PROJECT OVERVIEW

Recipient: Niagara-On-The-Lake Hydro Inc.	
Project Name: Distributed Generation Capacity Solution	
Duration of Project: 24 months	
Maximum Funds: $ 118,151.00	**Expiry Date of the Agreement:** 2021/10/03
Project Start Date: 2018/04/30	**Project Completion Date:** 2020/04/03

PROJECT CONTACTS	
Recipient Key Contact *Project Manager or equivalent who will act as the main contact for the Project with the Province*	**SGF Key Contact** *Staff person who will act as the main Provincial representative for the Project.*
Name: Timothy Curtis	Name: Andrew Brinn
Position: President	Position: Policy Advisor
Phone number(s): 905-468-4235	Phone number(s): 416 325-6794
Email: tcurtis@notlhydro.com	Email: Andrew.Brinn@ontario.ca
Address: 8 Henegan Road, PO Box 460, Virgil Ontario, L0S 1T0	Address:77 Grenville St., 6th floor, Toronto Ontario, M7A 2C1

Recipient Financial Administrative Contact *Financial Administrator who will provide items such as updated insurance certificates*	
Name: Jeff Klassen	Email: jklassen@notlhydro.com
Position: Vice President, Finance	Address: 8 Henegan Road, PO Box 460, Virgil Ontario, L0S 1T0
Phone number(s): 905-468-4235	

PROJECT COLLABORATORS *(Clearly state roles and responsibilities of each, including level of involvement, criticality to Project performance and execution)*
Organization: Panasonic Eco Solutions Canada Inc. Project roles: Panasonic will be providing a 250 kW / 250 kWh lithium-ion battery at cost to the Project. Panasonic will provide full vendor support to the installation of the battery and a warranty on the battery. Panasonic will also assist in the evaluation of the data analysis both before and after the installation of the battery to help ensure full comprehension of the value of the energy storage and its most efficient use.
Organization: Ravine Vineyard Estate Winery Project roles: Ravine Vineyard is in the process of installing a 71.4 kW net metering solar rooftop generator along the feeder on which the battery will be located. Ravine Vineyard will also make their consumption and generation data available for inclusion in the data analysis stage of the Project, thereby providing a specific example of how energy storage facilitates increased distributed generation on a feeder.

LOCATION OF PROJECT ACTIVITES	
Project Implementation Site: M1 feeder at York MTS, 609-625 York Road, Niagara-on-the-Lake, Ontario T2P 3G7	Activities that will occur there: Installation of energy storage solution and connection to M1 feeder at York transformer station.
Project Implementation Site: Ravine Vineyards 1366 York Road, St. David's, Ontario L0S 1P0	Activities that will occur there: One of Recipient's customers, Ravine Vineyards, is on the M1 feeder and is planning a 71.4 kW net metering rooftop solar installation.
Project Implementation Site: Niagara-On-The-Lake Hydro Inc. 8 Henegan Road, PO Box 460, Virgil Ontario, L0S 1T0	Activities that will occur there: Project Management, data collection and analysis.

PROJECT DESCRIPTION

Executive summary of the Project. This needs to clearly and concisely describe the Project in accessible terms for non-technical audiences.

This section must communicate the reasons for the deployment, the benefit over a traditional "poles-and-wires" solution, and how it will generate value for your utility and ratepayers. It must be able to stand-alone as an outline of the Project, which includes all the critical information about the Project, including technologies, interactions, and execution.

Be sure to include what Smart Grid functionality is being deployed.

**Do not include superfluous information e.g. introductory information regarding your organization, sector information, accolades about your company, how the Project was conceived or what the benefits of the solution are. This is to succinctly outline what the Project will do and how the Project will progress to achieve this goal.*

The Recipient operates a distribution system that consists of six 27.6kV feeders originating at two transformer stations. These feeders connect approximately 9,500 customers with a peak system load of about 50MW. The feeders also connect about 5MW of distributed renewable generation with around 140 individual renewable generators connected throughout its system. We believe this may be the highest ratio of renewable generators to customers at any LDC in Ontario.

Three of the feeders currently exceed generation capacity based on typical feeder connection standards used by LDC's of IEEE 1547. Unless protection schemes are installed that will not adversely affect normal operation of the feeders, the Recipient may be required to reject new applications to New applications connect renewable generation. These can be uneconomic depending on the size of renewable generation being proposed.

The limits on generation capacity in IEEE 1547 is summarized as follows: If the aggregate distributed generation capacity is less than one-third of the local feeder load, it is generally agreed that, should an unintentional island form, the distributed generation will be unable to continue to energize the load connected within the local feeder and maintain acceptable voltage and frequency. The origin of this 3-to-1 load-to-generation factor is an IEEE paper (Gish, Greuel, Feero [B13]) based on simulations and field tests of induction and synchronous islanded generation with various amounts of power factor-correcting capacitive kilo-volt amperes reactive. It was shown that as the pre-island loading approached three times the generation, no excitation condition could exist to support the continued power generation. Because minimum loads are rarely well-documented and can vary, using a conservative load-to-generation criteria of 3-to-1 gives a margin against future changes in the customer's minimum load. However, a 2-to-1 ratio may be acceptable in some applications. For installations in which the distributed generation is interfaced through inverters, the need for margin to guard against future drops in minimum load also exists, and the 3-to-1 rule still seems prudent. Where the actual minimum load is known, lower load-to-generation margins may be applied.

Alternative solutions to this problem include:

1. Refusing additional generation on the feeder lines at capacity. This has no cost to the LDC but does mean that customers are being denied the opportunity to benefit from the installation of distributed generation at their home or business.
2. Re- arranging feeder lines to better match load and distributed generation. This would not be feasible for radial lines but may be feasible in urban environments with loop or switchable circuits. It would only be feasible if the neighbouring feeder lines have capacity and only until the newly configured feeder line also reaches capacity. Most feeder lines have been developed to allocate the loan from the station in an optimal manner. Reconfiguring the feeder lines to match distributed generation will therefore likely open up issues of voltage and loading. This solution

may also create challenges to switching to limit the impact of power outages. This solution is therefore not usually viable.

3. Create additional load through the use of energy storage devices to allow greater distributed generation while complying with IEEE 1547. This solution is expensive but has the benefit of being a long term solution based on the life of the battery.

The Recipient will install an energy storage solution to make capacity available at a specific feeder (M1 from our York MTS) and connect it at the York transformer station site. The scope of this Project includes using real time feeder loading data and the installation of a 250kVA/250kVAh battery in a storage unit. The battery storage unit would be provided at cost by our Collaborator Panasonic Eco Solutions Canada Inc. ("Panasonic"). Past feeder performances will be analyzed to optimize discharge time and period of use for the stored energy. Following installation, feeder performance will be analyzed to confirm the optimal use of the battery for generation capacity purposes. The additional renewable generation capacity created by the use of the battery will be measured. With future renewable generation installations likely to be net metered, the incremental capacity of net metering versus direct connected generation will also be measured.

One of the Recipient's customers, Ravine Vineyards and a Collaborator on the Project, is on the M1 feeder and is planning a 71.4 kW net metering rooftop solar installation. The data from this solar installation will be analyzed as a means of providing a specific example of how the energy storage facilitates more generation on a feeder is otherwise at capacity.

Feeder performance improvements with voltage regulation, reduced harmonics, lower overall losses and reduction in available short circuit current will also be studied. It is recognized that while we should be able to measure improvements in voltage regulation, the other benefits may not be measurable due to the small size of the Project in an operating environment.

Further, when available, the battery will be utilized to shift time of use of electricity on the Recipient's distribution grid. This will provide a benefit to all of the Recipient's customers.

This Project will be staged in four major phases:

1. Data gathering and analysis,
2. Equipment selection and site location,
3. Installation and commissioning, and
4. measurement and verification

The first step will be to source data of past feeder performances that will confirm the identity of the feeder on which the storage unit will be installed. This performance will establish a baseline for the Project so as to quantify the success of such an installation.

The second step will be to work with our collaborator, Panasonic Eco Solutions, to conduct all system impact studies required for such an installation, optimize equipment selection, site selection and execute detailed engineering designs that will lead to the installation and commissioning stages.

The final step will include real time monitoring of the devices. This will allow the measurement and verification of the additional generation capacity created by the use of the storage unit as well as the ancillary benefits described above.

With lessons learned from this installation, the Recipient and other Ontario LDCs may be better able to establish a cost benefit analysis for the use of energy storage for the purpose of allowing more renewable generation on distribution feeder lines.

Equipment and Technologies

List major equipment and technologies that will be deployed to achieve the intended outcome, and provide their key characteristics.

M1 feeder at York MTS
- 27.6kV feeders
- 3 ph 600Y/347V 27.6/16 kV padmount transformer
- Commercial grade ION 8650A smart meter with SCADA compatibility

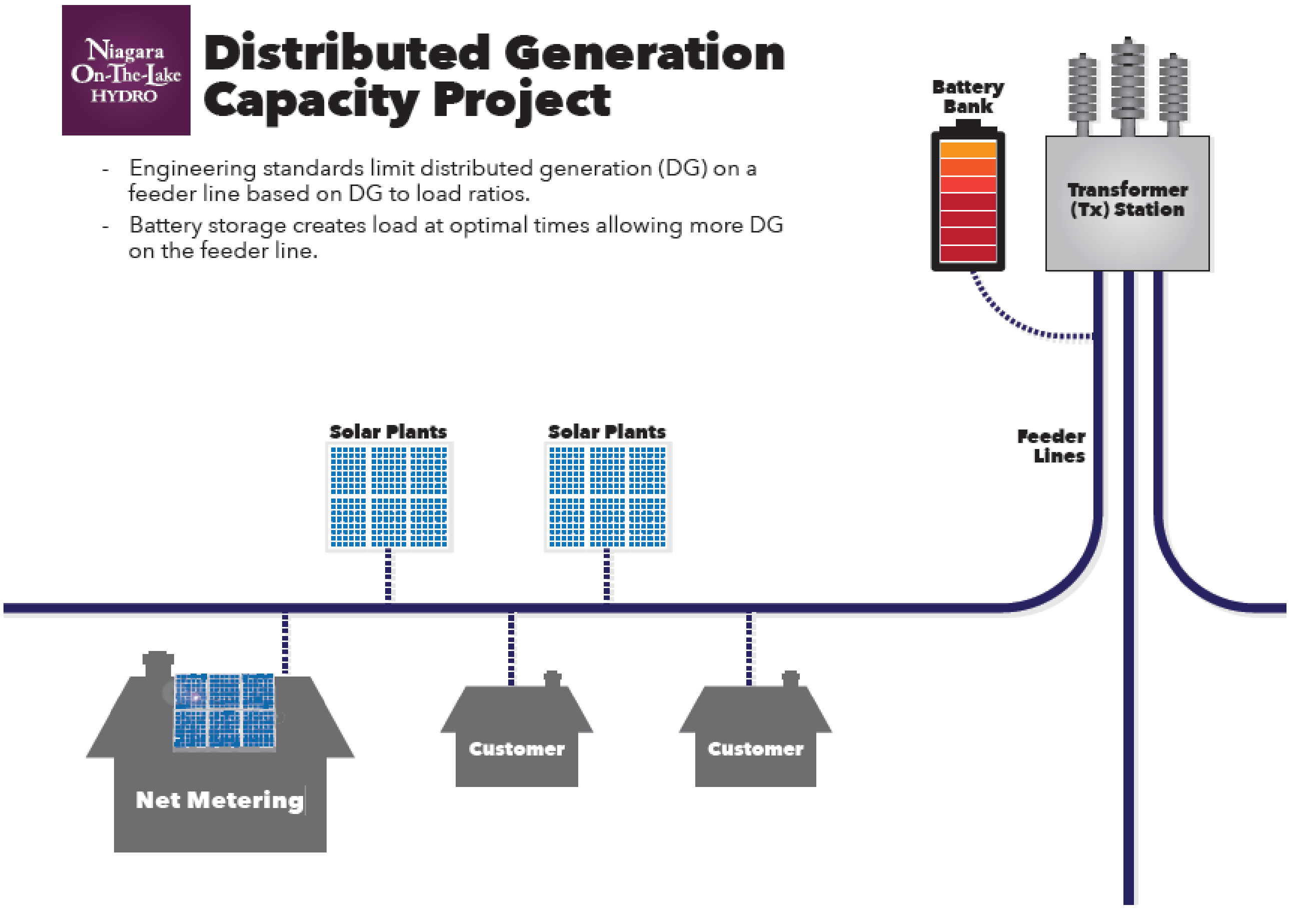
Battery storage system:
- 250kVA/250kVAh Lithium-ion battery
- Panergy Modular System with full BESS including inverters. This system will allow the programmed timing of the battery loading and discharge..
- Concrete pad of approximately one container
- Protection Relays and Control System at Battery
- Tier 1 cell with the highest safety standards.

Solar panel installation:
- 71.4 kW net metering rooftop solar panel
- 180 panels with c/w optimizers
- Two way power flow meter
- Online generation tracking system

SCADA system
- The Recipient’s SCADA
- Fiber optic cable between battery, York MTS and Recipient’s head office

Project Block Diagram

Please attach as a separate document a simplified block diagram for the Project. This should clearly illustrate how all of the key technology pieces of the demonstration will work together.



OUTCOMES

Clearly state what outcomes the Project is seeking to accomplish (see guiding questions below). This section must explicitly define the purpose of the deployment.

The most important performance outcome will be an analysis of how much additional generation capacity can be accommodated on a distribution feeder through the installation of battery storage solution. While It is recognized that every generation installation is different and there is not one conclusive answer to this question, this Project will provide useful data to support this analysis. As solar power becomes less expensive and the number of installations grow, the number of feeders reaching capacity will also grow. The key outcome of this Project will be data to help with the decision-making on whether energy storage is the best solution for this problem.

The key outcome of this Project will be the acquisition of data to inform decision-making on whether energy storage is the best solution for this problem. Given that net metering generation and directly connected generation (FITs and MicroFITs) have different load profiles, the analysis will also help identify impact differences between these types of generation.

Secondary performance outcomes include the measurement of the gain or loss from time of use shifting. This is not expected to be significant but by identifying the benefits of peak shaving, the Project will help LDCs complete a cost-benefit analysis of implementing similar storage systems Finally, if the improvement in voltage regulation can be measured that would greatly assist in assessing the use of battery storage on distribution systems for system efficiency and line loss minimization.

Outcome Measurement and Recording

Explain how you intend to measure outcomes, and include how you will capture the resulting learnings (see guiding questions below).

DER connectivity will be evaluated by the additional generation capacity (kW) added. This will be determined by interrogating IEEE standards using SCADA data both before and after installation of the battery. Every LDC will have different feeder and distributed generation conditions that limit the installation of additional distributed generation but the results will assist LDCs in the future with this analysis.

Time of Use shifting will be evaluated by the dollar value savings in cost of power. This will be based on actual load shifting by the battery and actual HOEP as provided by the IESO. The results will be provided as both hours and dollars. .

Voltage regulation will be evaluated by distortion percentage. This will be measured using SCADA data both before and after the installation of the battery. Every LDC will have different feeder and distributed generation conditions creating their own distortion issues but the results will assist LDCs in the future with this analysis.

Barriers to Grid Modernization and Innovation

Describe any internal or external barriers that exist in deploying your solution, and address how your Project will support overcoming those barriers.

A key aspect of grid modernization is consumer choice. It is envisioned that in the future consumers will have the choice between generating their own electricity with distributed generation, continuing to buy from the grid or having a combination of these two. Net metering is designed to provide consumers with an economically sound combination of owning distributed generation and purchasing from or selling electricity to the grid.

Feeder capacity is a barrier as it limits the amount of distributed generation on any one feeder. This may restrict the options available to consumers if the feeder line from which they draw power is at capacity. For these consumers, their options would be limited to installing distributed generation solely for their own use, which is inefficient and more expensive if personal storage is used, or continuing to purchase from the grid.

There are also regulatory issues associated with limited integration of distributed generation. Access to distribution lines for distributed generation has historically been provided on a first come/first served basis. This conflicts with the standard supply requirements for Ontario LDCs, which is to provide equal access to electricity for all customers.

The proposed energy storage solution will increase the capacity of a feeder in order to allow increased distributed generation. During the life of the Project additional distributed generation is expected to be added to the feeder. Ravine Vineyards has applied for a 71.4 kW net metering roof top solar installation. This Project will enable a calculation of how much additional generation can be handled due to the energy storage. It should be noted that the Ravine solar plant will not be directly connected to the battery. The battery will be at the transformer station while the solar plant will be at the winery. However, as a new distributed generation facility is being installed around the same time as the battery, the Ravine solar plant will provide an ideal analysis of the impact of both new generation and the battery load.

ADVANCING GRID MODERNIZATION IN ONTARIO

Summary

Describe how your Project will leverage or create digital information to promote greater efficiencies or value for your utility and/or customers, including greater customer choice, lower cost or efficiency.

This Project offers a practical method of capacity building at a feeder level for LDC's that have a high level of embedded generation, employing real time data with switchable stored energy as needed. It offers improved voltage stability, reduced losses with increased control over available fault current on devices that can continue to operate within its design limits compared to traditional energy resources which have a higher multiplier on the system. Stored energy can also improve the system efficiency in reduced losses and with this arbitrage see an improvement of the system power factor.

The normal utility solution to feeder overloads would be to consider construction of new feeders originating at the transformer station which can have several technical challenges and has to be pre-planned with associated regulatory approvals.

Benefits Allocation

Identify primary beneficiaries from this Project and its outcomes, and how these benefits will materialize. These include direct and diffuse benefits. See examples below.

Local Distribution Companies

- Practical experience in the use of battery storage to increase renewable generation capacity on a feeder line
- Allows additional renewable generation on feeder lines without having to try to reconfigure the lines, which is usually more costly and often not possible, in order to match distributed generation and load
- Practical calculations for the incremental generation made available by battery storage for both stand-alone generation and net metering
- Actual financial benefit of time of use shifting using battery storage

Electricity consumers

- The biggest benefit to customers from this Project will be the capacity to install additional renewable generation on the Recipient's distribution grid. There is a limit to how much renewable generation can be located on any one feeder line above which power quality issues arise. The standard used to determine this limit is IEEE 1547. If a feeder is at this limit then customer requests to install renewable generation and net metering must be refused. Adding battery storage is considered the most cost effective method of increasing this limit.
- All customers will also benefit from the time of use shifting capability of energy storage. There will be extended periods (many months) when the challenges created by the renewable generation are not severe so during those periods the energy storage can be primarily directed towards time of use shifting. The savings to the Recipient, by way of reduced HOEP, will be passed on to all customers by way of the variance account balances.

Transmitters

- Energy storage provided additional capacity during peak periods thereby mitigating overloading of circuits at the station source, and enabling distribution equipment, wiring and protection to operate within its design limitations. It avoids the need to shift loads between feeders and allows for capacity when performing momentary switching.
- This Project will supply real time data on grid for improved monitoring and control.

JOBS AND GROWTH

The SGF, as part of its broader commitment to collect data on the number of Jobs created through the Fund, will now request information on number of Jobs held by women to better understand gender trends in the sector. Using the table below, provide the number of Jobs forecast for the Project in accordance with the 'Job' definition below.

	Number of Jobs During the Project		Number of Jobs Ongoing After the Project	
	Women	**Total**	**Women**	**Total**
Recipient (total)	0	0	0	0
Engineering/Technical	0	0	0	0
Management	0	0	0	0
Other	0	0	0	0
LDC (total)	0	0.20	0	0
Engineering/Technical	0	0.05	0	0
Management	0	0.15	0	0
Other	0	0	0	0
Other Collaborators (total)	0	0.25	0	0
Engineering/Technical	0	0.15	0	0
Management	0	0.10	0	0
Other	0	0	0	0
Overall Total:	0	0.45	0	0

<u>Definition of a Job</u>

Jobs should be expressed as Full-Time Equivalent (FTE), e.g. an engineer spending 50% of his/her time on the Project over the 2 year demonstration period would be 1 FTE.

A 'Job' is counted as any person working directly on the Project. Directly is defined as any person working on Smart Grid product, service or solution being demonstrated in the following ways:

- *Managing the Project*
- *Engineering or development*
- *Manufacturing, creation or production*
- *Testing or conducting quality assurance*
- *Installing the Smart Grid product or solution on the electricity system, including any construction work to accommodate it*
- *Monitoring, analysing or reporting on performance*
- *Maintaining, servicing or supporting*
- *Conducting related sales and marketing activities*
- *Providing administrative support to the Project*
- *Providing technical or other specialized expertise to the Project*

- *These Jobs can be existing positions, or new ones created specifically for the Project*
- *These Jobs generally would be associated with the Recipient, but also include Jobs at LDCs, Collaborators, and consultants.*
- *These Jobs generally would not be associated with suppliers / vendors providing off-the-shelf products to the Recipient, unless the supplier is conducting engineering / development work to customize / tailor the product for the Project*

Costs associated with these Jobs may or may not be considered Eligible Costs.