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George Vari Engineering and Computing Centre, Ryerson University

Centre for Urban Energy Roundtable VI
**THE ICE STORM:
EXTREME WEATHER AND URBAN ENERGY**

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Executive Summary

On February 11, 2014, stakeholders from across the Greater Toronto Area (GTA) gathered at the Centre for Urban Energy at Ryerson University to participate in a roundtable dialogue to share lessons learned from the ice storm that battered Southern Ontario on December 21, 2013. The discussion focused on the ice storm, extreme weather and urban energy: what worked, what did not and how to prepare for the next time. The purpose of this report is to highlight the lessons learned and to identify priorities for the energy sector going forward as Ontario prepares for more frequent severe weather events.

Participants included Toronto Hydro, Hydro One, the Ontario Power Authority, the Office of the Fire Marshal and Emergency Management, the Ontario Ministry of Energy, the Institute for Catastrophic Loss Reduction, Veridian Connections, PowerStream, the Electrical Safety Authority, the City of Toronto, the Power Workers' Union, the Association of Municipalities of Ontario and the Canadian Electricity Association.

The roundtable participants recognized that the stakeholders involved in responding to the ice storm were aware of their responsibilities and coordination among them was well carried out. A level of safety was established; no injuries or fatalities occurred due to live wires.

Four key themes emerged from the roundtable discussion:

- 1. Vegetation Management** - There is a need for a comprehensive vegetation management strategy which clearly identifies the roles and responsibilities of the municipality, the utility and the property owner.
- 2. Communications** - There is a need for an emergency communication strategy that accommodates the overwhelming number of calls that Local Distribution Companies (LDCs) receive during significant power outages. This strategy should consider frequent in-person briefings by way of radio, the internet and social media.
- 3. Reliability** - There is a need to improve our understanding of the expectations of the customer with respect to the issues of: reliability and security; cost and benefit; and an acceptable level of risk. Consideration should also be given to the lack of preparedness at the household level for extended outages and to customers with accessibility challenges and medical conditions.
- 4. Energy Literacy** - There is a need to improve the energy literacy of the public concerning: electricity restoration protocols, the availability and supply of emergency response materials (e.g. diesel fuel, food, water, beds, blankets, hygiene kits etc.), the ownership and responsibilities of the homeowner for trees, emergency preparedness, damaged standpipes and the availability of qualified private electrical services during periods of unusually high demand.

1.0 Overview and Introduction

1.1 Introduction to Roundtable VI

On the evening of December 21, 2013, a storm moved into Southern Ontario, Quebec and the Maritimes, producing freezing rain, ice pellets and wind. A sharp drop in temperature overnight resulted in 30 millimeters of ice accumulating on infrastructure and trees throughout the region. The storm left more than 600,000 electricity customers across Ontario without power. Outages lasted up to 10 days in some areas causing 27 municipalities across Ontario to be declared disaster areas. Fifty LDCs were affected by the storm, either from damage to local distribution systems or being called to help with the ice storm relief. Two people lost their lives in Ontario from carbon monoxide poisoning during the outage. There were no fatalities or critical injuries as a result of the public coming into contact with electricity.

Some called this ice storm an “early warning” for the extreme weather this region could expect in the future. The band (zone) of winter weather conditions which potentially produce ice storms is drifting northward into Southern Ontario.¹

The purpose of this roundtable was to share lessons learned from the ice storm and to focus on: what worked, what did not and how to prepare for next time. The objective of this report is to summarize the discussion and to identify priorities going forward.

1.2 The Centre for Urban Energy

The Centre for Urban Energy (CUE) is an academic-industry partnership that is exploring and developing solutions to urban energy issues, such as the advancement of clean energy technologies, energy conservation and demand management, energy storage and smart grids. CUE was founded by Ryerson University with sponsorships from Hydro One, Toronto Hydro and the Ontario Power Authority (OPA). Some of the research projects currently being conducted include: utility scale battery storage, understanding the impact of photovoltaics on Hydro One assets and the development of a smart grid laboratory. From its inception, CUE has attracted approximately \$20 million in funds.

CUE is also home to the iCUE, a business incubator and accelerator devoted to urban energy solutions. Launched in November 2012, the iCUE is focused on the portion of the innovation process between ideation and technology development. Its goal is to help new companies turn their ideas into commercial products, services and/or technologies. The iCUE is focused on research innovation (applied research in collaboration with industry); business innovation (entrepreneurship); and student innovation (experiential learning).

¹<http://www.climateontario.ca/doc/workshop/2011LakeSimcoe/Adapting%20to%20Climate%20Change%20in%20Ontario%20Expert%20Panel%20Report.pdf>

1.3 CUE Certificate in Energy Management and Innovation

Ryerson's Chang School of Continuing Education and The Centre for Urban Energy offer a Certificate in Energy Management and Innovation. This certificate program provides adult learners with an opportunity to acquire a level of knowledge and expertise that will permit them to contribute effectively to energy management, conservation, sustainability, and public policy governing this regulated sector; and to energy innovation, entrepreneurship, and the challenges and opportunities for developing new energy technologies and business enterprises.

1.4 Overview of the CUE Roundtable Series

CUE works closely with stakeholders in the energy sector to identify and explore research, technology and/or policy gaps. CUE has the capability to assist industry stakeholders in bridging some of the identified gaps through informed dialogue and debate, following the Chatham House Rule.

This is the sixth roundtable hosted by CUE since 2010. Past roundtable discussions include:

- I. Electricity Prices – How Will Consumers Manage?
- II. Customer Solutions to Manage Energy Bills
- III. Making Meters Smarter
- IV. Perspectives on Energy Research and Development Aligning our investment
- V. Innovation and the Energy Regulator



1.5 Contributors

CUE would like to thank Toronto Hydro, Hydro One, the Ontario Power Authority, the Office of the Fire Marshal and Emergency Management, the Ontario Ministry of Energy, the Institute for Catastrophic Loss Reduction, Veridian Connections, PowerStream, the Electrical Safety Authority, the City of Toronto, the Power Workers' Union, the Association of Municipalities of Ontario and the Canadian Electricity Association for their contribution to this roundtable discussion.



From left to right. Back: Bob Singh, Hydro One, John Sprackett, Power Workers Union, Len McMillan, Hydro One, Francis Bradley, Canadian Electricity Association, Barney Owens, Office of the Fire Marshal and Emergency Management, Michael Angemeer, Veridian, Anthony Haines, Toronto Hydro, Sarah Marchionda, CUE Ryerson, Jim Baxter, City of Toronto, Sean Conway and Dr. Dan McGillivray, CUE Ryerson. Front: Steven Norrie, Ontario Power Authority, Paul Kovacs, Institute for Catastrophic Loss Reduction, Cathie Brown, Association of Municipalities of Ontario, Earl Davison, Electrical Safety Authority, Mike Matthews and John McClean, PowerStream. Not pictured: Rick Jennings, Ontario Ministry of Energy.

2.0 Toronto Hydro Technical Briefing

The December 2013 ice storm was the most disruptive incident Toronto Hydro has ever faced.²

- At 04:00 on December 22, 2013 Toronto Hydro declared a Level III Emergency (the highest emergency level).
- As a result of ice build-up, two million trees fell in Toronto, pulling down 500 energized wires.
- More than 300,000 customers lost power throughout the city.
- The Toronto Hydro call centre received 374,000 calls in 10 days, many of which were redials or repeat calls from the same customers wanting to know when the power would be restored.
- Critical infrastructure, including two hospitals, water pumping stations, 800 street lights and the Toronto Transit Commission (TTC) also lost power.

This was the first time in its history that Toronto Hydro called for mutual aid which necessitated a mobilization plan and the provision of accommodation for these additional workers. This ice storm has prompted Toronto Hydro to consider introducing a Level IV Emergency and establishing appropriate response protocols for increasingly severe storms.

Despite the fact that this storm occurred over the Christmas holiday period, 98 percent of Toronto Hydro's core trade workers participated in the restoration of power. In addition, personnel from eight other LDCs (Ottawa Hydro, EnWin, Sault Ste. Marie PUC, Horizon Utilities, Hydro One, Brockville, Greater Sudbury Hydro Inc. and Brant County Power Inc.) worked for 10 days on a rotational basis until power was fully restored, on December 31, 2013. It is estimated that the total cost of the storm for Toronto Hydro was approximately \$13 million (\$10 million in labour costs, \$2 million in capital expenditures and \$1 million in lost revenue).³

The temperature dropped as low as -15 degrees Celsius during the power restoration process. Fourteen warming centres were opened by the City of Toronto to provide food and shelter for those who lost power during the storm. Only 1,200 people used them in Toronto but participants noted that attendance at emergency shelters was higher in rural areas. It is believed that usage would have been higher in the city if a system-wide outage had occurred.

Toronto Hydro has established an Independent Review Panel to evaluate the response to the ice storm. The panel is being led by David McFadden with support from Davies Consulting, a group with significant expertise in emergency management for utilities.

² https://www.torontohydro.com/sites/corporate/Newsroom/Documents/2013%20Ice%20Storm%20Technical%20Briefing%20-%20FINAL_3.pdf

³ https://www.torontohydro.com/sites/corporate/Newsroom/Documents/Toronto_Hydro_Presentations.pdf

Additional details are available in:

- The City of Toronto Staff Report (January 8, 2014): *Impacts from the December 2013 Extreme Winter Storm Event on the City of Toronto*⁴ and
- The City of Toronto Emergency Plan (March 12, 2013) *Risk Specific Plan: Power Disruption (Electricity)*⁵



⁴ <http://www.toronto.ca/legdocs/mmis/2014/cc/bgrd/backgroundfile-65676.pdf>.

⁵ http://www.toronto.ca/wes/techservices/oem/pdf/power_rsp.pdf

3.0 Roundtable Themes

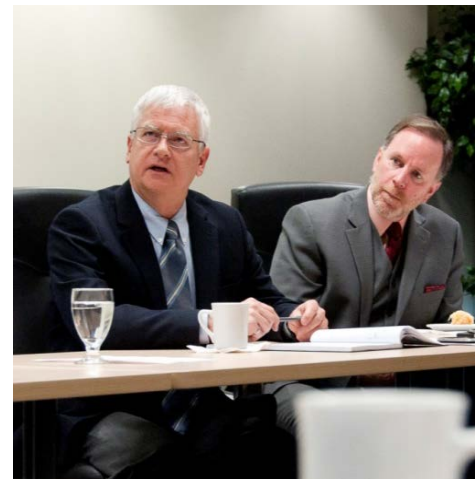
Four key themes emerged from the roundtable discussion: vegetation management, communications, reliability, and energy literacy.

3.1 Vegetation Management

It is estimated that there are over 10 million trees in Toronto, two million of which fell or lost branches during the ice storm pulling down wires and causing power outages.

The tree canopy in Toronto currently covers 28 percent of the city, and efforts are underway to increase it to 40 percent.⁶ Municipalities across southern Ontario are considering similar plans. These municipal forestry plans can have unintended and sometimes undesirable consequences for the electricity distribution system, particularly during extreme weather conditions. Setback distances from electricity infrastructure and tree species have been identified as important issues. Setbacks for trees and electricity poles are currently the same. It was also noted that some tree species are more vulnerable in ice storms than others. Manitoba maples and Siberian elms, for example, were particularly prone to damage from the storm.

Though Ontario LDCs do not own trees, LDCs have vegetation management programs to control trees that encroach on power lines. According to the *Electricity Act*, "A transmitter or distributor may enter any land for the purpose of cutting down or removing trees, branches or other obstructions if, in the opinion of the transmitter or distributor, it is necessary to do so to maintain the safe and reliable operation of its transmission or distribution system" 1998, c. 15, Schedule A, s.40 (4). Trees that are publicly owned are often treated like private property. As a result, LDCs spend significant resources engaged in disputes to obtain social license to maintain a reliable grid.



Recommendation 1

A comprehensive vegetation management strategy should be developed which clearly identifies the roles and responsibilities of the municipality, the utility and the property owner.

⁶ Toronto Street Trees, City of Toronto, Urban Design Streetscape Manual, In collaboration with Parks, Forestry & Recreation [http://wx.toronto.ca/inter/plan/streetscape.nsf/d2ee0d49ba602f3e85257457005a208d/491C15A190DCC0A7852576EB0066D3C5/\\$file/T-G-TreeGuide.pdf](http://wx.toronto.ca/inter/plan/streetscape.nsf/d2ee0d49ba602f3e85257457005a208d/491C15A190DCC0A7852576EB0066D3C5/$file/T-G-TreeGuide.pdf)

3.2 Communication

LDCs primarily used social media, e-mail and call centres to communicate outage updates with customers.

The response from Toronto Hydro included:

- 1,500 mass media interactions.
- 1,000 tweets.
- 6,000 customer comments on Facebook.
- 7,000 e-mails to city councillor networks.
- 37,000 e-mails sent to business and association networks.
- 374,000 customer calls in 10 days.



LDCs identified several challenges with regard to communication during the storm. The main concerns were:

- LDC customer service call centres could not handle the call volume. 374,000 calls were made to Toronto Hydro, 90 percent of which could not be connected because the telephone system was overwhelmed by the call volume. Continuously staffing call centres for mass outages would be prohibitively expensive.
- Many of the calls received were to inquire about restoration times and to report outages that LDCs were already aware of because of smart meters. There is perhaps a more effective way to address these inquiries such as in-person briefings or by way of the Internet. This would free up telephone lines for customers who are facing unique challenges and require call-centre support.
- Customers wanted face-to-face interaction but there was no appropriate forum. Some customers went to the head office of their local LDC. There were also customers who could not charge their mobile devices to receive electronic updates. This suggests that there is no substitute for an in-person briefing.
- Several customers experienced damage to the standpipe on their homes. It was recognized that although there is a clear protocol for repairing this damage between LDCs and Electrical Safety Authority (ESA), it is not widely understood by homeowners. The ownership boundary between the homeowner's private property and LDC equipment is not well understood or communicated. Some homeowners expected the standpipe repair and reconnection process to be quicker, but that is because most standpipes rarely require repairs and therefore rarely experience the standard connection authorization process used by LDCs and the ESA. Customers who hired licensed electrical contractors to make repairs to their equipment experienced minimal, if any, delays. For those customers unaware that the standpipe is their responsibility and not that of the LDC, the requirement for a

qualified electrician to make the repair and the ESA to inspect the work before the LDC could restore power was an unpleasant surprise. This led to delays in getting power restored for some customers. There are 11,000 registered electricians in Ontario and a system to find a contractor in your local area is available on the ESA web site.⁷ It was noted that some customers fell victim to unregistered and unqualified electricians, which is a challenge that the ESA experiences and investigates year-round. To counteract this, the ESA increased the use of its security investigators during the ice storm to discourage unethical contractors.

- The number of variables involved in restoring mass outages makes it almost impossible to establish clear restoration timelines. Many LDCs were unable to provide concrete timelines and had difficulty managing customer expectations. It was noted that the public's tolerance for power outages in cities appears to be getting lower (and shorter) every year. Twenty-four hours is becoming the new maximum duration. During an outage, customer attitude shifts from "oh well" to "angry" in 24 hours. It was also noted that rural customers are generally more prepared to withstand a power outage. LDCs in rural areas have a longer grace period, but only until such time as similar hardships lead to the same reaction as from city dwellers.
- There was consensus that local municipalities and LDCs need to improve coordination of their communication efforts. The Ontario Ministry of Energy is working with the Electricity Distributors Association (EDA) with the intent of developing a protocol to coordinate information and communication. Agencies such as ESA who interact with the EDA members but report to different ministries also need to be included in this process.

Recommendation 2

There is a need for an emergency communication strategy that accommodates the overwhelming number of calls that LDCs receive during significant power outages. This strategy should consider frequent in-person briefings and communication by way of radio, the internet and social media.

⁷ <http://www.esasafe.com/>

3.3 Reliability

Many roundtable participants agreed that more frequent and severe extreme weather events are likely going to present themselves in Ontario in the future. According to the Insurance Bureau of Canada, 2013 was the fourth year in a row that the Canadian insurance industry paid out over \$1 billion for weather-related damages.⁸ Recent events like the July 2013 flood in Toronto and the 2013 ice storm have already begun to change the risk profile for utilities. These trends have raised several important points:

1. Metrics should be developed to measure LDC responses to extreme weather events.

- In New York, for example, it has been proposed that utilities should be held accountable for their performance before, during and after extreme weather events. An example of a standard is establishing a minimum time to reach a 90 percent restoration threshold.
- The Ontario Energy Board released a scorecard program outlining performance metrics for LDCs in 2013. It is believed that these metrics should be reviewed and refined before storm-related benchmarks are pursued in Ontario.
- Despite the challenges associated with developing metrics, LDCs can expect that if metrics are not developed, even at an internal level, they will eventually be imposed.
- It is important to define a “storm” when developing performance metrics. Weather-related events vary significantly.

2. How much should LDCs invest in reliability?

- Investing in reliability is costly for utilities. For example, it has been estimated that it would cost \$15 billion to bury Toronto Hydro assets to prevent damage from further ice storms. Considering that the grid is generally very reliable for many weather-related events, the question was raised: would customers be willing to accept a significant rate increase to improve reliability or would they rather deal with the occasional extended outage? Surveys show that customers are generally not willing to accept rate increases to invest in adaptation.
- Public tolerance for electricity outages is diminishing. At the same time, there is significant evidence to suggest that ratepayers are not willing to absorb rate increases to reduce outages, or improve reliability. Keeping electricity bills as low as possible is a top-of-mind priority for customers in Ontario.

⁸ http://www.ibc.ca/en/Media_Centre/News_Releases/2014/January/Canada_inundated_by_severe_weather_in_2013.asp

- Toronto Hydro once proposed to a tax levy to bury wires in one Toronto neighbourhood. The proposal was highly controversial and fiercely opposed by the community.

3. Energy security was also raised as a concern.

Some expressed apprehension about the availability of the city's backup supply of diesel, which would be required for emergency and medical services as well as generators in the case of extended outages. A clear supply chain for diesel needs to be delineated.

Reliability is becoming increasingly important as threats to the electricity system increase. This raises the following questions:

- Is Ontario prepared to introduce reliability-related metrics? If so, what metrics are appropriate?
- Investing in reliability will require additional revenue streams. Are LDC and municipal expectations aligned?
- What protocol is in place for backup energy supplies like diesel in the event of a future extended power outage?

Recommendation 3

There is a need to improve our understanding of the expectations of customers with respect to the issues of: reliability and security, cost and benefit and an acceptable level of risk. Consideration should also be given to the lack of preparedness at the household level for extended outages and to customers with accessibility challenges and medical conditions.

3.4 Energy Literacy

The public and political reaction to the ice storm revealed a number of challenges with regard to the general knowledge of the electricity system, how it functions and how the system needs to be restored. The following observations were made:

- There is an overall lack of understanding about how electricity is actually delivered to homes and how smart meters provide utilities with insight on power outages. Following the ice storm, for example, a number of customers called to tell the utility that their power was out and as time passed, they called with questions as to why some parts of their street had power while other parts did not. Explaining these “apparent anomalies” to customers required call-centre resources that could have been used more effectively elsewhere.

- There is a misunderstanding about the protocol for restoring power following a major outage, particularly amongst municipal politicians. Outages are addressed in a sequence that will restore power to the highest volume of customers. Priorities are not established on the basis of political boundaries (e.g. wards). Many LDCs faced a significant level of political interference in the power restoration process. To be clear, the response protocol for LDCs after the ice storm was as follows:
 - Emergency situations are addressed first.
 - Next, critical infrastructure is restored, including hospitals and water pumping stations.
 - Then transformer stations are addressed because they affect the largest number of customers.
 - Then, in the following order, municipal stations, main feeders, multi-residential, lateral feeders and individual services are addressed.

- A misunderstanding was noted about what electrical equipment is the responsibility of LDCs and what is the responsibility of the homeowner. The demarcation point at which the utility responsibility ends and the customer ownership begins is not well understood by homeowners. It came as a surprise to many electricity customers that the standpipe that connects LDC distribution wires to houses and buildings is not owned by the utility. Many customers did not realize this until the distribution system was repaired and they were still without power because their standpipe was damaged. Customers who experienced broken standpipes only then became aware of the additional charges for an electrician to repair the pipe. And unfortunately, without information on certified electricians, some customers paid to have the standpipe repaired by fraudulent electricians performing substandard work only to have the ESA not approve reconnection of the home to the electricity grid.

- The ice storm revealed that minimal emergency planning is being carried out at the household level. Toronto Hydro and other LDCs have prepared checklists for customers.⁹ Notwithstanding these initiatives it is clear that many homes and businesses are not prepared for an extended outage. It was noted that some utilities and government agencies have developed emergency preparedness documents and power outage kits.¹⁰ Participants questioned if these tools would be used by the public in large numbers. While LDCs, municipalities and electricians play a key role during blackouts, there is a concern about whether the public is generally taking personal responsibility to prepare for outages.

⁹ https://www.torontohydro.com/sites/electricsystem/Documents/THESL_EmergencyChecklist_Residential.pdf

¹⁰ <http://www.getprepared.gc.ca/>

- In New York City, the continuity of the electricity system has been identified as one of the top three public health issues for the city. Opposition from rate payers and municipalities to invest in infrastructure improvements suggests that the same may not be true for Ontario municipalities. This is a concern, particularly for large urban centres like Toronto.

Recommendation 4

There is a need to improve the energy literacy of the public in the general area of emergency preparedness. Given recent experience with severe weather in Southern Ontario, citizens need to better understand:

- (a) Electricity restoration protocols.
- (b) The responsibilities of the utility and the home owner in case of a supply disruption - e.g. that the home owner is responsible for a damaged standpipe and finding a qualified electrician to repair it.
- (c) The importance of having an emergency supply of essentials available in the event of a sudden loss of service - e.g. food, water, fuel, batteries, blankets, first aid materials etc.
- (d) Why good vegetation management by the homeowner, the utility and the municipality matters in the case of severe weather like an ice storm.



4.0 Looking Ahead

Freezing precipitation lasted between 43 and 55 hours in the epicenter of the storm in Ontario,¹¹ causing a 30 millimeter buildup of ice on trees and distribution infrastructure. The majority of the damage caused by the 2013 ice storm occurred at the distribution level. The circumstances of this storm led to outages that were distributed in isolated pockets throughout the region. Many households and businesses that experienced extended outages had the option of moving to different parts of the city or region. Roundtable participants voiced their concern that if the storm persisted, infrastructure that remained relatively unaffected, like high-voltage transmission lines, could have been seriously damaged as it was during the 1998 Ice Storm, which saw 80 hours of freezing precipitation.¹²

The threat of increasingly frequent and severe weather is a significant concern for the utility sector, particularly because regions throughout the GTA are intensifying in their power needs and electricity infrastructure is aging. Significant progress is being made by way of energy conservation, however this is a solution for capacity constraints; it does not address the issue of reliability. Similarly, combined heat and power technology is being installed throughout Ontario, though beneficial to property managers, this is not a solution for grid reliability. The Copeland Transformer Station will be the first station to be built within Toronto city limits since 1955. This has been a major accomplishment for Toronto, but there remains the important issue of balancing demand with load in the GTA.

Given the circumstances arising from the 2013 ice storm, there was a general sense from the roundtable participants that going forward:

- Special attention should be paid to a comprehensive vegetation management strategy, the communication strategy and the backup emergency supply strategy for extreme weather-related outages.
- There is a serious conflict between the effort to keep electricity rates as low as possible and at the same time, establish a highly reliable supply of power to the increasingly urbanized and intensifying load centres throughout the GTA.
- Consensus needs to be built on how to design a future urban grid that is flexible and capable of addressing changing customers, changing loads, different buildings, extreme weather and new forms of generation (such as all DC current). Grid hardening and emergency preparedness should be considered.
- The insurance industry focus on risk management is putting pressure on utilities to adapt their risk management strategies to achieve resiliency.

¹¹ <http://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=5BA5EAF1-1&offset=5&toc=show>

¹² <http://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=3DED7A35-1#1>

- Solutions will require a rational political dialogue and should also include input from younger generations with new ideas.
- Energy literacy is a recurring issue for the sector. The public and their elected officials would benefit from understanding the storm response protocol.
- There should be a legitimate space for politicians to operate within the emergency response protocol.
- Attention should be paid to developing institutional knowledge around emergency preparedness.
- The emergency response needs to fit the context.
- It is important to identify what information is needed to manage the situation properly.
- The conversation must be kept alive.





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