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Toronto Hydro-Electric System Limited

EB-2014-0116

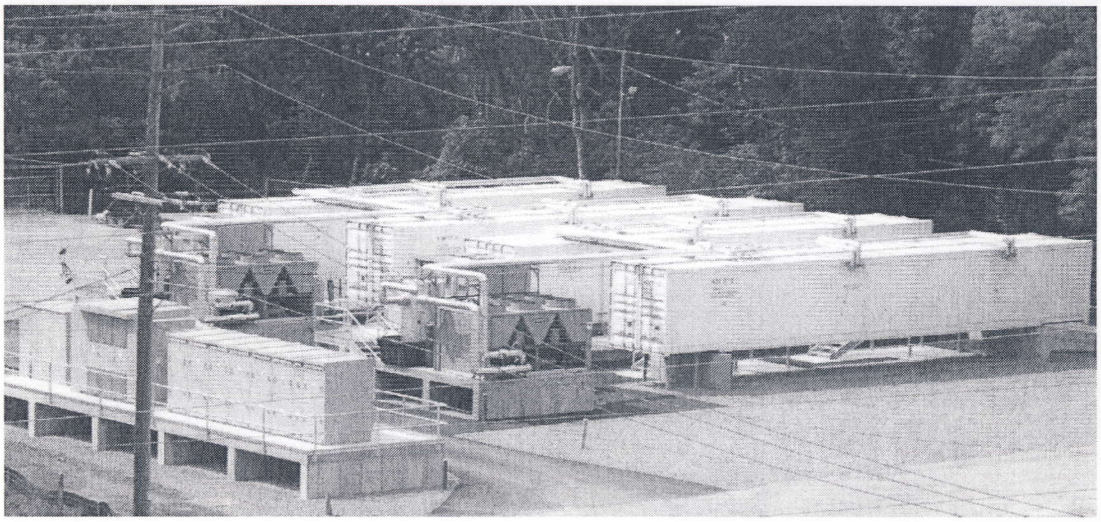
Panel 1

Distribution Capital and System Maintenance

Energy Probe Cross Examination Compendium

February 24, 2015

E7.11 Energy Storage Systems



LITHIUM ION BATTERY ES INSTALLATION

E7.11.1 Summary

Program Description

The Energy Storage Systems (ESS) program was developed to provide Toronto Hydro with strategic ancillary capabilities to address system efficiency, reliability and power quality, as well as Distributed Generation (DG) and Electric Vehicle (EV) enablement in targeted areas of the Toronto Hydro distribution system. Energy storage refers to the process of storing electrical energy for future use. An ESS can be constructed using various technologies and can be classified as either a centralized or decentralized system. By placing ancillary ESS strategically throughout the distribution system, localized issues can be addressed. This approach allows for a minor augmentation of the distribution system, rather than an expensive rebuild or major asset replacement. In this way, ESS deployments can be a creative and prudent approach to system risk mitigation.

Toronto Hydro plans to install 24 energy storage systems during the 2015-2019 forecast period. This represents a total installed aggregate capacity of approximately 4.4 MW with a total energy output of 10,000 kWh

Table A summarizes the anticipated benefits associated with the ESS program.

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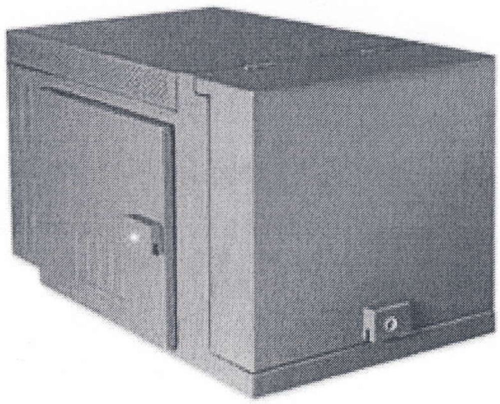

FIGURE 5: EXAMPLE OF LOCAL ENERGY STORAGE INSTALLATION[7]

Table 6 below outlines the total units of equipment to be installed as part of this portion of the ESS program.

TABLE 6: TOTAL GSES & LSES INSTALLATIONS (2015 – 2019)

Assets	2015	2016	2017	2018	2019	Total (Units)
Grid Support Energy Storage (GSES)	1	1	2	2	2	8
Local Support Energy Storage (LSES)	1	2	3	3	3	12

The assets that make up an entire ESS are expected to last approximately 10-20 years. While each type of system requires maintenance, including inspections of the ESS itself and associated ancillary equipment (such as backup power supply for remote communication equipment etc.), maintenance programs would be tailored to each particular ESS.

It is anticipated that the ESS program will provide Toronto Hydro with additional capabilities to address system efficiency, reliability and power quality, and DG and EV enablement challenges. The program is inherently customer-driven as the proposed work would assist Toronto Hydro to improve the operating conditions of the distribution system in a targeted, strategic and prudent

[7] S&C Electric Ltd., *Energy Storage Systems*, online: S&C Electric Ltd. <http://www.sandc.com/products/energy-storage/ces.asp>.

GSES systems are placed at strategically determined points along the primary portion of a feeder (e.g. the beginning, mid-point or end of a feeder) and LSES systems are positioned on single phase laterals. Table 5 provides an overview of de-centralized ESS.

TABLE 5: DE-CENTRALIZED ESS OVERVIEW

Energy Storage System Type (Typical Size & Duration)	Energy Storage Technology
Grid Support Energy Storage (GSES) (200 kW & 2.5 hrs)	Lithium Ion
Local Support Energy Storage (LSES) (100 kW & 1 hr)	Lithium Ion

Figures 4 and 5 provide examples of de-centralized ESS installations. The ESS in both figures have a smaller size and foot print than centralized systems and are housed in pad-mount enclosures (similar to pad-mount transformers and switches). In Section E7.11.7 – 2015 Projects, two proposed project locations have been determined for an LSES and GSES installation within the Toronto Hydro distribution system.

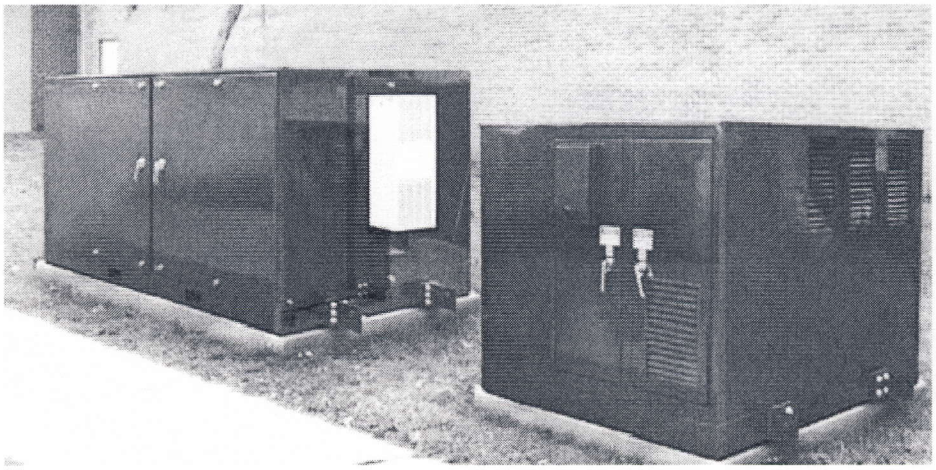

FIGURE 4: EXAMPLE OF GRID SUPPORT ENERGY STORAGE INSTALLATION[6]

[6] eCamion, *Community Energy Storage (CES) Overview*, online: eCamion <http://www.ecamion.com/portfolio/ces/>.

1 **TABLE A: SUMMARY OF PROGRAM BENEFITS**

Customer Value	▪ Provides backup power during emergency situations for critical customers (e.g. emergency services, hospitals, government buildings etc.).
Reliability	▪ Facilitates increased reliability and power quality. ▪ Provides the system with dynamic voltage support, low harmonics and uninterrupted service. ▪ Reduces demand fluctuations with peak shaving during peak demand periods and load leveling during off peak periods.
Safety	▪ Improves asset utilization, which extends the service life of distribution assets (e.g. transformers, conductors etc.), ensuring that equipment operates within nominal system parameters and helps to prevent catastrophic equipment failures.
Efficiency	▪ Station based ESS provide backup power for ancillary station services in case of an interruption or an emergency situation, enabling remote monitoring and control is maintained (e.g. station service for protection systems, communication system, station lighting etc.)

2 Program Drivers

3 The trigger and secondary drivers for this program are summarized in Table B.

4 **TABLE B: PROGRAM DRIVER**

Trigger Driver	Reasoning
System Efficiency	▪ Enhances system performance by storing electricity at off-peak times, and releasing it into the distribution system during peak times. These capabilities are expected to help Toronto Hydro manage the increasing variability of distribution system load. ▪ Capacity in certain areas of the system is strained due to load growth. ESS can help defer the need for large scale asset replacements that would otherwise be required to maintain sufficient capacity to meet demand through peak load reduction. ▪ ESS can increase the utilization and lifespan of existing distribution assets through peak load reduction. ▪ Assists in reducing the overall impact of routine maintenance programs carried out at MS. ▪ Helps dynamically correct phase imbalances. ▪ Enablement of DG & EVs.
Secondary Drivers	**Reasoning**
Reliability	▪ Increases the resiliency of the distribution system by providing reliable power for essential services over an extended period of time during emergency situations.
Power Quality	▪ Delivers consistent service voltage, low harmonics and uninterrupted service.

	▪ Provides dynamic voltage regulation/reactive power support.

Preferred Alternative

Toronto Hydro evaluated this program against the alternative of excluding ESS from the suite of possible technological distribution system solutions for the 2015-2019 period. Executing the ESS program as described is the preferred alternative as it would provide Toronto Hydro with strategic capabilities to address specific issues relating to system efficiency, reliability and power quality, and DG and EV enablement in targeted areas of the Toronto Hydro distribution system in a cost-effective manner.

The difference in the cost of ownership between existing and renewed assets (ΔCOO) for the first year of the program is $1.1 million, representing a reduction in negative impacts to customers (in this case represented by a $/kW benefit cost) over the life of the assets (see Section E7.11.7). Accounting for capital program costs, the first year's activities deliver a positive NPV of $0.58 million, confirming the economic prudence of the investments (see Section E7.11.7).

Timing and Pacing

Based on experience gained through current and past ES implementations, the ESS program will proceed at a gradual and methodical pace. In 2015, technology selection, detailed engineering and design work and site selection are planned for all ESS, followed by the installation and commissioning of one Local Support Energy Storage (LSES) and one Grid Support Energy Storage (GSES) unit. For 2016, Toronto Hydro plans to install and commission two LES and GSES units and one Municipal Substation Energy Storage (MSES) unit. From 2017 to 2019, Toronto Hydro plans to install and commission three LSES units per year, two GSES units per year, and one MSES unit per year.

TABLE C: HISTORICAL AND FUTURE SPENDING

	Historical Spending					Future Spending				
Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CAPEX ($M)	-	-	-	-	1.02	0.54	1.10	2.20	3.20	3.80

can result in outages to critical infrastructure that may need to be relied on during emergency situations. These include interruptions to supply, and damage to the primary and lateral sections of a feeder. At this time, Toronto Hydro does not have the ability to quickly restore service to critical loads when there is a major outage event (e.g. major failure, loss of supply etc.). With appropriate switching and isolation, ESS can provide temporary backup power to critical infrastructure, ensuring continual service for critical loads while repairs take place. Some examples of critical loads include emergency services, hospitals, government buildings and financial institutions. ESS located at MS would facilitate routine maintenance activities. The ESS would be able to temporarily support the load from equipment taken out of service for maintenance purposes. More specifically, it would prevent a temporary outage and support the load with other feeders decreasing the temporary burden experienced by alternate feeds.

The projected levels of DG connections from 2015 through to 2019 are expected to increase by 450 MW, to 626 MW of connected DG. In addition, the Government of Ontario's aspiration is for one in 20 vehicles in the province to be an electric vehicle by 2020.[9] These developments would impact Toronto Hydro's distribution system by introducing additional dynamic two-way generation and mobile loads and this impact is expected to increase as the penetration of DG and EV increases. Toronto Hydro is already attempting to address system-wide issues to enable the connection of DG, as outlined in the Generation Planning Monitoring & Control program; however specific locations in the distribution system are expected to have additional technical issues that may prevent the connection of DG and EVs. ESS can help to alleviate these localised issues and enable the connection of DG and EVs. This is illustrated by the proposed projects in Section E7.11.7 – 2015 Projects. Table 7 provides an overview of the anticipated benefits associated with the ESS program.

TABLE 7: PROGRAM BENEFITS

Customer Value	▪ Enables the integration of customer-owned DG and EVs ▪ Provides backup power during emergency situations for critical customers (e.g. emergency services, hospitals, government buildings etc.). • The difference in the cost of ownership between existing and renewed assets (ΔCOO) for the first year of the program is $1.1 million, representing a reduction in negative impacts to customers (e.g., customer interruption costs, emergency repair costs) over the life of the assets (see Section E7.11.7). • Accounting for capital program costs, the first year's activities deliver a positive NPV of $0.58 million, confirming the economic prudence of the investments (see Section E7.11.7).

[9] Pollution Probe, *Unlocking the Electric Mobility Potential of Toronto: Moving Toward an Electric Mobility Master Plan for the City* (Toronto: Pollution Probe, 2010), at page 67, online: Pollution Probe < http://www.pollutionprobe.org/pdfs/EMMP.pdf>.

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Table 1 below provides a breakdown of Toronto Hydro's Historical (2011-2013), Bridge and Test Year OM&A expenditures, broken down by program.

Table 1: Historical, Bridge and Test Year OM&A Expenditures by Program[3] /C

($M)	2011 Actual	2012 Actual	2013 Actual	2014 Bridge	2015 Test
Preventative & Predictive Maintenance	13.7	16.0	12.8	16.1	20.1
Corrective Maintenance	25.8	21.5	17.0	19.0	22.2
Emergency Response	13.3	13.9	26.3	16.2	15.3
Disaster Preparedness Management	0.9	-	-	-	2.4
Control Centre	8.4	8.3	8.9	8.2	8.4
Customer-Driven Work	6.0	5.9	7.0	8.2	10.1
Planning	9.0	9.0	11.5	10.3	12.9
Work Program Execution Management and Support	5.0	5.5	5.6	5.8	6.1
Work Program Execution	14.9	13.8	13.0	14.3	15.2
Fleet and Equipment Services	8.7	8.5	8.7	8.4	8.9
Facilities Management	24.6	23.5	24.2	27.2	27.5
Supply Chain Services	7.1	6.6	9.0	10.3	9.9
Customer Care	41.9	37.5	39.7	42.2	46.1
Human Resources and Safety	13.7	13.2	15.3	15.3	16.1
Finance	16.1	14.7	15.7	17.0	17.9
Information Technology	30.3	28.5	31.0	33.4	34.9
Rates and Regulatory Affairs	7.2	7.8	8.4	6.4	8.4
Legal Services	5.5	4.3	4.5	5.3	5.5
Charitable Donations (LEAP)	0.7	0.7	0.7	0.7	0.8
Common Costs and Adjustments	5.7	(6.0)	0.5	2.3	1.0
Allocations and Recoveries	(19.9)	(17.4)	(13.3)	(19.9)	(20.2)
Restructuring Costs	-	27.7	-	-	-
Total OM&A	**238.6**	**243.5**	**246.4**	**246.6**	**269.5**

/C /C /C /C /C /C

[3] Numbers may not add up due to rounding. /C

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RESPONSES TO ENERGY PROBE RESEARCH FOUNDATION INTERROGATORIES

INTERROGATORY 45:

Reference(s): **Exhibit 4A, Tab 2, Schedule 4**

Preamble:

Table 3 on page 25 shows $1.55 M for full time staff.

a) Please provide details of the number of employees included in this budget along with their position titles and job descriptions.

b) Given that Board approval may not be forthcoming on this application until the spring of 2015, is it reasonable to expect that staff can be recruited to the full extent of the budget in 2015? If not, what would be a reasonable expectation for staffing in 2015?

c) Is it reasonable that training, exercise and audit activity costs should be deferred until 2016 or later in light of the expected timeline for Board approvals and the lag inherent in establishing the program before downstream activities like these would be undertaken?

d) THESL notes at the outset of the discussion that some disaster planning has always been part of its activities. How much should be acknowledged as already embedded in rates for disaster planning activities?

e) Does THESL have an estimate of how much quicker or less costly the 2013 storm response would have been if it had its proposed disaster preparedness program in place at that time?

f) If yes, please provide details of how restoration could have proceeded more quickly or more cost effectively. If no, what evidence or analysis does THESL have that the proposed program would provide value to customers for the cost incurred?

RESPONSES TO ENERGY PROBE RESEARCH FOUNDATION INTERROGATORIES

RESPONSE:

a) Comparisons to industry peers indicate that a utility of Toronto Hydro's size should have at least eight dedicated full-time employees to manage all facets of the disaster and emergency management program. The group would consist of one Director and seven Emergency / Disaster Management Professionals. Please see the attached position descriptions (Appendices A and B).

b) Toronto Hydro plans to commence filling these positions following the anticipated implementation of the new rates in May 2015. Accordingly, the pace of the proposed 2015 expenditures would be in line with the incremental funding provided for through the requested budget.

c) Given the nature of these activities, Toronto Hydro does not believe that deferring them would be reasonable or desirable.

d) The current level of available rates funding used for the Disaster Preparedness Activities amounts to approximately $0.3 million.

e) No.

f) For a discussion of the value provided by a comprehensive Disaster preparedness Program, please see the Independent Review Panel Report assessing Toronto Hydro's response to the 2013 ice storm (Exhibit 4A, Tab 2, Schedule 5, Appendix A).

DISASTER PREPAREDNESS MANAGEMENT (DPM) PROGRAM

1. SUMMARY

Table 1: Disaster Preparedness Management Program Costs ($ Millions)

	2011 Actual	2012 Actual	2013 Actual	2014 Bridge	2015 Test
Total	0.9	-	-	-	2.4

Events such as the October 2012 Hurricane Sandy, July 2013 flash flood and December 2013 ice storm have places an emphasis on Toronto Hydro's capability for timely and effective response to major contingency events affecting a large proportion of the utility's customer base and the major urban environment it serves. While the utility has responded to these events in a timely and effective manner reflective of its capabilities and the combination of external constraints characterising each event, subsequent analysis, industry comparisons and feedback from customers and partner organizations indicate that Toronto Hydro and its customers would benefit from a more comprehensive and robust framework for disaster preparedness planning, management and operation under major contingencies.

Toronto Hydro has been, and remains compliant with all the applicable Ontario Energy Board ("OEB") and Independent Electricity System Operator ("IESO") emergency preparedness requirements. However, recent experience indicates that the utility needs to direct additional efforts towards entrenching and enhancing the existing emergency operating procedures, and conducting regular training and simulation activities to ensure that these frameworks are fully understood by the utility's employees and can be put into action when required on short notice. The need for the proposed program is driven by the increasing frequency of major weather events affecting the City in recent years, driven,