Customer Success Story:
Portland General Electric

Markets Served
Commercial, residential

Eaton helps Portland General Electric make tomorrow's smart grid a reality

Location:
Portland, Oregon

Segment:
Utility

Challenge:
Portland General Electric (PGE) needed to develop an energy storage system and customized solution for its new Salem Smart Power Center, a 5-megawatt energy storage demonstration facility.

Solution:
Eaton's power systems engineering expertise and industry-leading solutions helped PGE advance their electrical infrastructure and test new smart grid technologies with business and residential customers.

Results:
Eaton storage inverters operate in conjunction with distributed generation resources to demonstrate a highly reliable medium voltage feeder that serves as a replicable energy storage model, reliably powering commercial and residential customers.

"Together with our project partners and customers, we are demonstrating smart grid technologies to help Oregon and the nation learn how to build intelligent energy resources for the future while continuing to deliver long-term value for customers. PGE is eager to engage in the research and development needed to bring our local and regional grid into the 21st century."

Joey Ross,
Manager of Innovative Solutions, PGE

Background

In 1889, Portland General Electric (PGE) began its business by moving power 14 miles, from a generator at Willamette Falls in Oregon City to Portland, powering 55 street lamps. It was the first long-distance transmission line in the nation. Today, PGE is still on the forefront of energy innovation.

Powering our collective energy demands into the future requires an electrical grid that can do more than move power in a single direction. That grid will need to be smarter and more reliable, evolving alongside consumption habits to respond and accommodate business, residential and community needs. A smarter grid will enable better control of energy costs, reductions in energy requirements, more effective support of sustainability initiatives and improved power reliability.

PGE, Oregon's largest utility, is paving a way to that future. In 2009, the U.S. Department of Energy selected PGE as the Oregon utility partner in the $178 million Pacific Northwest Smart Grid Demonstration Project (PNW-SGDP). The overall project involves more than 60,000 customers in Idaho, Montana, Oregon, Washington and Wyoming.

The regional smart grid project would expand on PGE's existing infrastructure and test new energy storage technologies. It would also test new combinations of devices, software and advanced analytics to better manage energy consumption and enhance the power grid's reliability and performance.

To help achieve the project goals, PGE selected Eaton to develop the smart inverters for an energy storage system and integrate the system with smart grid control solutions. PGE drew upon Eaton's expertise in design, engineering, integration and testing. Eaton also modified award-winning Power Xpert® inverters to seamlessly work with the energy storage system.

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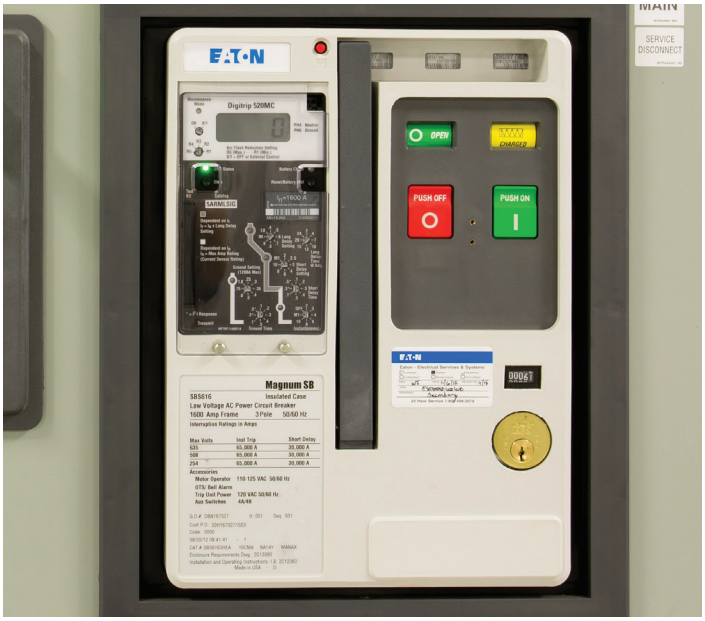
EATON
Powering Business Worldwide

Eaton low voltage switchboards at the Salem Smart Power Center, part of Portland General Electric's Pacific Northwest Smart Grid Demonstration Project.



Eaton Magnum DS® power circuit breakers are used for protection and isolation of the inverter blocks. Eaton low voltage power circuit breaker incorporated at the Salem Power Center.

Challenge

As part of the project, PGE would develop intelligent energy storage for a new Smart Power Center, a 5-megawatt energy storage facility in Salem. In 2009, energy storage with lithium-ion battery technology was just being deployed in utility-scale applications—and the PGE system would be an industry first.

This energy storage facility would be integrated with an existing distribution feeder and utility-dispatched distributed generation, forming a high-reliability zone. This distribution feeder needed to have sufficient energy storage and dispatchable generation, so that it could be operated either connected to the traditional utility supply or as an independent island. Bringing this system online would allow PGE to demonstrate the opportunity for integrated renewable energy resources to increase reliability and efficiency for business and residential customers. The Salem Smart Power Center would also provide a fully operational research model that could highlight the value and potential of these technologies and allow PGE to determine the products and services best suited for the energy storage system and its customers.

Through intelligent power management, the smart grid project can either store or release energy depending on current energy market conditions to optimize lower cost generating facilities. This can have the effect of lowering the utility's costs. The system can also prioritize renewable generation over fossil fuel plants, ensuring that the utility makes the best use of renewable energy that is already available.

To develop the system, PGE required power management expertise and products that could meet quickly evolving grid and consumer demands. To achieve these goals, PGE needed an experienced power management company with knowledge of both low and medium voltage electrical design and applications to provide the skills and project management services to successfully design, build and support the system.

Specific project challenges to be addressed included:

- How can solar and wind energy generated during non-peak periods be stored effectively for residential and commercial use during periods of peak demand?
- How can stored energy be used interactively with electricity generated by industrial facilities and others who generate their own power?
- Can a large number of batteries and inverters operate effectively in parallel?

Solution

PGE worked with Eaton to develop the energy storage system and customized solutions for the new Salem Smart Power Center. Eaton also worked with EnerDel, a leading provider of energy storage technology, to integrate the 5-megawatt, lithium-ion battery system supporting the project.

Eaton created and deployed a sophisticated control interface that operated the energy storage system in a variety of modes, according to PGE specification. Interfacing with inverters, power meters, the EnerDel battery management system and PGE's upstream system controls, the interface control system intelligently coordinates the operation of the inverters and balances demands among the battery blocks. The control system, combined with custom inverter programming, provides seamless support for loads in the event of an upstream outage—keeping the power on for commercial and residential customers served by the rural feeder. System modes allow the operator to request that the batteries be equalized in charge and enable the storage system to respond to real and reactive power commands from PGE. These modes help PGE test their smart grid control algorithms.

Additionally, Eaton engineers customized its Power Xpert inverters for use in the site's energy storage system. The inverters were originally designed to maximize energy harvest from renewable resources and transform energy into clean, reliable alternating current. Control modifications allowed the inverters to operate bi-directionally, converting direct-current (DC) energy from batteries to alternating current (AC) for consumers, or absorbing alternating current from the grid and storing energy in the batteries.

Smart Grid Project Manager Kevin Whitener at the low voltage switchboard in the Salem Smart Power Center.

New Salem Smart Power Center incorporates Eaton's industry-leading storage inverter solutions.

Results

PGE is learning how to advance our nation's electrical infrastructure with Eaton's power management expertise and solutions—making for a smarter and more efficient, reliable and sustainable grid. For more than a century, Eaton has provided innovative solutions that help transform the way our customers consume and manage power.

Unveiled in 2013, the Salem Smart Power Center is now a fully functioning 8,000-sq-ft energy storage facility. With the operational smart grid demonstration site, PGE is testing how to store and better integrate variable renewable energy sources like solar and wind into the electrical grid.

The intelligent energy storage system works with standby generators to create a high-reliability zone, which is able to detect faults and island a medium voltage feeder, helping to improve service reliability. Inside of the high-reliability zone, a 2.5-mile smart feeder system provides reliable power for residential, commercial and light industrial customers. Additionally, the energy storage system has sufficient capacity to support the micro-grid for several minutes, creating a backup power supply in case of an interruption.

In the next two years, PGE will provide test data to PNW-SGDP as one of the project's 13 sites that represent the region's diverse terrain, weather and demographics. The Salem Smart Power Center is testing and evaluating batteries with rapid charge and discharge cycles to determine optimum methods. It is also working with a local manufacturer to test solar storage for a 616-panel rooftop photovoltaic installation to bring solar energy to the grid to support demand when it is needed most.

"Together with our project partners and customers, we are demonstrating smart grid technologies to help Oregon and the nation learn how to build intelligent energy resources for the future while continuing to deliver long-term value for customers," said Ross. "PGE is eager to engage in the research and development needed to bring our local and regional grid into the 21st century."

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EATON SOLUTIONS

Eaton's Electrical Services & Systems team (EESS)
With one of the largest and most experienced teams of power system engineers in the industry, Eaton has an expansive team of utility application experts with a track record of solving unique problems and managing complex, integrated solutions and turnkey projects.

Power distribution
Eaton offers an industry-leading portfolio of products and services that reliably meet the challenging demands of today's electrical grid. Electric utilities rely on Eaton to help automate, protect and optimize the modern electrical grid.

Power distribution solutions installed at the Salem Smart Power Center include:

- **Power Xpert inverters**
  Twenty Power Xpert 250 kW storage inverters were customized for battery storage application. Eaton applied proven power electronics technology, which has been in the field for generations, to a new cutting-edge purpose—controlling a bi-directional battery storage application. The inverters provide full four-quadrant operation with capability to import or export real power while simultaneously responding to reactive power commands.
- **Low voltage switchboards**
  The custom-designed, low voltage switchboards were manufactured at the local Eaton Portland facility. The switchboards have a unique switched grounding system to support system operation in island mode.
- **Custom PLC control system**
  Eaton's Electrical Services & Systems team designed and built a sophisticated PLC-based distributed control system that now operates the energy storage system in various modes.
- **Eaton 9390 UPS**
  The Eaton 9390 uninterruptible power system (UPS) provides a reliable supply of backup power for the inverters and electrical control systems, allowing seamless operation through upstream utility outages.

The automation controller, part of the control system designed by Eaton, coordinates the operation of the inverter–battery system.

Transmission and distribution equipment in the Oxford substation near the Salem Smart Power Center.

Photos courtesy of Portland General Electric.

For additional information about Eaton solutions, visit **Eaton.com**

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