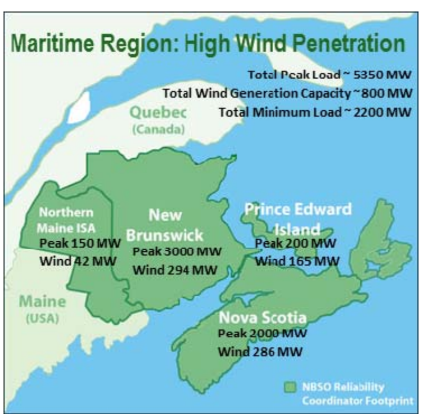
PowerShift Atlantic will demonstrate one of the world's first virtual power plants designed to allow for more effective integration and balancing of wind power onto the power grid. The project is a collaborative demonstration led by New Brunswick Power Corporation (NBPC) in partnership with Maritime consortium members from academia, utilities and government. It is demonstrating the capability of virtual power plants to balance high penetrations of wind power on a cross-jurisdictional system. Unlike typical demand response services, the virtual power plant uses, load and wind forecasting and aggregation capabilities to perform near real-time load shifting of commercial and residential loads and provide new ancillary services to the grid. This project was launched in 2010, and is jointly funded by Natural Resources Canada through the Clean Energy Fund and by members of the consortium.

As of 2013, the Maritime region is host to one of the highest penetrations of wind energy in North America (9%). The variability of the wind generation profile coupled with the existing variable demand profiles are currently balanced with ancillary services which are provided by on-line generators (i.e. oil, gas, coal and hydro) and off-line generators which can be brought on-line quickly as required. Load management via two virtual power plants in the PowerShift Atlantic project could reduce the requirement for ancillary services from existing assets. In this way it has the potential to reduce the costs and emissions associated with the integration of current wind energy in the Maritimes, as well as to increase the potential for future renewable development.

| PowerShift Atlantic Regional Characteristics | |
|---|---|
| Project Ownership | PowerShift Atlantic is a collaboration between:<br>• New Brunswick Power Corporation (NBPC)<br>• Saint John Energy (SJE)<br>• Maritime Electric Company Limited (MECL)<br>• Nova Scotia Power Incorporated (NSPI)<br>• New Brunswick System Operator (NBSO)<br>• University of New Brunswick (UNB)<br>• Government of New Brunswick<br>• Government of Prince Edward Island<br>referred collectively as the consortium. |
| Number of customers | Almost 1 million, across the 4 service areas<br>GWh mix: 40% residential, 26% commercial and 31% industrial loads (balance is street lighting and other non-metered loads) |
| Electricity delivered | 26,055 GWh in 2011 across the 4 service areas |
| Information on hosting utilities and markets | NBPC is owned by the province of New Brunswick. NSPI is privately owned by Emera, MECL is privately owned by Fortis and SJE is privately owned by its rate payers. All utilities are vertically-integrated, except SJE which is a local distribution company for the city of Saint John.<br><br>The NBSO operates the power system in New Brunswick, in Prince Edward Island and in Northern Maine (United States). NSPI operates the network in Nova Scotia. NBSO is the reliability coordinator for New Brunswick, Prince Edward Island, Northern Maine and Nova Scotia.<br><br>There is no wholesale energy market in the Maritimes. |
| Generation mix (based on energy generation) | Nuclear: NBSO (35%) NSPI (0%)<br>Fossil fuels: NBSO (30%) NSPI (77%)<br>Renewables: NBSO (30%) NSPI (17%)<br>Other (imports): NBSO (5%) NSPI (6%) |
| Contact | Michel Losier, Program Director, PowerShift Atlantic, mlosier@nbpower.com |




# Objectives

The primary objective of this demonstration is to determine if load shifting can provide an economic and effective alternative to building new supply side ancillary services for the integration of wind with minimal or no disruption to participating utility customers. As such there are technical, business, environmental and customer benefit research objectives that this project seeks to achieve:

*Technical benefit:* Test the ability of virtual power plants managing customer loads to perform in sync with system balancing and forecasted wind profiles, and to offer a reliable alternative for balancing renewable generation.

*Business benefit:* Test the cost effectiveness of operating virtual power plants as ancillary service providers and determine appropriate business models for integrating the components of a virtual power plant within a vertically-integrated utility.

*Customer benefit*: Explore new customer roles and customer relationships that support customer participation in load management, and capture value for the customer. Determine best practices for establishing relationships of trust for direct load shifting.

*Environmental benefit:* Determine the GHG reduction potential by operating a virtual power plant as opposed to operating flexible fossil fuel generation to balance variable supply and load profiles.

# Planning for Success

To demonstrate value as an ancillary service there must be a significant amount of load available for shifting by the VPP via aggregators. PowerShift Atlantic is targeting up to 2000 customer sites. Customer participation is therefore essential to the success of this project. As presented in Figure 1, year round management of customer loads is different from any other energy efficiency or demand side management program. A new level of trust must be established in the relationship between the customer and the utility in order to allow the utility to shift loads. Learning how to engage customers and keep them engaged will be a key finding for utilities from the project.

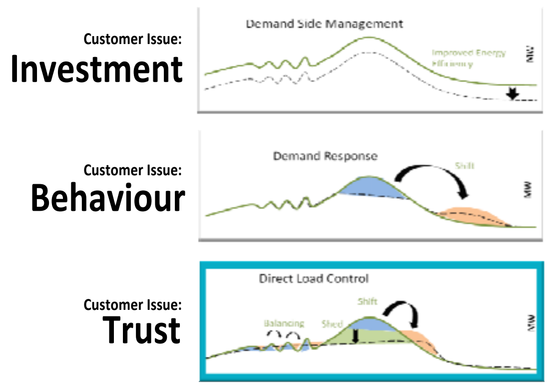



**Figure 1 : Relationships between the customer issues and demand-side solutions**

The other key aspect of the project planning is around the technical components. The key challenge will be to ensure reliable real-time grid operation with a virtual power plant (VPP). This project includes two VPP instances (one at New Brunswick Power and one at Nova Scotia Power). New energy management systems and aggregation architecture will be developed to balance demand against the variability of wind generation, and provide the equivalent of a 10 minute spinning reserve. The Maritime consortium, along with Stantec, Accreon, SAIC, and T4G companies are working on customer engagement, technology development and deployment, and VPP development. The following table gives a summary of the project (current status*) :

| New Brunswick Power VPP | | | Nova Scotia Power VPP | | |
|---|---|---|---|---|---|
| **Utility** | **Aggregators** | **Customers*** | **Utility** | **Aggregators** | **Customers*** |
| **Maritime Electric** | Integral Analytics | 133 residential<br>2 commercial | **Nova Scotia Power** | Steffes<br>Integral Analytics Enbala | 328 residential<br>21 commercial |
| **New Brunswick Power** | Enbala<br>Steffes<br>Integral Analytics | 20 commercial<br>10 residential | | | |
| **Saint John Energy** | University of New Brunswick | 204 residential | | | |
| **Project cost : $32M CAD** | | | | | |
| **Goal : 15 MW of up/down regulation** | | | | | |

## Current Status

To date, four aggregation pilot projects are underway with 675 residential customers and 43 commercial sites connected, amounting to 3.47 MW of connected load. Each pilot project has a unique technical solution, targeted end uses and aggregator service provider. Two instances of the VPP are up and running (one for each system operator). Each aggregator is at various stages of establishing connectivity to the VPP and performing controlled testing of end-to-end functionality. By September 2013, the project aims to have approximately 15 MW of controllable load through a combination of commercial and residential customers. Overall customer satisfaction with the program remains high (80%) with an expressed desire for more frequent detailed program information.

**STATUS**

- ✓ The build phase for the core functional components and primary interfaces that make up the VPP architecture is complete.
- ✓ Development and testing for all components to allow end-to-end testing is complete.
- ✓ Infrastructure is in place to implement aggregators, install required equipment, and perform load management and to measure results.
- ✓ End-to end functionality testing is underway for 2 of 4 NBSO aggregators and 2 of 3 NSPI aggregators.
- ✓ Customer recruitment and installations is ongoing.
- ✓ Quarterly surveys are conducted with participating customers.

## Benefits & Cost

As a research project focused on finding more effective ways to integrate wind energy into the electricity system, this four year demonstration project was considered an investment that would eventually lead to cost savings. The cost of this project is $32M, where half of the funding comes from the Canadian government's Clean Energy Fund and the other half from the consortium. Now that the project is progressing through the deployment phase and the VPP functionality implemented, the project team is developing the business case by identifying and quantifying potential benefits including, but not limited to:

- Avoided cost of fuel to provide ancillary services.
- Avoided cost of maintenance associated by fossil fuel start-up or cycling.
- Avoided cost of generation, transmission and distribution network capacity.
- Avoided GHG.

While the current research is focused on integrating wind generation more effectively, the learnings will be relevant for optimizing other sources of renewable energy generation, and potentially offsetting the need for building traditional generation in the future. Future development of the VPP may also include peak demand reduction or other types of ancillary services based on load management and storage. Customer buy-in and on-going involvement will be measured as a key indicator of the potential to move beyond research and demonstration to a commercial offering.

## Lessons Learned & Best Practices

**Collaboration to achieve a greater scope and scale**

This project challenges the more traditional approach to managing a project of this size and complexity. For it to succeed, the project required more resources and capabilities than any one project partner could have achieved on their own. Thus, PowerShift Atlantic dictated a collaborative governance model where the congenial competitive nature of each utility could fuel progress. All consortium members are fully engaged and the project has been fully endorsed at all levels within the utility companies.

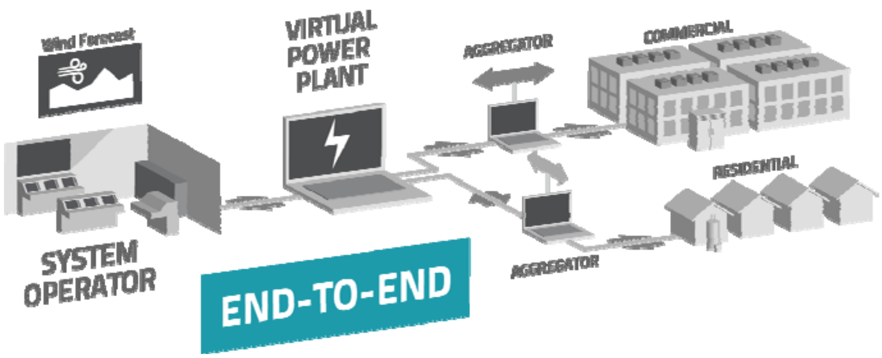
With a project of this scale and nature, the consortium is able to learn from operating a VPP with:

- A variety of residential and commercial end-uses (water heaters, water boilers, HVAC, refrigeration, electrical thermal storage).
- Two system operators, utilities with different ownership and governance, markets with different rate structures (time of day versus flat rate).
- Commercial customers with energy management systems, commercial customers with a specific device directly controlled by the aggregator.

**Project Management**

This project has rekindled a spirit of working together to find solutions. The project team continually challenges the consortium members to right-size their pilot projects with internal processes such as procurement and contract negotiation. As well, regular review and reporting of risk and issue management across all levels of governance has proven effective in managing the expectations of all stakeholders. The project is also influencing change across the broader industry, from a vendor, supplier and regulatory perspective. This has been significant in that:

- It has helped identify criteria for vendors and equipment, and to identify areas that are particularly challenging for the vendor.
- It has enabled the industry to better understand the utility's vision and some of the challenges they face with renewable services.
- Vendors are changing their products to accommodate PowerShift Atlantic requirements. This collaboration with the vendor is building strong relationships for future opportunities; pushing demand response providers to go beyond existing capabilities.
- The regulators are engaged in discussions about the project and future implications to regulation based on the results.




**Technical Lessons**

The PowerShift Atlantic project requires the seamless integration of modern technology, connecting customer to the aggregator and system operator. At this stage of installation and operation the project team has gained insight into the current industry capabilities with respect to load shifting, load forecasting and aggregation solutions. After receiving offers for the VPP technology platform, the consortium found that commercially available energy management systems (EMS) do not support continuous load management, and that the demand response management systems (DRMS) do not support ancillary service provision satisfactorily. Consequently, the consortium decided to develop an innovative VPP solution (developed by the system integrator Stantec, Accreon and SAIC), to provide load shape management and to provide the equivalent of a 10 minute spinning reserve on demand. Also, to further reduce project costs, the consortium decided to host the VPP solution on a Bell-Alliant virtual platform versus purchasing hardware.

The VPP operates continuously in near real-time, therefore continuous communication between the load and the aggregator, and between the aggregator, VPP and the system operator is required. On the residential aggregation side, it was demonstrated that aggregators utilizing customer broadband communications (Internet connection) were able to operate closer to real-time than those using radio frequency (RF) mesh-node networks. Most solutions involved are using broadband communications except one which uses the advanced metering infrastructure (AMI) communication network.

AMI utilizing RF mesh-nodes poses challenges for real-time management of loads. Inherent latency between issuing a load control action and confirmation of the execution of that action make it difficult to be utilized as a near real-time communications technology for load control. Data transfer through AMI is sometimes lost or delayed, challenging the load aggregation and the ability to provide reliable forecasts. Also, extracting information on the electric water heater status from the global household consumption measured by the smart meter, instead of direct measurement of the appliance, poses additional technical challenges in determining an appliance's status and forecasting its demand and load shifting capabilities.

**Customer Engagement Lessons**

To meet the project objectives, a good customer engagement strategy ensures that there is adequate controllable load to conduct the research. The project team realized that for customers to participate it must be easy, at no cost and with limited risk to their operations. The utilities invested in their customer engagement program up-front with surveys and related work to ensure that the solutions that would be developed would resonate with the customer. The up-front activities included:

- Studying best practices, conducting residential and commercial customer surveys and focus groups to better understand customer.
- Customer Engagement programs designed and being implemented.
- Ongoing participant surveys and communications.

The research indicates that Maritimers care about the environment; they care about protecting and preserving it, finding solutions to do so, and being proactive about it. It also shows that they value and appreciate when organizations (i.e. government, the region's utilities, and corporations) work together in a collaborative way to explore environmental options.

In collaboration, the utilities developed a common engagement program for customers in the project. This major achievement is the result of a strategy which incorporates the common aspects shared across utilities but also provides the flexibility to customize and meet the unique requirements of each utility and their customers. The Customer Engagement Program was designed with key customer principles agreed upon by all the utilities, as follows:

- Participation in the project is intended to be largely unnoticed by the customer, such that the customer will not notice any change in operations during load-shifting events.
- There is no cost for the customer to participate.
- There is no savings guarantee.
- There are no financial incentives provided as motivation for residential and commercial customers.

PowerShift Atlantic utility companies have found that the project has enabled them to build new types of relationships with their customers that foster new opportunities and methods for communication and involvement. Despite not having financial incentives or other guaranteed monetary benefits, customers have been keen to participate in order to contribute to finding ways to more efficiently integrate wind, as well as to capture other environmental benefits, such as reducing GHGs. Under the commercial program, customers are able to participate in a co-branding program with their utility promoting their involvement in PowerShift Atlantic. The co-branding program aligns with a commercial customer's corporate social responsibility objectives.

Managing customer expectations is paramount in a long-term research project, particularly with commercial customers since they tend to have lower tolerance for risk from interruptions compared to residential customers. Throughout customer recruitment, the utility companies have been up front with customers regarding the project duration and the fact that as a research project, the utilities do not have all of the answers. To mitigate any risk associated with that, the customer support services have been revisited and customer facing employees have been trained to be knowledgeable about the project, and about how to communicate aspects of the project with stakeholders.

**Engaging Large Customers Through Energy Management Providers**

Engaging large commercial customers through an aggregation service provided by energy management providers has proven to be a challenge. Energy management service providers controlling multiple sites through one energy management system are not abundant in the Maritimes and are not as advanced in this area as originally anticipated. While costs of installation could be avoided by leveraging the existing telemetry they have with their customers, those businesses would still need to upgrade their energy management system and capabilities to meet the aggregation service provider requirements dictated by the VPP. Their energy management platform would also have to evolve technically to provide short term load shifting forecasts for the next 36 hours to the VPP. In all cases the proposals for such upgrades received were deemed unachievable within the project budget and schedule constraints. As an alternative, NB Power and NS Power decided to move forward with the Canadian company, Enbala Power Networks. Enbala is providing the technology to integrate the building control equipment to be aggregated to participate in the program. NB Power and NS Power have also engaged Steffes Corporation to provide both electrical and thermal storage equipment and Integral Analytics for residential aggregation services.

## Policy in the Maritime Region of Canada

The provinces of New Brunswick, Nova Scotia and Prince Edward Island (PEI) each have their own policies, programs and plans which influence smart grid development in the region. New Brunswick set smart grid objectives in its New Brunswick Energy Blueprint and in 2012 announced the development of a 10 year Smart Grid Roadmap for the province including 40% renewable energy by 2020. Nova Scotia has a Renewable Energy Plan which led to the creation of a law dictating that 25% of Nova Scotia's electricity will be supplied by renewable energy sources by 2015. The Plan sets a further goal for 40% renewable electricity by 2020. Feed-in Tariffs and enhanced net metering programs support the integration of tidal and solar projects respectively. The Prince Edward Island Energy Strategy in 2008 doubled the government's Renewable Portfolio Standard, requiring 30% of electricity to come from renewable resources by 2013 and committed to investigate policy and financial mechanisms to integrate more distributed renewable generation.

This case study was developed by CanmetENERGY, Natural Resources Canada and the PowerShift Atlantic Consortium. Further information can be found from [www.powershiftatlantic.com](http://www.powershiftatlantic.com).