SMART GRID

1.0 INTRODUCTION

In the last Distribution Cost of Service proceeding the Board approved a smart grid funding adder for OM&A and Capital finding the expenditures to be prudent. This rider expired on December 31, 2011. This section details the 2013 incremental smart grid OM&A expenditures of $19.8 million. These investments support the provincial government's smart grid, renewable generation and energy conservation objectives, while providing improved distribution operations. Hydro One is seeking approval of a rate rider for the recovery of this expenditure to allow the company to continue deploying smart grid and in so doing to meet its service delivery obligations.

Table 1 contains a breakdown of the required smart grid OM&A expenditures in 2013.

Table 1
Incremental Smart Grid OM&A Expenditures
($ million)

Smart Grid OM&A Expenditures	**2013**
Sustainment of Installed Smart Grid Systems	7.0
OM&A Component of Additional Smart Grid Deployment	8.6
Smart Grid Studies	4.2
TOTAL	**19.8**

In EB-2009-0096, the Board approved the first phase of Hydro One's Smart Grid plan, primarily work in the Smart Zone pilot in Owen Sound and the need to facilitate connection of many FIT

and MicroFIT generators. Hydro One has executed the Smart Grid plan and requires additional OM&A funding in 2013 for:

Sustainment of Installed Smart Grid Systems

As Hydro One has executed its Smart Grid plan, the Company has installed a base of new smart grid assets including a Distribution Management System ("DMS"). These assets were installed to meet our obligation to connect a large number of FIT and microFIT generators on the Hydro One distribution system. These new assets require incremental OM&A to fund their sustainment. Without this incremental OM&A, the investment in these assets would be stranded and we would be unable to meet our obligation as a distribution operator.

OM&A Component of Additional Smart Grid Deployment

As Hydro One continues to execute its Smart Grid plan and connect increasing numbers of FIT and microFIT generators, additional smart grid deployment of field devices and back office systems are required. These assets will enable the efficient connection of renewable generators on the Hydro One distribution system, provide operational and efficiency benefit to Hydro One, and provide customers with tools to reduce their electricity use. Any delay in continuing the Hydro One Smart Grid plan will result in unnecessary demobilization and mobilization costs as well as delay potential benefits to our customers.

Smart Grid Studies

Hydro One has undertaken multi-year commitments with other organizations to identify, monitor, evaluate and validate new and emerging smart grid technologies - including laboratory and field demonstrations in order to support the timely deployment of Smart Grid. In order to maintain the deployment schedule for the overall Smart Grid Program, the schedules for the Smart Grid Studies Program must be maintained. These schedules necessarily include funding requirements for a series of Smart Grid Studies Program work required to be completed in 2013.

2.0 HYDRO ONE IS EXECUTING ITS SMART GRID PLAN APPROVED IN EB-2009-0096

In the previous Distribution rate application (EB-2009-0096) for 2010 and 2011, the OEB decided that

> *"Hydro One's Smart Grid plan includes many of the activities identified in the Board's filing guidelines regarding smart grid. Generally, the Board finds that the activities identified in Hydro One's Smart Grid plan are consistent with the filing guidelines.*"

… and that

> *"Therefore, the Board concludes that the costs as budgeted are prudent, and should be recovered in rates."*

The approved capital and OM&A expenditures are summarized in Table 2.

Table 2
OEB Approved Smart Grid Capital and OM&A Expenditures
($ million)

	2010	**2011**
Capital	30.1	62.4
OM&A	10.0	10.0

As indicated in EB-2009-0096, a significant portion of the proposed smart grid expenditures were with respect to the Smart Zone Pilot project. The Smart Zone serves as a test-bed site for new smart grid technologies and product applications to confirm their viability prior to widespread deployment in the Hydro One distribution system. This is a fundamental aspect of Hydro One Distribution's approach and strategy for the development of the smart grid and for making prudent investments.

3.0 SUSTAINMENT OF INSTALLED SMART GRID SYSTEMS

Release 1 of the Advanced Distribution System ("ADS") project established new systems that now need to be maintained. This creates additional OM&A costs in the form of licensing fees, computer infrastructure maintenance and staff to maintain the DMS system and other equipment.

Sustainment of New Smart Grid Systems	**$7.0M**

DMS is a new control system that needs to be maintained

The OGCC currently has two main control systems: a Network Management System to operate the transmission system, and the Outage Response Management System to handle trouble calls during storms and outages. The installation of the DMS represented a step-change increase in the computer infrastructure and IT support. As the DMS needs to perform computationally intensive state estimation and load flow algorithms on a distribution system that is 10 times the size in circuit kms of lines as the transmission system, it requires extensive infrastructure (servers, networking devices, firewalls). The DMS also requires a network model that is accurate and maintained to be in sync with the actual distribution system in the field in order to provide for the correct state estimation and load flow results. This requires a team to maintain the network model of the distribution system in the DMS. The DMS also comes with a host of power applications that will require power engineering and computer science expertise to operate and maintain on behalf of the control room.

Hydro One's distribution system was designed and built to serve 6,000 MW of peak load with one direction of power flow to 1.2 million load customers. The government laid out an objective in the Long Term Energy Plan that will see Ontario served by 10,700 MW of renewable generation overall. It is expected that 4,000 to 5,000 MW of that renewable energy will be installed on the Hydro One distribution system, with over a thousand MWs already installed and up to 4,000 MW of signed connection agreements scheduled over the next few years. This is already creating situations of reverse power flow on parts of the system. The DMS uses knowledge of the distribution network model, the limited points of telemetry currently available, and the customer load profiles to estimate the voltage and power flow on the distribution system. With this information, operators will be informed proactively of the direction of power flow and out-of-normal voltage levels on the distribution system.

Control room evolving to specialized distribution operators

The control room is also evolving due to the integration of renewable generation on the distribution system. The current control room has one class of operator. The current OGCC Controller operates the transmission system. With renewable generation proliferating on the distribution system along with an objective to improve distribution operations the control room will evolve into separate transmission and distribution operator's functions. This control room structure can be found at leading utilities such as BC Hydro, Florida Power & Light and Southern California Edison. The specialization between transmission operator and distribution operator will require a net increase in the number of operators. In addition, an extensive training program needs to be developed to train the distribution operators.

4.0 OM&A Component of Additional Smart Grid Deployment

The ADS project is completing its first release by the end of 2012. Hydro One is looking to continue executing its Smart Grid plan by commencing Release 2 of the ADS project in 2013.

This release is expected to deliver further enablement of DG, operational improvements for Hydro One, and improved conservation options for Hydro One customers.

Release 2 will implement new smart grid field assets as well as new back office systems. The new release includes costs associated with software development, process development and training development. Therefore there is a need for incremental OM&A to continue this project.

OM&A Component of Release 2 Project	**$8.6M**

To support the next phase of the smart grid program, Hydro One will make prudent investments in smart grid to provide the additional capabilities highlighted in Table 3.

Table 3

Release 2 Smart Grid Capabilities

Business Objective	Capability Today	Release 2 Capability
Enable More Distributed Generation using Existing Assets	No ability to control DGs other than tripping the feeders and causing a local area black out. Number of DGs limited to engineering limits, requiring new assets for additional DGs.	Provide ability to dispatch DG for transmission system reliability and enable more generation within existing assets. Number of DGs limited to real-time operational limits.
Use Energy Storage to Integrate DG	No energy storage projects deployed currently.	Pilot both battery and flywheel energy storage technologies in Owen Sound as tools to accommodate DGs.
Improve Outage Restoration Times and Efficiency	Wait for customers to call Hydro One to inform us their power is out and then dispatch field crews to search for the outage by patrolling the line.	Use smart meters to reduce trouble call costs and improve outage response times.
Catch & Reduce Energy Theft	Manually analyze customer energy usage for patterns where energy usage is the same hour-to-hour, day-to-day to provide targets for investigation.	Use smart meters and localized line loss analysis in the Distribution Management System to better identify and stop energy theft.
Demand Response for Consumers	40,000 customers have signed up for a critical peak pricing program where a pager-enabled thermostat is raised by 2 degrees during critical peak days.	Use smart meters to provide customers with real-time in-home monitoring and new CDM programs. Also trial using voltage regulating devices to save energy for customers.
Increased Energy Efficiency	Engineer feeder so that the last customer at end of the feeder has voltage within acceptable range by boosting voltage at beginning of feeder.	Manage the voltage along the feeder in real-time so that all customers along the feeder are receiving electricity at the low end of the acceptable voltage range, reducing customers' energy consumption.

5.0 SMART GRID STUDIES PROGRAM

Smart Grid Studies	**$4.2M**

A necessary and critical component of Hydro One's Smart Grid Deployment Plan is the Smart Grid Studies Program. For 2013, the program requires $4.2M in OM&A funding. Smart Grid is a relatively new and evolving construct that is being shaped by new and emerging technologies. The successful deployment of Smart Grid is predicated on Hydro One's proactive and lead role amongst a wide variety of manufacturing, university and college research institutes, government agencies and other utility participants. In so doing, Hydro One is moving to fulfill its obligations to its customers while concurrently responding to Ontario government's directions under the *Green Energy and Environment Act, 2009.*

As noted in EB-2009-0096, Hydro One has undertaken multi-year commitments with various participants in order to support the timely deployment of Smart Grid. These commitments in many cases take the form of joint funding collaborations with a number of participants. The programs involve identification, monitoring, evaluating and validating new and emerging smart grid technologies - including laboratory and field demonstrations – and collaboratively sharing associated information and findings with the participants.

This collaborative approach to funding is allowing Hydro One to leverage the OM&A expenditure and maximize its return on program investment.

These multi-year commitments are scheduled to support the larger Smart Grid Program. That is, in order to maintain the deployment schedule for the overall Smart Grid Program, the schedules for the Smart Grid Studies Program must be maintained. These schedules necessarily include funding requirements for a series of Smart Grid Studies Program work required to be completed in 2013.

Hydro One's multi-year commitments are of three general types:

1. Home energy management technologies;
2. Distributed generation integration and real-time management technologies; and
3. Energy storage technologies required to address solar and wind generation voltage fluctuation issues.

For example, home energy management technologies allow residential energy users to more effectively manage energy. Studies to date have demonstrated that smart grid technology can modify residential consumer behavior to conserve overall electricity consumption by 6.5%. Work needs to continue in 2013 in order to further develop commercial, agricultural and industrial consumer load profiles, user friendly web portals and a universal connector for in-home devices to work with Smart Meters.

A comprehensive listing of the Smart Grid Studies initiatives required to be funded in 2013 is presented in Table 4.

1 **Table 4**

SMART GRID STUDIES PROGRAM - 2013	SCOPE
Energy Storage Systems (Li-Ion Battery, Flywheel) Technologies.	Grid integration for multi year demonstration of large scale energy storage devices using flywheel and Li-Ion technologies in participative projects by Electric Power Research Institute (EPRI), Natural Resources of Canada(NRCan),Ontario Center of Excellence(OCE) with multi partner participation by governments, agencies, universities and the industry.
Energy Hub Management – Automated Home Energy Networks	Optimization in customer loads, generation, import, export and energy storage to further minimize cost of energy including development of web portal, In-Home devices to work with smart meters in collaboration with universities, OCE, NSERC, OPA and Local Distribution Companies(LDC).
Inverter, Flexible Alternating Current Distribution System (FACDS) Technology /Devices Studies	Performance assessment and validation of inverters as FACDS device interfaces to distribution grid for Wind and Solar generators in collaboration with universities, industry partners and OCE/ERI.
NSERC Micro Grid Networks by British Columbia Institute of Technology (BCIT) to develop and demonstrate Micro Grid Networks in a Canadian context	Development and Validation of Operation, Control and Protection ; Optimization and Regulatory issue, Information Technologies for Smart Micro Grid Network in participation with 26 other partners from Canadian Universities (9), industry (7), BC Hydro, New Brunswick Power, OPA, IESO, NRCAN, OCE, BCIT and Research Companies(3).
Advanced Grid Studies (various technology assessment and validation on distributed generation as well as as advanced grid options)	Technology development and validation work for grid integration and impact of renewable energy, grid Interface devices with performance and quality validations, electric vehicles and chargers, optimization of volt-var and, intelligent devices and sensors in collaboration with universities, EPRI, NSERC and OCE.
Clean Energy Initiatives (Geothermal, Combined Heat and Power, Pollution Probe, Center for Clean Energy)	Pollution Probe (PP), Centre for Clean Energy(CCE) and Toronto Atmospheric Funds(TAF) sponsored joint projects assessments, development and validation of clean renewable distributed generation for effective demand management.
Green Energy Impact / Integration Studies (Wind, Solar, Biomass Generation connections impact studies)Hierarchical Management, Control and Optimization)	Specific impact and integration studies of Green Energy renewable generation as they relate to power quality, protection and control, optimization and validation of hierarchical volt-var management with universities, NSERC and OCE..

SMART GRID STUDIES PROGRAM – 2013	SCOPE
Studies – Universities (Solar , Wind generator Modeling, Validations), Green Energy Impact / Integration Studies (Wind, Solar, Biomass Generation connections impact studies)	Validation for solar, wind generator modeling on proto type devices in partnership with universities. Specific impact and integration studies of renewable generation as they relate to power quality, dispatch, protection and control, and communication.
Energy Research Initiatives ERI Program (Solar Generation Connections / Micro Grid Impact Studies)	Assessment of Solar Generation and Inverter devices as well as validation studies relevant to micro grid networks in partnership with ERI, industry partners and universities.

In addition to these studies, Hydro One participates in the Conference Board of Canada's Centre for Clean Energy in developing technologies which integrate clean-energy supply sources with end-users by means of selected "pathways". The work also examines the unique challenges facing Canadian utilities and advances the understanding of the transition to clean electricity in ways which are practical, profitable and sustainable.

Hydro One has partnered with the Toronto Atmospheric Fund (TAF) in a multi-year "GeoCity - Advancing Urban Geo-Exchange Energy" initiative to support development of a geothermal system of heat exchanges for heating and cooling in urban areas.

Hydro One also plans to participate with universities and industry to support development and demonstration of cryogenic energy storage technologies. This initiative promises to facilitate the integration of renewable distributed generation, maximizing the energy potential of such generation and minimizing investment in other assets.

Hydro One will continue to collaborate with EPRI on a Plug-In Hybrid Electric Vehicle ("PHEV") as a part of a trial and demonstration work in Hydro One's Smart Zone along with third party collaboration until the end of 2013. This work is critical in developing an empirical based understanding of the patterns of demand driven by the growing number of PHEVs as well as the potential adverse impacts on the distribution system and will help inform Hydro One and other utilities of the investments required to accommodate PHEVs.

Hydro One is also participating on a multi-year initiative entitled "NSERC Micro Grid Networks" to develop and demonstrate intelligent microgrid in the Canadian context. This initiative is supported by the Natural Sciences and Engineering Research Council of Canada (NSERC). Hydro One is participating in collaboration with 25 partners from governments, agencies, universities, and research companies across Canada. The initiative focuses on the challenges related to operation, control, protection, communication, monitoring, optimization and the regulatory issues of intelligent microgrids.

6.0 SUMMARY

Hydro One is facing replacement of aging assets and the need to establish new standards now

In the coming years, there will be an accelerated rate of asset replacement on the distribution system due to aging assets. Without new standards and designs, Hydro One will replace these assets with existing standards and "old" technology. This equipment will be on the system for up to 50 years or more. It is important that Hydro One has OM&A funding in 2013 to develop new standards and designs that will enable the replacement of assets with "tomorrow's" technology.

Hydro One is sharing information with other LDCs and the Board

As part of its Smart Grid work, Hydro One participates in various Ministry/IESO/OEB sponsorship initiatives, e.g., Smart Grid Forum, Smart Grid Working Group (EB-2011-0004) and

other working groups. Hydro One has also launched a working group comprised of a number of LDC project managers engaged directly in the actual implementation of smart grid applications and initiatives for their respective LDC. This working group provides a forum to discuss and share information on implementation challenges associated with the various smart grid pilot projects being undertaken by the LDCs.

Going forward, Hydro One intends to discuss and cooperate with the Board in the establishment of an on-line repository of pertinent smart grid study and demonstration project information and reports (subject to confidentially agreements or other restrictions) in conformance with the OEB guidelines contained in EB-2009-0397 ("Filing Requirements: Distribution System Plans – Filing under Deemed Conditions of Licence", March 25, 2010). The sharing of this information will benefit the Board and other LDCs in the development of the smart grid across Ontario. By delaying the implementation of Release 2, Hydro One will be unable to provide new insights and lessons learned to other LDCs which could raise the cost of their own programs.

Why OM&A Expenditures are Needed in 2013

Hydro One has been executing the Smart Grid plan that was approved by the Board in EB-2009-0096. Phase 1 of the project created newly installed systems that now need to be maintained and require incremental OM&A. It is important for Hydro One to continue executing its Smart Grid program. Phase 2 of the project will deliver additional DG integration capability, operational benefits for the utility and conservation benefits to our customers. Stopping the project now will create unnecessary costs and delay benefits to the customers. For Hydro One to meet all of the business objectives laid out in its Smart Grid plan, it is also important that it continue the Smart Grid Studies it is participating in with other institutions. The technologies validated in these studies are important to the next releaseas of the ADS project and deferring this work will delay the implementation of Hydro One's Smart Grid plan.

RETAIL TRANSMISSION SERVICE RATES

Hydro One Distribution has adjusted its Retail Transmission Service Rates ("RTSR") to reflect the new Uniform Transmission rates effective January 1, 2012, resulting from the Rate Order under proceeding EB-2011-0268 issued December 20, 2011. The current Uniform Transmission Rates ("UTR's") used to adjust the RTSR are as follows:

- Network Service Rate $3.57 per kW per month;
- Line Connection Service Rate $0.80 per kW per month; and
- Transformation Connection Service Rate $1.86 per kW per month.

Hydro One Distribution calculated the proposed 2013 RTSR using the same methodology approved by the Board under the 3rd Generation IRM proceeding EB-2008-0187. Due to the significant proportion of load attributed to customers on Hydro One's sub-transmission ("ST") system, the Board has previously approved a methodology for determining Hydro One Distribution's RTSR that first splits the transmission costs between ST customers and retail customers, and then splits the costs between retail customer classes based on their relative monthly demand.

The methodology for calculating the proposed RTSR consists of estimating the charges from the IESO for Transmission by using the 2010 load approved by the Board in Hydro One's last cost-of-service application (EB-2009-0096) at each of its transmission connections and applying the currently approved 2012 Transmission rates. This resulted in a total estimated charge of $237.6 million for Network services, $44.4 million for Line Connection Charges, and $119.4 million for Transformation charges, for a total of $401.4 million as shown in Table 1.

The transmission charges to be recovered from each of the ST and retail rate classes are based on splitting the 2013 estimated IESO transmission charges between rate classes in the same shares applicable to those rate classes that were approved by the Board in Hydro One's last COS application EB-2009-0096.

Table 1 shows the estimated 2013 IESO transmission charges allocated to all customer classes.

Table 1
2013 IESO charges

	Tx Network	Tx Line	Tx Transformation	Total IESO Bill	Share
IESO Bill	$237,614,913	$44,373,264	$119,395,525	$401,383,701	
ST	$111,108,328	$19,283,000	$55,806,821	$186,198,148	46.4%
Retail	$126,506,585	$25,090,264	$63,588,704	$215,185,553	53.6%
UR	$ 9,833,709	$1,999,473	$5,067,460	$16,900,643	
R1	$ 33,740,063	$6,877,465	$17,430,231	$58,047,759	
R2	$ 40,516,267	$7,968,914	$20,196,396	$68,681,577	
Seasonal	$5,115,254	$1,043,210	$2,643,908	$8,802,372	
Uge	$2,125,201	$410,681	$1,040,829	$3,576,711	
Ugd	$3,516,673	$678,570	$1,719,766	$5,915,009	
GSe	$12,429,093	$2,429,451	$6,157,194	$21,015,737	
GSd	$18,524,791	$3,543,566	$8,980,805	$31,049,162	
Lighting	$680,695	$134,266	$340,284	$1,155,245	
Dgen	$24,838	$4,668	$11,831	$41,337	

The transmission charges allocated to each customer class are then divided by the corresponding billing parameter for each rate class approved by the Board in Hydro One's last COS application EB-2009-0096 to derive the RTSR.

Table 2 below shows the currently approved and the proposed RTSR. Customers billed based on energy will be charged the RTSR applied to meter quantities uplifted for losses. Customers billed on demand will be charged the RTSR values shown in Table 2 uplifted for losses. For customers that installed load displacement generation after October 1998, RTSR connection is billed at the gross demand level consistent with the guidelines in the Distribution Rate Handbook, section 11.3.2.5, and as approved by the Board in EB-2009-0096.

Table 2
Proposed 2013 RTSR

	Current rates		**Proposed Rates**	
RATE CLASS	Network	Line Connection*	Network	Line Connection*
Urban (¢/kWh)	0.575	0.456	0.696	0.500
R1 (¢/kWh)	0.585	0.464	0.707	0.509
R2 (¢/kWh)	0.574	0.440	0.690	0.480
Seasonal (¢/kWh)	0.543	0.431	0.652	0.470
Urban General Service energy (¢/kWh)	0.445	0.335	0.535	0.366
Urban General Service demand ($/kW)	1.45	1.09	1.75	1.19
General Service energy (¢/kWh)	0.431	0.329	0.518	0.358
General Service demand ($/kW)	1.40	1.04	1.68	1.14
Distributed Generator ($/kW)	0.29	0.22	0.35	0.23
Street and Sentinel Lights (¢/kWh)	0.362	0.278	0.435	0.303
ST ($/kW)	2.65	0.64 Line 1.50 Transformation	3.18	0.70 Line 1.63 Transformation

* For customer classes that do not have separate proposed Line and Transformation charges, the Line Connection charges shown include Transformation charges

The proposed 2013 RTSR rates have been input into the IRM3 Model Sheets 15 (Proposed RTSR – Network) and Sheet 16 (Proposed RTSR – Connection).