

GRID MODERNIZATION

ISSUE:

The distribution sector in Ontario is entering a period of renewal, with a significant portion of their assets reaching the end of their life. Concurrently, the emergence of new technologies will enable distributors to use this period of renewal to build a more resilient, reliable, and efficient grid. The Smart Grid Fund supports the integration of these new technologies by providing funds to companies, universities and utilities to test these innovations. These efforts will enable the integration of advanced technologies into Ontario's grid, such as storage and electric vehicles.

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SUGGESTED RESPONSE:

- Ontario's distribution grid serves over 5 million consumers.
- The basic infrastructure delivering this service has largely remained unchanged for decades. As system demands and consumer needs evolve, the infrastructure must keep pace in order to maintain reliability and efficiency.
- New smart grid technology is becoming available that can benefit consumers and utilities through better reliability, improved asset performance, and resiliency to external events.
- Grid modernization technologies – including sensors, smart meters, and communications infrastructure – can provide the data and information needed to encourage new business models and enable customer choice.
- Ontario is well positioned to build on its early action on smart meters to realize a truly modern grid. Through a third-party cost-benefit analysis, we found that if smart grid investments continue to be made through to 2035, they have the potential to deliver a net benefit of \$6.3 billion to the province. We are working with our partners to realize this value.
- Through our one-of-a-kind 50MW procurement, Ontario is an energy storage leader, with real world experience with advanced battery technologies, flywheels and pumped storage.
- The Ministry of Energy seeks to create a supportive policy framework that will increase the adoption and integration of Electric Vehicles (EVs) in Ontario.
- The Ministry of Energy is also encouraging the adoption of smart grid technologies through the Smart Grid Fund (SGF) by supporting the integration of emerging technologies into Ontario's distribution system.
- The Ministry's third call for SGF applications closed on November 30, 2015. The funding for Round 3 of the SGF is intended to support sector growth while the Ministry considers its option to expand the program, as contemplated in the 2013 Long-Term Energy Plan.
- On November 26, 2015, Ontario announced the creation of a \$325 million Green Investment Fund (GIF) in 2015-16 in its Fall Economic Outlook and Fiscal Review Statement. The Ministry of Environment and Climate change is leading GIF.
- Using the Green Investment Fund, the Ministry of Energy is leading a \$6M investment to develop advanced microgrid solutions in three First Nation communities, two of which are not economical to connect to Ontario's grid.
- This investment will support these communities in pursuing a clean energy future by reducing their reliance on diesel fuel. The Smart Grid Fund is being used as the mechanism and overall program framework to deliver the GIF funds.

If Asked About The Smart Grid Fund:

- The Smart Grid Fund (SGF) was introduced in 2011 to provide funds for the demonstration of smart grid technologies on the Ontario distribution system.
- The purpose of SGF is to develop the smart grid in Ontario while reducing uncertainty and risk for electricity utilities in deployment of new and emerging technologies to modernize the distribution system. It also aims to support economic development within the sector.
- The SGF supports 26 projects in the smart grid industry sector focusing on technology areas such as: electric vehicles, electricity storage, microgrids, grid automation, home energy management, data analytics and cyber security.
- This support has led to a sector level investment of approximately \$170 million, generated almost 900 jobs and involves 22 electricity utilities and 12 universities.
- Six projects have concluded, with the current projects scheduled to be completed by Spring 2017. As they are available, project highlights for each project will be posted on the Ministry website. These will outline the solution and project outcomes while fostering discussion between sector stakeholders on future technology deployments.
- New projects that are awarded funding will begin late summer to fall of 2016.

If Asked About the Navigant Report:

- Navigant's *Ontario Smart Grid Assessment and Roadmap* concludes that there is great potential in Ontario's smart grid – as long as we continue to develop it prudently.
- The report provides a strong business case for advancing the province's smart electricity grid: If smart grid investments continue to be made through to 2035, they have the potential to deliver a net benefit of \$6.3 billion to the province. We are working with our partners to consider Navigant's recommendations for realizing this value.
- Our early investment in smart meters provides a strong foundation for gaining more value from additional smart grid investments by leveraging the data those meters already provide.
- The technology functionalities listed in the report have been incorporated into the SGF program guidelines and application to guide applicants as to the technological developments that have been identified to impart the greatest benefit to Ontario.

If Asked About Smart Meters / Time-Of-Use (TOU) Pricing:

- Smart Meters provide environmental and system benefits, reduce costs over the long-term, and reward consumers who shift their consumption away from times when electricity is most costly to produce.
- Smart meters have enabled time-of-use (TOU) pricing. With TOU, customers have the ability to better manage their costs by reducing or shifting their consumption to off-peak times when electricity is less expensive to produce. Doing this reduces Ontario's overall peak demand which means we can defer or avoid costs to invest in new generation infrastructure.

See House Book C05 'Smart Meters and Time-of-Use' for further information.

If Asked About Energy Storage:

- Ontario is an energy storage leader, with real world experience with advanced battery technologies, flywheels and pumped storage.
- Ontario's one of a kind 50 MW energy storage procurement initiative provides opportunities to learn about different storage technologies and the commercial mechanisms needed to enable them.

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- This procurement secured contracts for actual energy storage services under real commercial arrangements – instead of selecting assets or specific technologies – which advanced both the technology and business model for storage simultaneously.
- Phase 1 of the IESO procurement was a great success for accelerating storage technology in Ontario with the competitive selection of 34MW of resources, representing a variety of technologies that will provide various beneficial services across the province.
- Phase 2 resulted in the successful selection of 16.75 MW of storage resources that will provide capacity services to the grid. The results were announced in November 2015.
- The IESO published a report in March 2016 on the opportunities for energy storage to provide system services to the wholesale electricity market. In June 2016, the Ministry asked Essex Energy Services to produce a report that will examine additional opportunities for energy storage on distribution systems.

If Asked About Meter Data Management:

- A by-product of the ongoing modernisation and transition to a ‘smarter’ grid is the emergence of vast quantities of real-time and granular data related to the generation, delivery & consumption of electricity.
- The province’s smart meter data repository, the MDMR, for example receives between 100 and 120 million meter reads from residential and small business customers every day.
- The Ontario Energy Board has directed the operator of the MDMR to develop a third-party implementation access plan to allow utilities, planners, and innovators to have access to non-personally identifiable smart meter data, encouraging innovation in the province while protecting the privacy of Ontarians.

See House Book C05 ‘Smart Meters and Time-of-Use’ for further information.

If Asked About Electric Vehicle Integration:

- The Ministry of Energy is creating a supportive policy framework that will increase the adoption and integration of Electric Vehicles (EVs) in Ontario.
- We are working with our partner ministries as well as key stakeholders, such as local distribution companies, to address the challenges and take advantage of the opportunities that EVs present.
- As part of the Climate Change Action Plan, the Ministry of Energy is working to establish a four-year free overnight electric vehicle-charging program for residential and multi-unit residential customers starting in 2017.
- The Ministry of Transportation recently announced funding to support the development of public charging infrastructure. The Ministry of Energy will work with MTO to ensure this infrastructure is well-integrated into the electricity system.

BACKGROUND: 1. DISTRIBUTION GRID CHALLENGES

- To address the various challenges facing the distribution grid, a modern electricity system is required. A ‘smart grid’ uses modern sensors, monitoring, communications, automation, and computer systems to improve the flexibility, reliability and efficiency of the electricity system. These challenges include:

Replacing Ageing Infrastructure and Maximizing the Life of Existing Infrastructure

- With some assets in place for 50+ years, there is a need to refurbish or replace with new investments as necessary to meet system growth. For example, Toronto Hydro’s Copeland Transformer Station, the first built in Toronto since 1955, will help increase reliability and supply in Toronto’s downtown core.

- As infrastructure typically incurs high capital costs, utilities need to look for opportunities to leverage solutions that continue to maximize the use of existing assets.

Extreme Weather Events

- Extreme weather events are a challenge for Ontario's distribution companies.
- In 2015, weather was the next most common reason for power outages in Toronto (after equipment failures and loss of supply from the transmission system).
- On the weekend of December 21-22, 2013, a significant ice storm moved through Southern Ontario. Ice accumulation resulted in downed branches, trees and power lines, which resulted in over 500,000 customers losing power in Ontario
 - The 2013 ice storm in Toronto cost Toronto Hydro an estimated \$12.9 million.
 - The event remains the most severe weather event in PowerStream's history.
- In 2012, Hydro One was hit by four weather events that affected more than 10% of its customers, including Hurricane Sandy.

Intermittent Renewable Energy and Integration of Distributed Energy Resources

- As non-hydro renewable sources of generation are expected to provide close to 25% of Ontario's electricity installed capacity in 2025, compared to 9% in 2013, maintaining reliability may become increasingly challenging.

Improving Customer Service and Preparing for New Innovative Technologies

- Electricity consumers are increasingly demanding more customer-friendly programs and information. At the same time, utilities must consider the impacts new technologies such as electric vehicles, localized generation, and storage will have on distribution systems.

2. GRID MODERNIZATION & SMART GRID ROADMAP

- Ontario's regulatory structure encourages distributors to incorporate and take advantage of advanced and innovative technologies when conducting infrastructure investments under their normal course of business.

1) Smart Grid Fund

- The Smart Grid Fund (SGF) provides financial resources to help companies, electricity utilities and organizations to demonstrate and commercialize the next generation of smart grid solutions by:
 - Developing and advancing the smart grid in Ontario in the near term (improving reliability and flexibility of the electricity grid)
 - Creating economic development opportunities and jobs for Ontario
 - Reducing risk and uncertainty of important electricity sector investments.
- There are 26 projects supported by SGF representing \$50M for a total sector investment of approximately \$170M.
- These projects cover the following technology areas: grid automation, data management, home energy management, electric vehicles, electricity storage, microgrids and cyber security.
 - All Round 1 projects are expected to complete by Spring 2017, with Round 2 projects to complete mid-2017. Following completion of each project, a project highlights document will be created outlining the project, technical solution, results of the project and how the solution supports the development of smart grid in Ontario. All project highlights will be posted on the Ministry website as they are completed.

- Recent Ontario electricity sector reports have recognized the value of continued investment in a smarter grid, consistent with the LTEP. This includes a report by the Ontario Smart Grid Forum and another by Navigant Consulting.
- A third call for applications to the SGF launched on October 7, 2015. The application deadline was November 30, 2015. This round of funding will support advanced energy technology functionalities and project focus areas such as:
 - Consumer-focused initiatives that seek to optimize smart technologies and systems by involving customers as active energy sector participants.
 - Self-healing grids that can perform fault location, isolation and service restoration using automated technologies and communication systems.
 - Enhanced fault prevention that can precisely detect faults while protecting equipment and enabling faster response.
 - Automated voltage control solutions to automatically track, operate, and optimise voltage levels on feeders.
 - Dynamic capacity rating that accurately monitors line conditions in real time.
 - Microgrid solutions in either urban or remote settings.
 - Distributed energy resources monitoring and control, enabling more effective and efficient integration of these types of assets onto distribution systems
 - Advanced metering infrastructure (AMI) that improves accuracy and security of meter reading and enhances the utility's ability to manage its system.
- 12 SGF and 3 GIF projects have been offered funding and are now completing the Transfer Payment Agreement process with the Ministry.

See Appendix A for a list of SGF projects currently underway.

2) Navigant Report

- According to Navigant's *Smart Grid Roadmap*, there is a strong business case for continuing to invest in smart grid through 2035 - \$6.3B net present value by 2045 - and for taking the smart grid beyond smart meters into additional functionalities.
- In order to overcome identified barriers to realizing the value of new investments, Navigant recommended six initiatives for the government, the regulator, and the sector to undertake:
 - Make grid modernization a component of community energy and regional planning processes.
 - Establish a province-wide framework for evaluating the benefits of smart grid investments.
 - Consider different approaches to cost allocation that enables distributors to recover costs associated with broader system benefits.
 - Create a long-term funding mechanism for distributor-led pilot projects.
 - Promote broader sharing of positive and negative experiences with smart grid investments.
 - Establish innovation catalyst funds within distributors.
- The Ministry is consulting with stakeholders to develop an approach for considering the recommendations.
- Elements of a modern Ontario grid include:
 - i) Smart Meters / Time-of-Use (TOU) Pricing

- ii) Energy Storage
- iii) Smart Grid Fund
- iv) Meter Data Management
- v) Electric Vehicle Integration

3) Smart Meters / TOU Pricing

- A smart meter is a digital meter that measures a consumer’s electricity consumption on a time-interval basis and remotely relays it back to the Local Distribution Company (LDC) for billing purposes.
- There are over 4.8 million smart meters installed in all Ontario homes and small businesses. Larger customers (>50kW) require a different kind of meter.
- The majority of residential and small business customers are on TOU pricing.
- TOU rates are designed to reflect the fact that the cost of producing electricity varies throughout the day. Prices are lower when demand can be satisfied with lower cost sources of generation (e.g. nuclear) and rise as demand increases and more expensive forms of generation (e.g. natural gas) are called upon.
- In addition to enabling TOU pricing:
 - Smart meters enable customer participation in conservation programs and initiatives such as Green Button which help customers access their usage data in insightful and innovative ways.
 - Smart meters allow LDCs to deliver electricity to consumers more efficiently by reducing the requirement for manual meter readings and estimated bills.
 - The hourly data remitted by smart meters also enhances grid visibility, better informs system planning and helps LDCs locate and respond to outages more rapidly.
 - Smart meters are also the base technology for a modern grid that enables emerging technologies and applications like electric vehicles, energy storage and innovations which make Ontario homes smarter.

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See House Book C05 ‘Smart Meters and Time-of-Use’ for further information.

4) Energy Storage

- Energy storage is an emerging technology class that can act as a buffer between the time electricity is generated and the time when it is consumed, allowing for more flexibility in managing the electricity system, as well as addressing key challenges, such as integration of increasing intermittent generation and the growing amount of distributed resources, such as micro-generation and electric vehicles.
- Following the 2013 Long Term Energy Plan commitment to include 50MW of energy storage in our procurement processes by the end of 2014, Ontario initiated a two-phase competitive energy storage procurement, led by the IESO, to satisfy this commitment. Phase 1 focused on grid reliability services and Phase 2 had a focus on long-term system needs.
 - The procurement framework for both phases was collaboratively developed by the IESO and formerly the OPA responding to the Minister’s request for the joint document that was completed on January 31 2014.
 - **Phase 1 procurement** led by the IESO launched on March 12 2014 with a competitive RFP to procure up to 35MW of reliability services from energy storage resources in four different areas of the province with an aim to maximize technology diversity. It closed on May 5, and the results were announced on July 25 2014. The IESO completed contracts with all vendors at the end of 2014. The contract terms allow vendors up to 30 months from execution date to bring their projects online.

- Phase 1 resulted in 12 projects totalling 34MW of energy storage resources composed of four different technology types, to be supplied by five vendors. These projects will provide a variety of services in four distinct regions.
- Successful vendors include: Canadian Solar Solutions, Convergent Energy and Power, Dimplex N. America, Hecate Energy, and Hydrogenics Corp.
- Technologies represented in the procurement include: solid state batteries, flywheel, thermal storage, and hydrogen.
- Four project locations include: 1.) TX-connected resources in Southern Ontario (uncongested); 2.) TX-connected resources in Northern Ontario (uncongested); 3.) TX-connected resources in congested areas (various locations); 4.) DX-connected resources (various locations)
- Vendors have encountered delays in delivering these projects. In December 2016 the IESO wrote to all projects to offer an extension to the delivery dates of up to 6 months. If accepted by vendors, Phase 1 projects should all enter service by the end of 2017.
- The Ministry also committed through the 2013 Long Term Energy Plan to commission an independent study of the roles of energy storage across the electricity networks
 - In March 2016 the IESO completed a report on the opportunities for energy storage to provide system services to the wholesale electricity market.
 - In June 2016, the Ministry contracted with Essex Energy services to produce a complementary report on the opportunities for energy storage on distribution systems. This report is expected in February 2017.
 - **Phase 2 procurement** evaluated energy storage resources for their ability to supply long-term system needs, such as capacity and renewables integration. It was launched on September 2 2014 with a pre-qualification (RFQ) stage that ended in March 2015. Qualified applicants could proceed to participate in the RFP process, which ran from April to July 10th. On November 23rd, 2015, the IESO announced the results - it successfully selected 16.75 MW of storage resources, spread across 9 projects, and 5 vendors.
 - Phase 2 resulted in 9 projects totalling 16.75 MW, representing 3 technology categories, and 5 vendors.
 - Successful vendors include: Ameresco Canada, SunEdison Canada Origination LP., NextEra Canada, NRStor, and Baseload Power.
 - Technologies represented in the procurement: Solid state batteries, flow batteries, and Compressed Air Energy Storage (CAES).
 - IESO continues to monitor progress of Phase 2 projects all of which are scheduled to enter service in early 2018.

5) Meter Data Management

- The province's Meter Data Management and Repository (MDMR) is the central system that stores and processes data for all smart meters in Ontario. The IESO, in its designation as the Smart Metering Entity (SME), is the operator of the MDMR.
- The MDMR receives hourly time and date-stamped meter reads from smart meters and performs a process referred to as Validating, Estimation and Editing (VEE) in order to return TOU framed data to LDCs for customer billing.
- The SME is developing a third-party implementation access plan to allow utilities, planners, and innovators to have secure access to non-personally identifiable smart meter data.
 - By permitting access to non-personally identifiable information – a process guided by *Privacy-by-Design* principles – the SME can provide data that can

drive sound planning and innovative energy solutions in Ontario while protecting the privacy of Ontarians.

See House Book C05 'Smart Meters and Time-of-Use' for further information.

6) Electric Vehicle Integration

- Increasing the adoption of electric vehicles (EVs) is a key priority for Ontario. To support EV adoption, the Ministry of Transportation manages three key incentive programs:
 - Green Licence Plate, which advertise a driver's choice of vehicle and enables access to high occupancy vehicle lanes on 400-series highways and the QEW,
 - EV Incentive Program (EVIP), which currently provides a rebate of up to \$13,000 for eligible new EVs, and
 - EV Charging Incentive Program (EVCIP), which currently provides a rebate of up to \$1,000 for a private / home charging station.
- In December 2015, MTO announced the launch of the Electric Vehicle Chargers Ontario Program (EVCO).
 - The EVCO is a one-time competitive grant program designed to cover the purchase and installation cost of public fast-charging stations for EVs along major inter-city transportation corridors and in urban centres (including workplaces, apartments, condominiums, etc.) across the province.
 - In total, close to 500 charging stations (over 200 [Level 3](#) 'fast-chargers' and close to 300 [Level 2](#)) will be installed across Ontario at over 250 locations. All charging stations under this program will be available for public use no later than March 31, 2017 and will comprise, by far, the largest public network of Level 3 stations in Canada.
 - The Level 3 charging station locations are generally strategically placed (e.g. near highways) to promote inter-city travel where cars can get up to 80% charge within 20 to 30 minutes.
 - The Level 2 charging station locations are generally strategically placed at locations close to major trip attractors and workplaces to promote in-city travel and charging for people who plan to spend more time at a given location.
 - The \$20 million program is a component of Ontario's new \$325 million Green Investment Fund, which commits money for projects that fight climate change.
- Historically, the Ministry has not been directly involved in the province's EV policy. However, it indirectly supports this policy through the following activities:
 - Developing smart grid policies which seek to enable innovation and adaptive infrastructure among electric utilities. The Smart Grid Fund is supporting three different projects that examine different ways to integrate EVs onto the grid and monitor their behaviour in a way that optimizes assets and reduces impacts.
 - Working with stakeholders in the energy and non-profit sectors to understand challenges to EV adoption and integration.
 - Actively monitoring and supporting EV projects underway with electric utilities to ensure learnings can be shared within the sector.
- In April 2016, the Province published the Climate Change Action Plan (CCAP). Many of the CCAP actions relate to electric transportation including, for example, an increase to the EVIP and EVCIP. ENERGY is leading the development of one of these actions:
 - Establish a four-year free overnight electric vehicle-charging program for residential and multi-unit residential customers starting in 2017. Consultations with stakeholders began in July 2016 and industry wide working groups were held in

September and November 2016.

- In addition, though not an explicit action of the publicly available CCAP, ENERGY will develop a roadmap for Vehicle to Grid opportunities and consult on these within the forthcoming Long Term Energy Plan (LTEP).
- In July 2015, a group of EV stakeholders launched a broad consultation initiative – *The Power Providers Working Group on EVs*. The group met regularly through to July 2016 and the final report is expected to be delivered in early 2017.
- The purpose of the group was to create a central venue for EV stakeholders to consider how Ontario could accelerate the adoption and integration of EVs across Ontario.
- The Ministry of Energy supported and facilitated this initiative, although remained arm's length to ensure the group's independence. Other ministries that were involved in EV policy participated, including the Ministries of Transportation and Environment & Climate Change.

Appendix A

Smart Grid Fund – Project Categorization Slide

Project	Applicant	LDC Partner(s)
Storage		
1) Advanced smart energy storage demo - integrating micro-grid, building management, EV, LDC benefit & renewables	eCamion - SES	Toronto Hydro, Greater Sudbury Hydro, Hydro Ottawa
2) Electricity Pole Mounted Energy Storage for Improving LDC System Reliability	Ryerson University	Toronto Hydro
Data Analytics		
3) Distribution Monitoring and Controls System	Essex Energy	Essex Powerlines Corporation
4) Smart Meter Cyber Security	N-Dimension Solutions	Burlington Hydro
5) IBM Canada Research & Development Centre	IBM	N/A
EV Integration		
6) Smart Charging of Electric Vehicles with Real-Time Vehicle Data, Utility Control & Owner Opt-In/Opt-Out	CrossChasm (known as Fleetcarma)	Toronto Hydro
7) Intelligent Electric Vehicle Charging System (IEVCS)	Tech Mahindra	Niagara-on-the Lake Hydro, San Diego Gas & Electric
8) SecCharge: Secure Electric Vehicle Ecosystem for Smart Grid	University of Ottawa	Hydro Ottawa
Micro Grid		
9) Woodstock Whites Lane smart microGRID for LDC & Residential application	eCamion - Woodstock	Woodstock Hydro Services,
10) Renewable Energy (RE) Microgrid Test Centre	Canadian Solar	Envida, Hydro One Remotes
11) Micro-grid Research and Innovation Park	Panasonic	Oshawa PUC
Grid Automation		
12) dTechs Oakville Hydro SGF	dTechs	Oakville Hydro
13) Prolucid Smart	Prolucid	Toronto Hydro
14) GE Grid IQ Center	GE	N/A
15) Distribution Transformer Monitoring - Beta Completion/Growth Preparations/Deployment	Grid 20/20	EnWin Utilities, Cambridge and North Dumfries
16) Distributed Generation Integration with Distributed Energy Management and Storage Network	Opus One	PowerStream, Hydro Ottawa, Veridian, Greater Sudbury Hydro, Horizon Utilities
17) Distributed Dynamic Voltage/VAR Control and Monitoring of Distribution Feeders	Varentec	Hydro One, London Hydro, EnWin Utilities, Entegrus
Behind the Meter		

Project	Applicant	LDC Partner(s)
18) Consumer Engagement for the Smart Grid (CESG)	Energate – customer engagement	PowerStream, Peterborough, Utilities, Cambridge and North Dumfries, Hydro Ottawa, Hydro One, Waterloo Hydro North
19) Customer Opt-In Dynamic Pricing Programs	Energate – dynamic pricing	PowerStream
20) Integrating Dynamic Pricing & Customer Feedback on Electricity Usage to Stimulate Residential Conservation & Demand Response	McMaster University	Hydro One
21) Residential Conservation & Energy Management	Rogers Communications	PowerStream
Unsolicited Applications		
22) Team Ontario Smart Home	Queen's University	No LDC partner
23) Ryerson Smart Grid Lab	Ryerson Centre for Urban Energy	No LDC partner
24) Green Button	MaRS	No LDC partner
25) Advanced Energy Centre	MaRS	London Hydro (after application was approved)
26) Opower	Opower Inc.	No LDC partner