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Enhancing the resilience of Canadian electricity systems for a net zero future

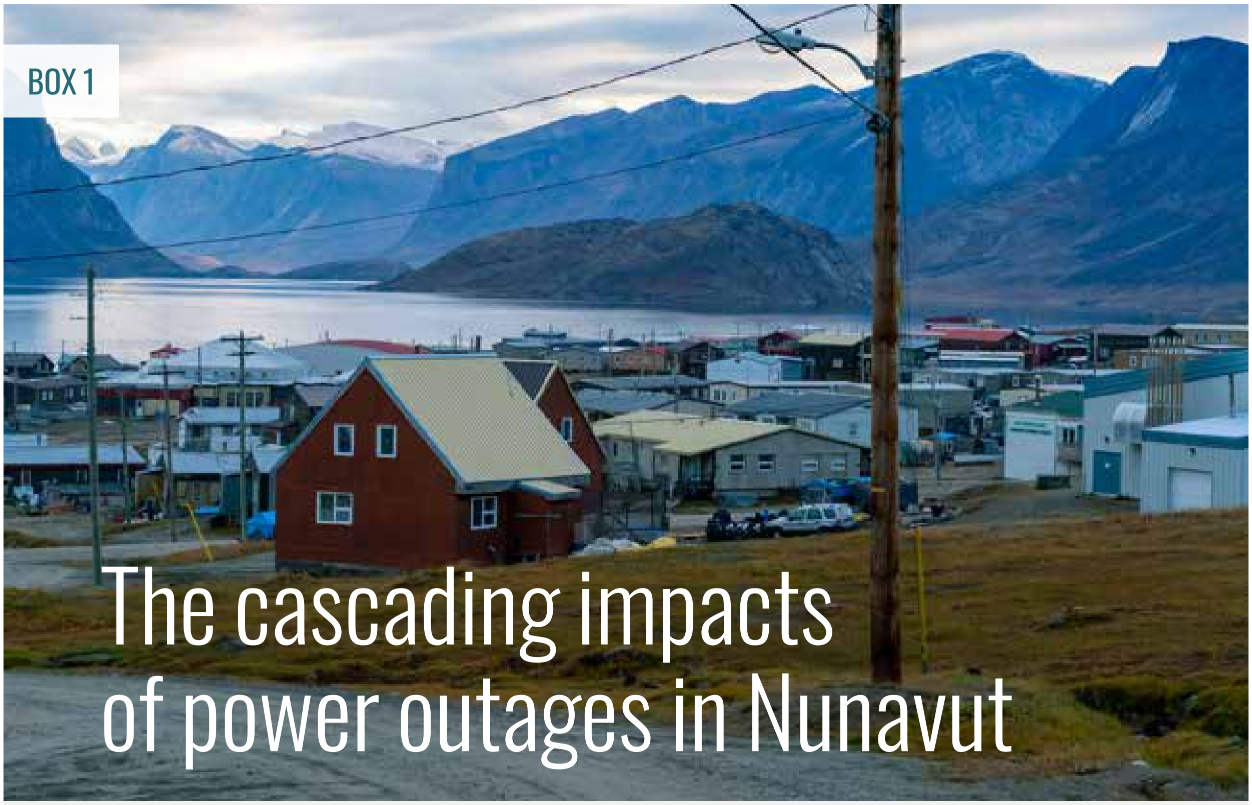
By Dylan Clark and Anna Kanduth, with contributions from Jason Dion, Caroline Lee, Ryan Ness, and Roger Street

Introduction

Reliable and resilient electricity systems are essential for a prosperous, net zero Canada. While Canadian electricity systems are generally reliable, they face growing challenges as climate impacts worsen and as electricity use increases through decarbonization. This scoping paper examines the expected climate-induced risks to Canadian electricity systems and discusses opportunities to enhance their resilience on the path to net zero.

> In the context of electricity systems, *reliability* refers to the ability of a system to maintain service delivery in the face of routine, local, and short-term disruptions. *Resilience*, on the other hand, is a broader concept that refers to the ability of a system to also withstand high-impact low-frequency events, minimize their impact, recover quickly, and implement measures to anticipate and reduce the impact of similar events in the future (Espinoza et al. 2016; NREL 2019).

Beyond powering homes and buildings, electricity systems power almost all essential services in Canada, including hospitals, 911 dispatch centres, water treatment plants, grocery stores, airports, and community centres. Industries and businesses also rely on dependable electricity to operate. When an electrical outage occurs, the impacts therefore affect other critical infrastructure and economic systems. These chain reactions are known as cascading impacts. For example, the massive power outages caused by the February 2021 winter storm in Texas not only saw millions of residents lose heat and light, but the loss of electricity also impeded COVID-19 vaccination efforts, affected the state's water and communications infrastructure, and disrupted food supply chains (Lee, 2021). In Quebec, the 1998 ice storm that left nearly five million people without power also led to prolonged business closures and lost economic output, transportation cancellations or delays, boil water advisories, telecommunication challenges, and disruptions to healthcare service delivery (Chang et al. 2007). These disruptions to critical services have even greater consequences for communities and individuals who are more vulnerable to service failures, including Northern and remote communities (see Box 1). With so many critical services dependent on electricity, ensuring the reliability and resilience of current and future electricity systems is essential.



BOX 1

The cascading impacts of power outages in Nunavut

The hamlet of Pangnirtung in Nunavut has experienced firsthand the detrimental impacts of electricity service disruption. In 2015, the hamlet's lone and aging diesel power plant was destroyed by a fire, resulting in a community-wide power outage and a month-long state of emergency (CBC 2017). The power outage had a number of cascading impacts, disrupting telecommunications, heating, and health services for the entire community.

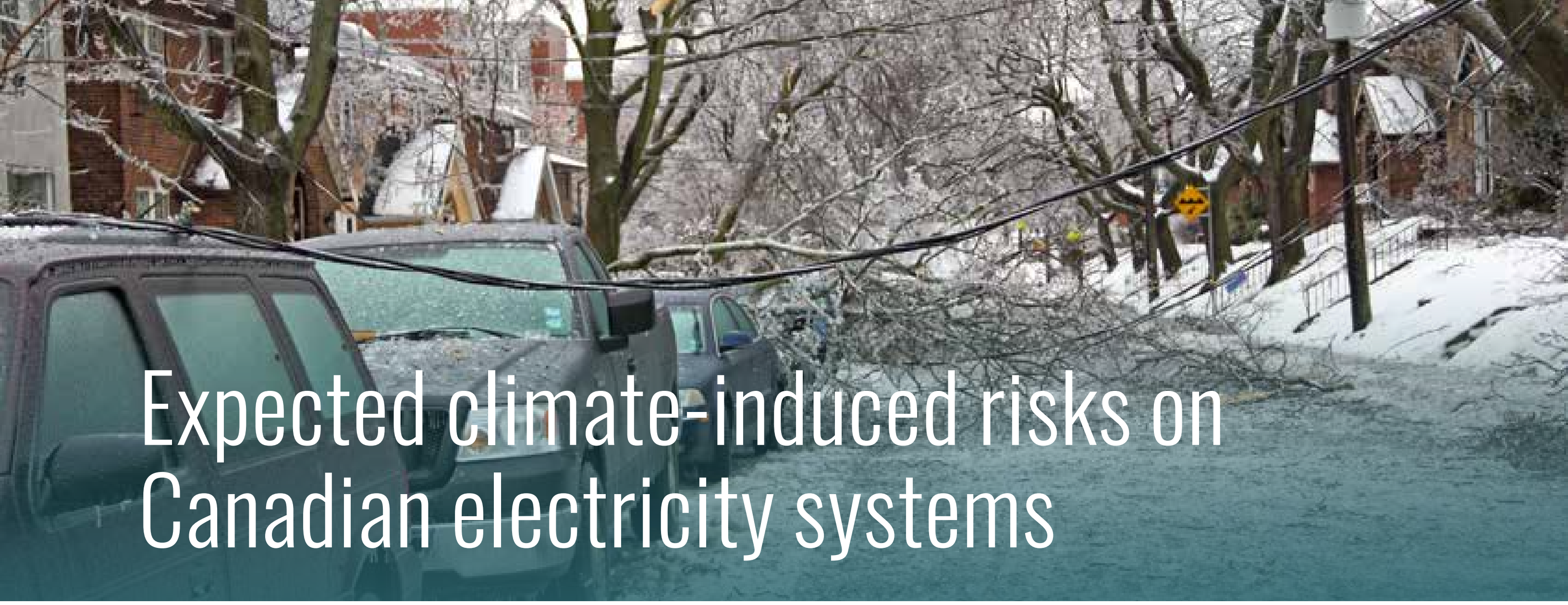
A few months later, in the middle of December, an electrical problem left the airport in Pangnirtung without runway lighting, making it difficult for airplanes performing critical services like medical evacuations and food deliveries to land (CBC 2015). The airport ultimately resorted to using flare pot candles to light the runway. Similarly, when a windstorm caused an outage in Grise Fiord the following year, community members had to light the runway with skidoo and truck headlights to help a plane carrying a line crew from the Qulliq Energy Corporation to land so that they could restore power (CBC 2016).

The power outages in Pangnirtung and Grise Fiord demonstrate the critical reliance on electricity in remote communities for essential services. The cascading impacts of the power outages to other critical infrastructure therefore underscore the importance of prioritizing secure and reliable electricity in northern and remote communities, especially as Northern Canada is warming at about twice the rate of southern Canada.

Canada's transition to net zero presents both risks and opportunities to the resilience of electricity systems. On the one hand, the accelerating electrification of transportation, buildings, and industrial sectors may place additional demand pressures on the system. In addition, this growing reliance on electricity means that any system failures will have increasingly detrimental and widespread impacts. Furthermore, if systems are not designed to increase grid flexibility and enable the integration of variable renewable resources, higher shares of electricity generation from wind and solar may increase the uncertainty of supply and exacerbate service disruptions.

At the same time, Canada's energy transition presents clear opportunities to improve the resilience of electricity systems. In particular, the net zero transition will involve massive investments to build new infrastructure and upgrade existing stock, from modernized electricity grids to electric vehicle charging networks, and from electric public transit to building retrofits. These investments present an opportunity to not only to advance the net zero transition, but to ensure that Canada's current and future electricity systems are resilient to a warming and increasingly volatile climate.

Failure to capitalize on these opportunities could expand the stock of vulnerable electricity infrastructure, increase overall system costs, lead to greater disruptions to households and businesses, and ultimately jeopardize Canada's net zero transition.



Expected climate-induced risks on Canadian electricity systems

Achieving net zero emissions globally by 2050 is critical to avoiding the worst impacts of climate change. However, even if the world achieves the target, the impacts of historic emissions will nevertheless increase climate hazards over the coming decades, threatening electricity systems in Canada. Climate change poses risks to every component of electricity systems—from generation, to transmission and distribution, to end uses. This section discusses some of the risks for electricity systems in Canada across each of these components.

Impacts on electricity generation

In order to achieve net zero goals, Canada's reliance on electricity will grow significantly, driven by the electrification of end uses, with non-emitting electricity supplying as much as 55 per cent of final energy demand in 2050 (Dion et al. 2021; EPRI 2021; IET 2021). This electricity could be generated from a mix of power sources, including hydro, nuclear, wind, solar, biofuels, geothermal energy, and possibly fossil fuel systems equipped with carbon capture and storage. Many of these generation types may face challenges, but also new opportunities, as a result of effects of climate change in Canada.

For example, climate-induced changes in temperature, precipitation, and snow and glacier melt will have implications for hydroelectricity generation in Canada. System-wide impacts would be felt most in provinces and territories with significant hydropower resources, notably British Columbia, Manitoba, Newfoundland and Labrador, Quebec, and Yukon. Analysis of climate change effects on hydropower in British Columbia found that by mid-century, climate change could be beneficial for the province's hydropower generation, with increased precipitation expanding generation potential. However, most of the increased generation would occur in the spring, rather than in the summer months when demand is highest (Parkinson and Djilali 2015).

In other regions, evaporation due to rising temperatures may not be offset by increased precipitation, which may result in lower water flows and reduced hydro-generation capacity. For example, a study on the economic impacts of climate change on hydropower production in Quebec found that the loss of production associated with lower water levels and flows could have significant negative financial implications (Larrivée et al. 2016). In regions where seasonal surpluses of hydropower are exported to other markets—whether within Canada or to the United States—

changes to water levels and flows could lower export revenues if electricity exports decline or become less predictable.

Changes to the availability, temperature, and quality of water due to climate impacts could also hinder the efficacy of thermal generation—whether using natural gas, coal, nuclear, biomass, hydrogen, uranium, or other fuels—which requires ample supplies of cooling water in the electricity production process. Rising temperatures in nearby water bodies may reduce the efficacy of cooling processes, increased prevalence of algae blooms may block water intakes and filters, and droughts may limit the overall supply of water (Braun and Fournier 2016). For instance, during Europe's 2019 heatwaves, nuclear reactors in France and Germany had to be powered down or taken offline due to high water temperatures (Reuters 2019).

Climate change will likely pose other challenges for electricity generation. Increased flooding—both inland and coastal—may result in flooding of power stations and access routes. More extreme storms, such as hurricanes, may damage offshore generation infrastructure like wind turbines. Climate change could see decreased wind speeds and changing wind patterns in some regions, resulting in potential reductions in wind power generation (Breslow and Sailor 2002; IPCC 2021; Yao et al. 2012). And finally, rising temperatures and increased cloud cover could reduce solar power production in regions with high solar-producing potential (Yin et al. 2020), though the implications for Canada's solar potential have not been well studied.

Impacts on transmission and distribution infrastructure

Climate change may impact electricity transmission and distribution by reducing the efficiency and reliability of infrastructure, notably power lines and substations. Warmer temperatures in summer months will decrease the capacity of power lines to transmit electricity. This will increase pressure on electricity systems on the hottest days when electricity demand is already at its peak due to increased air conditioning use. Without transmission infrastructure upgrades or efforts to reduce or shift demand—whether through energy efficiency, demand-side management,[1] or smart grids—increased peak electricity load coupled with reduced transmission capacity could jeopardize the ability of future electricity systems to meet demand (Bartos et al. 2015). This could lead to increased numbers of unintentional blackouts as well as intentional brownouts, whereby energy providers drop voltage to reduce load in an emergency.

Powerlines, poles, and towers can also be downed or damaged by severe weather events that may become more frequent as a result of climate change (such as wildfires, tornadoes, ice storms, and other extreme events) as well as due to shifts in the ground level and stability, known as subsidence (Johnson 2014). Hurricane Ida, which made landfall in Louisiana in August 2021, is a recent example of the devastating impacts of extreme weather on transmission and distribution infrastructure. The storm wreaked havoc on Louisiana's power grid, destroying transmission lines and leaving more than one million homes and businesses along the Gulf Coast

1 Demand-side management refers to strategies that encourage consumers to modify their energy consumption, often from high-peak intervals to off-peak intervals. Strategies may include education, incentives, programs, or technological solutions, such as smart charging systems that program appliances to only draw power at off-peak times.

without power (Kelly 2021). Ice storms, which are more common in Canada, can also damage or break power lines due to ice buildup weighing lines down, tree branches falling onto power lines, or high winds causing lines to sway or break (CEA 2016). Further, as temperatures increase and precipitation patterns shift, the speed and amount of vegetation growth will increase in many regions. This could increase the risk and severity of power outages and forest fires. Lastly, in regions of Canada where lightning is becoming more frequent, disruptions due to transmission and distribution line failures could also increase (Fant 2020).

In addition to potential impacts on power line reliability, climate change may also lead to more frequent substation and transformer failures. These failures may occur from a range of climate change impacts, including sea level rise, flooding, and heat waves (CEA 2016; IEA 2021).

Impacts from changing energy demand

As outlined above, the growing electrification of end uses on the path to net zero will place greater pressure on electricity systems. In addition, a warming climate will also have impacts on electricity demand. While warmer winters could result in less demand for heating, by mid-century and beyond, this reduced demand will be more than offset by the increases in demand for air conditioning in summer months (as well as increased demand year-round as we electrify). We are already seeing evidence of changing demand trends. In the summer of 2021, BC Hydro recorded a new record for summer peak hourly demand, as residents tried to stay cool during the province's historic heat wave (BC Hydro 2021). A recent report by the Canadian Institute for Climate Choices (the Institute) estimates that peak electricity demand will continue to rise in every province. This will have an aggregate effect of increasing peak electricity demand nationally by nine per cent by mid-century and by between 13 and 17 per cent by 2100 (Ness et al. 2021). Rising temperatures may also result in more frequent swings from low to high energy demand within a single day, placing more strain on electricity systems to adjust to changes in supply (Rivers and Shaffer 2020).

Risks to electricity system reliability and resilience may also emerge due to the dissonance between changes in demand and climate-induced shifts in generation. For example, more demand in summer months due to increased air conditioning use, combined with potentially diminished hydro generation as a result of climate-driven hydrologic change (as discussed above), will put increased pressure on the system (Hamlet et al. 2010). Similarly, wind generation typically produces more power at night and in the winter months, which does not align with projected growth in demand from air conditioning in the summer.

As Canada's clean energy transition accelerates and reliance on electricity for essential services grows, the consequences of mismatched supply and demand, notably the potential for more frequent electricity outages, will be even greater than today.

Reducing climate-induced risks to Canadian electricity systems

The significant infrastructure investments on the path to net zero represent an opportunity to enhance the electricity system resilience. Improving the resilience of electricity system infrastructure in anticipation of future climate change impacts could significantly reduce the impact and cost of damaged infrastructure as well as risk of service disruption, while also increasing the reliability of the grid. For example, the Institute's Under Water report quantified the costs of key climate hazards on Canada's electricity systems and found that early measures to enhance resilience can reduce damage costs by 80 per cent by the end of the century, or as much as $3.1 billion annually (Ness et al. 2021).

A number of opportunities exist for the public and private sectors to tackle the risks outlined above and increase system resilience and reliability. This section inventories some of those opportunities, specifically hardening electricity infrastructure, increasing system flexibility, improving energy efficiency, and ensuring systems can react to service disruptions and recover quickly.

Hardening infrastructure

As Canada transitions to net zero, electricity systems across the country will require significant investment in new transmission and distribution infrastructure, as well as upgrades to existing stock. Building new and replacing end-of-life-cycle infrastructure with more resilient, and often more cost-effective, materials and components can eliminate a significant percentage of costs associated with damage that would have occurred in the absence of such adaptation measures. In particular, the design, construction, maintenance, and replacement of power lines and other transmission and distribution infrastructure such as transformers must contend with existing system vulnerabilities and service gaps while also anticipating future climate risks consistent with proactive life-cycle management of those assets. Measures may include using new, more durable materials; burying power lines; pruning or removing vegetation to maintain power lines and reduce risks of outages or forest fires; relocating existing infrastructure to minimize exposure to hazards like floods or falling branches; or building flood defence systems for new or existing ground-level infrastructure, like substations.

Efforts to harden electricity infrastructure should also include reducing the vulnerability of other infrastructure to limit the potential for cascading impacts and reduce the overall cost and impact of an electrical failure. This could include building levees or protecting wetlands to minimize the impact of floods on homes, businesses, and critical infrastructure.

Increasing system flexibility

Increasing system flexibility enables electricity systems to be more resilient to climate change impacts and minimize service disruptions. Flexibility refers to an electricity system's ability to adjust generation, transmission, and distribution systems to accommodate variable and unpredictable supply and demand in order to maintain reliable and cost-effective service (IEA 2019). Enhancing system flexibility will be critical to balancing the intermittency of variable renewable sources, like wind and solar, whose share of electricity supply is expected to grow significantly on the path to net zero. As climate impacts worsen, enhanced flexibility will also be vital to ensuring electricity systems can respond to generation, transmission, and distribution disruptions quickly and maintain reliable service.

Various technologies can increase system flexibility:

- Demand-side management programs can better align electricity demand with supply, improving the stability, flexibility, and reliability of the power system (Cox et al. 2017).
- Energy storage can serve as sources of backup power when service is interrupted. Examples include short-term storage technologies like lithium-ion batteries, as well as long-term storage technologies like pumped storage hydropower, compressed air storage, flow batteries, and hydrogen.
- Distributed energy resources such as rooftop solar paired with storage can reduce susceptibility to single power outages and supply disruptions by spreading electricity generation across many sources and sites (NARUC 2019). These resources can also be deployed at a faster rate relative to large-scale systems to meet rapidly changing demand. More generally, enhancing the diversity of generation sources, including by increasing solar and wind shares, can help reduce vulnerability to disruption in a single generation source.
- Inter-regional transmission can help systems respond to disruptions in electricity supply by providing access to additional generation from neighbouring systems.
- And finally, smart grid technologies can bring together the above-mentioned solutions in a more efficient and reliable electricity system, while also improving response times to outages to limit their duration (IRENA 2018).

These solutions represent an important complement to hardening infrastructure. While hardening infrastructure is essential in many cases, it can be an expensive and time-consuming process. Flexibility can therefore reduce the need to harden less-critical infrastructure by limiting the impact of extreme events on the system. In addition, flexibility allows systems to remain adaptable to a range of climate futures, which is valuable given that the type, location, and severity of future climate impacts remain inherently uncertain (Accenture 2020).

While enhancing system flexibility is key to meeting both net zero goals and resilience objectives, in some cases, supporting some system redundancy may be needed to ensure that electricity systems remain reliable and secure. This may include retaining dispatchable back-up firm power, building out surplus wind and solar with storage, or providing targeted backup generation and storage for critical infrastructure—like hospitals—and for vulnerable communities. While a potentially important strategy for enhancing the reliability of electricity systems—especially for critical services and in regions that face barriers to enhancing system flexibility, such as remote communities—some forms of redundancy may conflict with emissions reduction objectives, notably back-up diesel generators and natural gas plants, if not equipped with carbon capture and storage.

Enhancing energy efficiency

Energy efficiency could play a central role in meeting Canada's net zero goal (Dion et al. 2021). Energy efficiency improvements can be defined as reductions in the amount of energy needed to provide an energy service, such as heating a home or driving a car. Less energy is used to provide the same level of service, thanks to more energy efficient technologies and measures. Examples include energy efficient household appliances, energy efficient building designs and materials, more fuel-efficient vehicles, and switching from fossil fuels to electricity for energy end-uses. This stands in contrast to energy conservation, which reduces the overall energy service provided. Examples of energy conservation include driving less, turning down the thermostat in the wintertime, or turning off home appliances when not in use.

Beyond supporting emissions reduction goals, energy efficiency and conservation can both support electricity system resilience. Energy efficiency can reduce vulnerabilities to energy disruptions by lessening demand pressures on electricity systems and enabling households to endure extreme events like heat waves at a lower cost. Similarly, during heatwaves or cold snaps, energy conservation and demand-side flexibility can reduce the likelihood of system outages or brownouts. In addition, a more energy-efficient system requires less electricity than a less efficient one. This translates to less infrastructure overall, and therefore less equipment that is potentially at risk of damage from climate impacts (Davis and Clemmer 2014).

Implementing measures to support recovery

Lastly, while targeted measures to harden infrastructure, increase system flexibility, and reduce demand can help limit the severity of climate impacts on electricity infrastructure, they cannot prevent them. As a result, ensuring that measures are in place to support rapid response, restoration, and recovery following climate-induced events is critical to ensuring that systems are prepared to quickly restore service and maintain reliability. This requires effective emergency response and restoration strategies, comprehensive resilience assessment frameworks for electricity infrastructure, maintaining financial reserves to cover losses, and sharing response resources across jurisdictions.

Challenges facing greater electricity system resilience and policy responses

Although the solutions discussed above are largely available and deployable today, there are many barriers to their implementation. This section inventories some of the key challenges facing greater electricity system resilience and provides potential policy responses.

CHALLENGE: Regulatory and utility mandates are not set up to tackle resilience

While regulator and utility mandates prioritize short-term reliability, they do not necessarily create incentives for prioritizing long-term resilience and adaptation. While reliability planning focuses on designing, building, and operating systems to keep electricity flowing during normal, predictable conditions, it does not prepare for a system's ability to respond to less frequent, extreme events. Reliability planning is therefore insufficient by itself to enhance electricity system resilience to climate impacts.

Several factors make effective resilience planning challenging. First, electricity regulators are reluctant to allow regulated utilities and local distribution companies to raise rates in order to invest in resilience projects, especially ones that may not benefit customers in the short-term. Utilities must maintain a balance between investments, rates on return, quality of service, and costs to consumers, and resilience-building options are often cost intensive. In addition, there is limited recognition of the return on investment of climate proofing infrastructure. Resilience-building measures cannot compete on a level playing field with other potential investments, since the benefits of investments in resilience today are hard to measure and have uncertain rates and timelines of return. As a result, utilities have inadequate sources of sustainable revenue to build resilient systems that can withstand emerging climate risks.

SOLUTION: Remove regulatory barriers and improve incentives

Removing regulatory barriers and establishing appropriate incentives for utilities to invest in adaptation and resilience is critical. One option is for provincial and territorial governments to formally extend or clarify the mandate of regulators to pursue long-term resilience goals and to prioritize adaptation planning. Another option is for regulators to require that utilities account for climate change impacts in their resource planning and operations. For example, the California Public Utilities Commission now requires utilities to conduct regular climate assessments of both their physical assets and their service delivery, particularly in disadvantaged communities, to better integrate climate risk across their planning processes (Chhabra 2020). Another way to incentivize resilience investments is for regulators to introduce performance-based ratemaking for system resiliency, whereby regulators establish resilience and adaptation targets or metrics for utilities and tie rate re\covery to performance against them (IEA 2021). An important first step is to develop metrics and methods for valuing resilience within asset planning processes, such as integrated resource plans, or within competitive energy markets—discussed below (NREL 2019).

CHALLENGE: Codes and standards are misaligned with resilience and adaptation objectives

Codes and standards—notably the Canadian Electrical Code—play an important role in enhancing the resilience of electricity systems. They set the minimum requirements for design and inform decisions at every stage of an infrastructure asset's lifecycle. Yet codes and standards often do not require new and replacement electricity infrastructure to account for future climate risk as they are based on past climate assumptions. The lack of climate risk information and guidance in codes and standards means that new infrastructure continues to be managed and built for the climate of the past. And while decision makers are aware of the insufficiency of Canada's infrastructure and building codes and standards, amendments to incorporate climate change risks in codes and standards have only just begun (Ness et al. 2021).

SOLUTION: Accelerate stronger codes and standards

National and regional codes and standards can be strengthened and implemented more rapidly in order to incorporate climate change risks and adaptation principles in new and existing infrastructure. First and foremost, electricity infrastructure design and system planning standards should be updated to reflect future climate impacts, while also allowing for regional variation (CEA 2016; CSA 2019). While this includes changes to the Canadian Electrical Code as well as regional electrical codes and standards, the scope of these codes is insufficient to meaningfully incorporate resilience into electricity system design, planning, and infrastructure. As a result, amendments to other codes and standards are needed to enhance electricity system resilience (CSA 2019).

For example, building codes and standards can be updated to enhance electricity system resilience. Building codes can require that buildings or electrical panels be elevated to reduce flood impacts (CSA 2019). Higher efficiency standards can reduce electricity demand and place less strain on the electricity system. And building codes can reflect the precipitation and temperature patterns of the future and require upgrades that reduce vulnerability to wildfires, floods, and heat waves (Ness et al. 2021). Having accurate and up-to-date climate information will be key to developing codes and standards that successfully integrate climate change adaptation and resilience considerations (Government of Canada 2021).

CHALLENGE: Decision makers lack sufficient information to integrate resilience into system planning

Utilities, regulators, and governments lack adequate information about the current and anticipated climate threats to electricity infrastructure. While Canada is working to increase access to projections of future temperatures and precipitation, this data only tells part of the story. Decision makers lack projections of key climate conditions like wind and ice storms, as well as detailed information about climate-related hazards (e.g. wildfire, flood, and permafrost thaw risk) that can affect electricity systems (Government of Canada 2019). Finally, there is also often little acknowledgment of the interconnectivity between electricity systems and other critical infrastructure—that is, until a failure occurs.

There is even less information about the downstream social and economic costs of climate-related risks. This information is important for the cost-benefit analyses that governments and regulators may use to inform policies and program decisions. Yet, the information is either not available, or if it is, it is not easily accessible. And what is available often lacks relevance, usability, and legitimacy from the perspective of those involved in making decisions—including utilities, regulators, and project developers—because it is either qualitative or regionally specific.

Beyond fundamental knowledge and data gaps, there is also a lack of robust and consistent approaches to assessing performance of resilience and adaptation strategies relative to targets and objectives. Tracking progress on adaptation and resilience is inherently difficult. Frameworks to measure progress are still in the early stages of development and unlike progress on emissions reductions, there is no one metric for assessing progress on reducing climate risks and enhancing electricity system resilience. As a consequence, in the electricity sector there is no formal consensus among regulators, utilities, governments, and industry about the data, performance metrics, or methods for evaluating electricity system resilience (Vugrin et al. 2017). In addition, standard decision-making processes and analytical frameworks often underestimate the risks of inaction or the benefits of action, and are inadequate to drive transformational, systemic change (Mercure et al. 2021).

SOLUTION: Fill information gaps and establish common performance metrics

Better data collection and sharing processes can help address existing information gaps while facilitating effective adaptation efforts across electricity and interdependent systems. This knowledge mobilization involves both improving access to high-quality, relevant data while also enhancing capacity to use this information to inform climate-resilient infrastructure planning. For electricity planners, downscaling large-scale projections to the regional level will be especially important.

In addition, standardizing resilience metrics and encouraging their consistent use by governments, regulators, and utilities can support resilience planning, while also enhancing collaboration across provincial and territorial electricity systems.

However, even with better data and more consistent metrics, climate models, like most predictive models, remain inherently uncertain and cannot provide perfect predictions of future risks and impacts. As a result, resilience and adaptation planning must remain flexible to multiple possible futures. Taking actions that address existing adaptation and resilience deficits with an eye to emerging climate risks can be an effective strategy for enhancing electricity system resilience.

SOLUTION: Improving climate risk assessment and disclosure

Climate risk and vulnerability assessments are important tools for increasing awareness about the need for resilience planning. While some utilities in Canada have conducted voluntary climate change vulnerability assessments, they are not a requirement. Governments and regulators in Canada could mandate that utilities perform regular climate risk assessments of both their physical assets and service delivery to better understand, and reduce, broader system-level risks. Given the cascading impacts of electricity infrastructure damage or service disruption, these assessments should consider the interdependencies across critical infrastructure and services and be underpinned by downscaled climate and socioeconomic data. They should also be integrated into broader electricity system planning frameworks, policy development activities, and decision-making processes to mainstream adaptation and resilience.

Fortunately, Canada is not starting from scratch. The Climate Lens, which is a mandatory requirement for several projects funded by Infrastructure Canada, provides a strong blueprint for conducting climate change resilience and risk assessments. However, most utilities are not yet required to complete the Infrastructure Canada assessment for capital projects. The Climate Lens, or a similar concept, could be extended to apply to all federally funded infrastructure projects—including electricity system ones—so that climate resilience becomes a key goal for long-term national infrastructure planning. Provincial and territorial governments could adopt similar frameworks for publicly funded infrastructure projects.

Looking ahead, as the federal government collaborates with provinces, territories, municipalities, and Indigenous governments to create a National Adaptation Strategy, it will be important to bring electricity service providers and regulators into the conversation. Implementing measures and strategies to enhance the resilience of electricity systems will be essential to building a climate resilient Canada.

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