Self-healing Grid Project

PowerStream's Fault Detection Isolation & Restoration (FDIR) system, fully integrated into its state-of-the art control room, is an ambitious effort in automatic isolation and restoration. PowerStream is one of the few utilities in North America moving forward with centralized automatic switching decision-making on a distribution network. Using the SCADA software system and leveraging existing automated switches in the field on all 27.6 kV feeders connected to 2 transformer stations (20 feeders in total), PowerStream is performing a two stage trial of automated system restoration following a feeder fault that trips the feeder breaker. Stage one involves the system creating recommended switching sequences and instructions to provide direction to control room operators to restore service to non-faulted line sections; while stage two is configured to enable automated switching and load transfer using control algorithms to reduce outage restoration times and restore power to more customers in less time. Based on the success of the FDIR trials, PowerStream will consider expansion of this technology to its other transformer stations in its south service territory in 2012-2016. Ontario-based company Survalent Technologies is the SCADA system vendor and developed the programming for the FDIR.

PowerStream	
Ownership	The distribution utility is jointly owned by the municipalities of Barrie, Markham and Vaughan.
Number of Customers	335,000
Number of Employees	513
Gross Revenue in 2010	$163 million ($26.6 million Net)
Electricity Delivered	8,395 GWh
Peak Demand for Power	1,961 MW
Transmission and Distribution Network	2,584 km of overhead circuit wires 4,848 km of underground cable 11 transformer stations 55 municipal substations
Company Description	PowerStream owns and operates $950.6 million in assets, and serves 9 municipalities making it the 3rd largest electric utility in Ontario and 4th largest municipally owned utility in Canada.
Contact	John Mulrooney, Director, Smart Grid Technologies, PowerStream john.mulrooney@powerstream.ca

Objectives & Benefits

The primary benefit of this project is reduced outage duration for customers on the non-faulted sections of the faulted feeder. The FDIR project facilitates supplying power for these customers from alternate feeders during a feeder fault and would leave the "faulted" section of the feeder isolated without power until PowerStream crews address the fault. It is estimated that the outage duration would be reduced by up to 15 minutes for customers on the non-faulted sections of a feeder during a feeder fault through the FDIR project.

A benefit cost analysis was conducted of the first two transformer trials, assuming a value of service of $20,000/MWh to customers[a] and an average outage rate of 0.35 that would be avoided and various other parameters regarding operational costs and economic conditions. This yielded an estimated overall present value project cost of $150,334 and an overall present value benefit of $923,011; a ratio of 6.1. Much of the automated distribution equipment was already installed which enhanced the value proposition for this project. Still the robust economic value of the FDIR was considered comparable to and consistent with other benefit/cost analyses conducted of similar automation projects in the US, regardless of location and feeder voltage.

[a] This number reflects the consumption by customer class in PowerStream's territory where $4,000/MWh was calculated for residential customers and $30,000/MWh for business customers. This value of service was inline with other estimates by Navigant Consulting given the relatively high percentage of consumption by business customers.

Financing

Project Details	
Stage 1 – Semi-automatic data collection and analysis	
SCADA System	20 feeders (27.6 kV) 2 transformer stations
Stage 2 – Fully automatic	
SCADA System	20 feeders (27.6 kV)on two transformer stations
PV of Project Cost	$150,334
PV of Project Value/Benefit	$923,011
Ratio of PV Value to PV Cost	6.1

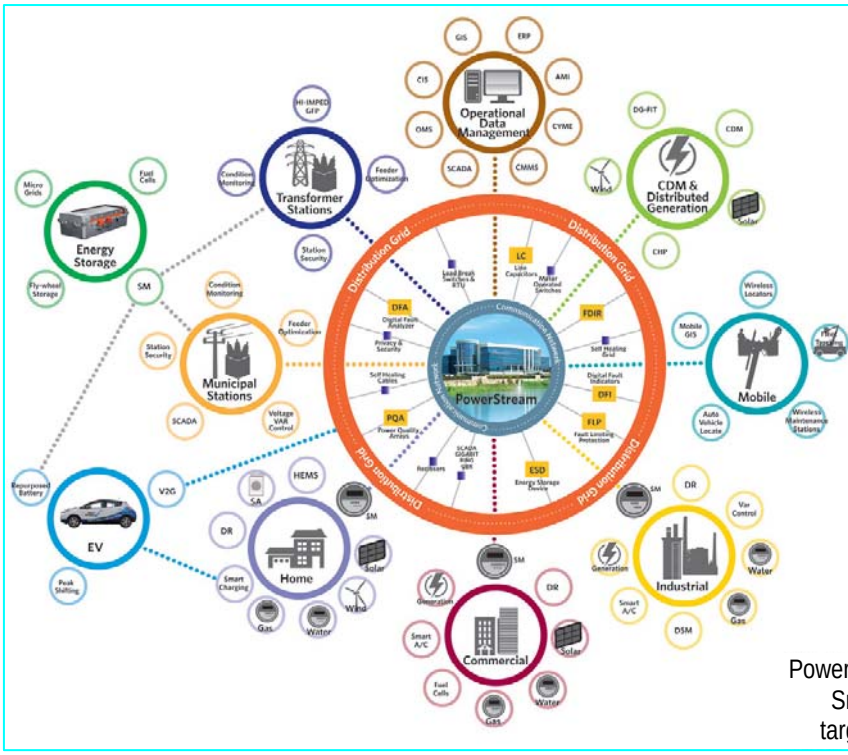
Distribution utilities in Ontario are responsible for the delivery of electricity to customers, the maintenance of distribution wires and equipment, the interconnection of distributed generation and billing. The provincial regulator determines the rates that distributors can charge customers for the delivery of electricity, and in this way influence a distributor's ability to invest in smart grid projects. Most utilities in Ontario are municipally owned, and any profits generated from operations result in dividends to the municipality, or reduced rates for customers. Funding for smart grid projects is thus secured through two main mechanisms, public funding or rate recovery. Rate recovery is more predictable, making it the favoured means of financing by utilities.

Rate-filings require a business case that demonstrates clear value to customers, which at the present time is still being defined for smart grid projects by both the regulator and the utilities. Outside of smart meter deployment, PowerStream's FDIR project has been one of the early success stories in developing its business case. The FDIR project is part of a suite of smart grid projects planned for over 2011-2015 resulting in an annual rate increase from $1.75 in the initial year to $5.22 in the final year, or approximately $0.44 per month. Financing for PowerStream's smart grid projects is facilitated by their Smart Grid Strategy developed and implemented by their Smart Grid Task Force.

Planning for Success & Making the Business Case

The strategy outlines a series of strategic investments in smart grid from 2011-2015. The strategy was developed under smart grid guiding principles which include enabling customer empowerment, improving reliability, exploring regional opportunities, maintaining privacy and security, and supporting a local green energy and economic development goals. The projects are listed under the categories of:

- Consumer Technologies
- Distribution
- Distribution Energy Resources
- Transmission
- Communications
- Electric Vehicles
- Innovation and the Economy



PowerStream's Smart Grid target areas

The Smart Grid Strategy has become integrated with PowerStream's annual capital planning process, which requires smart grid projects to compete head-to-head with other discretionary capital projects being considered. This integrated strategy and process have been critical factors determining PowerStream's ability to finance its projects, attract strong partners, and successfully implement smart grid.

Current Status

At this stage of the project, trials of the fully automated stage two conditions have been in operation but are still considered in a pilot phase until the results satisfy PowerStream by responding to a certain number and variety of outage events. All physical equipment has been installed, and only modifications to the SCADA system as dictated through project trials remain to be implemented.

Lessons Learned & Best Practices

Project management

The Fault Detection Isolation & Restoration (FDIR) project commenced in late 2010 when PowerStream offered to act as a Beta client for this new Survalent product. PowerStream already had remotely controlled switching devices that could be operated from the distribution management system from their control room. Thus, implementing an automated system was not a major technical hurdle, but it did require staff in the control room to be trained and educated on the FDIR scheme. A key feature that facilitated smoother integration of the FDIR into PowerStream's operations was the ability to run the FDIR in semi-automatic mode. Semi-automatic mode allows for the Survalent FDIR software to collect and review the field information, perform an analysis, and present a recommended switching order to isolate the faulted section and restore power to other portions of the feeder. Operating in this mode allowed staff to train and operate the FDIR at the same time. Some change management exercises were conducted, and supported by the confidence building as events occurred and the programming was improved. Some staff identified with the benefits very early on while others required ongoing reassurances. The confidence of the control room staff increased as they became more comfortable as additional events occurred and the tools produced tangible solutions to rapidly restore power to customers affected by the outage.

PowerStream control room with V.P. Operations John McClean, Natural Resources Canada Science and Technology advisor Jennifer Hiscock and PowerStream Director of Smart Grid John Mulrooney

Regular reviews were held between PowerStream and Survalent to review events and fine tune the FDIR tool. Both PowerStream and Survalent have expended resources in enabling the success of this project. It is a "win-win" partnership for PowerStream's customers and Survalent's other clients. Both have been willing partners and had excellent relationships before and during this project. Survalent Technologies continues to export its power systems software to much of the US, Central and South America and Asia, making it one of Ontario's fastest growing smart grid companies. The local economic development component is a priority for Ontario policy and a strategic objective for PowerStream. Subjected to a competitive process, if multiple proponents offer a similar value for cost, PowerSream chooses the Ontario company as a means of fostering local smart grid industrial capabilities for future technology development needs. This practice does not compromise PowerStream's ability to engage with international companies developing smart grid technologies, with a number of other projects supplied from vendors in Europe and the US.

Technical Lessons

The FDIR scheme is only as good as the information it receives. Early on in the project, fault reporting and communication weaknesses of some field devices were identified. As identified, PowerStream worked to improve the accuracy of the field devices and improve communication channels.

As the project evolved, additional issues were identified and acted upon by Survalent. Of note was changing the program to issue a "fast poll" of all downstream field devices on the feeder experiencing a fault. This resolved the issue of some messages getting caught up in a queue or in an incorrect order due to GPS time-stamps. A delay was also built in to the FDIR analysis to allow enough time for information to be received into the SCADA servers to enable a proper recommendation.

Customer Engagement Lessons

Ontario customers are sensitive to electricity prices, and the benefit of smart meters is not yet apparent for many, and for them is considered the face of smart grid. Knowing this, PowerStream implemented a comprehensive customer communications plan prior to and during the deployment and installation of smart meters to diffuse any customer concerns about the devices, and set the stage for future initiatives. Many other smart grid projects such as the FDIR are invisible to most customers, and cause little change to a customer's bill in the short-term. Yet over the longer-term, in addition to reliability improvements, efficiencies gained through smart grid initiatives can help to reduce the upward pressure on customer distribution rates. For this reason, PowerStream designed a communication strategy to inform and educate customers as well as key stakeholders about the benefits of smart grid technologies such as the FDIR.

Building a Smart Grid Strategy

Creating a Smart Grid Strategy demonstrates the need for utilities to maximize the use of existing assets in its technology deployment, and leverage established supplier partnerships. As a strategic planning and communications tool, this is one way of ensuring the benefit-cost ratio for such initiatives is kept as high as possible. It has helped maintain the overarching principal of "benefit to the customer" as the cornerstone to any smart grid initiative at Powerstream. This exercise was informed by the broader thinking around smart grid in Ontario through participation in the Ontario Smart Grid Forum. It includes utilities, companies developing smart grid technologies, system operators, regulators, government and planning authorities. The Forum meetings, stakeholder engagement and reports aid in the institutional learning that is required throughout Ontario in order to successfully implement smart grid.

Ontario's Smart Grid Policy

Ontario's policy environment for smart grid is the most defined in Canada. In April 2004, Ontario announced the deployment of smart meters in all homes and small business by the end of 2010. In 2010, the Ontario Energy Board set mandatory dates for the rollout of time-of-use prices for smart metered customers. As of February 2012, there were over 4.7 million smart meters installed in the province and close to 4 million customers on time-of-use rates. This combination of smart infrastructure along with time-based pricing has unlocked potentials for new business models and system innovations in the province. Under the Green Energy and Green Economy Act of 2009, Ontario's Minister of Energy directed the Ontario Energy Board to promote the implementation of smart grid capabilities. The directive also required that the regulator guide the development of mandatory Smart Grid Plans for distribution utilities, and that those plans be regionally coordinated. Ontario smart grid policy objectives are captured under the 3 focus areas: customer control, power system flexibility, and adaptive infrastructure. These policies coupled with feed-in tariffs for renewable energy, aggressive conservation targets, as well as the Smart Grid Fund, have attracted entrepreneurs, businesses, utilities and venture capitalists to invest in Ontario.

Sections of this case are taken with permission from the PowerStream Smart Grid Strategy, September 2010.
Watch the video about this project: canmetenergy.nrcan.gc.ca/videos/3122.