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ADVANCING COMMUNITY ENERGY RESILIENCE IN ALBERTA

PRIMER REPORT

QUEST

FUNDED BY:

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About QUEST

QUEST is a national non-government organization that works to accelerate the adoption of efficient and integrated community-scale energy systems in Canada by informing, inspiring, and connecting decision-makers. The organization commissions research, communicates best practices, convenes government, utility, and private-sector leaders, and works directly with local authorities to implement on-the-ground solutions. QUEST recognizes communities that have embraced these principles by referring to them as Smart Energy Communities.

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Project funder

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CEC · CCA · CCE

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LIST OF ACRONYMS

AUC	Alberta Utility Commission
CEA	Canadian Electricity Association
CEP	Community Energy Plan
DFAA	Disaster Financial Assistance Arrangements
FCM	Federation of Canadian Municipalities
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IBC	Insurance Bureau of Canada
MCCAC	Municipal Climate Change Action Centre
NRCAN	Natural Resources Canada
PBR	Performance Based Rate
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SEC	Smart Energy Communities

EXECUTIVE SUMMARY

Climate change is increasing the frequency of extreme weather events and as a result, the cost of climate hazards in Canadian communities have surged over the past decade. Canadian communities need to adapt to their changing climate. This need is particularly acute when it comes to energy. Climate change is a growing concern for Canada's electricity and natural gas systems. Loss of energy supply and prolonged power outages resulting from climate hazards leads to significant direct and indirect social and economic costs. This is particularly true for communities, as the capacity to maintain essential municipal services depends on the ability of distribution and transmission systems to supply energy. As a result, municipal governance and energy systems are interconnected, and must work together to maintain community resilience.

This report builds on the resilience work that QUEST has completed with seven small and mid-size communities across the province, through surveys and interactive workshops that brought together multiple community stakeholders, including energy utilities (see Appendix 1 for more details). The report also builds on an extensive literature review analysis of the Alberta Utilities Commission (AUC)'s decisions, as well as interviews conducted with half a dozen municipally-owned utilities and investor-owned electricity and natural gas distribution utilities in the province.

This report focuses on adaptation strategies specific to Alberta given the previous resilience work conducted in the province, and the need to tailor strategies to local reality and geographical, political, economic and energy contexts. The aim of this report is to inform policy-makers at the municipal and provincial levels about the climate impacts on the province's energy infrastructure and the state of energy resilience in Alberta. This is presented from the perspective of energy utilities and small and mid-sized communities, and provides recommendations to advance community resilience in the province.

The report can be summarized through the following findings:

▶ **Finding #1: Alberta's electricity infrastructure is highly exposed to wildfires, floods, and atmospheric hazards (wind gust, heavy/wet snow and freezing rain).** With significant geographical variation across the province. The exposure to these weather events is not new; however, the intensity and frequency of these events have increased over the past decade, and are projected to continue to increase due to climate change.

▶ **Finding #2: It is not possible to assess the cost of material damages from extreme weather on energy infrastructure in Alberta due to a lack of data**
Distribution and transmission utilities are not required to report on power outage data (only aggregated indicators) nor on the causes of outages. As a result, it is not possible to estimate the frequency and duration of power outages due to weather events in the province. There is no database to track the costs of damages related to weather events. This report only provides a partial snapshot of the costs of extreme weather events on the province's energy system. As a result, it is challenging to estimate the impact of extreme weather events on consumers' natural gas and energy bills.

▶ **Finding #3: The socio-economic costs of damaged energy infrastructure and prolonged power outages due to extreme weather events on communities are difficult to capture and quantify.** Alberta has experienced the two most costly disasters in the country's history; namely the Fort McMurray wildfires and the 2013 Southern Alberta floods - amounting to $1.7 billion. More research and studies are needed to assess the direct and indirect socio-economic costs of prolonged power outages and damaged energy infrastructure on communities in Alberta.

▶ **Finding #4: Despite the low uptake of formal vulnerability assessments and climate adaptation plans among Alberta energy utilities, there is an increasing awareness of the impacts of climate change within energy utilities, with more integration of climate projections and new adaptation practices.** Energy utilities in Alberta are not required to adopt climate projections or conduct vulnerability assessments. Only a few utilities are taking proactive steps, and there is no common methodology or standard. It seems that current asset management practices have been sufficient to cope with atmospheric hazards, given that utilities are already used to paying specific attention to climate variation. Overall, it is difficult to assess the efficiency of these informal adaptation practices given the absence of data. A few transmission and distribution utilities have recently been more intentional and included specific climate hazards in their asset planning, such as wildfire risk. However, these initiatives are not systematic or part of a preventive, standardized, and integrated resilience approach of asset planning and management.

▶ **Finding #5: Despite the sensitivity around the climate conversation, municipalities in Alberta are aware of the impacts of climate change and are willing to act on climate adaptation.** There is currently no requirement for municipalities in Alberta to adopt climate adaptation regulations. Given low public awareness on climate change, and the fact that it is perceived as a polarizing topic, the majority of municipalities working in energy resilience prefer to address weather-related hazards as well as prepare and communicate their efforts through the lens of emergency response management (e.g. threats to public safety and infrastructure).

▶ **Finding #6: While they have many strengths, Albertan communities can improve their energy resilience.** Areas of improvement include: better integration of climate projection and adaptation measures into asset management, land-use practices, and key municipal documents; improved communication and coordination on planning alignment and information sharing at the utility level, internally (to no longer work in silos) and with the public; enhanced facilities management practices to ensure backup generators are present in essential facilities; and specific strategies to address vulnerable populations' needs.

▶ **Finding #7: There is a gap between the willingness of Alberta municipalities to act on energy resilience and climate adaptation and the capacity or resources they have to do so.** Given the high upfront capital costs of a preventive approach, the lack of access to adequate financial resources to implement proactive risk reduction measures is a key barrier for Alberta municipalities to implement adaptation measures. In addition, small Albertan communities lack human resources and do not have dedicated staff to effectively work on energy resilience.

Based on the findings outlined above, the report makes a series of recommendations for key stakeholders across the province:

FOR THE GOVERNMENT OF ALBERTA

Recommendation #1: Put in place a sound, comprehensive and publicly available database tracking the impact of extreme weather events on energy transmission and distribution infrastructure

Recommendation #2. Improve the quality and granularity of provincial climate hazards maps

Recommendation #3: Require energy utilities to adopt and implement climate adaptation plans and provide adequate support by developing a Provincial Energy Resilience guideline

Recommendation #4: Provide local governments with adequate resources and support and require them to develop and implement a climate adaptation plan

AT THE AUC LEVEL

Recommendation #5: AUC should incorporate climate projection and climate adaptation into its regulatory assessment, for instance by requiring project proponents to include a climate vulnerability assessment in proposed projects when applying for permitting

AT THE COMMUNITY LEVEL

Recommendation #6: Develop and implement Community Energy Plans (CEP) in close collaboration with utilities

Recommendation #7: Evaluate and undertake climate change adaptation strategies that are specific to the community and may result in increased support for action in the area

UTILITIES AND COMMUNITIES

Recommendation #8: Facilitate better communication and alignment/coordination on energy resilience and energy planning between local government and energy utilities

INTRODUCTION

THE NEED FOR CANADIAN COMMUNITIES TO ADAPT TO CLIMATE CHANGE

Canadian climate is changing due to human activities[1], and our communities are on the frontlines of experiencing climate change impacts. While Canadian communities are at risk they are also uniquely situated as the carrier of climate action solutions.

As a result of climate change, extreme weather events have become more frequent, and the costs of climate hazards in Canadian communities have surged over the past decades. The total cost of disasters between 2010 and 2019 was $14.5 billion, which represents a substantial increase over the four previous decades had a total cost of $21 billion[2]. The average cost of an event is also notable. The average cost of a disaster in the 1970s was $8.3 million, whereas the cost in 2010 is about $112 million; an increase of 1,250%[3]. These economic impacts can also be seen at the individual level. Prior to 2010 the average per capita cost of a disaster as about $6, but this has risen to $40-50 since 2010[4]. These figures do not include costs related to lost income, relocation and uninsured property losses.

Data from the Canadian Disaster Database (CDD) and Insurance Bureau of canada (IBC) illustrates the increased frequency of weather-related disasters and the associated growing costs[5].

Figure 1 – Increasing number of weather-related disasters, from 1970-2019

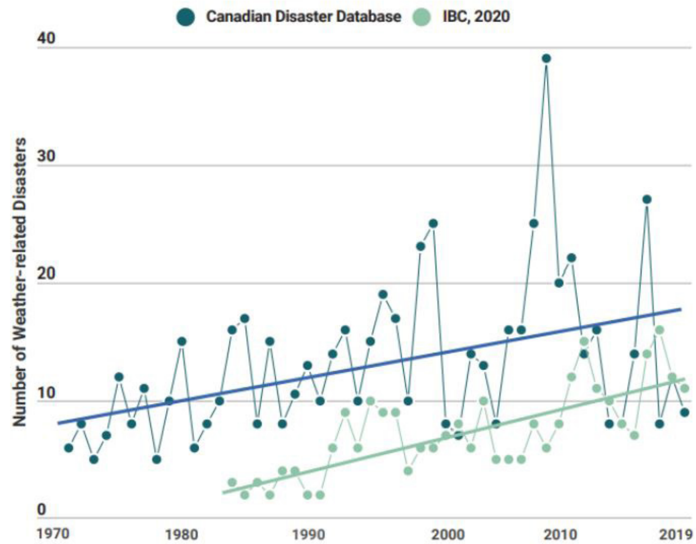
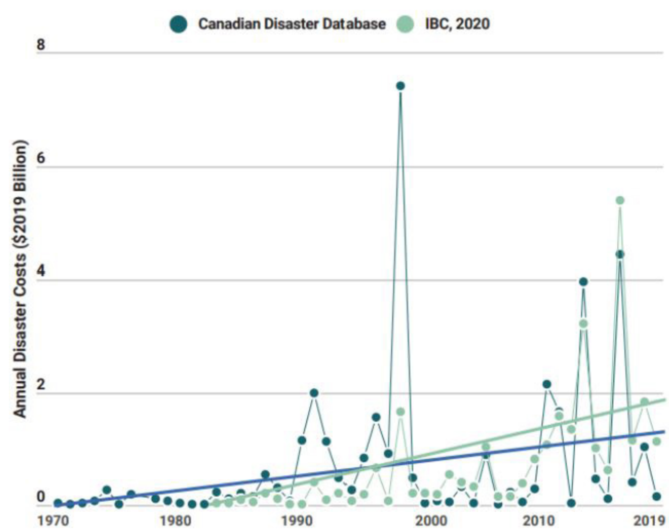


Figure 2 – Increasing annual cost of weather-related disasters (values in CAD $2019 billion)



1 NRCAN (2019) Canada's Changing Climate Report. Retrieved from: https://changingclimate.ca/CCCR2019

2 Canadian Institute for Climate Choices, December, 2020. Tip of the Iceberg. Navigating the Known and Unknown Costs of Climate Change for Canada: https://climatechoices.ca/wp-content/uploads/2020/12/Tip-of-the-Iceberg-_-CoCC_-Institute_-Full.pdf

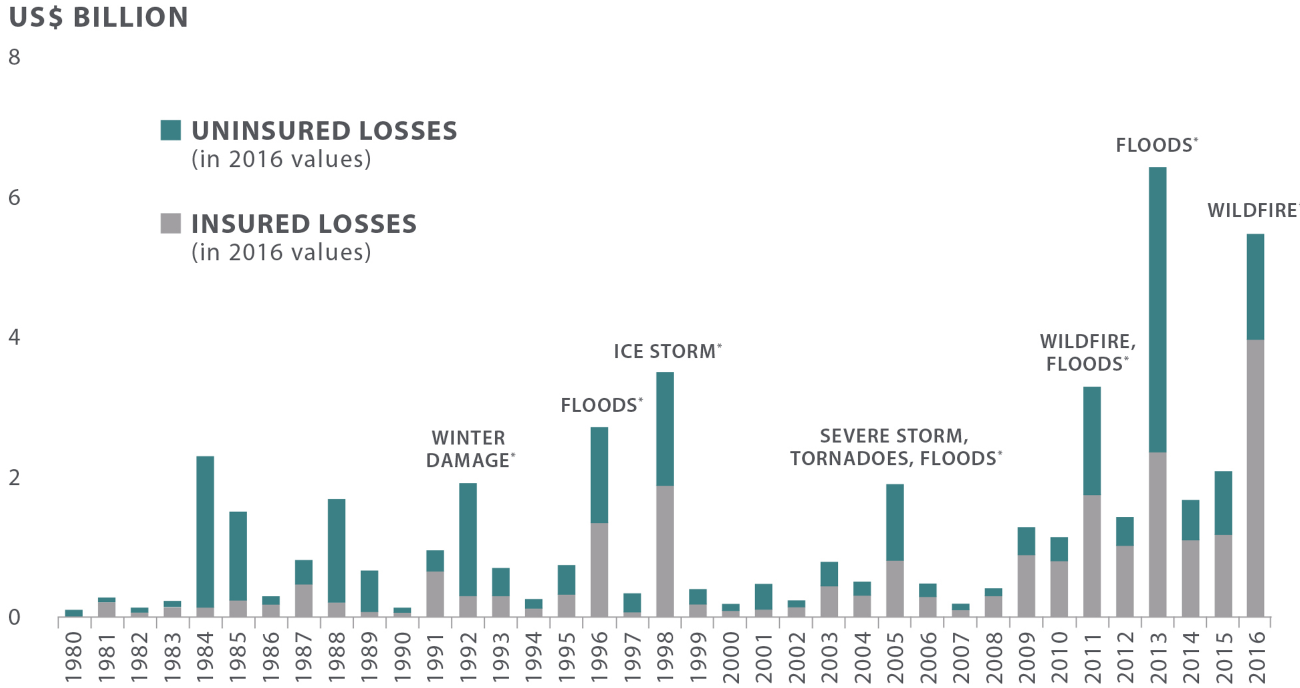
3 Ibid.

4 Ibid.

5 Ibid.

Most of these costs are not covered by insurance companies. Between 1980 to 2016, about $11 billion in losses (37%) due to natural disasters were borne by households, businesses, and municipal and provincial governments[6]. Figure 1 shows the evolution of catastrophic losses from natural disasters, broken out by insured losses and uninsured losses between from 1980 to 2016 (in USD 2016). As an example, from 2009 to 2015, the compensation provided by Disaster Financial Assistance Arrangements[7] (DFAAs) to provinces and territories was greater than the previous 39 fiscal years combined. The fund's payouts for the past five years (2013-2014 to 2017-2018) totalled $3.3 billion. The increase in DFAA costs over the past 10 years is attributed to more extreme weather events with greater intensity[8].

Figure 1 – Increasing number of weather-related disasters, from 1970-2019[9]



*costliest event(s) in the respective year

Source: From Moudrak, N.; Feltmate, B. 2017. Based on 2017 Munich Re, Geo Risks Research, NatCatSERVICE. As of February 2017.

Canadian communities need to invest in adaptation measures to both reduce the cost of climate hazard related damages and increase their capacity to function normally. Local governments will need to invest an average of $5.3 billion annually to implement measures that adapt municipal infrastructure to climate change[10]. Countrywide, this represents an annual expenditure of 0.26% of the Gross Domestic Product (GDP). These estimates only represent the total annual cost of the actions needed at the local level for public infrastructure owned and operated by municipalities. It does not account for most energy infrastructure because it is typically owned and operated by provincial entities or investor owned utilities.

[6] Parliamentary Budget Officer of Canada. 2016. Estimate of the Average Annual Cost for Disaster Financial Assistance Arrangements due to Weather Events in the FCM and IBC report

[7] In the event of a large-scale natural disaster, the Government of Canada provides financial assistance to provincial and territorial governments through the Disaster Financial Assistance Arrangements (DFAA), administered by Public Safety Canada.

[8] FCM and IBC, February 2020, Investing in Canada's Future: The Cost of Climate Adaptation: at the Local Level, Final Report, https://fcm.ca/en/resources/investing-in-canadas-future, page 10. Quoting the Office of the Auditor General Canada. 2016. Spring 2016 Reports of the Commissioner of the Environment and Sustainable Development, Report 2: Mitigating the Impacts of Severe Weather Events. Also reported in Moudrak et al., 2018.

[9] FCM and IBC, February 2020, Investing in Canada's Future: The Cost of Climate Adaptation: at the Local Level, Final Report, https://fcm.ca/en/resources/investing-in-canadas-future

[10] FCM and IBC, February 2020, Investing in Canada's Future: The Cost of Climate Adaptation: at the Local Level, Final Report, https://fcm.ca/en/resources/investing-in-canadas-future

THE ENERGY LENS: BUILDING A RESILIENT ENERGY COMMUNITY

The Cost of Energy Disruption on Communities

Loss of energy supply and prolonged power outages lead to significant indirect social and economic cost. The cost of these climate hazards impact both municipal systems and energy distribution systems. These two systems are essential, interconnected, and must work together to maintain community resilience (see Sidebar 1 on the next page).

Climate change is a growing concern for Canada's electricity and natural gas systems. Almost 90% of Canadian energy utilities have been significantly impacted by a weather event in the last decade[11]. Climate change brings more risks than opportunities for the electricity sector as it increases costs across all steps in the value chain, including transmission and distribution infrastructure. At the same time, revenues may decrease through the increased frequency and/or duration of outages and through reduced infrastructure efficiencies[12]. Aging electricity infrastructure in Canada's electricity sector is an aggravating factor because it is physically more vulnerable to damage from climate hazards than recently built infrastructure that considers climate hazards[13].

Climate change can impact energy systems in several ways[14]:

- Disruption of energy generation and supply during extreme weather events (power outages due to damages on the distribution or transmission grids, disruption of the operation of generating capacity, damaged road or rail routes which supply gas or diesel, damage to natural gas distribution pipes).
- Increased stress on transmission and distribution infrastructure (sensitivity to gradual changes in temperature and precipitation patterns).
- Growing demand for electrical generation (additional loads created by cooling requirements or additional electric heaters used to supplement natural gas heating during cold waves).

There is no reliable estimate of the impact of climate change on Canada's electricity and natural gas transmission and distribution systems. In the United States, the average annual cost of power outages caused by extreme weather events is estimated to be between USD $18 and $33 billion per year, and is expected to increase due to record breaking storms[15]. The Canadian Electricity Association (CEA) acknowledges that "climate change (and the increasing severity and frequency of extreme weather events that come with it) will continue to have a profound impact on the reliability of Canada's electricity generation, transmission and distribution system", adding that utilities "must make appropriate investment decisions now to increase the resiliency of the power grid[16]."

Therefore, building resilient energy systems is important for ensuring the health and economic prosperity of Canada's communities.

[11] Eddie Oldfield and Aïda Nciri (2019) Building Community Resilience Key Considerations and Lessons Learned from Twelve Canadian Communities, QUEST

[12] Canadian Electricity Association (2016) Adapting to Climate Change: State of Play and Recommendations for the Electricity Sector in Canada, p11.

[13] Most Canadian electricity assets will need replacement or renewal by 2050. Canadian Electricity Association (2016) Adapting to Climate Change: State of Play and Recommendations for the Electricity Sector in Canada, p3.

[14] Canadian Electricity Association (2016) Adapting to Climate Change: State of Play and Recommendations for the Electricity Sector in Canada

[15] Morand, A., R. Hennessey, J. Pittman and A. Douglas. (2015). Linking Mitigation and Adaptation Goals in the Energy Sector: A Case Study Synthesis Report. Report submitted to the Climate Change Impacts and Adaptation Division, Natural Resources Canada, 122p

[16] CEA (2015) Electric Utility Innovation: Toward Vision 2050

SIDEBAR 1

THE INTERDEPENDENCE OF ENERGY SYSTEMS AND COMMUNITIES

"There is a significant economic cost to all sectors that goes along with the disruption of power stemming from extreme weather, including lost output and wages, spoiled inventory, delayed production, as well as inconvenience. Extended power outages can interrupt the flow of clean water and solid waste removal from municipal water treatment facilities, cause hospitals to lose power and access to clean water, and result in businesses having to close, affecting sales and profitability. Disruptions to the energy system can have significant effects on other critical services such as communications, transportation and human health."

Page 5, Morand, A., R. Hennessey, J. Pittman and A. Douglas. (2015). Linking Mitigation and Adaptation Goals in the Energy Sector: A Case Study Synthesis Report. Report submitted to the Climate Change Impacts and Adaptation Division, Natural Resources Canada, 122p

The Benefits of Adaptation vs Inaction

NRCAN refers to climate adaptation as "actions that reduce the negative impact of climate change, while taking advantage of potential new opportunities. It involves adjusting policies and actions because of observed or expected changes in climate. Adaptation can be reactive, occurring in response to climate impacts, or anticipatory, occurring before impacts of climate change are observed[17]."

In most circumstances, anticipatory adaptations will result in lower long-term costs and will be more effective than reactive adaptations and inaction[18 19]. Research has found that the benefits of investing in adaptation and resilience outweigh the upfront costs of investments by a ratio of 6 to 1.7[20]. For example, building a new transmission line that is adapted to climate hazards only adds between 0-5% to construction costs. This is considerably less expensive than repairing and rebuilding infrastructure after a disaster. Adding 0-5% to the construction cost range is also recognized as a rule of thumb for incorporating adaptation initiatives into the design of a new structure[21]. This is why the Canadian Energy Association's (CEA) Board Committee on Sustainability encourages their members to adopt adaptation plans by the end of 2020[22].

Collaboration is Needed Between Municipalities and Energy Utilities

Building resilient energy communities requires strong collaboration and understanding between local governments and energy utilities. Working together is necessary to conduct climate risk and vulnerability assessments, select relevant climate adaptation measures, as well as to align energy planning and asset management.

Electricity and natural gas distributors have a critical role to play in proactively collaborating with other community-level stakeholders, including local governments, and in adapting infrastructure and practices. Similarly, local governments need to cooperate closely with distribution utilities as most electricity and natural gas distribution and generation infrastructure are not owned or operated by municipalities. Municipalities need to work with utilities to actively integrate energy planning into their assets management plans, adaptation plans, and emergency plans.

It is therefore instrumental to identify how communities and utilities in Canada can better work together and adapt energy infrastructure through end-use planning, asset planning, and emergency response during power outages.

17 18 Page 2, Richardson, G. R. A. (2010). Adapting to Climate Change: An Introduction for Canadian Municipalities. Ottawa, Ont.. Natural Resources Canada, 40 p https://www.nrcan.gc.ca/climate-change/impacts-adaptations/adapting-climate-change-introduction-canadian-municipalities/10079

19 Canadian Electricity Association (2016) Adapting to Climate Change: State of Play and Recommendations for the Electricity Sector in Canada

20 Martinez-Diaz, L., 2018, Investing in resilience today to prepare for tomorrow's climate change. Bulletin of the Atomic Scientists, 74:22, pp. 66-72.

21 FCM and IBC, February 2020, Investing in Canada's Future: The Cost of Climate Adaptation: at the Local Level, Final Report, 13 p https://fcm.ca/en/resources/investing-in-canadas-future

22 Canadian Electricity Association (2019), Resilient assets and sustainable outcomes - 2019 Sustainable Electricity Annual Report

A FOCUS ON ALBERTA

The impacts of climate change vary across Canada. In addition, each province and territory has their own energy mix, energy governance and regulations and policies which involve different energy utilities and stakeholders. This regional variance is also true for Canada's municipal governance landscape. This means that relevant adaptation measures, the range of possible adaptation options, the resources available and the ability to implement them, are not the same across Canadian communities.

As a result, approaches to climate adaptation need to be region-specific. Adaptation strategies and action plans need to be adjusted to each local reality and consider their geographical, political, economic and energy contexts[23]. This is why a provincial lens on energy resilience is essential.

Studies investigating the impacts of climate change on electricity and natural gas infrastructure at the provincial and territorial levels are largely absent. This report, with its focus on Alberta, contributes to fill the gap.

Similar to Canadian trends, Alberta's communities have experienced significant and increasing cost due to climate hazards this past decade. Between 1983 and 2008, Alberta averaged around CAD$100 million a year in catastrophic losses due to extreme events (hailstorms, wildfire, flooding, etc.). This value increased substantially starting in 2009, with Alberta averaging $673 million a year in insured losses from extreme weather events from 2009 to 2012 (see Table 1)[24].

While the cost of climate change in Alberta is significant, it is still manageable compared to other provinces. In the Prairies, the cost of adaptation is estimated to $300 million, which represents about 0.06% of the GDP. With the implementation of immediate climate adaptation measures, the cost of further damages due to extreme weather events will remain low[25].

The structure of Alberta's electricity and natural gas systems is complex however, with multiple distribution and transmission energy utilities — most of which are investor-owned utilities and some which are municipally-owned (See Sidebar 2). There is a need for coordination and alignment of adaptation practices and methods and measures among these multiple players, as well as a need to better integrate respective plans to adapt to climate change.

This report is a contribution to assist Alberta communities and their various stakeholders consider energy resilience and mitigate the economic, social, and human impacts of climate change through proactive climate adaptation measures.

Over the past three years, QUEST has worked with seven small urban and rural municipalities on energy resilience. Through this work, QUEST gained valuable insights directly from community representatives regarding energy system adaptations as well as areas of challenge and proficiency.

Table 1 – Catastrophic losses due to extreme events in Alberta[26]

	1983-2008	2009-2012
Average per year	$100 million	$673 million

23 Richardson, G. R. A. (2010). Adapting to Climate Change: An Introduction for Canadian Municipalities. Ottawa, Ont.. Natural Resources Canada, 40 p https://www.nrcan.gc.ca/climate-change/impacts-adaptations/adapting-climate-change-introduction-canadian-municipalities/10079

24 Government of Alberta, Climate Change in Alberta, https://www.alberta.ca/climate-change-alberta.aspx. Retrieved on April 21, 2020

25 FCM and IBC, February 2020, Investing in Canada's Future: The Cost of Climate Adaptation: at the Local Level, Final Report, https://fcm.ca/en/resources/investing-in-canadas-future

26 Source: Government of Alberta, Climate Change in Alberta, https://www.alberta.ca/climate-change-alberta.aspx. Retrieved on April 21, 2020

SIDEBAR 2

OVERVIEW OF ALBERTA'S ELECTRICITY AND NATURAL GAS TRANSMISSION AND DISTRIBUTION SYSTEMS

In Alberta, the natural gas distribution system and the electricity transmission and distribution systems are owned and operated by shareholder or municipally owned companies. Their activities are regulated by the Alberta Utilities Commission (AUC).

The AUC is an independent, quasi-judicial agency of the province of Alberta that is in charge of developing and implementing regulation based on policies developed by the government. The AUC also approves the rates charged by investor-owned and certain municipally-owned wires. The distribution tariff on a customer's bill recovers the cost to the wire or pipe owner for things such as the design, maintenance, operation, construction and financing of the electric and natural gas system that delivers energy to a customer's home.

- The four major electricity distribution companies in Alberta are EPCOR, ENMAX, ATCO and FortisAlberta. Additionally, there are six municipalities and 34 Rural Electrification Associations that manage distribution operations.
- The two major electricity transmission companies in Alberta are: AltaLink and ATCO Electric Transmission.
- The major investor-owned natural gas distribution companies that service the majority of Albertans are ATCO Gas and AltaGas Utilities Inc. The remaining natural gas distributors are natural gas co-operatives (regulated by their elected board members) and municipally owned utilities (regulated by their municipal councils).

Most energy utilities in Alberta are investor-owned utilities except for a few municipalities that have their own municipally owned utilities (such as the City of Red Deer, the City of Medicine Hat and the City of Lethbridge). In addition, there are many rural electrification and natural gas associations (REAs) that are member-based.

METHODOLOGICAL NOTES

The report builds on the resilience work QUEST completed with seven small and mid-size communities across the province (three in 2018 and 2019[27], and four in 2020) to assess their strengths and vulnerabilities from an energy perspective. A series of surveys and participatory workshops informed a personalized Climate Risk and Resilience Assessment and a Recommendations Report for each municipality. The communities include: The Town of Okotoks, the Town of Devon, the Town of Cochrane, the Town of Black Diamond, the Town of Raymond, Ponoka County, and Big Lakes County.

The report also builds on an extensive literature review and analysis of the Alberta Utilities Commission (AUC)'s publications. In addition, interviews with half a dozen municipally-owned utilities and investor-owned electricity and natural gas distribution utilities in the province were conducted.

THE IMPACT OF CLIMATE CHANGE ON ALBERTA'S ENERGY INFRASTRUCTURE

ALBERTA'S CHANGING CLIMATE

Current climate data and future projections for Alberta indicate an overall warming of temperature, change in precipitation and water cycle patterns, and increasing extreme weather events. Here are the key projected changes retrieved from federal data[28]:

- Average annual temperatures have increased by as much as 2.5°C (from the 1950s) and are projected to continue increasing by up to 6°C by 2100.
- Winters have shown the strongest warming changes and are expected to increase by as much as 7°C (from 1950s averages to 2100 projections).

[27] Eddie Oldfield and Aïda Nciri (2019) Building Community Resilience Key Considerations and Lessons Learned from Twelve Canadian Communities, QUEST. Available on https://questcanada.org/project/municipalities-utilities-partnering-for-community-resilience

[28] Climate Atlas of Canada; Climatedata.ca

- Fluctuations between warm and cold weather are increasing in frequency and severity, as both extreme heat waves and extreme cold spells have doubled and are projected to increase four-fold by 2100.
- Number of heating degree days (days where artificial heating is required) are decreasing throughout the province, while the number of cooling degree days (days where artificial cooling is required) are increasing. This changes the seasonal energy demand substantially.
- Annual precipitation throughout the province is set to increase slightly, however, snowfall throughout most of the province will decrease due to shorter, warmer winters and will be replaced with increased rainfall events.
- Projected increase in annual potential evapotranspiration, by as much as 300mm by 2100, will result in decreased soil moisture throughout the province, despite the increased precipitation.
- Greater fluctuation between wet and dry years is also projected, leading to increased risk of both flooding and drought events throughout the province.

As a result of this change in climate patterns, Alberta communities are at greater risk of being exposed to more frequent and intense occurrences of the following climate hazards events:

- Increased drought and flooding
- Severe snow, wind and hail storms and other atmospheric hazards
- Periods of extreme hot and cold temperatures
- Wildfires

Not all Albertan communities are equal when faced with these risks. Wildfire risk for instance, is not uniform across the province due to differences in the fire regime fuel usage, weather and topography. This is the same for floods, droughts, extreme weather and severe storms.

SIDEBAR 3

WHAT IS CONSIDERED "NORMAL" AND WHAT CAN BE ATTRIBUTED TO CLIMATE CHANGE?

Climate is a complex system and weather deviations have always occurred. What is clear is that climate change is causing a transformation in Alberta's characteristic weather patterns and events —notably, less precipitation and warmer temperatures over the past decades[29]. Extreme weather events — that is, weather events that are unusual in terms of their intensity, duration and impacts — have increased over the past decade in Canada.

The causality between climate change and an extreme weather event is difficult to establish given the multiplicity of factors. This is why scientific modeling uses an approach by likelihood to assess the link between climate change and extreme weather events. A recent report attributes both the 2016 Fort McMurray wildfire (medium confidence) and the extreme precipitation that produced the 2013 southern Alberta flood (low confidence) to climate change[30].

IMPACT OF CLIMATE HAZARDS ON ALBERTA'S ELECTRICITY INFRASTRUCTURE

Actual and potential material damages on transmission and distribution systems

Climatic geographical variations in Alberta are important, with different types of weather in the northern and southern parts of the province. Keeping this diversity in mind, Alberta's electricity infrastructure is highly exposed to wildfires, floods, and atmospheric hazards (wind gust, heavy/wet snow and freezing rain). Exposure to these weather events is not new; however, the intensity and frequency of these events have increased over the past decade, and are projected to continue to increase due to climate change.

29 NRCAN (2019) Canada's Changing Climate Report. Retrieved from: https://changingclimate.ca/CCCR2019

30 NRCAN (2019) Canada's Changing Climate Report. Retrieved from: https://changingclimate.ca/CCCR2019

Table 2 presents already experienced, or expected damages related to these extreme weather events on distribution and transmission systems[31].

Table 2 – Impacts of extreme weather events on electricity distribution and transmission infrastructure in Alberta[32]

Climate hazards	Electricity transmission, distribution and infrastructure
Increases in Air Temperature	Reduced transmission and distribution efficiency due to winds and higher ambient temperatures (risks of de-rating or failure for air cooled transformers, and in sag and annealing for overhead conductors) More stress on the distribution system due to more frequent heat waves Need for distributors and system planners/operators to manage energy demand in real time, to build in more system redundancy and revise maintenance and component replacement strategies
Ice Storms	Power lines snap or break;,broken down utility poles, and significant increase in tree contacts leading to widespread infrastructure damage and power loss
Higher Winds	Wires and distribution systems damage, especially through tree contact damage
Climate Impacts on Biodiversity/ Invasive Species	Changes in the seasonal migrations and nesting behaviours of species of birds protected under legislation could present new environmental challenges for constructing or maintaining transmission lines. Changes in vegetation growth and/or the introduction of new invasive species may require changes in vegetation management practices.
Changes in Precipitation and Runoff	High vulnerability of substations to flooding, and potential vulnerability of supporting infrastructure (e.g. copper and fiber-optic cables used in information and communication technology (ICT) systems to flooding) Increased number of "freeze/thaw" cycles due to fluctuations in winter precipitation and temperatures which could damage concrete (through expansion and contraction of moisture) and cause cracking and deterioration of underground vaults and cable chambers over time
Wildfires	Burning down of transmission lines and damage to transmission poles Annealed or damaged conductors leading to failure Damage of line through exposure to heat (non-direct contact with fire) Risk of "flashover" (ionization of the air due to smoke and particulate matter creating an electrical path away from transmission lines) leading to line shut down and power outages

[31] This table is adapted from a the following report Source: Adapted from Canadian Electricity Association (2016) Adapting to Climate Change: State of Play and Recommendations for the Electricity Sector in Canada to reflect Alberta context

[32] Source: Adapted from Canadian Electricity Association (2016) Adapting to Climate Change: State of Play and Recommendations for the Electricity Sector in Canada to reflect Alberta context

SIDEBAR 4

TRANSMISSION INFRASTRUCTURE AND WILDFIRES IN ALBERTA

Transmission utilities in Alberta are particularly concerned with wildfire. Referring to data produced by Alberta Wildfire, Altalink reports that the Forest Protection Area has experienced several destructive wildfire events: over the past 20 years, powerlines caused fires in Alberta's Forest Protection Area that account for 2.7% of total wildfires. Powerline wildfires have also increased from 64 fires in 1996-2005 to 850 fires in 2006-2017. This surge has also been associated with an increase in wildfires severity and in total area burned[33]. One of the identified contributing factors to explain the increasing trend of powerline caused wildfires is climate change[34].

Power outages and reliability

One of the most frequent impacts of extreme weather events on energy infrastructure are power outages. Distribution utilities are not required to report raw power outage data. As a result, it is not possible to estimate the evolution of frequency and duration of power outages due to weather events in the province.

Since 2014, distribution utilities are only required to report two indexes: the System Average Interruption Frequency Index (SAIFI) and the System Average Interruption Duration Index (SAIDI) (see Appendix 2). The recent tracking of these indexes and their aggregated nature does not allow for a historical analysis or to identify potential trends in power outages, nor the role of extreme weather events. Further, there is no power outages data available regarding transmission.

THE IMPACTS OF CLIMATE CHANGE ON ALBERTA'S NATURAL GAS INFRASTRUCTURE

Natural gas distribution systems tend to be reliable in the face of extreme weather events because the infrastructure is mostly buried underground. However, natural gas distribution pipelines are still vulnerable to extreme cold weather (pipeline cracks or ruptures from ground shifting) and flooding[35].

THE FINANCIAL CONSEQUENCES OF DISRUPTED ENERGY INFRASTRUCTURE

THE COST OF DAMAGED ENERGY INFRASTRUCTURE ON UTILITIES AND CONSUMERS

The cost of damaged electricity infrastructure

Assessing the cost of damage that weather events have on Alberta's electricity infrastructure is a challenge as there is no database to track the costs of damages related to weather events. As a result, the data presented in this section are not comprehensive and only provide a partial overview of the impact of extreme weather events on the province's energy system.

The only data found that were publicly available to assess the cost of weather events on distribution systems are presented in Table 3 and 4. The two tables present some capital and repair costs resulting from major weather events on FortisAlberta and ATCO Electric's distribution systems (damages over $400,000). Unfortunately, the series of data is incomplete with several years missing. Data for other distribution utilities were not found.

33 AltaLink, 2019, Appendix 22 AltaLink Wildfire Mitigation Plan 2019 - 2021 General Tariff Application, page 3. Retrieved from AUC Efiling system as part of the Proceeding 23848. Exhibit: 23848_X0169

34 AltaLink, 2019, Appendix 22 AltaLink Wildfire Mitigation Plan 2019 - 2021 General Tariff Application, page 3. Retrieved from AUC Efiling system as part of the Proceeding 23848. Exhibit: 23848_X0169.

35 Page 8, Lazlo, R. and Marchionda S, 2015, Resilient Pipes and Wires, QUEST, June 15 2015, https://questcanada.org/project/resilient-pipes-and-wires

Table 3 – Replacement costs due to damages from weather events on FortisAlberta distribution system between 2005 and 2010 and for 2017 (for damages above $400k)[36]

Type of Event	Cost ($000's) *Costs escalated to 2017 dollars	Year
April Snow Storm 2	9,694	2010
May 2017 windstorm	4,000	2017
Kenow Fire (Waterton National Park)	2,400	2017
April Snow Storm 3	1,399	2010
April Snow Storm	1,304	2007
June fire	1,178	2005
August Thunderstorm	775	2009
Hilda Fire	600	2017
July Wind Storm	494	2008

Table 4 – Replacement costs due to damages from weather events on ATCO Electric distribution system between 2002 and 2012 and (for damages above $400k)[37]

Type of Event	Cost ($000's) Costs at dollar value of the year incurred	Year
Snow Storm - April 13-14	1000	2010
Chisholm Forest Fire	600	2002
Gregoire Lake Contact	500	2004
Slave Lake Pulp Litigation - Mitsue Fire	500	2009
Wind Storm - July 12-13	500	2010
Hoar Frost Storm - November 1-5	500	2012
Fort Vermilion/LaCrete Windstorm	400	2004
Hoar Frost Storm - Jan 2006	400	2007
Wind Storm - October 2008	400	2008
Wind Storm - May 21-23	400	2010

36 AUC, Decision 24369-D01-2019 (June 19, 2019) - page 3 and 5.
37 AUC Decision 2014-297 2012 (Errata) (January 8, 2015). Page 18 and 19

In addition, the 2013 Southern flood cost estimate for ENMAX Corporation was approximately $4.9 million in capital cost and $4.7 million in operational costs[38]. The capital and operation and maintenance cost of the 2016 Fort McMurray wildfires were estimated to $7.0 million dollars for ATCO Electric[39].

Extreme weather events have also damaged transmission infrastructure. ATCO Electricity Transmission estimated the costs of the 2016 Fort McMurray capital replacement and repair to be $7.6 million[40].

Capital and operation and maintenance costs only represent a portion of catastrophic loss for distribution utilities. Loss of revenue can also be significant. ATCO Electric estimates lost revenue due to the 2016 Fort McMurray to be $6.5 million[41].

The cumulative cost of extreme weather events (damages over $400,000) reviewed in this section was over $43.6 million between 2002 and 2018, with the most costly weather events occuring after 2010[42]. It seems the catastrophic losses due to extreme weather events have increased over time in Alberta, driven by more frequent and severe wildfires, flooding, and wind or snow storms.

As these findings are based on partial, snapshots of data,it should be noted that it is difficult to identify clear trends. In addition, other factors need to be accounted for, such as the extension of distribution infrastructure systems to accommodate Alberta's population growth, which could not be factored in this assessment.

The cost of damaged natural gas infrastructure

Similar to electricity infrastructure, there is no data tracking the capital and repair cost of extreme weather events on natural gas infrastructure in Alberta. Table 5 presents major ATCO Gas' historic losses due to extreme weather events. Based on ATCO Gas historical data, natural gas infrastructure has only recently been impacted by climate hazards, as a result of the 2016 Fort McMurray wildfire and the 2005 and 2013 flooding events, suggesting that climate change is placing increasing strain on natural gas infrastructure. Yet, natural gas infrastructure still remains less vulnerable than electricity infrastructure.

38 CEA (2016), Adapting to Climate Change: State of Play and Recommendations for the Electricity Sector in Canada, p28
39 AUC Proceeding 25071 Exhibit 1
40 AUC Decision 22742-D02-2019 (October 2, 2019)
41 AUC Proceeding 25071 Exhibit 1
42 With the shortcoming that ATCO's data do not account for inflation.

Table 5 – ATCO Gas's historic losses due to extreme weather events (1987-2016)[43]

Type of Event	Cost ($000's)	Year
Southern Alberta Flood	2,067	2005
Tornado	253	1987
Southern Alberta Flood	5,933	2013
Fort McMurray Wildfire	11,199	2016

THE IMPACT ON ELECTRICITY AND NATURAL GAS RATES

The catastrophic losses caused by extreme weather events are impacting consumers' natural gas and energy bills. Depending on the nature of the loss[44], and whether they impact transmission or distribution infrastructure, there are different regulatory dispositions providing guidance on how utilities can recover these losses through consumer rates[45]. These are presented in Table 6.

Table 6 – Recovery of catastrophic losses dues to extreme weather events by utilities in Alberta

Type of costs	AUC decision	System	Who pays and how
Loss of the remaining value of destroyed assets	If considered as a loss from extraordinary retirement[46] as per Utility Asset Disposition (UAD) principles	Transmission and distribution	**Shareholders.** Transmission utilities cannot pass an insurance line to ratepayers to cover for the loss of extraordinary retirement, such as climate hazards[47]. Similarly, even when the Z factor is activated for distribution (see below), the shareholders must pay for the remainder of the Net Book Value[48].
	If considered as a non extraordinary retirement	Distribution	**Ratepayers**. Utilities pass the costs to ratepayers located in the area that was damaged, after approval of the costs by AUC. This occurred once with ATCO Gas (estimated to 1.2 million)[49], following the 2016 Fort McMurray wildfire and with ACTO Electric following the 2013 flood (estimated to $500k[50]).
		Transmission	**Ratepayers**. Utilities pass the costs of damages to ratepayers following the cost-of-recovery model, after approval of the costs by AUC.

[43] Decision 21608-D01-2018 (June 5, 2018) Page 9 and AUC Decision 21608-D01-2018

[44] There are three types of loss: loss of the remaining value of destroyed assets (or Net Book Value); losses related to additional capital and operational costs (replacement and repair of damaged infrastructure), and loss revenue of not operating these infrastructure.

[45] Distribution utilities' rate structure is governed by a Performance-Based Rate (PBR) system, whereas transmission utilities' rate structure is governed by the cost-of-service principle. In both cases, they are reviewed and approved by AUC.

[46] For the AUC "a determination of whether an event is an extraordinary retirement is fact-specific to the particular characteristics of that event and to a particular utility. If the current retirement event exhibits characteristics sufficiently similar to prior events incorporated into the last approved depreciation study for the utility, the retirement events could be considered ordinary retirements. If the current retirement events exhibit sufficiently dissimilar characteristics, the retirement events could be considered extraordinary retirements."Decision 21609-D01-2019(October 2, 2019) paragraph 118

[47] See paragraphs 1260-1266 for AUC Decision 20272-D01-2016 ATCO Electric Ltd. 2015-2017 Transmission General

[48] See Paragraph 128 of AUC Decision 21609-D01-2019: http://www.auc.ab.ca/regulatory_documents/ProceedingDocuments/2019/21609-D01-2019.pdf

[49] Paragraphs 1 and 28 of AUC Decision 21608-D01-2018: http://www.auc.ab.ca/regulatory_documents/ProceedingDocuments/2018/21608-D01-2018.pdf AUC asked ATCO to review the $1.2 million amount.

[50] See paragraphs 1 and 93 of AUC Decision 2738-D01-2016: http://www.auc.ab.ca/regulatory_documents/ProceedingDocuments/2016/2738-D01-2016.pdf

Asset replacement and repair	Non-activation of the Z factor	Distribution	Three mechanisms, as per the Performance Based Rate (PBR) system: 1. Pass to ratepayers through utilities' self-insurance/ reserve for injuries and damages reserve fund, which is factored in the I-X mechanism. The primary purpose of a reserve fund is to capture the effects of major events that are not covered by insurance[51]. 2. Unusual capital costs not accounted for in the X-I mechanism can be passed to ratepayers through the K factor[52], that is calculated through a capital tracker process[53]. 3. None of the above is approved by AUC, and it should be covered by the utilities, which often mean their shareholders.
	Activation of the Z factor - PBR formula	Distribution	**Ratepayers**. Utilities pass the costs to ratepayers located in the area that was damaged, after approval of the costs by AUC.
	Cost-of-recovery mechanism	Transmission	**Ratepayers**. Utilities pass the costs of damages to all ratepayers following the cost-of-recovery model, after approval of the costs by AUC.
Loss Revenues	Non-activation of the Z factor	Distribution	Unclear
	Activation of the Z factor - PBR formula		**Ratepayers**. Utilities pass the costs to ratepayers located in the area that was damaged, after approval of the costs by AUC.
	Cost-of-recovery mechanism	Transmission	Unclear

In the case of transmission infrastructure, utilities are recovering most of the costs through rates, following the cost-of-model recovery. This model provides a relatively transparent account of the costs related to climate hazard paid by ratepayers. However, the data to evaluate these costs are not easily available, and require an analysis of AUC decisions dealing with transmission rates.

In the case of distribution infrastructure, most of the mechanisms enabling utilities to recover the costs of catastrophic losses are through ratepayers. In only one instance, costs are recovered by shareholders. However, because of the complexity of the PBR system, and the lack of available data, it is difficult to estimate the share paid by the ratepayers and the share paid by the shareholders.

Only the costs passed to rate-payers through the Z factor are easy to retrieve. The Z factor "allow[s] for an adjustment to a distribution utility's rates to account for a significant financial impact (either positive or negative) of an exogenous event outside of the control of the distribution utility and for which the distribution utility has no other reasonable opportunity to recover the costs[54]". The Z factor includes operation and maintenance expenditures costs, revenue

51 "The Commission considers that during the PBR term the significant events that the companies are concerned about could be addressed as Z factors while the non-significant events should be covered by the I-X mechanism. The Commission will allow the companies to include a provision in their going-in rates calculated as follows. The provision will be equal to the average value of each event that was included in their deferral account or as an adjustment to their reserve account for the most recent five-year period. This amount is to be reflected in the companies going-in rates." Paragraph 687 in AUC Decision 2012-237 (September 12, 2012)

52 "The Commission acknowledges that there are circumstances in which a PBR plan would need to provide for revenues in addition to the revenues generated by the I-X mechanism in order to provide for some necessary capital expenditures. The way in which this is accomplished is through a capital factor (K factor) in the PBR plan." Paragraph 549 AUC Decision 2012-237 (September 12, 2012). Check also section 15.1.3

53 "The Commission has determined that a mechanism to fund certain capital-related costs outside of the I-X mechanism through a capital factor is required. … 587. A capital tracker mechanism in a PBR plan is warranted in circumstances where the company can demonstrate that a necessary capital replacement project or capital project required by an external party cannot reasonably be expected to be recovered through the I-X mechanism. The Commission concludes that a structured criteria-based approach provides the most objective method for assessing whether projects qualify as capital trackers" Paragraphs 586 and 587. AUC Decision 2012-237 (September 12, 2012. Check also paragraph 464 of the same decision.

54 AUC, Decision 20414-D01-2016 (Errata), Section 8, pg 9: http://www.auc.ab.ca/regulatory_documents/ProceedingDocuments/2016/20414-D01-2016%20(Errata).pdf

requirements related to capital expenditures and loss revenues (see Sidebar 5 for more information).

The "Z factor" has been used only three times in Alberta. It was used to cover losses due to two extreme weather events: the 2013 Southern Alberta flooding and the 2016 Fort McMurray wildfires. AUC is in charge of approving the loss the utility is authorised to pass to ratepayers located in the damaged area:

- ATCO Gas was approved to recover a Z factor cost in the amount of $11.9 million for the 2016 Fort McMurray wildfire[55].
- ATCO Electric estimated a Z factor of $13.4 million for the 2016 Fort McMurray wildfire[56]. The final amount is currently being determined.
- ATCO Gas was approved to recover a Z factor cost in the amount of $3.1 million for the 2013 Southern Alberta flood[57].

This means that aforementioned costs will be passed to ratepayers who live in impacted areas over the coming years, resulting in an increase of the fixed costs of their energy bills.

55 Decision 21608-D01-2018 ATCO Gas (http://www.auc.ab.ca/regulatory_documents/ProceedingDocuments/2018/21608-D01-2018.pdf), a division of ATCO Gas and Pipelines Ltd. Z Factor Application for Recovery of 2016 Regional Municipality of Wood Buffalo Wildfire Costs issued June 5, 2018. In compliance Decision 23723-D01-2018 (http://www.auc.ab.ca/regulatory_documents/ProceedingDocuments/2018/23723-D01-2018.pdf

56 Decision 21609-D01-2019, ATCO Electric Ltd (http://www.auc.ab.ca/regulatory_documents/ProceedingDocuments/2019/21609-D01-2019.pdf). Z Factor Adjustment for the 2016 Regional Municipality of Wood Buffalo Wildfire issued October 2, 2019.

57 Decision 2738-D01-2016 ATCO Gas and Pipelines Ltd (http://www.auc.ab.ca/regulatory_documents/ProceedingDocuments/2016/2738-D01-2016.pdf). Z Factor Application for Recovery of 2013 Southern Alberta Flood Costs issued March 16, 2016. As set out in para 95, ATCO Gas

SIDEBAR 5

DESCRIPTION OF THE Z FACTOR[58]

The Commission considers that the following criteria will apply when evaluating whether the impact of an exogenous event qualifies for Z factor treatment:

i. The impact must be attributable to some event outside management's control.

ii. The impact of the event must be material. It must have a significant influence on the operation of the distribution utility; otherwise the impact should be expensed or recognized as income, in the normal course of business.

iii. The impact of the event should not have a significant influence on the inflation factor in the PBR formula.

iv. All costs claimed as an exogenous adjustment must be prudently incurred.

v. The impact of the event was unforeseen.

The Commission considers that all of the above criteria must be met in order for an item to qualify for a Z factor rate adjustment. The Commission considers that Z factors should be symmetrical in that they should apply to exogenous events with both additional costs that the distribution utility needs to recover and also reductions to costs that need to be refunded to customers.

58 AUC, Decision 20414-D01-2016 (Errata), Section 8, pg 91: http://www.auc.ab.ca/regulatory_documents/ProceedingDocuments/2016/20414-D01-2016%20(Errata).pdf

THE COST ON THE LOCAL ECONOMY

The utilities industry in Alberta amounts over $30 billion and provides electricity and natural gas to over 3 millions sites[59]. As a result, damaged energy infrastructure and prolonged power outages caused by extreme weather events also harm local economic activities. These socio-economic costs on residential, commercial, industrial and agricultural consumers are difficult to capture and quantify. Based on information collected in seven communities in the province[60], Albertan communities noticed increased frequency in flooding, severe wind and hail storms, wildfires, extreme heat periods, and droughts. Participating municipalities identified flooding, storms and wildfires as the greatest areas of concern as they are the more likely to threaten energy infrastructure and public safety and have the more costly financial impact.

The increasing cost of extreme weather events in Alberta provides an overview of such socio-economic impacts. Between 1983 and 2008, Alberta averaged around $100 million a year in catastrophic losses due to extreme events (hailstorms, wildfire, flooding, etc.). This value increased substantially starting in 2009. Alberta averaged $673 million a year in insured losses from extreme weather events from 2009 to 2012[61]. In addition, according to the Insurance Bureau of Canada, Alberta has experienced the two most costly disasters in the country's history with the Fort McMurray wildfires at $3.58 billion and the 2013 southern Alberta floods at $1.7 billion[62]. If accounting for non-insured loss, damage is estimated to be as high as $6 billion, with 100,000 people being displaced from their homes[63]. Damage on transmission lines due to wildfires have resulted in further impacts to communities and businesses, prolonging community evacuations and business closures[64].

Studies are needed to assess the direct and indirect socio-economic costs of prolonged power outages and damaged energy infrastructure on communities in Alberta.

59 AUC, 2019, 2019-2022 Strategic Plan, p 26

60 These data were collected by QUEST during their work with seven small and mid-size communities on Energy Resilience Community

61 Government of Alberta, Climate Change in Alberta, https://www.alberta.ca/climate-change-alberta.aspx. Retrieved on April 21, 2020

62 Government of Alberta, Climate Change in Alberta, https://www.alberta.ca/climate-change-alberta.aspx. Retrieved on April 21, 2020

63 Bob Weber, "Alberta Flooding 2014: Some Evacuations, While Others Hold Ground," The Canadian Press, June 18, 2014, available: http://www.huffingtonpost.ca/2014/06/18/alberta-flood-evacuations_n_5507617.html

64 AltaLink, 2019, Appendix 22 AltaLink Wildfire Mitigation Plan 2019 - 2021 General Tariff Application, page 3. Retrieved from AUC Efiling system as part of the Proceeding 23848. Exhibit: 23848_X0169

SIDEBAR 6

WILDFIRE IMPACTS

Fort McMurray AB, April 30 to June 1, 2016. Wildfires broke out in northern Alberta resulting in one of the most expensive natural disasters in Canadian history. In total, the Fort McMurray fires burned approximately 579,762 hectares of land causing the evacuation of over 90,000 people and destroying 2,400 homes and businesses, as well as 530 additional buildings. At its peak, there were over 2,000 firefighters battling the fires daily, including helicopters and water bombers. In addition, 200 firefighters from the United States, 60 from Mexico and 298 from South Africa provided support. Estimated total cost: $4,068,678,000. Two fatalities, 90,000 evacuated[65].

Strathcona County and Lamont County, May 2018. Two large wildfires in Strathcona County and one in Lamont County burned approximately 300 hectares of land. In this area served by FortisAlberta, more than 40 poles were downed and 80 primarily oilfield customers were left without power. FortisAlberta ensured customers were informed and that a plan was in place to safely restore power once they were given the clearance to start work. It took about four days for local fire crews to have the blazes under control and for FortisAlberta to be able to energize two three-phase lines outside of the burn area. The rebuild, which included 43 pole replacements, was complete eight days later[66].

Slave Lake AB, May 15 to May 22, 2011. 49 wildfires in north-central Alberta burned across the Lesser Slave River Region, prompting one of the most destructive wildfires in Canadian history. A state of emergency was declared after a wildfire that originated in the town of Slave Lake began to spread uncontrollably, affecting surrounding communities. The wildfire devastated the Town of Slave Lake, where 374 buildings were destroyed and 52 were damaged by the flames. Approximately 7,000 people were evacuated from the Town of Slave Lake and 735 individuals and families lost their homes. Outside of the Town of Slave Lake, 59 other buildings were destroyed and 32 were damaged. Other affected communities include High Prairie, Little Buffalo, Red Earth Creek, Loon Lake First Nation (FN), Whitefish Lake FN and Woodland Cree FN. Penn West Petroleum, Exall Energy Corp. and Canadian Natural Resources Ltd. halted drilling in the region, suspended production and evacuated their employees. Canadian National (CN) Railway also halted their services in the region. By May 19, the number of evacuees rose to approximately 12,055. The total cost in damages was estimated at over $500 million[67].

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65 National Disaster Database

66 Adapted from https://www.fortisalberta.com/about-us/our-company/blog/fortisalbertablog/2018/06/04/fortisalberta-responds-to-destruction-caused-by-wildfires

67 National Disaster Database

FLOOD IMPACT

Southern Alberta, June 19-28, 2013. A massive storm system crept through Alberta causing significant flooding throughout the Southern part of the province. As of 2013, this event was responsible for the largest evacuation due to a natural disaster in Alberta's history. Heavy rain spanning a region from Canmore to Calgary produced an average of 75 to 150 mm during a three-day period. Twenty-nine local states of emergency were declared throughout the province and one provincial state of emergency. This is the first time a provincial state of an emergency had ever been issued in Alberta. Four deaths were attributed to the floods, which caused significant disruptions across the province to power, telecommunications, clean water supply, and transportation corridors. Over 4,000 businesses were affected and 3,000 buildings were flooded, including the Saddledome and the Calgary Zoo. In total, flooding forced the evacuations of approximately 100,000 Albertans. Insurance payments are estimated at $1.2 billion. It's estimated to have reduced GDP in Southern Alberta by $550 million (2013 dollars)[68].

In addition, the 2013 flooding in Alberta led to a 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. ENMAX Corporation estimated the cost to be $4.7 million in operational costs and capitalized costs of $4.9 million[69].

Southern Alberta, June 6-8, 2005. Heavy rainfall and high water levels across southern Alberta caused massive flooding in several waterways. Multiple municipalities across the region issued a state of emergency. Severe flooding caused the evacuation of 2,000 people in Calgary, 1,300 in Sundre, 3,200 in Drumheller, 200 in High River, 70 in Foothills, 58 in Okotoks and 200 in Red Deer County. Officials reported that the 200-year flood event resulted in significant damages to approximately 40,000 homes. The damages were estimated to be $130 million (2005 dollars).

68 National Disaster Database
69 CEA (2016), Adapting to Climate Change: State of Play and Recommendations for the Electricity Sector in Canada, p 28

EMERGING PRACTICES AND REMAINING CHALLENGES FOR RESILIENT ENERGY COMMUNITIES IN ALBERTA

VULNERABILITY ASSESSMENT AND ADAPTATION PLANS

To identify where vulnerability to the impact of climate change exists (i.e. what infrastructure is most at-risk to extreme weather events), communities and utilities can develop adaptation plans based on risk assessments of key climate hazards. This helps inform planning strategy and direct investments to the most vulnerable assets. Risk assessments include detailed climate analyses and models, and describe the impact that climate trends will have on distribution infrastructure and operations.

Conducting vulnerability assessments is important to understand which people and assets are exposed to climate hazards and to understand climate projections. This understanding can help communities become more resilient, and in turn, gain the capacity to cope with hazardous events and disturbances by responding or reorganizing in ways that maintain essential function, identity and structure. To conduct sound vulnerability assessments and identify appropriate adaptation measures, access to climate data and mapping of major climate hazards is essential.

ENERGY UTILITIES' EMERGING PRACTICES AND CHALLENGES

Challenges in the uptake of formal vulnerability assessment and climate adaptation plans

In Alberta, utilities are not required to integrate climate projections or conduct vulnerability assessments, such as those investigating exposure to wildfires or 100-year flooding events. The only two provincial requirements that exist are:

- *The Powerline Hazard Assessment Plan* (PHAP) led by Alberta Wildfire. The purpose of the PHAP is to reduce wildfires caused by powerline contacts or equipment failures and the threat of infrastructure damage from an encroaching wildfire. The PHAP was last updated in 2010[70]. This program is applicable to all power lines within the province of Alberta.
- The *Wildfire Risk Reduction Program*. Established in 2013, this program consists of practices conducted by ATCO Electric to minimize wildfires caused by power lines (see Sidebar 8), which include Hazard Tree Identification, Tree-Free programs and FireSmart Community programs. ATCO Electric spent a total of $76.3 million on its Wildfire Risk Reduction Programs between 2013 and 2017[71].

SIDEBAR 8

THE WILDFIRE RISK REDUCTION PROGRAM

This program was created from the Agreement for the Reduction and Prevention of Wildfires in the Forest Protection Area (Wildfire Agreement) signed between ATCO and Alberta Environment and Parks (formerly Alberta Environment and Sustainable Resource Development — ESRD).

The work completed under this program involves removing vegetation along power lines in high-risk areas identified by ATCO Electric and the government. There are three program areas listed as part of the Wildfire Risk Reduction program:

- Hazard Tree Identification – consists of removing a small number of trees that are at risk of contact with power lines;
- Tree-Free programs – involves widening the right-of-way around a power line to remove all trees that have the potential to make contact with a power line in remote or high wildfire-risk areas; and
- FireSmart Community-Based Wildfire Risk Reduction – consists of removing vegetation around power lines specifically to protect communities from wildfires

[70] Alberta Wildfire website, retrieved on September 2nd, 2020: https://wildfire.alberta.ca/prevention/industry/powerline-hazard-assessment-plan.aspx

[71] ATCO Electric 2017 Performance-Based Regulation Capital Tracker True-Up Decision 23739-D01-2018(December 18, 2018) - page 20

In addition, a CEA report points to three challenges explaining the low adoption of formal climate adaptation and management plans amongst their membership[72]. They are:

- That the climate hazards under consideration are not yet deemed as a high priority
- A lack of confidence in reliability and geographical scale of climate data, and the lack of access to provincially-based climate modelling on the frequency,severity and secondary consequences of extreme weather/climatic events (versus median increases)
- The difficulty to make sense of climate data from a planning perspective, and to define a better and more detailed process to connect adaptation and investment planning and decision making tools

As climate modelling is improving and more robust data is made publicly available, utilities may be encouraged to conduct voluntary risk and vulnerability assessments.

According to interviewed utilities, the absence of formal adoption of climate vulnerability assessments and climate adaptation plans can also be explained by the fact that current asset management practices have been deemed sufficient thus far to cope with climate hazards, especially in terms of atmospheric hazards (such as freezing snow, wind storms, etc.) Large energy utilities are already experienced in paying specific attention to climatic geographical variations in their planning practices and have already mapped vulnerabilities to common atmospheric hazards and areas exposed to potential power outages. They use these data to adjust construction and asset standards as well as to harden infrastructure as needed. For example, utilities often have regional specifications such as adding guy-wire or increasing pole strength during pole replacement or maintenance. In some cases, they also adopt larger rights of way to prevent trees from falling and/or growing too close to wires. A utility interviewee noted that given the current design criteria for power lines, power failure experienced as a result of extreme weather events has been lower than expected. In addition, many management practice changes introduced in the 1990s have helped increase the resilience of distribution infrastructure to atmospheric events.

[72] CEA (2016), Adapting to Climate Change: State of Play and Recommendations for the Electricity Sector in Canada, p 34

These included changes to pole design, specifically shortening span length between two poles in order to mitigate wire damage due to ice storms (both for pole replacement and new development) and phase-out of polychlorinated biphenyls (PCB) to prevent transformer failures during lightning.

This resonates with CEA's argument that "the robustness of existing investment planning, including methods designed to ensure high levels of reliability, suggests that some climate adaptation considerations may already be finding their way into company decision-making through less formal processes". The Canadian Association of Electricity Utilities, concludes that "while these plans may not explicitly discuss climate change, they may help anticipate some of its impacts[73]."

However, it is difficult to assess the efficiency of these informal adaptation practices given the absence of data to track power outages and damages due to extreme weather, their associated costs as well as the absence of an adaptation standards and methodologies benchmark tailored to the province of Alberta.

Emerging resilience practices to address wildfires and flood hazards

Alberta's distribution utilities are relatively proactive in emergency response planning. They have been proactive in developing mutual aid agreements and improvements to their outage detection, response, and recovery activities. For example, most utilities have three day weather modeling forecasts to determine what crews are needed and to predispatch them in the case of weather events. A few distribution utilities are also installing automated system monitoring on their substations, feeders, and transformers — such as supervisory control and data acquisition (SCADA) devices and for some smart meters — in order to detect, map, and track outages in real time.

In addition, most distribution utilities have sound emergency plans in place along with customer education programs that detail what to do and what not to do in case of prolonged power outage. Many have dedicated web pages. There are also observable shifts to new standards, such as encouraging households to have a 72-hour emergency kit.

[73] CEA (2016), Adapting to Climate Change: State of Play and Recommendations for the Electricity Sector in Canada, p 35

However, it is not common practice for utilities to work in close collaboration with community emergency responders to coordinate and align education efforts. For example, there is no regular contact or coordination between municipality and the local utilities or development and implementation of joint training exercises.

On the prevention side, despite the absence of provincial requirements, most utilities have processes in place, or under development, to capture and record lessons learned from past emergency situations. As a result, they have strengthened some aspects of their infrastructure and assets management, such as:

- Stricter enforcement of tree trimming in urban areas (on properties and city land)
- Adoption of best asset management practices, such as stricter pole testing and replacement (with a ranking system to identify potential failed poles and replace them)
- Adoption of more stringent standards in order to harden infrastructure in areas impacted by extreme weather events (e.g. taller culvert around poles in order to protect wooden parts of the structure, concrete berms to protect assets located in flood areas etc.). The transmission standards have been refreshed recently to account for increased wind speed and include higher clearance and icing loads.

A few transmission and distribution utilities have recently started to include specific climate hazards in their asset planning. For instance, recognizing the growing wildfire risk, Altalink[74] and ATCO Electric Transmission[75] are in the process of integrating adaptation measures into their rate structures in order to mitigate the impact of wildfires. Both utilities identify climate change as a contributing factor to increased wildfire frequency and severity and explain that current Capital Replacement and Upgraded Capital Expenditures (CRU) programs do not account for these "heightened risks".

Their respective Wildfire Mitigation Plans estimate the cost of responding to increased wildfire activities and compare it to a course of inaction. They also include the cost of: development of wildfire assessment maps; enhancement of current wildfire mitigation practices, operations and maintenance programs; and implementation of additional practices or investments to reduce further the risk of transmission system operation caused by fire ignition.

AltaLink's Wildfire Management Plan forecasts an operational investment of $3.0M and capital investment of $35.0M over a test period of four years[76]. ATCO Electric Transmission wildfires management program forecasts expenditures of $9.9 million in 2020, $27.1 million in 2021, and $32.4 million in 2022[77]. These costs are to be integrated within a general tariff paid by ratepayers, subject to AUC approval[78].

However, these initiatives are not systematic or part of a preventive, standardized, and integrated resilience approach to asset planning and management (e.g. integration of climate projections, vulnerability assessment and mapping, and climate adaptation plan). For instance, only one interviewed utility mentioned they were incorporating windstorms and flood projections into their strategic plan or new constructions and capital replacement.

SIDEBAR 9

ENMAX

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. They will also be adding more modular electrical supply systems that allow specific neighbourhoods to be cut-off from electricity[79].

74 AltaLink, 2019, Appendix 22 AltaLink Wildfire Mitigation Plan 2019 - 2021 General Tariff Application, page . Retrieved from AUC Efiling system as part of the Proceeding 23848. Exhibit: 23848_X0169.

75 ATCO Electric Transmission 2020-2022 General Tariff Application TCM Project: Wildfire Mitigation and Grid Resiliency, Include in Exhibit 24964-X0143.01(CL)

76 AltaLink, 2019, Appendix 22 AltaLink Wildfire Mitigation Plan 2019 - 2021 General Tariff Application, page 5. Retrieved from AUC Efiling system as part of the Proceeding 23848. Exhibit: 23848_X0169.

77 ATCO Electric Transmission 2020-2022 General Tariff Application TCM Project: Wildfire Mitigation and Grid Resiliency, Include in Exhibit 24964-X0143.01(CL). p10

78 AUC deferred its decision for Altalink (AUC, Decision 23848-D01-2020)

79 Page 13, QUEST report

ALBERTAN COMMUNITIES' EMERGING PRACTICES AND CHALLENGES

The challenges of developing and implementing climate adaptation plans

There are currently no climate adaptation regulatory requirements for municipalities. The Emergency Management Act only mandates that communities complete annual emergency response exercises, and climate change hazards are not explicitly considered. Despite limited regulations in this area, Alberta municipalities are becoming increasingly concerned by the impacts of more frequent extreme weather events on their energy systems and capacity to maintain essential service during prolonged power outages. This has been demonstrated by four out the seven Albertan communities QUEST has worked with who now have Climate Change Adaptation Plans (see Appendix 1).

As a result, municipal action on climate adaptation is uneven: it is completed on a voluntary basis, reflecting local leadership on climate change response as well as the capacity to access financial and human resources to conduct this work. Communities identified a series of barriers that prevent them from developing and/or implementing climate adaptation measures and advanced energy resilience.

The first of these barriers is that climate change is perceived as a sensitive or polarizing topic. As a result, public communication on the impacts of climate change is not a municipal priority and public awareness is typically low. The majority of municipalities working on climate adaptation and energy resilience prefer to communicate their energy resilience work through the lens of emergency response management (e.g. threats to public safety and infrastructure).

Second, municipalities lack adequate financing and human resources. There are limited resources for proactive risk reduction measures and municipalities which invest in these types of measures, rely on their limited municipal budget. Available provincial and federal funding sources are unstable and uncertain, and focus mainly on post-recovery projects, emergency response and rebuild efforts, rather than on adaptation and prevention. For instance, a municipality received $2 million to invest in flood berms only after being hit by a significant flood. Representatives from that community explained that they would not have been able to access this funding as part of a preventive measure. Similarly, all participants expressed interest in renewable energy (with six already having installations). However, the capital cost of installing these technologies was identified as a barrier to implementation. This was especially true in communities where climate change is a contentious topic. External grants/cost sharing and a reasonable payback period on energy investments are important to address this challenge.

The lack of adequate financial resources also results in a lack of human capacity. QUEST's Resilience workshop participants noted that municipal staff can "wear many hats". As a result, it is challenging for them to apply to grants and access federal and provincial funding. The lack of internal capacity also explains the absence of dedicated staff to work on climate adaptation and resilience in general, and energy resilience in particular.

Community strengths and areas of improvement to advance energy resilience

The work QUEST conducted with seven small and mid-size Albertan communities[80] provides some insights on the emerging practices and areas of improvement regarding community energy resilience. In terms of good practices, basic planning practices and emergency planning responses are already in place in many communities, and can be adapted to include a focus on energy resilience. For example, half of participating communities have strong capacity and procedures in place to respond to emergencies and disasters and are actively enforcing tree trimming to prevent damage to power lines (directly or through their utility) and are in the process of installing backpower generators on essential facilities (see Sidebar 10). Further, four municipalities also have Climate Change Adaptation Plans and distributed energy resource (DER) initiatives, and all participating communities have completed mapping to a 1:100 yr level, which informs land use decision-making and placement of energy infrastructure.

[80] It is relevant to note that the municipalities that worked with QUEST may be more advanced in local capacity and planning, so this insight may not be representative of the entire province.

In addition, communities are increasingly interested in DER initiatives. In six communities, there were distributed solar PV installations on municipal facilities, or on residential or commercial buildings. In addition to solar development, five municipalities expressed interest, or have installed, combined heat and power (CHP) and two are considering electric vehicles for their fleet. The Town of Raymond achieved net-zero emissions status as a result of solar generation (see Sidebar 11). The community is now looking to electrify its municipal fleet.

SIDEBAR 10

BACKUP GENERATORS ON ESSENTIAL MUNICIPAL FACILITIES

All seven municipalities participating in QUEST's resilience workshops have at least one backup power generator (diesel or natural gas). This generator is either portable or can be installed permanently on critical infrastructure. All municipalities have backup power, or are in the process of installing backup power on Emergency Operations Centres and municipal administrative buildings. Four out of the seven communities have backup power, or are in the process of installing backup power on their water infrastructure (e.g. treatment plants, lift stations).

Backup generators, especially for key facilities such as emergency shelters and health care facilities are also crucial. However, five municipalities did not know whether these facilities were equipped with backup generators or have the capacity for backup power.

SIDEBAR 11

THE TOWN OF RAYMOND - A SOLAR NET ZERO COMMUNITY[81]

The Town of Raymond is a leader in distributed renewable energy. To save on power costs, increase self-sufficiency, and reduce GHG emissions, the Town installed an extensive solar PV system. Panels were placed on municipal facilities such as the town administrative building, aquatic centre and ice arena, fire hall, and water treatment plant. The municipality received funding from the Municipal Climate Change Action Centre (MCCAC) to conduct these projects. The Town has hosted dozens of site tours, presented at conferences, and given interviews to organizations around the world since the system went live. Raymond is now considering additional steps to implement electrification that will benefit the community and municipal operations into the future.

Receiving Recognition[82]: On September 14, 2020 FCM announced that Raymond had been selected as a winner of one of its 2020 Sustainable Community Awards. Raymond received recognition in the Energy category for its solar project which made the Town the first Canadian municipality to become Net-Zero in electricity.

Photo credit: Greg Robinson (2019)

[81] The Town of Raymond (2019), Solar Energy, Retrieved on September 17, 2020. 2020: http://raymond.ca/business-investment-attraction/#solar-energy

[82] The Town of Raymond (2020), Town of Raymond Receives 2020 Sustainable Community Award from FCM. Retrieved on September 17, 2020. http://raymond.ca/town-of-raymond-earns-energy-award-from-fcm/

While they have many strengths, Albertan communities can improve their energy resilience by better integrating energy planning into existing planning practices. Only two municipalities had plans specifically related to energy (a Solar Net Zero Plan and a Climate Adaptation Plan focused on GHG mitigation) and none of the communities had a holistic Community Energy Plan or formal process to include energy planning and resilience in municipal plans and land use planning decisions.

In addition, these Albertan communities also lack public communication and coordination initiatives with key stakeholder groups to align planning practices and share information on energy resilience.

- At the *utility* level: Most municipalities were in contact with their utility only on an annual basis and a few were unclear about how often they communicate with their utility. Only one municipality reported to be in contact with their utility on a regular basis. All communities emphasized that more needs to be done to strengthen partnerships and increase information sharing with utilities.
- At the *community* level, there is a lack of coordination with key stakeholder groups. For example, in regards to backup generators, many municipalities did not know whether or not emergency shelters and health care facilities were equipped with backup generators or the capacity to have backup power. On the emergency side, municipalities are aware that better public communication on climate hazards, emergency preparedness and what to do during an outage is needed. Inviting local stakeholders to exercises and increasing their involvement was also identified by four municipalities as a way to reduce risk and improve community resilience.
- Internally, municipal staff often operate in "silos" and are not always aware of initiatives related to climate change and energy resilience. Increasing governance mechanisms for cross-departmental collaboration and opportunities for internal knowledge sharing are essential.

Finally, the majority of participating municipalities did not have a plan for contacting and supporting vulnerable populations (homeless, low income, seniors, etc.), during an emergency, although three had considered this in their Emergency Management Plan. Given the projected increase in heatwaves in Alberta, specific procedures are needed for vulnerable people, as they may need to be transported to cooling centres or require attention to ensure they keep hydrated.

Table 7 summarizes participating municipalities' key vulnerabilities and strengths in relations to climate change.

Table 7 – Key climate vulnerabilities and strengths for participating municipalities

Category	Climate Vulnerabilities	Strengths
Planning & Emergency Management	Few communities had Resilience, Local Energy, Climate Change Adaptation Plan, or Asset Management Plan. More funding is needed to integrate climate considerations more directly into municipal plans. Proactive risk reduction planning is required but limited resources serve as a barrier. While some communities had a plan to reach and communicate with vulnerable populations, many did not. Extreme weather events will disproportionately impact vulnerable peoples, so they must be considered.	Emergency Response Plans are in place. Fire Prevention and Evacuation Plans, or applicable bylaws to maintain buffer zones, are generally in place. Some municipal plans consider climate risk. Participants expressed increasing recognition that municipalities need to consider climate change and resilience in their planning.

Coordination & Communication	Communities need to increase public understanding of climate risks, projected trends, and how residents may be impacted. Work in this area has been relatively limited. Emergency response exercises are conducted, but participants explained the importance of expanding attendance to include utilities and other local stakeholders. Meetings between municipalities and utilities may be infrequent or regular). Regardless, work should be done to strengthen these relationships and facilitate information sharing. While Emergency Operations Centres and communications infrastructure tends to be in place, backup power is not always present. Some communities are unsure if their utility knows priority areas for restoration.	Communication Plans are in place. Most elected officials and municipal staff know their roles and responsibilities during an emergency. Most communities had local alliances in place, particularly for fire and emergency response. These relationships can always be strengthened. Municipalities have efforts to communicate to the public. Most participants did outreach related to 72 hour preparedness.
Land Use & Asset Management	Communities need to ensure Plans and land use decisions consider current and future flood risk to ensure key energy infrastructure is outside the floodplain. Invest in structural measures to protect critical infrastructure. Expanding natural flood retention measures and green infrastructure would be a low-carbon way of reducing flood risk. Disaster risk assessment does not appear to be applied consistently when making planning decisions.	Most communities have completed mapping to a 1:100 yr level which informs land use decision-making. Development and placement of critical power infrastructure is generally outside the floodplain. Some municipalities have backup power for lift stations, water towers, and treatment plants. Backup power includes solar arrays as well as permanent and portable generators.
Energy Infrastructure	FireSmart principles and buffer zones are not always in place to reduce threats to power lines. Prolonged outage exercises should be completed, ideally with the utility and local stakeholders. A limited number of power lines are above ground. Transformers/substations and transmission/distribution lines are sometimes near water bodies or on the floodplain. Not all communities have provisions to keep service stations open during extreme events or prolonged outages. More cooling centres are needed (due to rising temperatures and increased heat waves), particularly those for vulnerable populations. Most municipalities do not have a monitoring system to track energy use in facilities.	All communities (or their utilities) undertake tree trimming to prevent trees falling on powerlines. Flood risk is generally assessed when making planning decisions and installing infrastructure. Utilities have maps of their infrastructure and real time tools to monitor and detect issues. Some municipalities have solar PV installations and are interested in CHP and electric vehicles. Most communities are equipped with training and PPE to respond to oil and gas explosions and spills/contamination.

Energy Supply	Municipalities require an inventory of where backup power is installed and/or possible at key infrastructure and facilities (schools, health centres, etc.). Not all municipalities have distributed energy systems or renewable energy sources. Cooling facilities will need backup power to reduce the risk of prolonged outages.	Most municipalities have at least one backup generator in the community. Some municipalities are developing renewable energy (mainly solar, although there is some interest in CHP) to reduce reliance on the main electricity grid. Battery storage systems are also being investigated.

RECOMMENDATIONS AND NEXT STEPS

FOR THE GOVERNMENT OF ALBERTA

▶ Recommendation #1: Put in place a sound, comprehensive and publicly available database tracking the impact of extreme weather events on transmission and distribution infrastructure

It is not possible to capture the cost of extreme weather events over time on the province's energy infrastructure due to the absence of data. Some data exist through AUC proceedings and decisions, but they require significant resources to retrieve and are difficult to compile and analyze. Without readily available, accessible and granular data identifying the actual cost of past and present extreme weather events on the province's natural gas and electricity infrastructure and on communities' activities, it is difficult to conduct cost-benefit analysis and to make sound investment and planning decisions on preventive adaptation and resilience measures, including hardening investments, changes in asset management and power outages mitigation.

A sound, comprehensive and publicly available database on the impact of extreme weather events on transmission and distribution infrastructure is needed. It is recommended that this database:

- Track and report on the frequency and duration of power outages caused by extreme weather events
- Track and report on the replacement and repair costs of energy infrastructure resulting from extreme weather events
- Track and report utilities' lost revenue due to damaged energy infrastructure

A historical database could also be developed by retrieving information and data from past AUC proceedings.

▶ Recommendation #2. Improve the quality and granularity of provincial climate hazards maps

In Alberta, the availability of climate data and maps of current and projected climate hazards are uneven.

Available data include:

- Climate projection through a federal government portal that enables communities to access, visualize, and analyze climate data, and provides related information and tools to support adaptation planning and decision-making[83]
- Alberta Wildfire has recently produced wildfire maps for Forest Protection Areas only. Alberta Wildfire is currenting developing risk management plans and performing risk assessments for their jurisdiction of the Forest Protection Area in Alberta.

Missing or incomplete data include:

- Wildfire maps outside of Forest Protection Areas. The responsibility for areas outside the Forest Protection Area falls under municipal governments[84]. Yet, a large portion of distribution and transmission assets are not located within the Forest Protection Area. For instance, Altalink estimates that approximately 85% of its assets do not fall within the Forest Protection Area; however, due to a lack of resources many municipalities don't have the capacity to produce a wildfire risk map.
- Windstorm maps and other atmospheric events maps
- Flood hazard maps, flood inundation maps, flood likelihood maps and flood range maps are available through Alberta Environment and Parks's website[85].

[83] See: https://climatedata.ca ClimateData.ca provides high-resolution climate data to help decision makers build a more resilient Canada
[84] Alberta Wildfire https://wildfire.alberta.ca/compliance-and-enforcement/default.aspx
[85] Alberta Environment and Parks, https://www.alberta.ca/final-flood-maps.aspx

They include 1:100 flood events, although not for the entire province. These maps are currently being updated to include recent flood events and cover a larger portion of the province[86].

The government of Alberta should continue its efforts to develop climate hazard maps across the province for atmospheric hazards, floods and wildfires for 1:100 and 1:200 year events. The robustness of vulnerability assessment mapping depends on the quality and granularity of these data.

▶ Recommendation #3: Require energy utilities to adopt and implement climate adaptation plans and provide adequate support by developing a Provincial Energy Resilience guideline

According to CEA, utilities should establish real and credible objectives and/or targets to adapt and be more resilient to the impacts of climate change. CEA has already established an aspirational objective to have its members develop adaptation plans by the end of 2020 and encourages them to take this commitment seriously and make progress on this objective[87]. Yet, progress to date in Alberta has been slow.

Energy utilities are not required by the province to account for climate projections, conduct vulnerability assessments for climate hazards or to develop climate adaptation measures in their asset planning and management practices. When they do so, there are no streamlined standards and methodology on how to proceed.

A key challenge in developing and implementing climate adaptation measures is understanding the appropriate regional system design requirements and methods. As CEA explains, "overbuilding leads to charges of the utility investing in 'goldplate' systems simply to maximize its capital expenditures; underbuilding leaves society as a whole vulnerable to severe weather and climate variability. Finding the right balance will require the completion of climate modelling and system vulnerability analyses[88]".

[86] Alberta Environment and Parks, https://www.alberta.ca/draft-flood-maps.aspx, Retrieved on Oct 30, 2020

[87] CEA (2019) 2019 sustainable electricity annual report: Resilient Assets and Sustainable Outcomes, p 13. Retrieved from: https://electricity.ca/library/26530/

[88] CEA (2015) Electric Utility Innovation: Toward Vision 2050, p18: https://electricity.ca/library/electric-utility-innovation-toward-vision-2050/

A provincial resilience energy guidebook tailored to Alberta's climate, geographical and energy context and targeted at transmission and distribution utilities needs to be developed. The purpose of the resilience guidebook is to streamline the integration of climate projection, vulnerability assessments to climate hazards and standards or measures for climate adaptation plans.

The development of this guidebook can be informed by:

- Sharing best practices in climate adaptation, including models and methods in the province and outside the province. Appendix 3 presents high level strategies and actions identified by the Canada Electricity Association).
- Engineers Canada's Public Infrastructure Engineering Vulnerability Committee Protocol (PIEVC Protocol). The PIEVC Protocol was first developed in 2008 and has been applied to risk assessments for almost 40 infrastructure systems in Canada, including several electricity projects.

Once this guidebook is published, utilities should be required to develop and implement climate plans following the standards and methods set in the guidebook. Considering the challenges that small utilities may face, especially REAs and natural gas co-ops, it is important that the province considers providing them with specific support and resources to develop and implement their climate adaptation plans.

The Alberta Electricity System Operator (AESO) should also be required to Incorporate climate scenarios into load forecasts and long-term outlook reports.

▶ Recommendation #4: Provide local governments with adequate resources and support and require them to develop and implement a climate adaptation plan

There are currently no provincial requirements for local governments to develop and implement climate adaptation. However, climate hazards pose significant health and safety risks to Albertans, and result in high recovery costs. Communities recognize this through first hand experience with events like local flooding and hail storms.

The province should require each municipality to implement a climate adaptation plan that includes energy resilience as a key component.

These plans should include (at a minimum):

- A climate vulnerability assessment to identify climate hazards of greatest concern, exposed areas, and impacts on people, infrastructure, municipal services and the environment
- Community engagement with stakeholders and the public to both educate on climate hazards and the impact of climate change as well as to identify and prioritize actions
- Tangible ways to take action on the resilience improvement items
- An internal process to track and monitor progress over years, as well as to document successes and challenges that are being experienced in order to communicate achievements and identify solutions to overcome gaps and challenges
- References to existing municipal plans (and amendments to those plans to include reference to the climate adaptation plan) to ensure climate hazards are considered throughout municipal operations. For example, the climate risks identified in the Climate Change Adaptation Plan can be referenced and addressed in the Municipal Development Plan and other land use planning documents, Asset Management Plans, Emergency Management Response Plans, Community Energy Plan, etc.

Given existing financial and capacity barriers Albertan municipalities are facing, it is important that the province provides them with adequate funding and programs to support the development and implementation of their climate adaptation plans.

The province can support municipalities through:

- Stable, predictable and significant funding for proactive climate adaptation and resilience initiatives. Currently, most funding is available for recovery/rebuild efforts after an extreme event. These funding and programs should cover:
    - Capital investment in preventive actions (e.g. construction of berms)
    - Operational funding to enhance existing practices (climate vulnerability assessment, cost to access software, etc.) or harden/adapt existing infrastructure (e.g. back-up generators)
    - Hiring a dedicated staff person to oversee the development, implementation and monitoring of the climate adaptation plan as well as stakeholder and community engagement. Municipal staff 'wear many hats' and may not have capacity to develop a plan due to already heavy workloads.
- A tailored guideline with clear instructions, guidance, and examples of what a climate adaptation plan should look like, including methodologies and standards, governance structure and processes and steps needed to develop one. Energy resilience should be included in this guidebook.
- Creating opportunities for mentorship between communities that already have a climate adaptation plan and those in earlier stages. Creating space for knowledge sharing between communities may lead to efficiencies via cost and risk sharing.

AT THE AUC LEVEL

▶ Recommendation #5: AUC should incorporate climate projection and climate adaptation into its regulatory assessment, for instance by requiring project proponents to include climate vulnerability assessment in proposed projects when applying for permitting

The AUC's mandate is to focus on the lowest cost approach when setting rates. Additional costs related to infrastructure hardening or climate adaptation will be taken into consideration on a case-by-case basis only if the proponent can convince AUC that this investment saves money over the life cycle of the asset, through a business case or a cost-benefit analysis. As a result, the existing rate setting process seems to encourage a post-disaster recovery approach rather than a pro-active one.

As climate data become more widely available, and operation and maintenance costs due to extreme weather events are likely to increase, the AUC should incorporate climate projection and climate adaptation into its regulatory activities.

For example, the AUC could:

- Set electricity rates that allow for the recovery of costs related to adaptability and resilience needs when these costs are well supported and motivated by utilities

- Review electricity system standards and revise as necessary to account for climate projections (e.g. adoption of dynamic thermal line rating system)
- Authorize some grid-hardening solutions to be tested on a small scale before being rolled out across a full service territory
- Change existing processes to collect and track data related to the cost of extreme weather events, including power outages, cost of material damages, etc.

AT THE COMMUNITY LEVEL

▶ Recommendation #6: Develop and implement Community Energy Plans (CEP) in close collaboration with utilities

A Community Energy Plan (CEP) is an important tool to guide community priorities around energy. A CEP takes an integrated approach to energy planning by aligning energy, infrastructure, building and site planning, land use and transportation planning. A CEP is therefore an essential first step and a valuable tool to reduce GHG emissions and build net zero communities that contribute to both provincial and federal climate targets. Through a CEP, a municipality can influence energy systems in a way that achieves economic, environmental, health and community resilience objectives. Energy is central to all aspects of life (heating our homes, driving to work, treating our water), and as such a CEP can assist municipalities in making land use decisions and infrastructure investments with energy in mind. Most municipalities have master plans focused on water or transportation; developing a plan focused on energy is emerging as another critical plan in many communities.

Participants explained that energy plans are also useful to secure funding from Council or provincial and federal funding because it shows that resources are being put into initiatives that are well-thought out and have Council's support. In addition, sustainability and climate change are now key considerations in many federal applications and a CEP demonstrates a municipality's commitment to these sustainability and climate goals.

A CEP can help address the gaps we have identified around energy resilient communities, including sound back-up generation and alternative energy sources to mitigate the impact of prolonged power outages; reduced risk to power and oil and gas infrastructure; and, enhanced communication, coordination and alignment among municipal departments and with external partners, including energy utilities.

Communities should consider the following in the development of their CEP:

- Collaboration and coordination: A strong CEP should include feedback and perspectives from a wide array of internal and external stakeholders. Communities developing a CEP should engage their energy utilities, local organizations, residents, developers, and other local stakeholders, as well as internal municipal departments like emergency management, finances, communication, public works, etc.
- Distributed energy: Discussions with energy utilities will be important in determining the types of projects that are feasible in the community, particularly around grid stability.
- Backup power:
    - Fossil fuel generators or renewable power and storage systems can reduce municipal risk of prolonged outages. Power for essential services like healthcare, water treatment, and emergency management office is critical.
    - Most participants were not aware of all facilities with backup power or the capability for backup power. Municipalities can develop an inventory of the existence of backup power for key services/infrastructure (including grocery stores, schools, service stations, etc.).
    - Coordination with utilities will ensure that investment in backup generators is not redundant (i.e. spend capital elsewhere if there is an agreement for the utility to provide backup generators).

The concept of Smart Energy Communities (SEC) can assist how a municipality thinks about and develops a CEP. SECs seamlessly integrate local, renewable, and conventional energy sources to affordably, cleanly, and efficiently meet their energy needs. SECs 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.

Building on technical and policy principles specific to SECs, QUEST has developed a range of recognized and participatory workshops and tailored advisory services to help communities develop robust and comprehensive CEPs that engage internal and external stakeholders, and consider the technological, the communication and the governance dimensions. These services include:

- Energy Mapping Workshops
- CEP Preparation Services
- CEP Implementation Services

▶ Recommendation #7: Evaluate and undertake climate change adaptation strategies that are appropriate for the community and may result in increased support for action in the area

Participants emphasized the importance of getting "buy-in" from residents and elected officials to advance climate adaptation. The costs related to adaptation measures and the low engagement on climate change were viewed as significant barriers. Communication and engagement plans are therefore key to communicating the benefits of adaptation in a way that is meaningful to community members.

Such strategies may include:

- Building a business case:
    - Participants explained that having a CEP or Climate Adaptation Plan will be increasingly important when they apply for funding. More and more funding applications include climate and sustainability requirements. Having these plans in place can make applications more competitive and may save time when applying because the municipality's climate change plans are already documented.
    - A CEP and/or Climate Adaptation Plans are also useful within municipal operations. Staff can use these plans to support their budget requests to Council and to justify decision-making to residents.
    - All participants emphasized the critical importance of articulating an initiative's return on investment or resulting cost savings. Municipalities operate on a limited budget so there are always competing priorities for funding. This point is particularly important in communities where the level of climate change awareness is low and/or Council does not view climate adaptation as a priority.
    - The Municipal Climate Change Action Centre has a variety of programs to make distributed energy, energy efficiency and climate adaptation initiatives more economical[89]
- Adopting a regional approach: Regional coordination among municipalities can generate economies of scale and synergies. For example, municipalities can share the cost of energy investments through aggregated purchases (i.e. backup generators), common studies (i.e. climate hazards mapping) or joint-initiatives (i.e. community energy projects).

UTILITIES AND COMMUNITIES

▶ Recommendation #8: Facilitate better communication and alignment/coordination on energy resilience and energy planning between local government and energy utilities

Communication and coordination between stakeholders is a critical component of resilience. Municipal participants recognized the value of QUEST's in-person and online resilience activities to bring together municipal staff from different departments and energy utilities, share respective perspectives and learn from each other. A key finding of our work on the ground is that communication between municipalities and energy utilities needs to be strengthened across Alberta.

There are several ways to increase collaboration and cooperation between local governments and energy utilities:

- Participation in a CEP Committee and/or in a Climate Change Adaptation Committee
    - Providing a structured space for municipal staff from different departments, energy utilities and other key stakeholders to share knowledge, identify shared solutions and actions, and align their respective asset planning, management and other practices is more fruitful than the occasional email or phone call.

[89] Municipal Climate Change Action Centre, 2020, Funding Programs, Retrieved on November 9, 2020 https://mccac.ca/programs/

- Committees create synergies and resource efficiencies. For example, if the municipality and the energy utility can share data about energy consumption, flood or wildfire maps, hosting capacity for DERs, and public education on emergency response, there is no need to complete an additional energy audit and there is better alignment between vulnerability assessment and investment and action to enhance energy resilience.

- On-going coordination, and collaboration and support on:
    - Exercises/drills: Participants said that it is critically important to invite all local stakeholders to emergency drills and that they are looking for more opportunities to bring people together. These community-wide exercises provide an opportunity to practice various roles and responsibilities during emergency response, but also serves as a space to share knowledge between utilities, municipalities, and other stakeholders. Participating in annual emergency response drills can strengthen these relationships and implement best practices across entities.
    - Insights to technical and policy challenges for DERs: Early and ongoing communication between the municipality and utility on DER projects facilitate their implementation as requirements are identified early on. For example, a utility may require an installation to be below a certain threshold or for an additional connection point to be installed to accommodate a project. Providing hosting capacity for DERs is also helpful for municipalities. For instance, Fortis released a publicly available interactive map that illustrates hosting capacity for FortisAlberta's distribution circuits[90]. This tool can facilitate the development of a CEP or assist in siting a project. These types of interactive tools are an effective way for a municipality and utility to coordinate.

CONCLUSION

Alberta's energy infrastructure is highly exposed to wildfires, floods, and atmospheric hazards and the impact of climate change is placing increasing pressure on these infrastructure.

Despite the sensitivity around climate conversations, the awareness of the need to adapt to climate change and advance community energy resilience is increasing among communities and energy utilities in the province. While there are a lack of provincial requirements, many communities and distribution and transmission utilities are starting to consider the impacts of climate change and are adapting their planning and asset management practices to better address climate hazards. Yet, there are no clear standards, methodologies and guidelines at the provincial level to support this work.

This report also highlights the need for better coordination, alignment, and integration on emergency plans and climate adaptation strategies among the various stakeholders involved in community energy resilience, from municipal staff to energy utilities. More specifically, improved collaboration between energy utilities and municipalities are needed to build energy resilient communities.

Finally, the report points to the gap between the willingness of Albertan communities to act on energy resilience and climate adaptation and the capacity or resources they have to do so. Given the high upfront capital costs of a preventive approach, the lack of access to adequate financial resources to implement proactive risk reduction measures is a key barrier for Albertan municipalities to implement adaptation measures. In addition, small Albertan communities lack human resources and do not have dedicated staff to efficiently work on energy resilience.

The work QUEST conducted with seven Albertan communities was instrumental in fostering collaboration among community stakeholders and providing sound expertise to municipalities. By the end of the project most participating municipalities started to incorporate low-hanging fruit objectives to improve existing municipal plans and/or inform their adaptation strategy.

[90] FortisAlberta, 2019, Hosting Capacity Map, Retrieved on November 9, 2020 https://www.fortisalberta.com/customer-service/get-connected/generation/hosting-capacity-map

The lessons learned suggest the need to:

- **Gather more local data and conduct additional studies to inform policy**. So far, the information required to assess the direct and indirect cost of damaged energy infrastructure and power outages on communities due to extreme weather events are difficult to measure and quantify due to the lack of available data. This report is a first piece to this undertaking and aims to encourage more research assessing the cost of climate inaction as well as the benefits of climate adaptation and preventive measures on the province's energy system.
- **Continue developing and refining specific methodology and tools focused on local energy systems**.For this initiative, QUEST developed an innovative methodology focused on energy resilience and energy infrastructure tailored to the Alberta context. Working with various municipalities and utilities, QUEST's tools proved efficient in informing energy resilience planning and strategy by engaging utilities and making recommendations to strengthen energy supply and infrastructure. It also highlighted a series of potential avenues for future projects and programs that intend to increase energy resilience.
- **Integrate mitigation and adaptation through a Smart Energy Community approach**. Developing and adopting a CEP and conducting community energy mapping were a key recommendation selected by participating municipalities. A CEP is recognized across Canada as an effective pathway to Smart Energy Communities. It provides a platform for multiple stakeholder groups to convene, coordinate, and implement innovative community energy projects and programs, resulting in more energy efficient, resilient and vibrant communities. In the context of the quick uptake of distributed energy resources and new energy technologies, CEP offers new opportunities to rethink local energy systems in relation to the main grid, and to enhance energy resilience.
- **Provide more provincial and federal programs to support communities.** Financial resources as well as capacity-building supports are needed for municipalities to take action on climate adaptation and energy resilience. In conjunction with large adaptative capital funding, capacity building projects enable municipalities to access and retain sound expertise, identify and prioritize actions and measures, and adopt new planning and governance practices. The Climate Adaptation Program[91] is a first step to address this gap and funding should continue to be provided to advance community energy resilience.

QUEST has appreciated working with all participating municipalities, local stakeholders, and energy utilities. The QUEST team would like to thank each of the workshop participants for their time and valuable insights.

91 Municipal Climate Change Action Centre, 2020, Funding Programs, Retrieved on November 27, 2020 https://mccac.ca/programs/climate-adaptation-program

APPENDIXES

APPENDIX 1: QUEST RESILIENCE WORK WITH SEVEN ALBERTA COMMUNITIES

Project Purpose

The impacts of climate change are a reality for all communities throughout the province. Increasing frequency and severity of extreme weather events, including atmospheric and hydrological events, pose significant risk to municipal infrastructure, energy distribution systems, public health and safety, the continuity of essential services and the local economy. Studies show that preventive adaptation measures are often less costly than post-disaster recovery. This project undertakes a local, community focused approach that enables municipalities to better understand the climate risks they are exposed to, as well as assess their resilience strengths and vulnerabilities. This project also identified tailored measures municipalities can put in place to increase their resilience. Having the right tools and information allows for more informed decisions regarding resilience.

Project Description and Deliverables

Part 1: Understanding where we are at: Climate Risk and Vulnerability Assessment

The process began with the collection and analysis of climate data and projections and community specific baseline information. These preliminary findings fed into an interactive community workshop engaging key stakeholder groups (municipal staff, elected officials, representatives from Emergency Management Organizations (EMOs), provincial organizations, local businesses, and energy utilities). The workshop consisted of table-top discussions and mapping exercises that tap into participants' knowledge and experience, resulting in the identification of key hazards, risks and vulnerabilities, resilience opportunities and strengths. QUEST then prepared a Climate Risk and Resilience Assessment Report for the community, including local climate trends and projections, as well as a thorough analysis of risk and resilience to various climate hazards.

Part 1: Climate Risk and Resilience Assessment

STEP 01
Baseline Surveys
Municipal leads and utility contacts receive a baseline survey (Community Baseline or Utility Baseline). Surveys are completed internally to understand the current state of resilience/climate impact preparedness within the community.

STEP 02
Desktop Research
QUEST creates a profile of community demographics and climate risks based off of Statistics Canada, Climate Data Canada and the Climate Atlas of Canada. Community provides flood mapping data.

STEP 03
Engagement Survey
Municipal leads distribute the survey to internal staff and utility contacts. Questions focus on understanding the individual's perception of the community's resilience. Local assets and vulnerabilities are identified through "10 Essentials" and "Local Resilience" exercises.

STEP 04
Workshop 1
Municipal staff and utility contacts participate in a joint workshop. QUEST presents information gathered through desktop research and surveys, and attendees provide feedback and supplemental information. Action Planning Exercises completed.

STEP 05
Climate Risk and Resilience Assessment Report
QUEST prepares a draft Assessment Report based on all of the information collected. Draft is sent to the municipality to get feedback before it is finalized.

Part 2: Understanding our options: Recommendations/Solution-Oriented Planning

Building on the findings of Phase 1, a second interactive and participatory workshop was held with the same stakeholder group. Workshop participants selected place-specific recommendations to address identified weaknesses based on the type of climate hazards in the community. They prioritized them, and assigned them a cost, a timeline, and a department lead. The community then received a Resilience Recommendation Report, which organized recommendations by the lead department responsible for implementing them, and has a tracking table for each recommendation.

Part 2: Recommendations:

STEP 01

Recommendations Worksheet

Based on findings from the Climate Risk and Resilience Assessment Report, QUEST identifies potential recommendations to improve resilience. The worksheet is sent to municipal staff and utility contacts prior to Workshop 2.

STEP 02

Workshop 2

Municipal staff and utility contacts participate in a joint workshop to discuss the recommendations and action plan. Timeline, priority, budget, and leads for the action items are identified.

STEP 03

Resilience Recommendations Report

QUEST prepares a draft Recommendations Report based on the information collected. The draft is sent to the municipality to get feedback before it is finalized.

Value to the Community

This project has enabled the community to gain a better understanding of their strengths and vulnerabilities as it relates to climate resilience and prolonged energy outages, as well as to identify measures to become a more resilient community. There were two key benefits to the community:

1. **An opportunity for increased collaboration across municipal departments and stakeholder groups.** Workshops were designed to be inclusive and engage key stakeholders throughout the community. This led to a collaborative approach to climate adaptation, with workshop participants being able to break down both internal and external siloes by engaging in more cross-departmental communication. Roles and responsibilities related to climate adaptation and risk management are often divided up over different departments and there is little mechanism for cohesion and integration. This project acted as a first step toward building more inter-department collaborations on climate adaptation. It also initiated more open communication between utilities and municipal staff as it related to: public education, emergency preparedness, mitigating risk to municipal services, disaster response and recovery (management).
2. **A holistic understanding of community resilience, strengths and opportunities based on an integrated, systemic framework.** The project's process enabled the community to identify key documents and governance processes to leverage. The community then identified and planned actions to advance climate adaptation and resilience, such as supporting cases for council approvals (e.g. flood zone bylaws, official plan review), applying for funding for adaptation measures such as flood risk reduction, launching community training and education initiatives, collaborating with their utility on resilience measures, informing the development and/or update of Climate Adaptation Plans and Emergency Management Plans, or deciding on governance structures.

APPENDIX 2: OUTAGES REPORTING INDEX IN ALBERTA ON DISTRIBUTION SYSTEM

Like in many other provinces, the Alberta regulator requires regulated distribution utilities to report on two indexes, as per AUC Rule 002[92] *Service Quality and Reliability Performance Monitoring and Reporting for Owners of Electric Distribution Systems and for Gas Distributors.*

- **The System Average Interruption Frequency Index (SAIFI)**, with and without major events included. This measure pertains to distribution-related interruptions and represents the average number of times that a customer experiences an interruption; and
- **The System Average Interruption Duration Index (SAIDI)** to measure electric distribution system performance and reliability, with and without major events included. This measure also pertains to distribution-related interruptions and represents the amount of time in total the average customer experiences interruptions throughout the year.

The formula is set by AUC. Given the diversity of service areas, AUC has developed a specific standard for each distribution utility, as presented in Table 1. These standards are calculated by considering a five-year average, and include standard deviation.

In the case of natural gas, 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. The AUC does not require reporting on unplanned gas outage. This may reflect that there are minimal reliability issues on Alberta's natural gas distribution system.

92 Retrieved from: http://www.auc.ab.ca/Shared%20Documents/rules/Rule002.pdf

APPENDIX 3 : ADAPTATION STRATEGY FOR ENERGY UTILITIES

Different adaptation strategies can be distinguished for electricity and natural gas utilities. They are presented in the Table below.

The five streams of climate adaptation for utilities[93]

Adaptation stream	Outcomes
Infrastructure solutions	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: 1) Hardening, that is improving the robustness of infrastructure and improving distribution system design standards; 2) Building redundancy into the distribution system; and 3) Expanding microgrids and identifying opportunities for distributed energy resources.
Operational solutions	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 and right-of-way management.
Communications and engagement 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.
Organizational solutions	Actions that improve information sharing during extreme weather events with customers, the public and key stakeholders.

93 Adapted from Page 15, Lazlo, R. and Marchionda S, 2015, Resilient Pipes and Wires, QUEST, June 15 2015, https://questcanada.org/project/resilient-pipes-and-wires/

The table below presents opportunities for distribution and transmission utilities to increase grid resilience in the context of climate change.

Opportunities to increase grid resilience in a context of climate change[94]

Focus area	Outcomes
Demand Response	Reduces pressure on the system during times of peak demand and can provide short-term cover for emergency downtime or unscheduled loss of supply at traditional power plants (through frequency regulation for instance).
Distributed Generation	Distributed generation can increase or undermine grid reliability and resiliency, depending on how it is managed. Establishing dispatch controls and "anti-islanding" protection schemes can help increasing grid reliability and resiliency[95].
Electric vehicle	Over the longer term, vehicle-to-grid and vehicle-to-home applications could contribute positively to grid resiliency.
Optimization of Asset Uses	Big data and grid modernization tools such as sensors, integrated distribution communications systems, advanced analytics software and new diagnostic tests allow for increasingly targeted operations and asset management programs, helping utilities maximize asset performance, proactively maintain equipment and optimize replacement strategies. Maintaining asset health is critical to ensuring Canada's electricity grid continues to operate to a high standard of reliability. Asset optimization will prepare utilities to face extreme weather events.
Fault detection and mitigation	Fault detection such as supervisory control and data acquisition (SCADA) and other energy management systems speed recovery. Developing full fault location with isolation and restoration capabilities require tying together numerous utility systems —outage management, advanced metering, distribution management, geographical information—and hardening the system so it can withstand more severe weather events.

94 Adapted from CEA, 2015, Electric Utility Innovation: Toward Vision 2050. Retrieved from: https://electricity.ca/library/electric-utility-innovation-toward-vision-2050/
95 If distributed generation continues to supply electricity to a location when power lines are down, there is a risk to utility workers.

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