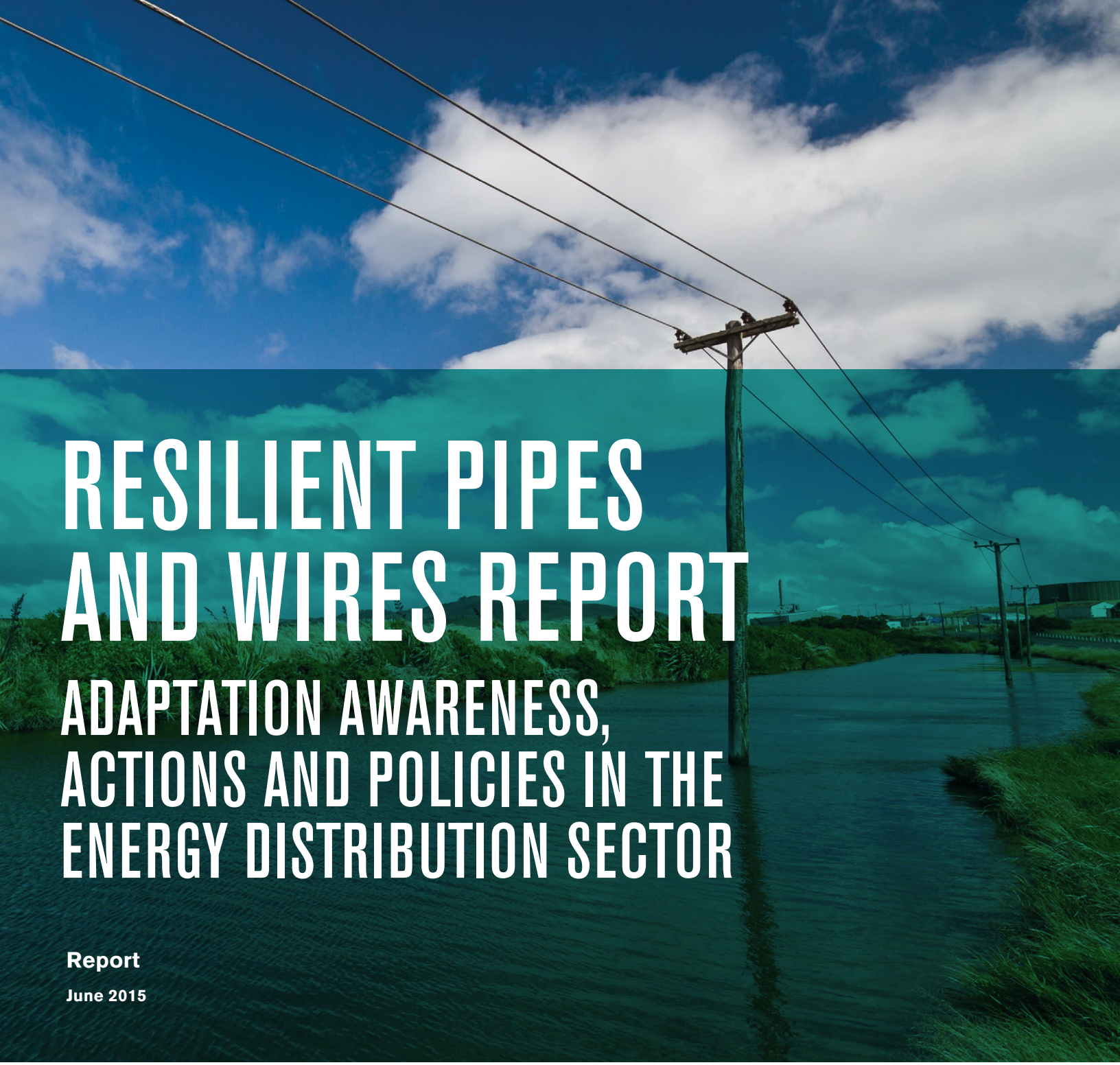

RESILIENT PIPES AND WIRES REPORT

ADAPTATION AWARENESS, ACTIONS AND POLICIES IN THE ENERGY DISTRIBUTION SECTOR

Report

June 2015

QUEST
Quality Urban Energy Systems of Tomorrow

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ASSOCIATION CANADIENNE DU GAZ

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QUEST | Quality Urban Energy Systems of Tomorrow

QUEST is a non-profit organization that conducts research, engagement and advocacy to advance Smart Energy Communities in Canada. Smart Energy Communities improve energy efficiency, enhance reliability, cut costs, and reduce greenhouse gas emissions. With the help of 8 provincial and regional Caucuses, QUEST brings together key stakeholders from government, utilities & energy providers, and the real estate sector among others to transform Canada's 5400 communities into Smart Energy Communities.

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INTRODUCTION

Impacts from a changing climate, including changing temperatures, changing precipitation patterns, flooding, wildfires, permafrost degradation and hurricanes, among other impacts,[1] have exposed critical energy distribution infrastructure to significant risks in recent years. These impacts have led to adverse outcomes leaving millions of Canadian homes and businesses without power, heating or cooling for extended periods of time.

The interruption or loss of energy distribution is not only a serious public health and safety risk; it can have long term negative impacts on economic activity, energy distribution rates, public confidence, and utility reputation. As energy distribution infrastructure ages, cities continue to intensify, and an increasing amount of our economic activity relies on the uninterrupted distribution of electricity, natural gas, and thermal energy, the consequences of widespread and prolonged outages will become increasingly severe.[2]

The vast majority of energy distributors have been impacted by extreme weather in the last decade and a growing number of voices are forecasting that the frequency, duration and intensity of extreme weather events will increase over the next 50 years.[3] Given the potential impacts of extended outages on health and safety and the economy, there is a need to understand how energy distributors and policymakers are responding.

Resilient energy distribution is important not only for ensuring the health and welfare of our cities and communities, but also for advancing Smart Energy Communities, which improve energy efficiency, enhance reliability, cut costs and reduce greenhouse gas emissions. In order to achieve resilience, electricity, natural gas and thermal energy distributors must adapt their infrastructure, operations, organizational structure, and communications to address the climate change risks.

Electricity, natural gas and thermal energy distributors have a critical role to play in proactively collaborating with other community-level stakeholders, and aggressively adopting new technological and program innovations in order to integrate conventional energy networks, make smart land use decisions, and harness local energy opportunities to advance Smart Energy Communities and improve reliability and resilience.[4]

The Resilient Pipes and Wires report undertakes to:

- Identify the level of awareness of climate change risks within the energy distribution sector and describe the actions energy distributors are taking to adapt to extreme weather events;
- Identify federal, provincial and local policies relevant to adaptation actions;
- Demonstrate how government policies are acting as drivers or barriers to adaptation in the energy distribution sector; and
- Recommend measures to address identified barriers and leverage drivers to enable adaptation and enhance resilience in the energy distribution sector.

INVESTING IN RESILIENCE

Resilient energy distributors are characterized by the following four indicators, identified in an analysis for the U.S. National Association of Regulatory Utility Commissioners.[5]

Resilience

Robustness: the ability of an energy distributor to withstand extreme weather events and continue operating;

Resourcefulness: the ability of an energy distributor to effectively manage operations during extreme weather events;

Recovery: the ability of an energy distributor to restore operations to desired performance levels following a widespread outage; and

Adaptability: the ability of distributors to incorporate lessons learned from past events to improve resilience in the future.

Resilient energy distribution is often characterized by the robustness of infrastructure to withstand outages. There is increasing recognition from organizations, such as The Centre for Resilience of Critical Infrastructure (CRCI) at the University of Toronto, that distributor investment decisions must look beyond infrastructure solutions and should consider the broad risk context under which the energy distributor operates. Though robust infrastructure has a role to play in enabling resilience, utilities that also focus on operational aspects of the utility business may be better equipped to predict and adapt to the risks posed by extreme weather events.[6]

There is a strong case to be made for investing in adaptation. A 2013 report by the Executive Office of the President of the United States of America estimates that between 2003 and 2012 weather-related outages cost the U.S. economy an annual average of $18 billion to $33 billion.[7] A TD Economics report projects that the long-term fiscal impact of natural catastrophes in Canada may increase to more than $40 billion annually by 2050 and urges businesses and policymakers to start thinking about the potential consequences of inaction.[8]

The insurance industry has also been influential in shaping the conversation about climate change risks. With a growing proportion of insured losses being caused by extreme weather events, the insurance industry is calling on businesses and governments to incorporate climate change risks into future decision making.[9]

1 (Natural Resources Canada, 2008)
2 (QUEST, 2014)
3 (Insurance Bureau of Canada, 2012) (Sandink & Gilbeaut, 2014) (ICLEI Canada) (SENES Consultants Ltd., 2011)
4 (QUEST, 2015)
5 (Keogh & Cody, 2013)
6 (Hay & Bristow, 2014)
7 (Executive Office of the President, 2013)
8 (Alexander & McDonald, 2014)
9 (Insurance Bureau of Canada, 2012)

The TD Economics report also forecasts that for every dollar invested in adaptation, $9-$38 of future damages are avoided.[10] Not only can these investments help energy distributors become more robust and better equipped to restore services after extreme weather events, investing in resilience can help them prepare for other risks, including threats to data security and terrorism.

There is evidence that there is strong customer support for the continuity of energy supply.[11] CRCI has found that the market tolerance for energy service interruptions has decreased significantly, from weeks in 2001 to hours in 2015.[12] Industrial customers in particular tend to be willing to pay more for a continuous supply of service, driven by broad market trends, such as just-in-time delivery.[13]

RESEARCH APPROACH

The Resilient Pipes and Wires report brings together two projects including:

- Assessing the adaptation awareness and actions in the energy distribution sector; and
- Assessing policies as drivers and barriers to integration of adaptation in the planning and operation of the energy distribution sub-sector.

The report focuses on energy distributors, including electricity, natural gas and thermal energy distributors. It is focused on how distributors can enhance the resilience of energy services to respond to risks associated with a changing climate. Climate impacts considered for this study focus on, but are not limited to, high winds, heavy precipitation, flooding and storm surges, extreme extended cold and heat waves. Risks and actions related to infrastructure, operations, communications and organizational structure of energy distributors are considered. This includes actions to enhance the robustness of infrastructure, and enhance the resourcefulness, recovery and adaptability of operations to minimize restoration times following extreme weather events. The report also examines the policy influence of federal, provincial and local policymakers and regulators in driving resilience in the distribution sector.

Excluded from the scope are energy production (e.g. oil and gas production), all bulk energy transmission (e.g. natural gas transmission lines or high voltage electricity transmission), and non-stationary fuel distributors (e.g. diesel and propane distributed by truck). The scope also excludes, most electricity generation, although distributed energy resources, particularly thermal distribution involving combined heat and power, is within the scope of this research as it requires energy distributor involvement.

[10] (Alexander & McDonald, 2014)
[11] (MacLeod, 2015)
[12] Personal communication, Alec Hay
[13] (Ontario Energy Board, 2013)

The findings from this report are based on:

- A comprehensive literature review, which looked at energy distributor actions, and government policies across Canada, the United States and internationally;
- Participation in third party panel discussions and roundtables with subject matter experts including *QUESTtalks Resilience: Smart Energy Communities in the Age of Extreme Weather*[14] in Toronto, Ontario, the ICLEI *Livable Cities Forum*[15] in Vancouver, British Columbia, the International District Energy Association conference *Moving Community Energy Forward*[16] in Seattle, Washington, the Co-Operator's *Partners for Action Roundtable Forum*[17] in Mississauga, Ontario, and the Natural Resources Canada Climate Change Impacts and Adaptation Division Adaptation Platform Energy Working Group;[18]
- 24 survey responses from senior-level decision makers at electricity, natural gas and thermal energy distributors across Canada;
- Two working sessions with 22 senior-level staff at distribution companies, provincial regulators, industry associations, consulting firms and the Federal government, held in Ottawa, Ontario and Calgary, Alberta;
- One-on-one interviews with subject matter experts to obtain data, inform and refine draft content; and
- Oversight from the Resilient Pipes and Wires Advisory Committee, made up of five organizations and industry associations.

The findings in this report are supported with examples from jurisdictions across Canada, and international examples are used where they illustrate potential actions or policy approaches. International cases may not always be applicable because the regulatory and policy context may differ from Canada.

RISKS TO THE DISTRIBUTION SECTOR

Energy distributors are all vulnerable to extreme weather events. The extent to which they may be impacted depends on the geographic location of the infrastructure and to a large extent on whether the infrastructure is above or below ground. It also depends on the organizational structure of the distributor and whether the right processes and protocols are in place to respond and communicate effectively following an outage. Some of the most common climate-related risks to electricity, natural gas and thermal energy distributors are described here.

RISKS COMMON TO ELECTRIC, NATURAL GAS AND THERMAL DISTRIBUTORS

Extreme weather events pose risks that are common to electricity, natural gas and thermal distributors. If unprepared, an energy distributor may see impacts on staff involved in responding to outages. This includes both field staff as well as staff responsible for overseeing restoration efforts (e.g. control room staff, communications staff and executive staff). For field staff, there are real health and safety risks associated with restoring energy services due to inclement weather, poor driving conditions, damaged trees, fallen telephone lines and electricity wires, long work hours and mutual assistance crews working in unfamiliar territory. For staff responsible for overseeing the restoration process, distributors risk drawing out the restoration times if staff are not aware of their roles, if communication is uncoordinated and if proper processes are not in place to cope with widespread outages caused from extreme weather.

[14] (QUEST, 2014)
[15] (ICLEI, 2014)
[16] (International District Energy Association, 2014)
[17] (The Cooperators, 2014)
[18] (Natural Resources Canada)

Electricity Distributors

Electricity distributors are inherently more at risk from extreme weather events compared to natural gas and thermal energy distribution systems because a greater proportion of electricity distribution infrastructure is exposed aboveground.

Some of the greatest threats to electricity distribution infrastructure include high winds, precipitation, ice storms and wet snow, storm surges, flooding and extreme heat. These threats can damage infrastructure including transformer stations and substations, pole-mounted distribution transformers, distribution lines, reclosers, voltage regulators, capacitors and switches, poles and conductors, as well as customer-owned connection equipment such as service masts, among other components of the distribution system.

Underground electricity infrastructure may still be vulnerable to flooding and ground shifting. The risks are highest where wires emerge near transformers and other aboveground infrastructure.[19]

Toronto Hydro, Toronto, Ontario

The 2013 Toronto Ice Storm caused damage to 168 transformer station feeder lines, 49 municipal station feeder lines and 50,000 individual service lines operated by Toronto Hydro. The damage left over one million residents and businesses without power across the city, some of them for up to ten days. The storm resulted in $11.9 million in direct damages to Toronto Hydro and $1 million in lost utility revenue.[20]

Toronto Hydro, 2013

ENMAX, Calgary, Alberta

The 2013 flooding in Calgary led to temporary loss of access to a substation owned by ENMAX, the local electricity distributor. That substation provided critical power to a hospital in the south of Calgary and left 35,000 customers without power, some of them for up to eight days.[21] The flood resulted in $9.6 million in direct damages to ENMAX.[22]

Source: (ENMAX, 2014)

[19] (Royal Academy of Engineering, 2011)
[20] (Toronto Hydro, 2014)
[21] (City of Calgary Expert Management Panel on River Flood Mitigation, 2014)
[22] (ENMAX Corporation, (n.d.))

Natural Gas Distributors

Natural gas distribution systems tend to be very reliable particularly in the face of extreme weather events, due to the infrastructure being mostly buried underground. Canada's 258,702 kilometres of natural gas distribution pipelines,[23] however, are still vulnerable to the impacts of extreme cold weather and flooding. In recent years natural gas distributors have experienced pipeline cracks or ruptures from ground shifting due to extreme precipitation and flooding. Though relatively rare, extreme cold weather may also cause line heater failure impacting the operation of the natural gas delivery system.[24]

SaskEnergy, Saskatoon, Saskatchewan

In 2012, SaskEnergy had to shut off the natural gas supply to a Saskatoon neighbourhood because of an unexpected 1.5 meter drop in ground level, referred to as a slope failure. The Centre for Hydrology at the University of Saskatchewan suspects the slope failure was caused by higher than normal water table levels from extreme rainfall.[25]

Source: (CBC News, 2012)

Thermal Energy Distributors

Canada's 128 district (thermal) energy systems[26] tend to perform at a high level of reliability, similar to natural gas systems, due to the systems being buried underground.[27] They are, however, susceptible to extreme weather. Depending on where a system is located, district energy systems may be at risk of floods from storm surges, extreme rainfall, high winds or extreme extended cold weather, which can cause damage to district heating pipes, including corrosion and pipe failures.[28]

Tri-Generation Energy-from-Waste Facility, Charlottetown, Prince Edward Island

In January 2000, a storm surge on the coast of Charlottetown, Prince Edward Island, caused damage to a pumphouse and backup generating facility at the Tri-Generation Energy-from-Waste facility. The facility is the primary source of heating services for almost 80 buildings in the downtown core and caused an estimated $20 million in damages to property and infrastructure across the province. Climate models show that the heating lines from the distribution system are vulnerable to increased flooding.[29]

(Stewart, D., 2010)

[23] (Statistics Canada, 2015)
[24] (FERC/NERC, 2011)
[25] (University of Saskatchewan Centre for Hydrology)
[26] (Canadian Industrial Energy End-use Data and Analysis Centre, 2014)
[27] (New York City Government, 2013) (Thornton & Pielli, 2014)
[28] (Kraftringen, 2015)
[29] (Shaw, 2001)

UNDERSTANDING RELIABILITY AND RESILIENCE IN THE ENERGY DISTRIBUTION SECTOR

Exposure to weather-related risks is not new for energy distributors in Canada and internationally, as weather is one of the primary causes of energy distribution outages.[30] Despite exposure to these risks, distributors have a reputation of delivering electricity and natural gas at reliability rates exceeding 99.93 percent and 99.99 percent respectively.[31]

Reliability is calculated in the following ways:

- **Electricity distribution:** The reliability performance indicators for electricity distributors, "System Average Interruption Frequency Index" (SAIFI), "System Average Interruption Duration Index" (SAIDI), and "Customer Average Interruption Duration Index" (CAIDI), measure the frequency, duration and magnitude of outages, respectively.
- **Natural gas distribution:** Reliability is measured by the total duration of unplanned outages in hours versus the total number of hours that natural gas service should have been available. Some natural gas distributors calculate reliability using the number of significant unplanned supply interruptions.
- **Thermal energy distribution:** Thermal distributors determine reliability using an assessment of plant production availability and reliability of customer service.[32]

Distributors are required to maintain reliability to keep their franchise rights and license to operate. Traditionally, they plan for and seek rate approval from regulators to maintain this high degree of reliability. In some cases, distributors have calculated customer tolerance for the frequency and duration of outages which they take into consideration as part of the infrastructure investment planning processes.

While electricity distributors tend to achieve reliability rates of 99.93 percent, they are permitted to exclude outages that are beyond their control from reliability indicators. This includes extreme weather events.[33] Excluding these events is problematic because it leaves little incentive for distributors or regulators to calculate or understand how an increase in frequency and duration of extreme weather events will impact service reliability going forward and what customers might be willing to pay to avoid future widespread, extended outages.

[30] (Executive Office of the President, 2013) (Enbridge Gas Distribution, 2015) (The Sarnia Observer, 2014)

[31] Data retrieved from the Canadian Electricity Association and Enbridge Gas Distribution

[32] Availability is calculated by the number of total hours of forced outage divided by total hours in period multiplied by the number of production units. Reliability is determined by the number of customer hours of unplanned interrupted service divided by total annual customer hours. Interruptions are defined as incidents where the service provider deviates from acceptable operating criteria. Reliability calculations exclude temporary shutoffs for planned construction or maintenan

[33] (Keogh & Cody, 2013)

It is important to note that resilience extends beyond infrastructure investments and must consider operational response. Resilience is about "planning and designing for continuity of operation through a catastrophic event."[34] In order for an energy distributor to withstand and recover quickly from a widespread, extended outage, electricity, natural gas and thermal distributors must look beyond improving the robustness of critical infrastructure and examine the broad risk context under which they operate.

So what does a resilient energy distributor look like? The following table provides an overview of some of the characteristics of resilient energy distributors. This list of indicators is not exclusive and is meant to provide a starting point for discussion. A resilient energy distributor is one that is:

Robust

- Has business continuity plans and emergency plans in place and conducts emergency response and restoration exercises on a routine basis;
- Has access to accurate climate forecasting models to identify risks, and to make sound business planning and infrastructure siting decisions;
- Proactively hardens infrastructure that may be vulnerable to future climate risks; and
- Is supported where possible by complementary sources of redundant distribution and distributed generation and storage.

Resourceful

- Has trained staff, equipment, communications protocols and mutual assistance agreements in place to respond to widespread outages following extreme weather events; and
- Has conducted senior management media training.

Recoverable

- Can identify outages remotely;
- Can isolate faults and restore services more rapidly (for electric utilities, this can be done through a centralized Supervisory Control And Data Acquisition (SCADA) system or an Advanced Distribution Management System (ADMS) or through a distributed approach such as a Distributed Control System (DCS));
- Can dispatch crews accurately and effectively;
- Can communicate accurate restoration times to stakeholders and customers; and
- Has effective customer service through channels such as call centres and on-line communication.

Adaptable

- Is able to incorporate learnings from previous outages into future decision making;
- Has the organizational flexibility to quickly respond to new climate change information;
- Coordinates distribution planning with emergency response practices and land use practices; and
- Balances investments in infrastructure hardening and protection with investments in improving its ability or recover from extreme weather events more rapidly.

[34] (Hay, Alexander, 2014)

PART A:
CLIMATE CHANGE ADAPTATION AWARENESS AND ACTIONS IN THE ENERGY DISTRIBUTION SECTOR

1.0 AWARENESS OF CLIMATE CHANGE RISKS IN THE ENERGY DISTRIBUTION SECTOR

The first part of the Resilient Pipes and Wires study focuses on determining the level of awareness and concern for climate change risks among energy distributors. The findings are based on a literature review, a survey, and two working sessions with distributor subject matter experts.

1.1 SUMMARY OF KEY FINDINGS

Awareness of historical climate change impacts to the distribution sector is high.

- 90 percent of distributors surveyed stated their organization had been negatively impacted by a significant weather event in the last decade.
- While the impacts on electricity distributors tends to be greater, the interdependencies of the electricity, natural gas and thermal energy distribution systems have impacted the service delivery of natural gas and thermal distributors.

Awareness of predicted impacts of future climate trends to the distribution sector is low but developing.

- Energy distributors are aware that the frequency, duration and severity of extreme weather events are increasing and that this may pose risks for their infrastructure and operations.
- Though distributors are aware that extreme weather events are generally becoming more frequent, longer and more severe, the understanding about how this will affect their future operations and infrastructure is generally low.
- The majority of utilities surveyed are implementing actions to reduce the distribution system's vulnerability to extreme weather events. Natural gas and thermal distributors tend to be implementing fewer actions due to infrastructure being buried mostly underground and therefore less vulnerable to extreme weather.
- Some utilities have developed climate risk assessments or adaptation plans to more systematically direct these investments. Distributors rely on climate models that contain enough detail to identify the risks posed to infrastructure and operations.
- Climate models are being developed on an ad-hoc basis by local governments and academic institutions among other organizations, however there is currently no standard approach to developing regionally-specific climate models that contain a level of detail necessary for distributors to make investment decisions to adapt infrastructure.

All distributors expressed concern for the impacts of future climate trends.

- The majority of electricity and thermal distributors surveyed identified climate change to be of similar concern to other stressors like ageing assets and changing regulatory requirements.
- Due to its inherent resilience of being mostly underground, natural gas and thermal energy distributors tend to be less concerned about climate change impacts on their infrastructure.
- Electricity and thermal distributors are particularly interested in adapting infrastructure and operations for extreme weather events.
- There is consensus among all distributors that although there are some supportive policies and regulations in place to support adaptation efforts for energy distributors, the current policy and regulatory framework does not adequately incent distributors to invest in infrastructure adaptation to respond to future climate change risks.

Adaptation response continues to take place on an ad-hoc, reactive basis in the aftermath of extreme weather events.[35]

- A 2011 study by the Clean Air Partnership shows that only 27 percent of electric utilities have conducted a quantified analysis to make decisions about adaptation and only 6 percent have evidence that climate change has been integrated into their internal corporate governance procedures.[36]
- Over 90 percent of the electric distributors surveyed worldwide by the Carbon Disclosure Project identified that they were at risk from climate change, however, less than a third claimed to undertake any financial or quantified evaluation to the impact of climate change on their business.[37] All utilities are taking some actions but there is an opportunity to address risks and improve resilience in a more systematic fashion.

[35] (Government of Canada , 2009)
[36] (Clean Air Partnership, 2011)
[37] (de Morsella, 2009)

2.0 ADAPTATION ACTIONS IN THE ENERGY DISTRIBUTION SECTOR

Energy distributors can and are taking steps to enhance robustness, resourcefulness, recovery and adaptability of their infrastructure and operations. Adaptation can fall under five categories:

- Adaptation planning and risk assessments
- Infrastructure solutions
- Operational solutions
- Communications and engagement solutions
- Organizational solutions

Actions currently being taken, as well as suggested future actions, were identified through:

- 24 survey responses from senior-level decision makers at electricity, natural gas and thermal energy distributors across Canada;
- Two working sessions with 22 senior-level staff at distribution companies, provincial regulators, industry associations, consulting firms and the federal government, held in Ottawa, Ontario and Calgary, Alberta;
- One-on-one interviews with subject matter experts to obtain data, inform and refine draft content, and
- A literature review.

The actions, described below, are intended to be illustrative rather than comprehensive. Recommended actions do not necessarily reflect the position of all industry stakeholders.

2.1 ADAPTATION PLANNING AND RISK ASSESSMENTS

Electricity, natural gas and thermal energy distributors can voluntarily develop adaptation plans or conduct risk assessments to identify what infrastructure is most at-risk to extreme weather events. This insight can help to direct investments to the most vulnerable parts of the distribution system. Risk assessments include detailed climate analyses and models and describe the impact that climate trends will have on distribution infrastructure and operations.

Across Canada, 57 percent of electricity distributors have developed an adaptation plan.[38] The number of adaptation plans in the natural gas distribution sector is not known, however, risk assessments are standard tools of the industry.

Toronto Hydro, Ontario

In 2012, Toronto Hydro partnered with Engineers Canada to pilot a Climate Change Engineering Vulnerability Assessment.[39] The assessment was developed in collaboration with field staff, control room staff, engineering staff and the planning department. It provides an inventory of existing infrastructure, detailing which parts of the distribution system are most at risk to outages. The next phase of the pilot project will examine how future weather risks are expected to impact the system.[40]

Hydro-Québec, Québec

Hydro-Québec focuses much of its adaptation work on its generation and transmission systems. It has, however, developed a Task Force to look at technical aspects of undergrounding its electrical distribution infrastructure.[41]

Electricity, natural gas and thermal energy distributors are required by law to develop Emergency Response Plans, which must meet criteria set out in provincial legislation.[42] Emergency Response Plans typically define the actions an energy distributor will take following widespread extended outages, including internal procedures, roles and responsibilities, coordination with other emergency service agencies, and the management of mutual assistance agreements. Distributors also run mock emergencies to test their response to various emergencies. The Federal government legislates mock emergency testing from some institutions such as hospitals through the Canadian Standards Association C282, which is enforced through the National Building Code.[43] This legislation requires these institutions, to test backup power systems weekly. Provincial emergency management organizations,[44] and electricity, natural gas and thermal distributors also routinely run mock emergencies to test their response preparedness.

Some distributors have voluntarily bundled Emergency Response Plans, business continuity plans and adaptation plans into a single document, recognizing that these plans are highly interdependent and complementary.

[38] (Canadian Electricity Association, 2014)
[39] (AECOM, 2012)
[40] Ibid.
[41] (Mirza, 2012)
[42] (Independent Electricity Systems Operator, 2015), (Alberta Energy Regulator, 2014) (Government of British Columbia, 1996)
[43] (CSA Group, 2009)
[44] (Public Safety Canada, 2015)

Recommendation #1: Electricity, natural gas and thermal distributors have adaptation plans and risk assessments in place using local climate models to better identify risks to the distribution system.

2.2 INFRASTRUCTURE SOLUTIONS

Infrastructure solutions include actions to enhance the robustness of physical assets to help withstand damage from extreme weather events and to prevent the interruption of energy delivery. Infrastructure approaches are often expensive. Infrastructure investments based on detailed risk assessments and adaptation plans, however, can be cost effective, when it is well understood that the infrastructure is particularly vulnerable or has a high probability of failing in extreme weather conditions.

Infrastructure solutions can be organized in the following categories:

- Improving the robustness of infrastructure and improving distribution system design standards;
- Building redundancy into the distribution system; and
- Expanding microgrids and identifying opportunities for distributed energy resources.

Improving the Robustness of Infrastructure and Improving Distribution System Design Standards

Improving the robustness of infrastructure includes any physical changes that help improve an energy distributor's ability to withstand an extreme weather event.[45]

Electricity distributors can improve robustness by siting infrastructure away from disaster-prone areas such as flood plains, using higher temperature-rated transformers and wiring to withstand extreme heat,[46] replacing wooden poles with concrete poles to withstand strong winds and hurricanes, and burying distribution wires to reduce risks of impacts from ice storms and strong winds.

Hydro-Québec and Ontario Hydro

Following the 1998 Ice Storm that impacted Québec and parts of Eastern Ontario, 40 percent of the Ontario Hydro distribution system, now owned and operated by Hydro One, was damaged. Damage amounted to $140 million for Ontario Hydro and $800 million for Hydro-Québec.[47] In Ontario, 10,750 wood poles, 1,800 pole-mounted transformers and 2,800 kilometers or wires had to be replaced. The damage left 150,000 people without power, in some places for up to three weeks.[48]

"Manitoba Hydro crews putting ice rollers on the energized lines to avoid outages to our customers. The rollers are pulled across the wires to break the ice off. This stops the wind from bouncing the lines, which causes problems like the wires splashing together, or the weight breaking cross arms etc."

Manitoba Hydro, (n.d.)

[45] (Edison Electric Institute, 2014)
[46] (Hammer & Parshall, 2009)
[47] (McGillivray, 1999)
[48] (Hydro One Inc., 2009)

Natural gas distributors can improve the robustness of pipelines by replacing bare steel pipes that are more prone to corrosion, leaks and cracks with coated steel and plastic pipes. The robustness of intermediate and high-pressure pipelines can be improved by installing back-flow prevention devices on vent lines to protect against flooding.[49] Excess flow valves can be installed on residential service lines to limit potential damage as well. Monitoring and control systems (SCADA) can also be made more robust by building in alternate data paths and backup sources of electricity generation.

BC Hydro

BC Hydro is implementing a number of concurrent strategies to prevent future outages, including incorporating energy storage for peak load shaving, implementing corrosion-resistant hardware, using a dynamic thermal circuit rating and using a dynamic rating for transformers.[50]

Energy distribution design standards are established by bodies such as the Canadian Standards Association, and enforced by federal and provincial policymakers and regulators through legislation such as the National Building Code provincial building codes and other legislation pertaining to energy distribution construction standards. Energy distributors often establish design and construction standards that exceed these requirements.[51] Distributors concerned that engineering standards established by organizations such as the Canadian Standards Association and adopted by federal and provincial regulatory bodies are inappropriate and not sufficiently supportive of adaptability and resilience needs could submit a joint proposal to change the rate structure to support higher standards.

Hydro-Québec

Hydro-Québec changed its construction standards following the 1998 Ice Storm. They strengthened transmission poles and anchoring to ensure that the poles remain intact in high winds and icy conditions. Now, the conductors fall rather than the poles.[52]

Building Redundancies into the Distribution System

Building redundancies into the distribution system is a method for reducing the probability of a distribution outage by providing multiple paths over which energy may flow. This is particularly relevant in instances where one path becomes obstructed."[53] For electricity distributors, this can take place in the form of installing redundant circuits over which the power can flow. Natural gas distributors could increase back-feeds or loops within their systems. Thermal distributors can incorporate redundancy in the production of heating and cooling as well as diversifying generation sources.

On-site backup power, though not a traditional form of redundancy, can also accomplish the same objective of reducing the probability of an outage and maintaining critical energy services.

Neighbourhood Energy Utility, Southeast False Creek, City of Vancouver

The City of Vancouver owns and operates the Neighbourhood Energy Utility district energy system. The district energy plant is located near a sewer pump station. The primary heat source for the plant is recovered from wastewater via heat exchangers. The system has on-site backup power and full redundancy in its heat production capacity, using both heat pumps and natural gas as a source for heat. Remote operation of the system is feasible using the contemporary "supervisory control and data acquisition" system (SCADA).

[49] (New York City Government, 2013)
[50] (Clean Air Partnership, 2011)
[51] (Institute for Catastrophic Loss Reduction, n.d.)
[52] (Hydro-Québec, 2013) (Institute for Catastrophic Loss Reduction, n.d.)
[53] (Evans, 2014)

Expanding microgrids and identifying opportunities for distributed energy resources

One of the most touted approaches to enhancing the resilience of energy distribution infrastructure is by integrating microgrids, distributed generation and storage opportunities into more traditional, centralized electricity and natural gas distribution grids.[54] These approaches often require collaboration among distributors, local governments, provincial governments, property owners and private stakeholders.

City of Toronto

The City of Toronto is currently working with Toronto Hydro, Enwave and other community stakeholders to implement distributed generation projects. Some examples include:[55]

- The implementation of 700 solar photovoltaic systems totalling an estimated 50 to 60 megawatts of electricity (facilitated by Toronto Hydro via Ontario's Feed-in-Tariff program);
- The Toronto Hydro Process and Systems Upgrade Initiative, administered by the IESO, which is currently working to install 63 megawatts of combined heat and power with large industries;
- The implementation of a new district energy system with combined heat and power at Exhibition Place (led by the City); and
- The potential expansion by Toronto Water and Enwave of the Deep Lake Water Cooling System, which already reduces peak electricity demand by 61 megawatts.

Asset Renewal

Asset renewal - the replacement and refurbishment of energy distribution infrastructure - is a significant stressor for energy distributors. According to the Conference Board of Canada, the electricity and natural gas distribution systems will require investments amounting to $62 billion[56] and $20 billion[57] respectively, to replace, refurbish and build new infrastructure over the next 20 years.

Improving the robustness of infrastructure and building redundancies into the distribution system for the purpose of improving the resilience of the distribution system can be costly for distributors and ratepayers. Investments in asset renewal may present an opportunity for utilities to invest in more robust and resilient infrastructure.

Alberta Urban Pipeline Replacement Project

In 2014, the Alberta Utilities Commission approved a $700 million application made by ATCO Gas for the Urban Pipeline Replacement Project – an initiative to replace up to 84 percent of its natural gas pipelines within Edmonton and 81 percent of its pipelines within Calgary installed prior to 1968. The rates approved were not the lowest cost alternative. The primary case made for the rate approval was natural gas pipeline age and safety. Disruptions due to unpredictable, extreme weather were also argued to be putting significant pressure on the natural gas distribution systems in both urban centres. Though the primary argument in the rate case was not resilience, the project presents an opportunity to adapt the natural gas system to withstand future extreme weather events.[58]

[54] (Bizikova, Neale , & Burton, 2008)
[55] (City of Toronto, 2014)
[56] (Baker, 2011)
[57] (Antunes, 2012)
[58] (Alberta Utilities Commission, 2014)

Recommendation #2: Electricity, natural gas and thermal distributors improve the robustness of their infrastructure based on identified future vulnerabilities and integrate resilience planning, including distributed generation and storage, into asset renewal planning.

2.3 OPERATIONAL SOLUTIONS

Operational solutions include actions that help distributors track, monitor and efficiently deliver electricity, natural gas, steam, hot water and cold water. These solutions can help distributors detect outages more accurately and reconnect service more rapidly, enhancing resourcefulness, recovery and adaptability. Distributors can implement operational improvements, such as:

– Smart meters
– Weather forecasting and weather pattern prediction systems
– Predictive asset management programs
– Right-of-way management

Electricity distributors have introduced smart meters in many jurisdictions across Canada, including Québec, Ontario, British Columbia and some parts of Saskatchewan. Smart meters record and transmit interval energy consumption readings to the distributor's Meter Data Management (MDM) and billing system. Smart meters can also provide power off and power restoration status which enables distributors to integrate this information with Outage Management Systems (OMS) to pinpoint customer outages, optimize power restoration effectiveness and improve customer outage information. While many distributors have started to access and analyze the data collected from smart meters, there are opportunities to improve the way it is being utilized to enable work programs such as asset management, revenue protection, smart meter network operations and predictive maintenance.

Distributors can also install power line monitors upstream as a way to detect outages and identify fault locations.[59]

ENMAX, Calgary, Alberta

In response to its experience with the 2013 flooding, ENMAX, located in Calgary, Alberta will be installing smart meters in flood-prone areas to enable remote disconnections and reconnections of customers.[60] They will also be adding more modular electrical supply systems that allow electricity to be cut-off at the level of specific neighbourhoods.[61]

Energy distributors can use data analytics to improve performance before, during and after an extended outage. Traditional analytics, used prior to an extreme weather event, can enable an energy distributor to determine which assets are most likely to fail based on the coordinates of the storm and the number of assets, such as transformers, in its path. Distributors can enhance traditional analytics by adding visualizations, advanced analytics and predictive modelling. This approach can help an energy distributor to more accurately predict which assets are most at risk of failure due to vegetation growth, weather exposure, historical patterns or equipment failure patterns during events. Predictive modelling can enable an energy distributor to be better prepared to manage crews, equipment, customers, stakeholders and communications for future outages. Advanced analytics, which draws real time data from SCADA, OMS, distribution management systems (DMS), static data from geographic information system (GIS), maintenance records, asset management data bases, and vegetation management systems can help to predict where the path of the storm is occurring and what the extent of the damage could be.

Hydro One, Ontario

Hydro One recently went through an exercise to decentralize part of their OMS and workforce management to field operations centres to reduce bottlenecks of information and management that commonly occur when a single operating/dispatch centre is relied upon during extended outages. This approach also provides the Forward Command Post (FCP) to have direct control of the workforce in their emergency zone to optimize prioritization of restoration activity.

[59] (City of Toronto, 2013)
[60] (City of Calgary Expert Management Panel on River Flood Mitigation, 2014)
[61] Ibid.

Energy distributors obtain rights-of-way to access municipal or private lands for the purpose of building and maintaining distribution systems. Considerations vary for aboveground and underground infrastructure. Utilities can work with landowners to coordinate and optimize right-of-way management, including vegetation management and road use management.

Nova Scotia Power, Nova Scotia
Following the tropical storm Arthur in the summer of 2014, Nova Scotia Power was ordered by the Nova Scotia Utility and Review Board to review its vegetation management practices. Nova Scotia Power proceeded to submit a proposal to double its tree trimming budget from $10 million to $20 million per year beginning in 2016. Trees falling on electricity distribution wires caused 90 percent of outages during the storm.[62]

Recommendation #3: Electricity, natural gas and thermal distributors examine opportunities to enhance operations before, during and after extreme, extended outages through enhanced weather forecasting systems, predictive asset management programs, advanced outage management and distribution automation solutions, improved right-of-way management and smart metering solutions.

2.4 ORGANIZATIONAL SOLUTIONS

Organizational solutions include improving labour force protocols during a widespread outage as well as improving and documenting response procedures for future generations. These actions can help distributors reduce the time it takes to restore services following extreme weather events and build capacity in organizations to respond more quickly to future widespread outages, enhancing the resourcefulness, recovery and adaptability of distributors.

Modifying Internal Labour Force Communication and Protocols

Responding to a widespread, extended outage following an extreme weather event requires that all staff understand roles and responsibilities in the response. In many cases staff have to call into call centres to receive status updates. One strategy to address this is to implement a proactive messaging system with automated telephone calls so staff know where they are expected to be and what they are expected to do during these events. In some cases it has been useful for distributors to document procedures in detail so that they may be easily referred to and updated following widespread outages.

BC Hydro, British Columbia
A 2012 audit of BC Hydro found that it does not have an effective governance structure to oversee, coordinate and report on disaster preparedness activities should a widespread outage occur.[63]

Improving Mutual Assistance Agreements

A mutual assistance agreement is an agreement between two or more companies setting out the terms by which they agree to help each other in the event of a disaster. The agreement includes terms for sharing human resources, materials and equipment. Detailed mutual assistance agreements are critical for ensuring a timely and effective response to widespread, extended outages.

Canadian Gas Association Mutual Assistance Agreements
Following Hurricane Sandy in November 2012, all Canadian gas distributors initiated a process to revise and update mutual aid agreements (including commonly understood procedures and lessons learned such as considerations about unions, drug testing and border crossings), via the Canadian Gas Association (CGA) Standing Committee on Operations. The CGA holds this agreement for its members and the agreement is scheduled to go into effect as of July 1st, 2015.

[62] (Withers, 2015)
[63] (Tromp, 2013)

Recommendation #4: Electricity, natural gas and thermal distributors clearly define staff roles for before, during and following an extreme, extended outage, including mutual assistance agreements which include detailed information about crews, spare equipment and design specifications. Lessons learned are clearly documented to ensure that the processes are well understood and passed on within the organization.

2.5 COMMUNICATIONS SOLUTIONS

Communications solutions include actions that improve information sharing during extreme weather events with customers, the public and key stakeholders. Information sharing can help to enhance the recovery, resourcefulness and adaptability following an outage.

Improving Communication with Customers and the Public
Distributors use a variety of approaches for communicating recovery times following widespread outages including outage maps on their websites, social media, radio, call centres and emergency centres among other channels. There is currently no standard approach to communicating with the public following widespread, extended outages.

Distributors can also engage in proactive public engagement to help improve customer preparedness for an extended outage in advance of extreme weather events.

Improving Communication with other Utilities
Electricity and natural gas systems are highly interdependent. In some cases, natural gas is used to generate electricity.[64] In some cases electricity is needed for the delivery of natural gas services, such as for operating furnaces, boilers, water pumps and heat pumps. In British Columbia and Manitoba, energy distributors are integrated and deliver both electricity and natural gas services. In other provinces the systems are not integrated and therefore require a higher degree of coordination. Electricity and natural gas distributors might also benefit from collaborating for emergency preparedness to ensure customers receive the energy they require.

One way to improve communication with customers, the public and other utilities is to develop a communications strategy. An effective communications strategy communicates a high-level summary of the cause, and the extent of the damage and restoration actions and procedures. It should also communicate localized information such as an estimated time for restoration, crew status and safety information. It is important to have a single, definitive source of information during the restoration of an event to ensure that all information is timely, accurate and complete. The communications plan should include to whom messages are being conveyed (e.g. the public, city officials, other key stakeholders such as the fire department, the provincial/territorial government, etc.), by whom messages are being conveyed (e.g. LDC president to media, senior operations personnel to other complementary body operations personnel), how often and via what media channels messages are being conveyed (e.g. utility outage maps, updates via the internet, social media, radio, call centres and in-person at emergency centres).

ENMAX, Calgary, Alberta
EXMAX is making several changes to the way it communicates with emergency responders and city staff following widespread extended outages in an effort to improve the speed at which reconnections can be made. It will enhance its ability to share geospatial data with the Calgary Emergency Management Agency regarding the status of power re-connections. The City of Calgary has also agreed to provide ENMAX and City staff with enhanced information system tools.[65]

Recommendation #5: Electricity, natural gas and thermal distributors have a communications strategy in place. They are the lead point of communication for stakeholders and the public, and have a clear communication process in place to address interdependencies following an extended or widespread outage.

[64] (FERC, 2014)
[65] (City of Calgary Expert Management Panel on River Flood Mitigation, 2014)

3.0 RECOMMENDATIONS FOR ADAPTATION ACTIONS IN THE ENERGY DISTRIBUTION SECTOR

Resilient energy distribution is important not only for ensuring the health and welfare of our cities and communities, but also for advancing Smart Energy Communities, which improve energy efficiency, enhance reliability, cut costs and reduce greenhouse gas emissions. In order to achieve resilience, electricity, natural gas and thermal energy distributors must adapt their infrastructure, operations, organizational structure, and communications to address the climate change risks.

Electricity, natural gas and thermal energy distributors are committed to delivering energy services to end users as reliably and cost-effectively as possible. There is a desire for distributors to invest in adaptation, and many are already taking steps to address impacts from a changing climate.

In order to achieve resilience, an energy distributor must be robust, resourceful, able to recover and adaptable. The recommended actions distributors can take to enhance resilience are described in Figure 3.A.

Figure 3.A - Summary: Recommended Adaptation Actions in the Energy Distribution Sector

Adaptation Planning and Risk Assessments
Electricity, natural gas and thermal energy distributors have adaptation plans/risk assessments in place using local climate models to better identify risks to the distribution system.

Adapting Infrastructure
Electricity, natural gas and thermal energy distributors improve the robustness of their infrastructure based on identified future vulnerabilities and integrate resiliency planning, including distributed generation, into asset renewal planning.

Adapting Operations
Electricity, natural gas and thermal energy distributors examine opportunities to enhance operations before, during and after extreme, extended outages through enhanced weather forecasting systems, predictive asset management programs, advanced outage management and distribution automation solutions, improved right-of-way management and smart metering solutions

Adapting Organizational Structure
Electricity, natural gas and thermal energy distributors clearly define staff roles for before, during and following an extreme, extended outage, including mutual assistance agreements which include detailed information about crews, spare equipment and design specifications. Lessons learned need to be clearly documented to ensure that the processes are well understood and passed on within the organization.

Adapting Communications
Electricity, natural gas and thermal energy distributors have a communications strategy in place. They are the lead point of communication for stakeholders and the public, and have a clear communication process in place to address interdependencies following an extended or widespread outage.

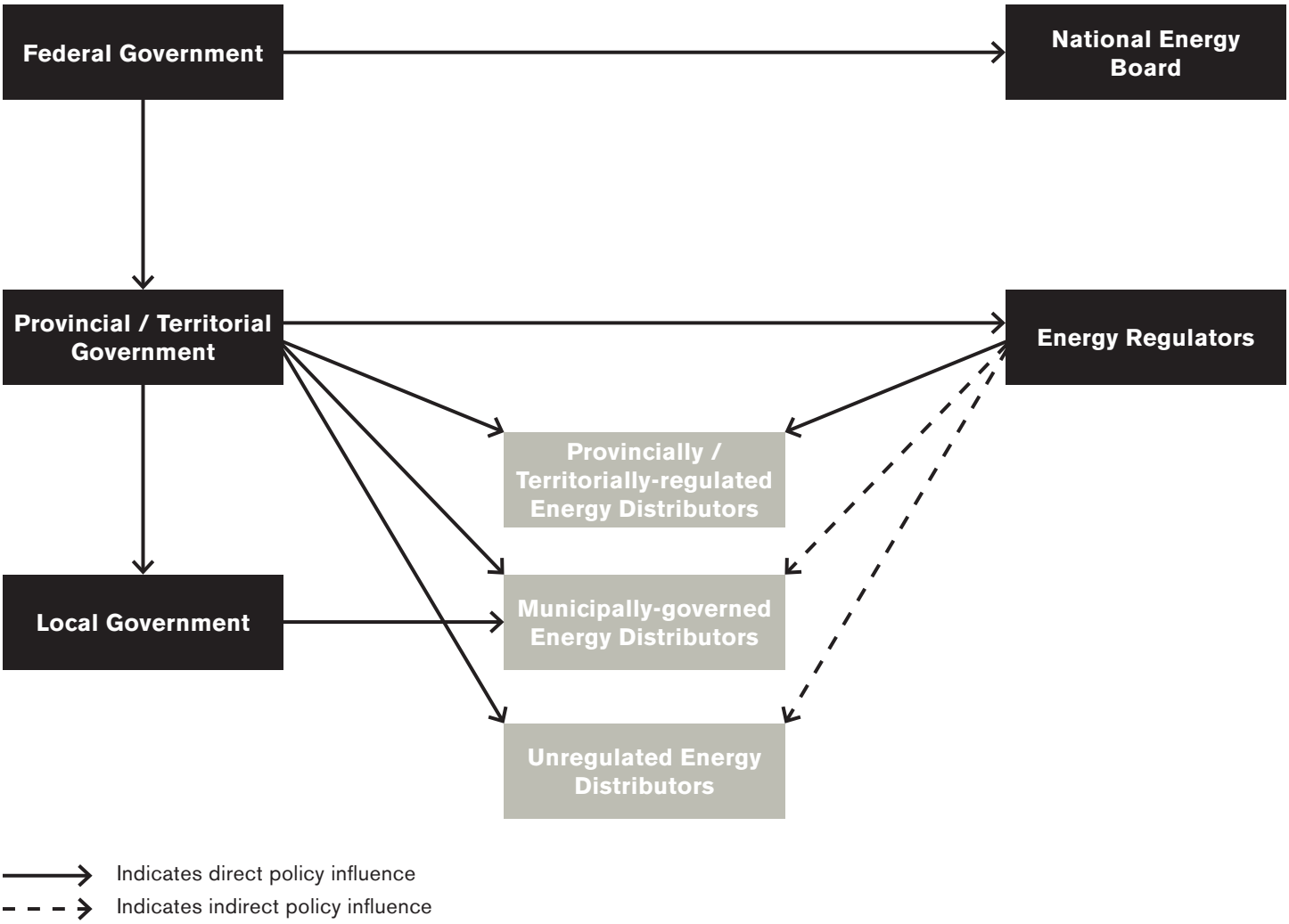
PART B:
POLICY AND REGULATORY DRIVERS AND BARRIERS TO CLIMATE CHANGE ADAPTATION IN THE ENERGY DISTRIBUTION SECTOR

4.0 POLICY AND REGULATORY FRAMEWORK FOR THE ENERGY DISTRIBUTION SECTOR IN CANADA

Canadian energy distributors operate under a complex set of policies and regulations established at the local and provincial/territorial level. The policy and regulatory context has significant influence over the ability of energy distributors to make decisions to withstand and recover from extreme weather events. Figure 4.1 represents the policy and regulatory framework for energy distributors.[66]

While Part A of this report focuses on the technological and procedural actions energy distributors can take to adapt their infrastructure and operations for extreme weather events, Part B focuses on the role of the federal, provincial, territorial, regulatory and local policymakers in driving adaptation in the energy distribution sector.

Figure 4.1 Policy and Regulatory Framework for the Energy Distribution Sector*



[66] The direction of the arrow depicts the direction of influence by policymakers and regulators on distributors. Solid arrows represent direct policy influence, meaning that policymaker can mandate specific actions. Dashed arrows represent soft policy influence, meaning the policy maker influences actions, but does not necessarily require specific outcomes.

* This framework does not illustrate the process whereby distributors can provide feedback to policymakers.

Figure 4.2 lists the policy and regulatory areas over which federal, provincial, regulatory and local policymakers have influence that may encourage climate change adaptation in the energy distribution sector. Legislation corresponding to each area of influence is listed in Appendix I.

Figure 4.2 Summary of Policy and Regulatory Areas of Influence to Support Adaptation in the Energy Distribution Sector

Policymaker	Key Areas of Policy and Regulatory Influence
Federal Policymakers	– Developing and implementing a national adaptation strategy – Enforcing building standards through the National Building Code – Knowledge sharing, capacity building and data collection – Supporting projects and leading by example – Providing clarity for stakeholders about privacy legislation
Provincial and Territorial Policymakers	– Developing and implementing provincial adaptation or climate change plans – Requiring or encouraging local adaptation planning – Encouraging distributed energy resources, supporting projects and leading by example – Requiring or encouraging technology adoption (e.g. smart meters) – Enforcing emergency management standards and protocols – Enforcing of land use tools and policies – Establishing building code requirements and design standards
Provincial and Territorial Regulators	– Rate setting for electric, gas and in some cases thermal distributors to allow for recovery of costs of adaptability and resilience needs.
Local Policymakers	– Developing municipal adaptation plans and climate risk assessments – Enforcing land use tools and policies – Encouraging locally-owned energy generation and distribution, supporting projects and leading by example

What follows is an analysis of the role that policymakers and regulators play with regard to adaptation in the energy distribution sector. It includes a series of recommendations based on:

– Input from 22 industry stakeholders, including energy distributors, provincial energy regulators, industry associations, consulting firms and government staff, during two working sessions hosted in Ottawa, Ontario and Calgary, Alberta;
– 24 survey responses from senior-level decision makers at electricity, natural gas and thermal energy distributors across Canada;
– One-on-one interviews with subject matter experts to obtain data, inform and refine draft content; and
– Input from the Resilient Pipes and Wires Advisory Committee.

The recommendations put forth do not necessarily reflect position of all industry stakeholders.

4.1 THE ROLE FOR FEDERAL POLICYMAKERS

The Canadian Federal government has a role to play to encourage climate adaptation in the energy distribution sector through:

- A national adaptation strategy
- National Building Code requirements
- Knowledge sharing, capacity building and data collection
- Supporting distributed generation and storage projects and leading by example
- Privacy legislation

National Adaptation Strategy

The Federal government has developed a Federal Sustainability Strategy and an Adaptation Framework which sets out a federal vision and approach to climate adaptation.[67] The objectives of the Framework are:

1. Canadians understand the relevance of climate change and associated impacts on their quality of life;
2. Canadians have the necessary tools to adapt to climate change effectively, and
3. The federal government, as an institution, is resilient to a changing climate.

The strategy broadly encourages policymakers to formulate policy related to climate change adaptation.

There is consensus among energy distributors that there is a need to achieve the first objective set out in the Framework: "Canadians understand the relevance of climate change and associated impacts on their quality of life." One way to achieve this is to have the Federal government communicate high-level support for adaptation so that energy distribution investors and end users understand the value of investing in adaptation actions at the distribution level. High-level support from the Federal government may help to garner more support from provincial policymakers, regulators, industry and end users for investments in climate change adaptation at the distribution level.

International Best Practice

The United States Federal government is playing an active role in media messaging and deliberately trying to trigger greater uptake of adaptation within the energy sector. One way it is accomplishing this is through the issuance of a policy framework – including a report detailing vulnerabilities in the energy sector and economic benefits of climate adaptation in the energy sector, among other documents to encourage policy development at the distribution level.[68]

Recommendation #6: The Federal government enhance current efforts to communicate the relevance of climate change and the associated impacts on the quality of life of Canadians.

Canadian Standards and Building Code Requirements

The Standards Council of Canada and the National Research Council of Canada develop national building standards and codes which influence construction requirements for distributors as well as emergency backup power requirements for buildings. These standards may be adopted by policymakers in the National and Provincial Building Codes.

Standards impacting the ability of energy distributors to withstand and recover quickly from extreme weather events include, but are not limited to, CSA C282 - Emergency Electricity Power Supply for Buildings, CSA C22.3 No. 1 Overhead Systems and CSA C22.3 No. 7-10 - Underground Systems OPSD 3090.101 - Foundation, Frost Penetration Depths for Southern Ontario and CSA S501-14, CSA S501-14 moderating the effects of permafrost degradation on existing foundations, and CSA Z662 Oil and Gas Pipeline Systems.

CSA S501-14 moderating the effects of permafrost degradation on existing foundations, was developed by the Standards Council of Canada in 2015 to upgrade design standards to take permafrost degradation into consideration.[69] Public Safety Canada has recognized the need for northern building codes and standards to take accelerated climate change impacts into account going forward.[70]

[67] (Environment Canada, 2013)
[68] (U.S. Department of Energy, 2014)
[69] (NewsWire, 2015)
[70] (Pembina Institute, 2011)

CSA C282 Emergency Electricity Power Supply for Buildings has been adopted by the National Building Code. CSA C282 provides design, installation, operation, maintenance and testing requirements for life-safety emergency electrical power generators and associated equipment, all purposed to help in the safe evacuation of building occupants during an emergency. Currently, the standard requires emergency generators, which can be fed by either on-site stored fuel (e.g. diesel) or off-site fuel (e.g. utility-fed natural gas) to supply back-up power to elevators, fire-water booster pumps, and lights. There is an opportunity for to evolve to enable the emergency systems in buildings to sustain occupants more safely during these increasing frequent extreme weather events using natural gas-fired generators whose design may also include being configured as combined heat and power systems.The focus of the current standard is to evacuate a building during an emergency and does not yet take non-emergency outages into consideration.

Recommendation #7: The Standards Council of Canada and the National Research Council of Canada lead a review of standards impacting the ability of energy distributors to withstand and recover quickly from outages cause from climate change, and the Federal government adopt these updated standards in the National Building Code.

Knowledge Sharing, Capacity Building and Data Collection

The Federal government has the ability to conduct or fund studies and sector-specific working groups to help support, foster collaboration and build capacity among decision makers. The Natural Resources Canada Adaptation Platform currently supports studies and working groups which provides an opportunity for industry to share knowledge and resources to increase the sector's understanding of the impacts of a changing climate on the energy sector.

Data collection is another domain that falls within the mandate of the Federal government. The majority of policymakers and decision makers at energy distributors currently do not have access to climate modelling data that is standardized or accurate enough to identify specific infrastructure vulnerabilities to justify investments in adaptation.

Recommendation #8: The Federal government continue to fund the Natural Resources Canada Adaptation Platform working group.

Recommendation #9: The Federal government establish a clear process and identify stakeholders responsible for developing consistent and detailed climate modelling data.

Distributed Generation and Storage Projects and Leading by Example

The Federal government has the authority to allocate funding and enter into cost sharing agreements to support climate adaptation programs focused on implementing recovery measures at the distribution level. Currently municipalities can apply to Public Safety Canada for disaster relief funding following the declaration of a state of emergency to pay for damage caused from extreme weather events. Funding takes place on a reactive basis after an emergency has been declared.[71] A 2014 report by TD Economics has calculated that for every dollar invested in adaptation, $9-$38 of future damages are avoided.[72]

The Federal government also has the ability to implement distributed generation and storage projects for the buildings it owns. According to the District Energy Inventory prepared by the Canadian Industrial Energy End-use Data and Analysis Centre, the Federal government owns 10 percent of the district energy projects in Canada.[73] The Federal government may also install renewable energy projects, storage projects and other conventional projects in its facilities that support resilience.

International Best Practice

In July, 2014, the U.S. Federal Government announced the development of a $1 billion fund to make U.S. cities more resilient to climate change. $236.3 million will be allocated to rural cities to build or improve distribution lines and implement smart grid projects. An example of use of the fund is that in September, 2014, the U.S. Department of Energy allocated $1.2 million to assist the Olney Town Centre Microgrid Project to enhance resilience.

Recommendation #10: The Federal government support projects to enhance the resilience of electricity, natural gas and thermal energy distributors (e.g. through matched funding or cost sharing for pilot projects).

[71] (Public Safety Canada, 2015)
[72] (Alexander & McDonald, 2014)
[73] (Canadian Industrial Energy End-use Data and Analysis Centre, 2015)

Recommendation #11: The Federal government implement energy systems (both district energy systems and conventional energy systems) that enhance the resilience of their own operations.

Privacy Legislation

The *Personal Information Protection and Electronic Documents Act, 2000*[74], defines the rules for the sharing and use of utility data, including energy consumption data and internal operations data, such as mutual assistance information. The law currently does not permit utilities to share information of energy consumption.

Utilities would benefit from receiving clarity about what information can be shared with key strategic stakeholders, like local governments, to understand where the energy system is most vulnerable, and to help distributors improve recovery procedures following extreme weather events.

Recommendation #12: The Federal government clarify what data electricity, natural gas and thermal energy distributors can and cannot share with various organizations such as municipalities under the Personal Information Protection and Electronic Documents Act.

Summary: Federal Policy Recommendations

- The Federal government enhance current efforts to communicate the relevance of climate change and the associated impacts on the quality of life of Canadians.
- The Standards Council of Canada and the National Research Council of Canada lead a review of standards impacting the ability of energy distributors to withstand and recover quickly from outages cause from climate change, and the Federal government adopt these updated standards in the National Building Code.
- The Federal government continue to fund the Natural Resources Canada Adaptation Platform working group.
- The Federal government establish a clear process and identify stakeholders responsible for developing consistent and detailed climate modelling data.
- The Federal government support projects to enhance the resilience of energy distribution systems (e.g. through matched funding or cost sharing for pilot projects).
- The Federal government implement energy systems (both district energy systems and conventional energy systems) that enhance the resilience of their own operations.
- The Federal government clarify what data electricity, natural gas and thermal energy distributors can and cannot share with various organizations such as municipalities under the Personal Information Protection and Electronic Documents Act.

[74] (Government of Canada, 2000)

4.2 THE ROLE FOR PROVINCIAL AND TERRITORIAL POLICYMAKERS

Provincial and Territorial governments have a significant degree of influence over adaptation in the energy distribution sector through their ability to encourage or require:

- Adaptation or climate change plans
- Supporting distributed generation and storage projects and leading by example
- Technology adoption
- Emergency management protocols
- Land use planning tools
- Supporting projects and leading by example
- Building code requirements and design standards

Adaptation or Climate Change Plans

Provincial and territorial governments have the authority to develop provincial adaptation plans and strategies to encourage the development of adaptation policies at the local level. Provincial and Territorial adaptation plans provide an opportunity for to encourage other decision makers, including various provincial/territorial ministries, regulators and distributors, to take critical energy infrastructure into consideration in planning processes. British Columbia,[75] Alberta,[76] Saskatchewan,[77] Manitoba,[78] Ontario,[79] Québec,[80] Nova Scotia,[81] Atlantic Canada[82] and the North,[83] have taken steps to develop or advance the development of adaptation strategies. These plans largely exclude critical energy distribution infrastructure.[84]

Crown corporations such as BC Hydro, Manitoba Hydro and Hydro Québec, as well as distribution system operators such as the Independent Electricity System Operator in Ontario and the Alberta Electricity System Operator in Alberta can also play a role in adaptation planning. A 2009 report by Ontario's Expert Panel on Climate Change Adaptation highlights the role that energy transmission and distribution planning organizations have to play in developing climate change risk assessments and recommends that the Ontario Ministry of Energy and Infrastructure request the Independent Electricity System Operator, in accordance with its responsibility for maintaining the reliability of the electricity grid in the province, complete a climate change risk assessment of the Province's electricity grid and to propose adaptive actions.[85]

Provincial and territorial governments may also encourage or require local governments to develop community energy plans (CEPs) or local adaptation plans.

Across Canada, over 180 communities have developed a CEP. A CEP is a tool that helps define community priorities around energy with a view to improving efficiency, cutting emissions, and driving economic development. Provincial governments can encourage or require local governments to develop CEPs, and to incorporate adaptation efforts into the CEP.

Government of Nova Scotia

In Nova Scotia all municipalities are required to develop a Municipal Climate Change Action Plan (MCCAP).[86] MCCAPs must identify possible climate impacts, disaster-prone areas, infrastructure vulnerabilities and priorities for action.

International Best Practice

The Governor of Maryland issued an executive order in 2012 to establish a Grid Resilience task force to provide recommendations to improve the resilience of the state's electricity system. The task force recently recommended that utilities be allowed to own and operate "public purpose" microgrids that serve areas with high reliability needs, including hospitals.[87]

[75] (British Columbia Ministry of Environment, 2010)
[76] (Alberta Environment and Sustainable Resource Development, 2010)
[77] (SaskAdapt)
[78] (Government of Manitoba)
[79] (Ontario Ministry of Environment and Climate Change, 2011)
[80] (Government of Québec, 2012)
[81] (Climate Change Nova Scotia, 2011)
[82] (Atlantic Environment Ministers, 2008)
[83] (A Northern Vision, 2011)
[84] (Environmental Commissioner of Ontario, 2012)
[85] (Expert Panel on Climate Change Adaptation, 2009)
[86] (Service Nova Scotia)
[87] (The Economist, 2014)

Recommendation #13: Provincial and Territorial governments enhance provincial adaptation plans to explicitly state the importance of energy distribution system resilience, and include direction with respect to critical energy distribution infrastructure.

Recommendation #14: Crown corporations and electricity system operators (e.g. the Alberta Electric System Operator and the Independent Electric System Operator) conduct full system risk assessments to support adaptation at the distribution level.

Recommendation #15: Provincial and Territorial governments encourage or require local governments to develop community energy plans and also include guidelines for local governments to consider adaptation for critical energy distribution into local energy planning.

Supporting Distributed Generation and Storage Projects and Leading by Example

Provincial and Territorial governments can influence decisions about where and how energy is produced. Provincial energy plans, such as the BC Energy Plan[88] and Ontario's Long-Term Energy Plan,[89] are two examples of provincial plans which set out strategic priorities regarding distributed energy resources within the province. Ontario legislated the procurement of more distributed energy generation and storage through *the Green Energy and Green Economy Act.*[90] Provincial governments can use plans such as these to communicate a commitment to distributed energy resources.

In some cases, the policy or regulatory structure may act as a disincentive for the uptake of distributed generation and storage. For example, standby charge regimes, designed to enable electricity distributors to cover fixed costs of assets, may increase the cost to build and maintain distributed generation projects, affecting the ability of some distributed generation and storage projects to operate cost-effectively.

Provinces and territories also the authority to allocate funding and enter into cost sharing agreements to support climate adaptation programs focused on implementing recovery measures at the distribution level. . There is also an opportunity for Provincial and Territorial government to implement distributed energy resources in its own facilities. According to the District Energy Inventory prepared by the Canadian Industrial Energy End-use Data and Analysis Centre, Provincial and Territorial governments, institutional buildings (e.g. hospitals and academic institutions), and crown corporations own 39 percent of the district energy projects in Canada.

Government of Ontario

In 2015, the Ontario Ministry of Economic Development, Employment and Infrastructure with support from the Ministry of Energy and the Ministry of Agriculture and Rural Affairs launched the Natural Gas Access Loan and the Natural Gas Economic Development Grant. The programs will help expand natural gas infrastructure to rural communities in Ontario.[91]

Government of British Columbia

The government of British Columbia is enabling greater uptake of district energy projects through the granting of low cost capital to municipal governments.[92]

Government of Alberta

The Government of Alberta currently has a Climate Change and Emissions Management Fund. The Fund is supported by high greenhouse gas emitters. The mandate of the Fund is to establish or participate in funding initiatives that improve the province's adaptability to climate change.[93] The fund is currently supporting ENMAX to implement distributed solar and wind generation projects.[94]

[88] (British Columbia Ministry of Energy, Mines and Petroleum Resources, 2009)
[89] (Ontario Ministry of Energy, 2013)
[90] (Ontario Ministry of Energy, 2009)
[91] (Ontario Ministry of Econmic Development, Employment and Infrastructure, 2015)
[92] (Elenchus Research Associates Inc., 2010)
[93] (Climate Change and Emissions Management Corporation, 2014)
[94] (CCEMC, n.d.)

International Best Practice

The Connecticut Department of Energy and Environmental Protection established a Microgrid Pilot Program in 2013 to establish power to large scale facilities, test an isolation system and provide power to the community during outages.[95]

International Best Practice

Damage caused by hurricanes in Texas and the Louisiana Gulf Coast led to the adoption of critical infrastructure policies. Texas Bills HB 1831 and HB 440952 and Louisiana resolution No. 171, passed in 2009 and 2012, respectively, require that all government entities (including all state agencies and all political subdivisions of the state such as cities, counties, school districts, institutes of higher education, and municipal utility districts) must:

- Identify which government owned buildings and facilities are critical in an emergency situation.
- Prior to constructing or making extensive renovations to a critical governmental facility, the entity in control of the facility must obtain a feasibility study to consider the technical opportunities and economic value of implementing combined heat and power (CHP).

This legislation was enacted because several major natural disasters (hurricanes Katrina, Rita, and Ike) showed the vulnerability of the states' critical infrastructure. It was found that these natural disasters could knock out portions of the electric grid for weeks and backup generators were not necessarily reliable. Texas and Louisiana have found that the high pressure pipeline system that supplies natural gas throughout the state has provided highly reliable service throughout recent hurricanes. Underground natural gas pipelines provide a secure source of energy to on-site CHP systems, which can then deliver electricity, steam, and chilled water securely throughout the facility.[96]

Recommendation #16: Provincial and Territorial governments consider legislative approaches for enabling greater uptake of distributed energy resources.

Recommendation #17: Provincial and territorial policies are reviewed to identify and address disincentive to the uptake of distributed energy resources and other projects to enhance the resilience of electricity, natural gas and thermal energy distribution systems.

Recommendation #18: Provincial and Territorial governments support projects to enhance the energy distribution systems resilience (e.g. through matched funding or cost sharing for pilot projects).

Recommendation #19: Provincial and Territorial governments implement energy systems (both district energy systems and conventional energy systems) that enhance the resilience of their own operations.

Technology Adoption

Provincial and Territorial governments have the authority to provide directives to provincial and territorial energy regulators to require the implementation of technologies that may improve the ability of distributors to predict and respond to extreme, extended outages. Smart meters offer an example of such technology.

Government of Ontario

In July, 2004, the Ontario Minister of Energy gave a directive to the Ontario Energy Board, under Section 27.1 of the Ontario Energy Board Act, 1998 requiring the Board to develop an implementation plan to install electricity smart meters for every customer in Ontario by 2010. The objective of the directive was to:

- Automate all meter reading and reprogramming read periods using two-way communication within a region with multiple distribution service areas;
- Ensure the system can record hourly data for every customer; and
- Provide information on the previous day's electricity use to all customers, so they can review their actual electricity use and understand how the amount they use and when they use it affects what they pay.[97]

[95] (State of Connecticut Department of Energy & Environmental Protection, 2013)
[96] (ICF International, 2013)
[97] (Ontario Energy Board, 2005)

Recommendation #20: Provincial and Territorial governments require or encourage technologies (e.g. smart meters) as a way of improving utility operations and strengthening the resilience of the energy distribution system.

Emergency Management Protocols

Provincial emergency management offices[98] as well as energy system operators, such as the Independent Electricity System Operator in Ontario, conduct mock emergencies and table-top exercises with distributors to help energy distributors test emergency response protocols.

There is consensus that mock emergencies and table-top exercises are helpful for improving the ability of energy distributors to recover quickly from extreme weather events and should continue. Though mock emergencies are critical, they are led by all levels of government as well as by energy system operators. Currently, there is no coordination among these activities.

Recommendation #21: Provincial and Territorial governments play a lead role in defining the role of organizations for emergency management planning and act as a coordinating body among them.

Land Use Planning Tools

Provincial governments are responsible for establishing the energy and land use policy framework under which local land use decisions are made. These frameworks encourage or require local governments to implement specific policy actions into local energy and land use planning processes that can significantly impact the resilience of the energy distribution system. Provincial legislation sets out what local governments are allowed to include in official plans and by-laws which can impact policies developed at the regional, local, neighbourhood or site scale. Two examples include the Ontario *Provincial Policy Statement*[99] and the Manitoba *Provincial Land Use Policies*[100]

Provincial governments can also encourage or require local governments to develop community energy plans, or adaptation plans to identify priority actions related to energy infrastructure. Provincially/territorially-mandated programs requiring the development of such plans should include guidelines related to adaptation.

Government of Ontario

The Ontario Provincial Policy Statement includes language which encourages governments to provide opportunities for local energy generation and distribution systems, alternative energy systems, as well as consider climate change adaptation in land use and development patterns.[101]

Government of Manitoba

Manitoba's land use regulations include provisions to encourage communities to anticipate and plan for the impacts of climate change and to implement adaptation strategies through various planning documents and processes.[102]

Government of British Columbia

The government of British Columbia is enabling greater uptake of district energy systems through the introduction of Bills 27 and 44. Bill 27, enacted in 2008 amends the Local Government Act and the Community Charter to allow local governments to implement district energy projects through by-laws and Development Permit Areas and allows them to reduce development cost charges (DCCs) for developments that have district energy systems.[103] The Local Government Act also establishes requirements for undergrounding electrical distribution infrastructure and vegetation management.

Recommendation #22: Provincial and Territorial governments include language related to climate change adaptation and resilience in land use planning policy frameworks.

Frameworks that already include policies related to adaptation can augment requirements for local governments to incorporate energy distribution infrastructure into the planning process. Provincial governments can also require or encourage local governments to develop community energy plans or climate action plans and can include adaptation considerations within the guidelines.

[98] (Public Safety Canada, 2015)
[99] (Ontario Ministry of Municipal Affairs and Housing, 2014)
[100] (Government of Manitoba, 2009)
[101] (Ontario Ministry of Municipal Affairs and Housing, 2014)
[102] (Government of Manitoba)
[103] (Rutherford, 2009)

Building Code Requirements and Design Standards

Provincial and Territorial governments can encourage standard bodies such as the Standards Council of Canada and the National Research Council of Canada to review and modify existing standards that pertain to energy distribution resilience (e.g. Canadian Standards Association C282) in order to enhance the ability of distribution systems to withstand and recover from widespread, extended outages caused from extreme weather events.

Crown corporations may also introduce building standards to address regionally specific climatic conditions.

Alberta Electric System Operator

The Alberta Electric System Operator divides the province into zones with respect to design requirements for electrical transmission equipment. These take into account specific vulnerabilities to weather. These design standards take into account specific vulnerabilities due to regional climatic conditions and are applicable to electric transmission lines built in Alberta.[104]

Government of British Columbia

In response to sea level rise along its coasts, the government of British Columbia has released new guidelines for the construction of new sea dikes and for identifying and managing low-lying areas[105]

Recommendation #23: Provincial and Territorial governments encourage standard setting organizations, industry and local governments to review standards pertaining to utility resilience.

Summary: Provincial Policy Recommendations

- Provincial and Territorial governments enhance provincial adaptation plans to explicitly state the importance of having resilient energy distribution systems, and include direction with respect to critical energy distribution infrastructure.
- Crown corporations and electricity system operators (e.g. the Alberta Electric System Operator and the Independent Electric System Operator) conduct full system risk assessments to support adaptation at the distribution level.
- Provincial and Territorial governments encourage or require local governments to develop community energy plans and also include guidelines for local governments to consider adaptation for critical energy distribution into local energy planning.
- Provincial and Territorial governments consider legislative approaches for enabling greater uptake of distributed energy resources.
- Provincial and territorial policies are reviewed to identify and address disincentive to the uptake of distributed energy resources and other projects to enhance the resilience of electricity, natural gas and thermal energy distribution systems.
- Provincial and Territorial governments support projects to enhance the resilience of energy distribution systems (e.g. through matched funding or cost sharing for pilot projects).
- Provincial and Territorial governments implement energy systems (both district energy systems and conventional energy systems) that enhance the resilience of their own operations.
- Provincial and Territorial governments require or encourage technologies (e.g. smart meters) as a way of improving utility operations and strengthening the resilience of the energy distribution system.
- Provincial and Territorial governments play a lead role in defining the role of organizations for emergency management planning and act as a coordinating body among them.
- Provincial and Territorial governments include language related to climate change adaptation and resilience in land use planning policy frameworks.
- Provincial and Territorial governments encourage standard bodies, industry and government to review standards pertaining to utility resilience.

[104] (Alberta Electric System Operator, 2010)

[105] (British Columbia Ministry of Environment , 2012)

4.3 THE ROLE FOR PROVINCIAL REGULATORS

In Canada, the mandate of provincial and territorial energy regulators is determined by provincial and territorial governments as set out in legislation, regulations and directives.[106] While their mandate is focused primarily on rate setting, it has expanded in recent years to include greater emphasis on communications as well as implementing distributed energy resources and smart grid technologies, among other responsibilities. Regulators therefore play a critical role in enabling utilities to adapt to climate change.

Rate-setting rules vary from province and territory. Energy regulators adhere to generally accepted rate making principles when evaluating rate applications for rate-regulated utilities.[107] When an energy distributor submits a rate application it must justify proposed capital and operating budgets. Regulators are responsible for approving or rejecting these budgets, taking current standards of operation, as well as consumer interests into consideration. The checks and balances applied by regulators are important to ensure prudent investments are being made.

Though regulators have expressed an openness to consider proactive investments in resilience in rate applications, and have historically approved applications that are not necessarily the lowest cost alternative, there is no obligation or formal process for regulators to take resilience into account when approving or rejecting the applications. There is a lack of clarity under the current structure around what distributors should be including in rate applications. Distributors are also expected to play a lead role as a communicator before, during and after widespread, extended outages. There is a lack of clarity around how much they are expected to communicate and what the role of the regulator is when it comes to communicating expectations associated with rates and reliability to customers.

Ontario Energy Board - Performance Based Regulation

The Ontario Energy Board is moving from a cost-of-service framework toward performance-based regulation.

In 2012, the Ontario Energy Board introduced the Renewed Regulatory Framework for Electricity Distributors. The framework demonstrates the Ontario Energy Board's shift from a cost-of-service rate-setting framework toward a performance-based regulation (PBR) rate-setting framework. PBR focuses on long-term value for money, rather than cost and cost recovery and is designed to support investments in the electricity distribution system that enable utilities to achieve specific outcomes, such as resilience.[108]

[106] (Ontario Energy Board, 2013)
[107] (Kaiser & Heggie, 2011)
[108] (Ontario Energy Board, 2012)

International Best Practice

New York State: In 2014, the New York Public Service Commission, which regulates distribution in New York City, passed a regulatory ruling requiring Consolidated Edison of New York to raise rates by $1 billion to pay for resilience measures.[109] Later in 2014, the New York Attorney General proposed a bill to require utilities to assess vulnerabilities to climate change. The legislation would require utilities to make initial assessments of the probable impacts of climate change on their infrastructure, operations and service delivery, and to document how they intend to incorporate their findings into future operations, planning, infrastructure design, and emergency preparations.[110]

Connecticut: Utilities that do not comply with restoration and recovery standards are liable to pay civil penalties.[111]

United Kingdom: In 2010, Ofgem, the regulator in the UK, permitted electricity companies to collect an extra £112 million from customers for flooding resilience.[112]

Recommendation #24: Regulators make expectations related to infrastructure adaptation explicit and apply rate application rules consistently.

Summary: Regulatory Recommendations

– Energy regulators make expectations related to infrastructure adaptation explicit and apply rate application rules consistently

[109] (District Energy, 2014)
[110] (Attorney General Eric T. Schneiderman, 2014)
[111] (McCarthy)
[112] (U.K. House of Parliament, 2010)

4.4 THE ROLE FOR LOCAL POLICYMAKERS

Municipal policymakers can influence adaptation to climate change in the distribution sector through:

- Municipal adaptation plans and climate risk assessments
- Land use tools and policies
- Locally owned distributed energy resource projects and distribution and leading by example

Municipal Adaptation Plans and Climate Risk Assessments

Across Canada, municipalities have started incorporating adaptation measures into local plans and policies.[113] With the exception of Nova Scotia, the incorporation of adaptation policies is voluntary. Municipalities are generally not required to complete climate change adaptation plans or risk assessments to identify vulnerabilities and identify policy actions.

Identifying risks at the local level can include updating floodplain maps,[114] carrying out comprehensive climate modelling, as was done in Toronto in 2012,[115] or developing backup power plans in the event of extended outages. While this could have a significant positive impact on decision making at the distribution level, it does not absolve the utilities from conducting their own location risk assessments to determine how their infrastructure may be impacted by significant weather events.

Local governments can also implement structural measures to protect infrastructure from climate change risks. Some examples include dams, levees, seawalls and other engineered structures.[116]

City of Vancouver

The City of Vancouver has created a city-wide power back-up plan to minimize electrical power disruption.[117]

Regional Municipality of Halifax

The Halifax Regional Municipality has created a Municipal Climate Change Action Plan to comply with Nova Scotia's provincial requirement. Halifax has identified that electric utility infrastructure is vulnerable and has identified the need to conduct studies regarding burying the infrastructure.

City of Toronto

In 2012, the City of Toronto released the Toronto's Future Weather & Climate Driver Study Outcomes Report. The report, developed by Senes Consulting Ltd. includes climate trends and models and is intended to help municipalities better plan for infrastructure investments.

British Columbia

Since 2008, communities across BC have undertaken adaptation planning to identify priority areas from among the risks or opportunities of climate change. Participating communities include Castlegar, Regional District of Central Kootenay, Rossland, Kimberly and Elkford. Metro Vancouver, Vancouver, North Vancouver, Surrey, Delta, the Capital Region District and Victoria are all piloting a new adaptation guidebook.[118]

Recommendation #25: Local governments develop local adaptation plans, floodplain maps and municipal risk assessments to help local stakeholders, including energy distributors, make infrastructure siting decisions.

Land Use Tools and Policies

Municipalities can use land use tools to encourage or require adaptation measures for the distribution sector. The framework for these tools is established at the provincial level. Land use policy tools include official plans, secondary plans, growth strategies, by-laws and development cost charges, among others. They can be used to establish requirements for district energy, facility siting, undergrounding electrical infrastructure, right-of-way widths, setback requirements and vegetation management. Local governments can also play a role in preventing outages through tree species selection and funding tree maintenance.[119]

City of Sudbury

The City of Sudbury has an Official Plan policy requiring the installation of all electricity distribution wires underground in new subdivisions and roads. The cables are buried deep enough to avoid freeze-thaw cycle damage and they are more resilient to ice or wind storms.[120]

[113] (British Columbia Ministry of Environment , 2012)
[114] (City of Toronto, 2014)
[115] (SENES Consultants Ltd., 2011)
[116] (Kovacs, 2001)
[117] (City of Toronto, 2014)
[118] (Columbia Basin Trust)
[119] (Hauer, 1994)
[120] (Ontario Centre for Climate Impacts and Adaptation Resources)

City of Vancouver

The City of Vancouver has an Energy Utility System By-law that requires connection to the Southeast False Creek Neighbourhood Energy Utility.[121]

City of Toronto

The City of Toronto implemented a Renewable Energy Bylaw which permits energy production and distribution using renewable energy devices and cogeneration devices on properties thereby reducing demand on high greenhouse gas generating energy sources.[122]

City of Calgary

The City of Calgary's Centre City Downtown Bylaw provides incentives for Green Building features such as district energy and combined heat and power connectivity.[123]

City of Ottawa

In the 1990s, the City of Ottawa had a committee which focused on coordinating underground infrastructure development. It included considerations for sewer, water main and energy distribution construction and replacement.

International Best Practice

In 2013, New York City released a suite of recommendations to improve grid resilience in New York City. 23 initiatives are identified, whereby the city has declared to play an active role in (1) redesigning the regulatory framework, (2) hardening infrastructure, (3) reconfiguring the network to include more redundancy, (4) reduce energy demand and (5) diversify customer options through distributed generation and backup generation.[124]

Recommendation #26: Local governments coordinate with energy distributors regarding right-of-way management practices (e.g. vegetation management, including trimming cycles, tree species and setback bylaws), as well as through coordinating on the use of rights-of-way.

Recommendation #27: Local governments comprehensively review bylaws to identify opportunities to enhance the resilience of the energy distribution systems. Local bylaws and regulations be examined to enable greater uptake of distributed energy resources.

Recommendation #28: Local governments implement energy systems (both district energy systems and conventional energy systems) that enhance the resilience of their operations.

Summary: Local Policymaker Recommendations

- Local governments develop local adaptation plans, floodplain maps and municipal risk assessments to help local stakeholders, including energy distributors, make infrastructure siting decisions.
- Local governments coordinate with energy distributors regarding right-of-way management practices (e.g. vegetation management, including trimming cycles, tree species and setback bylaws), as well as through coordinating on the use of rights-of-way.
- Local governments comprehensively review bylaws to identify opportunities to enhance the resilience of the energy distribution system. Local bylaws and regulations can also be examined to enable greater uptake of for distributed energy resources.
- Local governments implement energy systems (both district energy systems and conventional energy systems) that enhance the resilience of their operations.

[121] (City of Vancouver, 2013)
[122] (City of Toronto, 2013)
[123] (City of Calgary)
[124] (New York City Government, 2013)

4.5 SUMMARY OF KEY FINDINGS – POLICIES DRIVERS AND BARRIERS TO INTEGRATION OF ADAPTATION IN THE PLANNING AND OPERATION OF THE ENERGY DISTRIBUTION SUB-SECTOR AND RECOMMENDATIONS

Resilient energy distribution is important, not only for ensuring the health and welfare of our cities and communities, but for advancing Smart Energy Communities, which improve energy efficiency, enhance reliability, cut costs and reduce greenhouse gas emissions.

Electricity, natural gas and thermal energy distributors across Canada are taking steps to adapt their operations, infrastructure, organizational structure and communications to a changing climate. These actions are enabling distributors to withstand and recover more rapidly from outages caused by extreme weather events. There is however, an opportunity for energy distributors to address climate-related risks and enhance resilience in a more systematic way.

Policies established at the federal, provincial, territorial and local level can play a significant role in driving or acting as barriers to adaptation within the electricity, natural gas and thermal energy distribution sector.

All levels of government, including federal, provincial, territorial and local policymakers and provincial regulators, currently have policies in place to support adaptation actions, however the degree to which the identified policies act as drivers or barriers varies among policymakers. In some cases, policies are in place that are intended to be supportive of adaptation actions, however, the policies could be enhanced to encourage greater uptake of adaptation efforts among distributors. The policy and regulatory recommendations emerging from the Resilient Pipes and Wires project are as follows:

Summary: Federal Policy Recommendations

- The Federal government enhance current efforts to communicate the relevance of climate change and the associated impacts on the quality of life of Canadians.
- The Standards Council of Canada and the National Research Council of Canada lead a review of standards impacting the ability of energy distributors to withstand and recover quickly from outages cause from climate change, and the Federal government adopt these updated standards in the National Building Code.
- The Federal government continue to fund the Natural Resources Canada Adaptation Platform working group.
- The Federal government establish a clear process and identify stakeholders responsible for developing consistent and detailed climate modelling data.
- The Federal government support projects to enhance the resilience of energy distribution systems (e.g. through matched funding or cost sharing for pilot projects).
- The Federal government implement energy systems (both district energy systems and conventional energy systems) that enhance the resilience of their own operations.
- The Federal government clarify what data electricity, natural gas and thermal energy distributors can and cannot share with various organizations such as municipalities under the Personal Information Protection and Electronic Documents Act.

Summary: Provincial Policy Recommendations

- Provincial and Territorial governments enhance provincial adaptation plans to explicitly state the importance of having resilient energy distribution systems, and include direction with respect to critical energy distribution infrastructure.
- Crown corporations and electricity system operators (e.g. the Alberta Electric System Operator and the Independent Electric System Operator) conduct full system risk assessments to support adaptation at the distribution level.
- Provincial and Territorial governments encourage or require local governments to develop community energy plans and also include guidelines for local governments to consider adaptation for critical energy distribution into local energy planning.
- Provincial and Territorial governments consider legislative approaches for enabling greater uptake of distributed energy resources.
- Provincial and territorial policies are reviewed to identify and address disincentive to the uptake of distributed energy resources and other projects to enhance the resilience of electricity, natural gas and thermal energy distribution systems.
- Provincial and Territorial governments support projects to enhance the resilience of energy distribution systems (e.g. through matched funding or cost sharing for pilot projects).
- Provincial and Territorial governments implement energy systems (both district energy systems and conventional energy systems) that enhance the resilience of their own operations.
- Provincial and Territorial governments require or encourage technologies (e.g. smart meters) as a way of improving utility operations and strengthening the resilience of the energy distribution system.
- Provincial and Territorial governments play a lead role in defining the role of organizations for emergency management planning and act as a coordinating body among them.
- Provincial and Territorial governments include language related to climate change adaptation and resilience in land use planning policy frameworks.
- Provincial and Territorial governments encourage standard bodies, industry and government to review standards pertaining to utility resilience.

Summary: Regulatory Recommendations

- Energy regulators make expectations related to infrastructure adaptation explicit and apply rate application rules consistently

Summary: Local Policymaker Recommendations

- Local governments develop local adaptation plans, floodplain maps and municipal risk assessments to help local stakeholders, including energy distributors, make infrastructure siting decisions.
- Local governments coordinate with energy distributors regarding right-of-way management practices (e.g. vegetation management, including trimming cycles, tree species and setback bylaws), as well as through coordinating on the use of rights-of-way.
- Local governments comprehensively review bylaws to identify opportunities to enhance the resilience of the energy distribution system. Local bylaws and regulations can also be examined to enable greater uptake of for distributed energy resources.
- Local governments implement energy systems (both district energy systems and conventional energy systems) that enhance the resilience of their operations.

APPENDIX I – LEGISLATION CORRESPONDING TO AREAS OF POLICY INFLUENCE

The following table provides a reference to the legislation, regulations and policies that correspond to the key areas of policy influence described in Section 4.0.

Key Area of Policy Influence	Legislation, Regulation or Policy Reference
Federal Policymakers	
National adaptation strategy	Government of Canada (n.d.). *Federal Sustainable Development Act, 2008.* http://laws-lois.justice.gc.ca/eng/acts/F-8.6/FullText.html Environment Canada (November, 2013). *Planning for a Sustainable Future: A Federal Sustainable Development Strategy for Canada 2013-2016.* https://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=A22718BA-1 Government of Canada (2011). *Federal Adaptation Policy Framework.* Gatineau, Quebec. (available upon request).
National Building Code requirements	National Research Council of Canada (2010). *National Building Code of Canada 2010.* http://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/2010_national_building_code.html Canadian Centre for Occupational Health and Safety (2015). *Canadian Standards Association Standards.* http://www.ccohs.ca/legislation/csa.html CSA Group (2015) *C282-15 – Emergency electrical power supply for buildings.* http://shop.csa.ca/en/canada/general-standards/c282-15/invt/27012072015 NewsWire (2015, January 8). *Standards Council of Canada approves two new national standards to help address the effects of climate change on Canada's North.* Ottawa. http://www.newswire.ca/en/story/1470075/standards-council-of-canada-approves-two-new-national-standards-to-help-address-the-effects-of-climate-change-on-canada-s-north
Knowledge sharing, capacity building and data collection	Natural Resources Canada (March, 2013). *The Adaptation Platform 1st Annual Report.* https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/adaptation/NRCan_AdaptationAR-En(Web).pdf
Distributed Generation and Storage Projects and Leading by Example	Public Safety Canada (February, 2015). *Disaster Financial Assistance Arrangements (DFAA).* https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/rcvr-dsstrs/dsstr-fnncl-ssstnc-rrngmnts/index-eng.aspx#a04
Privacy legislation	Government of Canada (2000). *Personal Information Protection and Electronic Documents Act (S.C. 2000, c. 5).* http://laws-lois.justice.gc.ca/eng/acts/p-8.6/
Additional resources	Government of Canada (1982). *Distribution of Legislative Powers. Canadian Constitution Act.* http://laws-lois.justice.gc.ca/eng/const/page-4.html

Key Area of Policy Influence	Legislation, Regulation or Policy Reference
Provincial Policymakers	
Adaptation or climate change plans	British Columbia Ministry of Environment (February, 2010). *Preparing for Climate Change: British Columbia's Adaptation Strategy.* http://www.livesmartbc.ca/attachments/Adaptation_Strategy.pdf Alberta Environment and Sustainable Resource Development (April, 2010). *Climate Change Adaptation Framework.* http://esrd.alberta.ca/forms-maps-services/publications/climate-change-adaptation-framework.aspx SaskAdapt (n.d.). *Extreme Events: Adaptation Strategies.* http://www.parc.ca/saskadapt/extreme-events/extreme-adapt Government of Manitoba (n.d.). *Planning Resource Guide: Climate Change Adaptation Through Land Use Planning.* http://www.gov.mb.ca/ia/plups/pdf/cca.pdf Ontario Ministry of Environment (January, 2014). *Climate Ready: Adaptation Strategy and Action Plan 2011-2014.* http://www.ontario.ca/environment-and-energy/climate-ready-adaptation-strategy-and-action-plan-2011-2014 Government of Québec (2012). *2013-2020 Government Strategy for Climate Change Adaptation.* http://www.mddelcc.gouv.qc.ca/changements/plan_action/stategie-adaptation2013-2020-en.pdf Government of Nova Scotia (February, 2011). *Nova Scotia's Climate Change Action Plan.* http://climatechange.gov.ns.ca/content/actionplan Government of Nova Scotia (n.d.). *Municipal Climate Change Action Plans: Background and Overview of Key Elements.* http://www.novascotia.ca/dma/pdf/mun-climate-change-action-plan.pdf Government of Newfoundland and Labrador (2011). *Charting our Course: Climate Change Action Plan 2011.* http://www.exec.gov.nl.ca/exec/ccee/publications/climate_change.pdf Atlantic Environment Ministers (2008). *Climate Change Adaptation Strategy for Atlantic Canada.* http://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Climate-Climatiques/ClimateChange%20AdaptationStrategyAtlanticCanada.pdf A Northern Vision. (2011). *Pan-Territorial Adaptation Strategy.* http://www.anorthernvision.ca/documents/Pan-TerritorialAdaptationStrategyEN.pdf
Technology adoption (e.g. smart grid policies)	Government of British Columbia (2012). *Smart Meters and Smart Grid Regulation.* http://www.bclaws.ca/civix/document/id/complete/statreg/368_2010 Ontario Energy Board (January 2005). *The Ontario Energy Board's Smart Meter Implementation Plan.* http://www.ontarioenergyboard.ca/documents/communications/pressreleases/2005/press_release_sm_bg_260105.pdf
Emergency management standards and protocols	Public Safety Canada (2015). *Emergency Management Organizations.* http://www.getprepared.gc.ca/cnt/rsrcs/mrgnc-mgmt-rgnztns-eng.aspx
Land use planning	Government of British Columbia (2014). *Local Government Act Part 26 – Planning and Land Use Management.* http://www.bclaws.ca/civix/document/LOC/complete/statreg/--%20L%20--/Local%20Government%20Act%20[RSBC%201996]%20c.%20323/00_Act/96323_30.xml Government of British Columbia (November, 2011). *Development Permit Areas for Climate Action: A Guide for Energy Conservation and GHG Emissions Reduction. Ministry of Community, Sport and Cultural Development.* http://www.cscd.gov.bc.ca/lgd/library/dpa_guide/dpa_guide.pdf West Coast Environmental Law (2012). *Preparing for Climate Change: An Implementation Guide for Local Governments in British Columbia.* http://wcel.org/sites/default/files/WCEL_climate_change_FINAL.pdf Alberta Ministry of Environment and Sustainable Development (2008). *Land Use Framework.* https://www.landuse.alberta.ca/Documents/LUF_Land-use_Framework_Report-2008-12.pdf

Key Area of Policy Influence	Legislation, Regulation or Policy Reference
Land use planning	Government of Saskatchewan (2012). *Saskatchewan Statement of Provincial Interest Regulations.* http://www.publications.gov.sk.ca/details.cfm?p=63700 Government of Manitoba (n.d.). *Manitoba Planning Resource Guide: Climate Change Adaptation Through Land Use Planning.* http://www.gov.mb.ca/ia/plups/pdf/cca.pdf Ontario Ministry of Municipal Affairs and Housing (2014). *2014 Provincial Policy Statement.* Ontario. http://www.mah.gov.on.ca/AssetFactory.aspx?did=10463 Government of Nova Scotia (February, 2011). *Guide to Considering Climate Change in Project Development in Nova Scotia.* http://www.novascotia.ca/nse/ea/docs/Development.Climate.Change.Guide.pdf Prince Edward Island Department of Finance, Energy and Municipal Affairs (April, 2013). *Provincial Land Use Policies Consultation Document.* http://www.gov.pe.ca/photos/original/consultation.pdf
Distributed Generation and Storage Projects and Leading by Example	British Columbia Ministry of Finance (2008). *The Revenue-Neutral Carbon Tax.* http://www2.gov.bc.ca/gov/topic.page?id=DB88EFE64EE84E9AAFF7628EC8EFEEA3 British Columbia Ministry of Energy, Mines and Petroleum Resources (2009). *The BC Energy Plan: A Vision for Clean Energy Leadership.* http://www.energyplan.gov.bc.ca/ Government of British Columbia (2010). *Clean Energy Act.* http://www.leg.bc.ca/39th2nd/1st_read/gov17-1.htm Government of British Columbia (2014). *Vancouver City Charter.* http://www.bclaws.ca/civix/document/LOC/complete/statreg/--%20V%20--/Vancouver%20Charter%20[SBC%201953]%20c.%2055/00_Act/vanch_09.xml#se ction300.1 Alberta Ministry of Environment and Sustainable Resource Development (2009). *Climate Change and Emissions Management Fund.* http://esrd.alberta.ca/focus/alberta-and-climate-change/regulating-greenhouse-gas-emissions/greenhouse-gas-reduction-program/default.aspx Alberta Ministry of Municipal Affairs. (n.d.). *Municipal Grants - Community Development Trust Fund.* http://www.municipalaffairs.alberta.ca/municipalgrants-name.cfm Government of Saskatchewan (2014). *Government Direction for 2014-2015.* http://www.finance.gov.sk.ca/PlanningAndReporting/2014-15/GovernmentDirection1415.pdf Ontario Ministry of Energy (December, 2013). *Achieving Balance: Ontario's Long- Term Energy Plan.* http://www.energy.gov.on.ca/en/ltep/ Government of Ontario (2009). *Green Energy and Green Economy Act.* http://www.energy.gov.on.ca/en/green-energy-act/#.UxdB2fldXRM Government of Québec (2014). *Section 46.16 of the Environment Quality Act.* http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=5&file=2009C33A.PDF Government of Newfoundland and Labrador (2011). *Charting our Course: Climate Change Action Plan 2011.* http://www.exec.gov.nl.ca/exec/ccee/publications/climate_change.pdf
Building code requirements and design standards	Alberta Electric System Operator (2010). *Bulk Transmission Line Technical Requirements.* http://www.aeso.ca/downloads/Information_Document_-_Bulk_Transmission_Line_Technical_Requirements.pdf
Additional resources	Canadian District Energy Association (June, 2011). *An Action Plan for Growing District Energy Systems Across Canada.* http://www.districtenergy.org/assets/CDEA/Policy/CDEA-RESEARCHFINAL-REPORTJULY-18-2011.pdf

Key Area of Policy Influence	Legislation, Regulation or Policy Reference
Provincial Energy Regulators	
Rates and performance standards	British Columbia Utilities Commission (2002). *Understanding Utility Regulation: A Participant's Guide to the British Columbia Utilities Commission.* http://www.bcuc.com/Documents/Guidelines/2011/DOC_3939_ParticpantGuide_July2002.pdf Alberta Utilities Commission (2012). *Urban Pipeline Renewal Project.* http://www.auc.ab.ca/applications/decisions/Decisions/2012/2012-233.pdf Ontario Energy Board (2012). *Renewed Regulatory Framework for Electricity Distributors: A Performance-Based Approach.* Retrieved from http://www.ontarioenergyboard.ca/oeb/_Documents/Documents/Report_Renewed_Regulatory_Framework_RRFE_20121018.pdf Government of Québec (2014). *An Act Respecting the Régie de l'Énergie, CQLR c R- 6.01.* http://www.canlii.org/en/qc/laws/stat/cqlr-c-r-6.01/latest/cqlr-c-r-6.01.html
Additional resources	Kaiser, G., & Heggie, B. (2011). Energy Law and Policy. Toronto: Carswell.

Key Area of Policy Influence	Legislation, Regulation or Policy Reference
Local Policymakers	
Municipal adaptation plans and climate risk assessments	City of Windsor (September, 2012). *Climate Change Adaptation Plan.* http://www.citywindsor.ca/residents/environment/environmental-master-plan/documents/windsor%20climate%20change%20adaptation%20plan.pdf City of Toronto (2014). *Climate Change Adaptation: Toward a Resilient City.* https://www1.toronto.ca/wps/portal/contentonly?vgnextoid=78cfa84c9f6e1410VgnVCM10000071d60f89RCRD The City of Toronto Office of Emergency Management (2013). *Risk Specific Plan for Power Disruption (Electricity).* http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=f42407ceb6f8e310VgnVCM10000071d60f89RCRD
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