart meter information can potentially be used for theft detection.

- **Effects on System Capability to Meet or Modify Peak Loads:** N/A

- **Effects on Reliability:** Historical data and thermocouple date should also provide more predictability on transformer life expectations. This should assist the Engineering department in identifying when a transformer is at the end of its' useful life and when replacement is warranted. This type of preventive maintenance should reduce unplanned outages and overtime labor over the long term.

- **Effects on Integration of New Loads:** The data from ST will assist Avista in building accurate load profiles for various types of customers. These load curves can be utilized to more accurately determine new loading requirements for future loads.

- **Cyber and Physical Security Of Utility Operational and Customer Information:** N/A

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** N/A

- **Non-quantifiable Societal Benefits:** N/A

Transactive Signal System

Description

The transactive signal is the backbone component of the larger Pacific Northwest Regional Smart Grid Demonstration Project (PNWSGDP) lead by Battelle. The transactive signal is an irregular time series of values transmitted by Battelle to the project participants. The transactive signal quantifies the value of energy including all types of constraints so as to provide the understanding of need for load reductions or increases in generation. Avista enlisted participants in a smart thermostat program that enabled the adjustment of temperature set point in return for a $100/year incentive. Approximately 75 smart thermostats were installed.

Washington State University participated by allowing Avista to request that load reductions be initiated with building air handler systems and chillers. Additionally three backup generators were made available for dispatch. The system includes communication technology connecting WSU and Avista for asset operation requests as well as measurement data. WSU substantially upgraded their building management systems as a part of a separately funded project that made the transactive signal system possible. The system has functioned as intended for the PNWSGDP scope of work and can now be leveraged as appropriate when the need for generation or load reduction is beneficial for Avista operational needs.

The solution includes:

- Approximately 39 air handlers at WSU
- Nine chillers at WSU
- Two natural gas backup generators at WSU
- One diesel backup generator at WSU
- A transactive software engine
- Communication directly from WSU to Avista
- 75 thermostats in customer homes
- Predictive analytics engine for thermostat load and availability
- DR engine coordinated with the transactive signal to control thermostat temperature set points.

Funding Source

Funding for this system was included in the larger SGDP project. Project partner, Spirae, provided more than 45% of the funding, the Department of Energy provided 50% and Avista provided approximately 5%. The system leveraged numerous other components of the SGDP project.

Status/Timeline

The transactive signal system has been fully deployed and is operational including a 4 quadrant valuation dispatch tool that guarantees the understanding of cost or benefit to participant and Avista. Plans for the future use of this system will be included in the final reporting for the PNWSGDP project.

Benefits Description

This section should address the following:

- **Cost Effectiveness:** the transactive signal system was primarily funded outside of Avista for the purpose of demonstrating the concept of a transactive system that can automatically react to grid needs for increased reliability. The system has provided results in line with expectations and has provided valuable research results for the DOE, however is not anticipated that the signal from Battelle will be used beyond January of 2015. The system components listed above can be used for utility and customer benefit with minimal expense going forward as appropriate. See the WSU technology report for specific details.

- **Operational Savings:** the system provides savings by allowing operation of assets with minimal human intervention. Quantification of operational savings to be reported at end of 2014.

- **Effects on System Capability to Meet or Modify Peak Loads:** the scale of assets influenced by the transactive system is small, but the system is expandable and at a larger scale can provide demand response of sufficient size to help meet or modify the energy of peak loads. Avista is actively analyzing potential for the system beyond the current installation with quantification by the end of 2014.

- **Effects on Reliability:** the system has proven it can respond to the transactive signal as well as an internal signal for immediate response to grid needs, potentially increasing reliability.

- **Effects on Integration of New Loads:** the system has been designed for prediction and operation of distributed assets regardless of type. Accordingly, new types of loads such as electric vehicle chargers can be managed for DR, load balancing, and time of use scheduling. Recommendations and quantification of capability to be completed by the end of 2014.

- **Cyber and Physical Security Of Utility Operational and Customer Information:** the system was architected to provide cyber & physical security at the equivalent level of smart grid and customer systems. Risk analysis and mitigation strategy was created via the standard Avista process.

- **Interoperability and Upgradability of Technology and Compliance with National Standards:** the system utilizes available interoperability standards.

- **Non-quantifiable Societal Benefits:** the system can manage distributed assets of all types with predictive analytics. Given a larger asset collection, the system can provide customer feedback, balanced loading to reduce peak demand and enhance the grid by reducing the need for new generation. New customer services may be possible. Final reports due at the end of 2014.

AMI Web Portal & Customer Engagement Web-Portal

Description

Avista's web-portal program builds off of the AMI system (Advanced Metering Infrastructure) by delivering near real-time energy usage information to customers via the internet. The program is part of the Smart Grid Demonstration Project (SGDP). Customers can access this tool simply by authenticating on Avista's website, MyAccount, and clicking on their My Advanced Meter icon. This tool also provides pricing information of energy used since the last bill was rendered. All residential through rate schedule 22 and commercial customers through rate schedule 21 have access to this tool, approximately 13,000 customers in the Pullman/Albion community.

As part of this deployment and overall project, Avista implemented a web-portal customer engagement tool also. The Home Energy Advisor (HEA) enhanced Avista's existing on-line home energy audit tool and provided a customer engagement opportunity by offering energy savings ideas and social engagement. Avista deployed this to all residential 22 and below, and commercial customers 21 and below.

Funding Source

Funding for this program was provided under the Smart Grid Demonstration Project (SGDP) and Avista's Demand Side Management tariff rider (a portion of the HEA only).

Status/Timeline

This program is currently in progress as part of the SGDP. The program began June 2012 and will continue through December 31st, 2014.

Update

Program results will be thoroughly evaluated Q4 2014.

Benefits Description

This program is available to customers with an AMI meter (Advanced Metering Infrastructure). Benefits from this program will be evaluated Q4 2014 to determine cost effectiveness and if a similar program should be implemented when AMI is deployed to customers throughout the Avista service territory.

Likewise, the HEA tool will be evaluated Q4 2014 to determine the value to Avista and its customers.

- **Cost Effectiveness:** N/A - in progress
- **Operational Savings:** N/A - in progress
- **Effects on System Capability to Meet or Modify Peak Loads:** N/A - in progress
- **Effects on Reliability:** N/A - in progress
- **Effects on Integration of New Loads:** N/A - in progress
- **Cyber and Physical Security Of Utility Operational and Customer Information:** Customers must first authenticate via web-service on Avista's website. All data transfers are properly encrypted using Secure Socket Layer (SSL).
- **Interoperability and Upgradability of Technology and Compliance with National Standards:** N/A
- **Non-quantifiable Societal Benefits:** N/A - in progress

Demand Response – Commercial

Description

In partnership with Washington State University (WSU), Avista implemented a commercial demand response program as part of the Smart Grid Demonstration Project (SGDP). Demand response events are isolated to the WSU campus in Pullman, Washington. There are five demand response tiers [chiller loads, air-handler loads, 2 tiers of gas distributed generation (DG) and a diesel fired generator, DG] that can be deployed one at a time or in conjunction with one another depending on the need. WSU has a control operator in the middle to accept or reject the event, but otherwise the command and control for the Demand Response events has been established to be a headless (automated) operation. The purpose is three-fold. First, Avista is required at a project level to automatically respond to the regional value signal to curtail loads or dispatch backup generation. Second, Avista is testing commercial demand response cost effectiveness. The third purpose is to learn the value predictive analytics provides to demand response event planning in comparison to the traditional command/control of demand response programs. See the Transactive Signal technology report for details regarding response to the regional value signal

Funding Source

Funding for this program was provided under the Smart Grid Demonstration Project (SGDP).

Status/Timeline

This program is currently in progress as part of the SGDP. The program began June 2012 and will continue through December 31st, 2014.

Update

Program results will be thoroughly evaluated Q4 2014.

Benefits Description

Benefits from this program will be evaluated Q4 2014 to determine cost effectiveness and full business analysis of offering an automated commercial demand response program.

- **Cost Effectiveness:** N/A – in progress

- **Operational Savings:** N/A – in progress
- **Effects on System Capability to Meet or Modify Peak Loads:** quantifiable results will be provided at end of 2014, however the technology has demonstrated that a positive impact can be demonstrated to meet or modify peak loads.
- **Effects on Reliability:** quantifiable results will be provided at end of 2014, however the technology has demonstrated that dispatch of assets is reliable and could be used to increase system reliability. Cost effectiveness to be calculated.
- **Effects on Integration of New Loads:** system could be used for the integration of new loads. Recommendations to be provided by end of 2014.
- **Cyber and Physical Security Of Utility Operational and Customer Information:** All data transfers are performed securely. The Enterprise Security Working Group meets monthly and annually reviews the Smart Grid Vulnerability Assessment to assess both customer and utility vulnerability.
- **Interoperability and Upgradability of Technology and Compliance with National Standards:** Applicable standards have been implemented, however standards are not comprehensive enough for all system capabilities and interconnections.
- **Non-quantifiable Societal Benefits:** the system can provide for reserve capacity, regulation, peak loading, and most importantly provide impetus for the customer to more accurately control their load with more robust internal systems.