Save up to 2.3 Terawatt Hours Per Year in Ontario:

Intra-Grid Sensors Drive Conservation in Front of the Meter

The Challenge: At the direction of the Minister, the IESO and LDC's within Ontario must strive to achieve 7 Terawatt Hours of Conservation by 2020. A series of efforts will combine to create the realization of this Conservation First Framework (CFF) goal. But, what emerging technology can be implemented to create faster Conservation results, and further improve energy efficiency in Ontario?

The Problem: Over 4.639 Billion kWh of unmetered loss 'leaked' from LDC's distribution grids in 2015 according to the Ontario Energy Board's 2015 Yearbook of Electricity Distributors. Using Ontario's 2015 average retail cost of $0.1117 per kWh (i.e., 11.17 cents), this loss represents in excess of $518 Million of electricity that was unmetered/unbilled, but was amortized as cost across Ontarian's hydro bills.

Presently, there are positive conservation efforts to install LED bulbs and 'Smart' thermostats, plus embrace solar rooftop/wind renewables to help lower hydro rates, and reduce generation demands. And there are incentives to purchase electric vehicles (EVs) to collectively contribute toward lowering Greenhouse Gas Emissions. However, simultaneously to these proactive efforts to reduce consumption at the grid edge, over 4.6 Billion kWh was lost upstream of the consumer's meters in Ontario in 2015. And, it is worthy to note that while many benefits are attributed to Ontario's 100 percent AMI (i.e., 'smart meters') deployment, over 4.6 Billion kWh went unmetered in 2015, with maximum AMI penetration.

The "Problem" is that electricity is invisible; and, it is leaking within the Distribution grid, in front of the AMI meters, at significant rates. Because it is invisible, there has been no way for LDCs to accurately identify where these substantial power 'leaks' are occurring. To this end, while we are focused on a series of beneficial maneuvers to improve conservation, and Bend Down the Rate Curve in Ontario, the significance of losing over 4.6 Billion kWh, or over $518 Million (annually) within Ontario's distribution infrastructure is negatively offsetting conservation. This reality cannot be overlooked, nor unattended.

The Opportunity (Solution/Impacts): Through the use of intra-grid sensors, Ontario has the opportunity to create up to approximately 2.3 Tera Watt Hours of conservation savings per year via Technical and Non-Technical line loss identification/remediation, while simultaneously gaining a vast series of additional grid management benefits to help reduce hydro bills for Ontarians, lessen power outage occurrences/durations, improve energy efficiency, and ready the grid for the future.

Cost-effective intra-grid sensors now exist to help identify where the significant distribution grid loss is occurring – Ontarians no longer have to bear this cost burden. Through its Smart Grid Fund initiative, the Ontario Ministry of Energy partially funded a Demonstration Project in 2014/2015 to help determine if intra-grid sensor technology could deliver value to the Province, and beyond. By the conclusion of the Demonstration Project, the Ministry of Energy featured the project as a success story (see attached pamphlet produced by the Ministry of Energy). The prominent LDC participant in the project concluded the success and value of intra-grid sensors. In this case, the intra-grid sensors evaluated within the SGF project were invented in, developed in, and manufactured in Ontario.

Using 2015 information provided by the Ontario Energy Board (OEB), a Business Case Overview for deploying intra-grid sensors has been prepared for the entire Province, and is similarly available for each LDC. While some data must be estimated since the 2015 OEB information does not contain every data element that is required to derive a definitive Business Case Overview, it is projected that if intra-grid sensors are deployed on every distribution transformer in Ontario – as AMI has been deployed at every endpoint metering location-- the "Return On Investment" (ROI) would be approximately 3.62 years.

Net Benefit to Ontario: Leveraging intra-grid sensors to identify, and then remedy the significant 'leaks' occurring within the Ontario grid(s) has the ability to yield the following estimated Net Benefits:

a) Facilitate Conservation Voltage Reduction efforts to lessen excessive power consumption costs,

b) Conserve up to 2.3 Tera Watt Hours/Year--- in addition to the current CFF planned efficiency gains,

c) Reduce Ontario's Greenhouse Gas Emissions by up to 1.2 Million Metric Tonne per Year,

d) Create Manufacturing Jobs in Ontario (i.e., manufacturing of intra-grid sensors exists in Ontario today),

e) Generate up to $68.4 Million (or more) in HST Revenues for Ontario,

f) Safely Posture the Grid for Emerging Solar/Wind Renewables (i.e., DER/DG),

g) Embrace Emerging Electric Vehicle Impacts upon the Grid,

h) Decrease Power Outages which impact Ontario's commercial productivity and impacts residents,

i) Shrink Operating Costs of LDC's in Ontario (e.g., fewer unplanned outages, fewer trouble calls, etc),

j) "Bend Down the Rate Curve" for Ontarians by up to approximately $250 Million Per Year,

k) Produce estimated Carbon Tax Credits Value of over $18.2 Million Per Year for Ontario,

l) Create Positive Trade Revenue by manufacturing/supplying intra-grid sensors throughout the world,

m) Increase 'Metered' Revenues for LDCs (i.e., converting unmetered loss into metered revenue),

n) Lower Capital Expense by reducing premature replacement of Transformers due to overloading, and

o) Deliver a deployment ROI of approximately 3.6 years using a 50% Loss Reduction factor,

The Extensive Value Propositions Created Via Intra-Grid Sensors: By installing intra-grid sensors on distribution transformers, a myriad of unique, powerful opportunities become unveiled to LDCs. While substations technology and AMI meters place a firm grasp on the grid at the beginning and endpoints, neither asset class reliably reaches into the heart of the grid in a timely, accurate, and consistent manner; algorithms are unable to displace the need or value of accurate/timely information being extracted from within the grid. The area/assets of the grid which connects substations to AMI meters represents the undisputed most volatile, most dynamic, and most vulnerable section of any grid in the world. It is this intra-grid space that when monitored via cost-effective sensors, can produce an unrivaled (growing) list of value propositions for LDCs. In turn, these value propositions will establish intra-grid sensors as a mainstay in any comprehensive smart grid effort within Ontario, and worldwide.

Intra-Grid Sensor Value Proposition capabilities include, but are not limited to:

Conservation Voltage Reduction (CVR) – timely/accurate intra-grid voltages to enhance CVR

Renewables – safe and effective embracement of Distributed Energy Resources (e.g., wind, solar)

Asset Loading – ensures proper sizing, avoids premature asset failure, improves SAIFI ratings

Outage Restoration – accelerated to reduce customer impact, improves SAIDI ratings

Aging Infrastructure – preventive maintenance avoids unplanned outages, and lost meter revenue

Voltage Imbalances – reduce downstream equipment damage/costs, and maximizes asset longevity

Unmetered Loss Identification – reveals technical loss, and power theft loss for remediation

Improper Multipliers/Billing Errors – helps to uncover clerical billing errors that cause lost revenue

Improved GIS Mapping Accuracy – ensures proper meter-to-transformer association

Enhanced AMI Data Value – uncover GIS errors and pre-meter taps to ensure AMI data accuracy

AMI Range Extender – can function as a repeater inside AMI networks for hard-to-reach meters

Micro-grids – permits detailed data leveraging to maximize various distribution efficiencies

Carbon Footprint Reduction – reduces generation demand by identifying 'leaks' for remediation

Carbon Emission Reduction Credits – lessen generation to lower CO_2 emissions and create revenue

Future Proof – "Over The Air" technology affords ongoing upgrades/advancements to the sensors

Automated Alerts – creates a "Hands-Free" intra-grid management solution for LDCs

The Business Case (for Ontario):

Ontario LDC Chart For the year ended December 31, 2015	TOTALS
Average Cost per kWh (11.17 Cents) Ontario	
0.1117	0.1117
Total kWh Delivered (excluding losses)	119,900,512,321
Total kWh Delivered on Long-Term Load Transfer	88,504,610
Total Distribution Losses (kWh)	**4,639,679,517**
Total kWh Supplied	124,628,696,448
Proprietary Information within this section	
Total Customers (Meters)	**5,054,739**
Total Distribution Losses per Meter (kWh)	918
Total Losses in Canadian Dollars	**$518,252,202.10**
Losses in Canadian Dollars per Meter	**$ 102.53**
Losses Expressed as a Percent	**3.72%**
Total Distribution Transformer Monitors (Qty)	**475,516**
Proprietary Information within this section	
Total H/W Cost $ (Equals DTM plus PDTM cost)	**$483,200,713.29**
Proprietary Information within this section	
ROI (expressed in years)	3.62
1 kWh (unit) reduction is calculated to reduce CO2 emissions by 0.535 Kg	
Total Losses Yearly in kWh	4,639,679,517
Amount of CO2 Generated in Tonne (Metric Ton) per Year	2,482,229
USD to CAN Exchange Rate Adjusted to November 9, 2016	
1.34	1.34
CER Credit USD equals CO2 Tonne x USD $11.00 x Exchange Rate	$36,588,048.71
CAN Dollar Value of 50% Reduction of Total Losses per Year	$18,294,024.35

Summary: Heretofore, LDCs and the related government entities that oversee Conservation, and Power Delivery standards/requirements did not have awareness of, nor access to the recently developed, cost-effective intra-grid sensors. However, it was the Ontario Ministry of Energy that had the foresight in 2014 to strategically invest Smart Grid Fund (SGF) resources to vet the value of intra-grid sensors within the Ontario grid. The SGF focus was to assess the capability of the technology, determine its Conservation value, and to permit real-world testing for Ontario LDC vetting to occur. Ontario manufactured sensors were successfully evaluated.

Resulting from the success of intra-grid sensor testing in Ontario, LDCs are now postured to embrace this emerging, cost-effective technology. These rapidly-installed sensors will assist efforts to improve Conservation within the Province, and to "Bend Down-The-Rate-Curve" for Ontarians over time. The unique value of intra-grid sensors is vast; due to the deployment location of the sensors within the heart of the grid, a myriad of features/benefits and value is now available to LDCs. It is important to note that the estimated Business Case Overview presented herein is focused solely on the effort of identifying/remediating approximately 50% of the 4.6Billion kWh (over $518 Million) of loss presently escaping, in unmetered fashion, from within the distribution grid(s) of Ontario. When the additional value propositions presented by intra-grid sensors are similarly factored into the equation, and leveraged over time to the benefit of the LDCs/Ontarians, a powerful justification for this cost-effective technology is visible to those who actively pursue Conservation efforts, improved operating efficiencies, reduced hydro bills, Energy Efficiency, and future grid preparedness. The aforementioned value propositions can be harnessed by LDCs, lowering operating costs, improving power delivery performance to rate payers, and converting unmetered loss and multiplier errors into properly metered revenues.

It is important to note that within all distribution grids, approximately 1.0% - 1.5% Technical loss is 'expected' due to the shear physics of electricity delivery (e.g., line loss, resistance loss). This suggests that approximately 60%-73% of both Technical and Non-Technical (i.e., unauthorized unmetered consumption) Loss in Ontario may be outside of the 'expected' Technical Loss associated with the physics of electricity delivery across power lines/resistance. In turn, the intra-grid sensors bring 'vision' into the heart of the grid, allowing LDCs to now identify the otherwise "invisible", costly loss that has been/is perpetually leaking from the distribution grid(s) throughout Ontario, and similarly throughout grids around the world.

Intra-grid sensors present a unique, unparalleled depth of value to enable Ontario/LDCs to vastly improve Conservation efforts, shrink LDC Operating Costs, improve reliability of power, increase metered revenues, and simultaneously lower hydro rates for Ontarians. No other emerging technology solution presents this depth and breadth of ability to create such a vast series of value and benefits, supported by such a rapid Return on Investment. Intra-grid sensors convert 'invisible power loss', into 'visible loss" that can be cost-effectively remediated. LDCs can now be empowered to proactively manage the grid(s); costly reactive behavior is now a process of the past due to the emergence of cost-effective intra-grid sensors.

NOTE: The views expressed in this document are the views of GRID20/20, Inc. and do not necessarily reflect those of the Province of Ontario.

The following "Success Story" was prepared and published by the Ontario Ministry of Energy (two pages)

GRID20/20®
Optimize Energy Efficiency

ONTARIO'S SMART GRID

SUCCESS STORY

PROJECT OVERVIEW

The most vulnerable segment of Ontario's power grid is between substations and endpoint meters. This section of the larger grid translates to around 123,500 km of power lines and over 330,000 transformers.

Lightning strikes, pole damage, power theft, renewable energy sources, and overloaded transformers all place stress on the grid, leading to outages and inefficiencies. Local Distribution Companies (LDCs) are particularly susceptible to fluctuating grid conditions.

North American distribution transformer monitoring (DTM) company, GRID20/20, partnered with two Ontario LDCs to install and test an intelligent sensor system that offers an unparalleled window into the heart of the power grid.

With additional help from manufacturing and design experts, GRID20/20 has evolved its OptaNODE™ sensor and software platform into a world-class solution with plans for future deployment across Ontario and international markets.

Sponsored by Ontario's Ministry of Energy, the 21-month pilot is an important demonstration in grid reliability and a shining example of the innovative projects being funded through Ontario's Smart Grid Fund.

AT A GLANCE

Technology
OptaNODE™ intra-grid sensor and software solution

Collaborators
- Aequus Global Solutions Inc.
- Kinectrics Inc.
- Vexos

Project Partners
- EnWin Utilities
- Cambridge North Dumfries Hydro

Recognition
2015 Smart Grid Product of the Year Award
- SmartGridTMCnet.com

2015 Fierce Innovation Awards: Energy Edition Winner

Project Duration
21 month pilot

Fastest Installation time in Industry
typically **3-9** minutes

Key Outcome
$170,000 of power theft identified from only two transformers

Instant intra-grid data availability once installed. Scalable sensor solution.

OptaNODE™ devices successfully tested in 10 countries

Ontario

THE TECHNOLOGY

GRID20/20's OptaNODE™ intra-grid sensor solution is a reliable, versatile, and intelligent power grid monitoring system that captures highly accurate energy, voltage, current, and external temperature readings and sends them (via a network of cellular carriers or radio frequency mesh) to a secure location for interpretation by LDCs.

The information generated helps LDCs reduce operating costs by:

- Pinpointing losses (both technical & theft)
- Accelerating outage detection
- Foreseeing maintenance needs
- Embracing renewable energy
- Monitoring EV charging station impacts
- Improving reliability of power delivery to customers

GRID20/20 is the only Distribution Transformer Monitor (DTM) provider in the world that can be deployed into both Landis+Gyr's Gridstream and Itron's OpenWay Advanced Metering Infrastructure (AMI) systems. The OptaNODE™ DTM sensor also boasts the fastest installation rate in the marketplace with no need to de-energize or pierce assets.

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HOW IT WORKS

Substations and endpoint meters across Ontario have been substantially upgraded to strengthen grid monitoring capabilities. However, the entire grid segment that connects substations to endpoint meters is lacking in sufficient data awareness by LDCs. The GRID20/20 OptaNODE™ solution offers unprecedented visibility into this grid segment, changing the grid management dynamic from reactive to proactive, while embracing energy conservation practices and lowering costs for rate payers.

PROJECT OUTCOMES

The GRID20/20 pilot, which involved the installation of 128 sensors at partner LDCs in Ontario, proved that intra-grid data can be extracted in a fast and accurate manner and used proactively to identify unfavorable distribution grid conditions for remediation by LDC operators.

Following is a summary of project outcomes:

- Significant power losses identified and remediated
- Voltage levels and imbalances identified and corrected
- Electric vehicle charging stations monitored for loading impacts
- Reverse energy monitored to properly manage renewables/conservation practices
- Automatic alerts to notify LDCs of undesirable intra-grid conditions
- Under/oversized transformers identified

NEXT STEPS

LDCs across Ontario are beginning to take notice and understand the intra-grid data value provided by GRID20/20's breakthrough technology. Sensors will be incorporated via targeted niche applications in some instances, and comprehensively deployed on transformers within other LDCs. GRID20/20 has established collaborative activity with industry providers and plans to expand commercial operations into international markets such as the United States, Latin America, the Caribbean Islands, Asia Pacific, and Africa.

Powered by ONTARIO'S SMART GRID FUND through a $1,607,450 investment.

For more information about Ontario's Smart Grid Fund, visit **ontario.ca/smartgrid**