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CLIMATE CHANGE AND EXTREME WEATHER EVENTS

THE ENGINEERING PROFESSION'S POSITION

- There is overwhelming evidence that the world's climate is warming and there is an immediate urgency to adapt to this change while still encouraging mitigation efforts to slow the rate and magnitude of climate change.
- In serving the public interest, engineers are uniquely qualified and positioned to ensure that Canada's infrastructure is designed and maintained to be resilient and have adaptive capacity to respond to impacts from extreme weather and long-term changes to our climate.
- Bodies responsible for engineering codes, standards, and work practices must factor in climate change when reviewing, establishing, or updating codes, standards, and work practices. Improved climate science understanding and modelling future projections is crucial to reducing uncertainties associated with future scenarios.
- It is imperative that all levels of governments engage and collaborate with the engineering profession on policies relating to adaptation to climate change and extreme weather events for the benefit of the public that they both serve.
- Education and professional development must provide engineers with the required information, skills, and tool/techniques to properly design for and adapt to current and future risks posed by climate change.

The challenge(s)

The case for climate adaptation has strengthened in recent years. Research provided in Canada's Changing Climate Report, has shown that Canada is warming at twice the global rate (greater than twice as fast in the north), and the effects of this are manifesting through extreme weather – more frequent and intense rainfall, storms, and extreme heat, and increased drought and wildfire risk; as well as through slower onset changes such as rising sea level[1].

The economic impacts of these changes are great – over the last ten years the costs of climate-related natural disasters in Canada have increased from 1 per cent of GDP growth to 5-6 per cent of GDP growth, and vulnerability is present in many aspects of the economy, including households, jobs, and infrastructure[2]. New research, launched by global professional services company GHD, titled *Aquanomics: The economics of water risk and future resilience*, outlines that droughts, floods, and storms could result in a total loss of CA$108 billion to Canadian gross domestic product (GDP) between 2022 and 2050, which equates to an average annual GDP loss of 0.2 per cent[3]. The upward trend in catastrophic loss is felt by Canadian households and insurers: the Insurance Bureau of Canada reports that insured weather-related catastrophic losses in Canada have exceeded $2 billion/year in 2020 and 2021, with most of the loss due to water-related damage – this is compared to the period between 1983-2008, when insured losses averaged only $422 million per year[4,5].

[1] Bush, E.. & Lemmen, D.S., Eds. (2019). Canada's changing climate report. Ottawa: Government of Canada, Ottawa, ON. https://changingclimate.ca/CCCR2019/.

[2] Sawyer, D., Ness, R., Clark, D.G. & Beugin, D. (2020). Tip of the Iceberg: Navigating the Known and Unknown Costs of Climate Change for Canada. Canadian Climate Institute (formerly Canadian Institute for Climate Choices).

[3] GHD (2022). "Aquanomics: The economics of water risk and future resilience. Retrieved September 12, 2022 from: https://aquanomics.ghd.com/en/canada.html

[4] IBC. (2021), January 18). Severe Weather Caused $2.4 Billion in Insured Damage in 2020. http://www.ibc.ca/on/resources/media-centre/media-releases/severe-weather-caused-$2-4-billion-in-insured-damage-in-2020

[5] IBC. (2022), January 18). Severe Weather in 2021 Caused $2.1 Billion in Insured Damage. http://www.ibc.ca/ns/resources/media-centre/media-releases/severe-weather-in-2021-caused-2-1-billion-in-insured-damage

Focusing on infrastructure - extreme weather and rapid changes to Canada's climate present a profound risk to both public safety and the reliability of Canada's infrastructure. For example, unprecedented flooding in BC in November 2021 damaged property and public infrastructure (major highways and bridges), and cut off supply chains, having far-reaching social and economic consequences. Considering extreme weather and climate-related risk, the projected cost of damage and disruption to Canada's infrastructure could be large. A recent report titled: *The Costs of Climate Change for Canada's Infrastructure*, found that:

- Flood damage to homes and buildings could increase fivefold by mid-century and by a factor of 10 by the end of the century, with costs reaching $13.6 billion annually .
- Damage to roads and railways (heat and rainfall-related) could increase by up to $5.4 billion annually by mid-century, and up to $12.8 billion annually by end of century6.
- Damage to electrical transmission and distribution infrastructure (heat and rainfall-related) could double by mid-century and triple by end of century, costing up to $4.1 billion annually[6].

The increase in infrastructure damage caused by extreme weather events to date, combined with future risk, highlights the immediate need to invest in climate resiliency and adaptation measures that protect communities and federal assets. While the government has made significant investments towards a green recovery plan to create jobs, build a clean economy, and protect communities against climate change, it is more important than ever for engineers and policy makers to understand the full economic and social/environmental costs of infrastructure project decisions—and not just impacts relating to material choice or from initial construction, but the impacts of climate adaptation choices across the entire life cycle of a project.

Infrastructure owners need the capacity and knowledge to assess the climate vulnerability of planned and existing infrastructure to anticipate and manage potential extreme weather impacts. Such analysis not only helps identify issues and solutions to adapt the infrastructure to the impact of climate change, but also provides evidence to improve existing policies and procedures as well as develop new ones to address emerging needs, issues, and concerns.

The necessity of responding to the impacts of climate change and extreme weather events extends beyond protecting physical infrastructure; it includes protecting Canadian households and communities from extreme weather events, such as flooding, wildfire and extreme heat.

How Engineers Canada has contributed

Engineering is on the front line in the provision of infrastructure to society. For this reason, engineers have a significant role to play in addressing climate change issues and incorporating them into engineering practice in Canada.

Since 2005, Engineers Canada has partnered with the provincial and territorial engineering regulators and other organizations to engage engineers with scientists, policy planners, industry leaders, and government decision-makers to discuss how to adapt public infrastructure to climate change.

Between August 2005 and June 2012, Engineers Canada, with funding from Natural Resources Canada and in collaboration with partners from

[6] Ness, R., Clark, D.G., Bourque, J., Coffman, D. & Beugin, D. (2021) Under Water: The Costs of Climate Change for Canada's Infrastructure. Canadian Institute for Climate Choices. Ottawa, ON. https://climateinstitute.ca/reports/under-water/

all levels of government and other sectors, formed the Public Infrastructure Engineering Vulnerability Committee (PIEVC). The committee developed and validated the PIEVC Protocol, a tool to be used for vulnerability assessments of infrastructure systems located in small communities and large urban centres, in Canada's North and most recently in First Nations communities. Ownership and control of the PIEVC Program was transferred to an alliance consisting of the Institute for Catastrophic Loss Reduction, the Climate Risk Institute and Deutsche Gesellschaft für Internationale Zusammenarbeit in March 2020.

Engineers Canada has published a publicly available national practice guideline on the *Principles of Climate Change Adaptation and Mitigation for Professional Engineers* that provides guiding principles for engineers to consider climate change in their professional practice. Our organization has also provided input to various federal public consultations regarding national mitigation and adaptation strategies, which includes comments to Canada's first National Adaptation Strategy.

Recommendations for the federal government

Engineers and the engineering community have the necessary knowledge that is imperative to dealing with the issue of climate change and extreme weather events. The profession has been engaged in this issue for over 20 years with a focus on infrastructure climate vulnerability and risk assessment, as well as proposing adaptation policies, strategies, and professional practices to improve resilience.

Resilient infrastructure

It is Engineers Canada's view that climate resiliency across the entire lifetime of infrastructure is the goal, and adaptation is the key strategy to achieve it. Therefore, all adaptation actions should lead to an outcome of improved resiliency for all communities be they municipalities, cities, towns, or reserves, as well as more generally across provinces and territories. Engineers Canada encourages the federal government to continue to require climate vulnerability processes and risk assessments to be a condition for funding approvals of infrastructure projects. This policy should be applied across all federal departments who own and operate existing infrastructure or who design and construct new infrastructure.

Further, given that the federal government regulates several industries, and as part of its regulatory responsibilities, should require such industries to undertake climate vulnerability and risk assessments. Recent events have shown that such vital high-tech infrastructure such as internet and cell phone operation can be compromised, with significant impacts on the economic and social welfare of Canadians.

Nature-based solutions

Nature-based solutions is a design approach that leverages the positive benefits of natural systems in conjunction with traditional engineering. It encompasses a wide range of approaches—from the restoration of habitats to water resource management, disaster risk reduction, and green infrastructure—to address societal problems. As we continue to see the devastating impacts of climate change due to warmer global temperatures, nature-based solutions can provide value as a result of their vital roles in carbon sequestration. Engineers have the technical expertise and are working to use green infrastructure and natural areas for flood prevention, to eliminate heat islands, and to improve air, water, and soil quality. Engineers Canada believes that the federal government should continue to invest in nature-based solutions to address climate change as these are important steps in recognizing the role that natural infrastructure can play.

Extending national climate parameters

Align engineering needs with climate projections and include specific climate parameters that go beyond temperature, rainfall, and precipitation. Including these additional climate parameters will build confidence in climate projections, support accurate risk assessments in built environments, and will provide engineers with defensible and authoritative climate data when supporting resilient communities across Canada. The role of various climate parameters on various types of infrastructure is of high importance and changes must be anticipated. Understanding meteorological and climate parameters, such as temperature, local changeability, heavy snow, fog, etc., is essential before designing and constructing physical infrastructure across Canada. The combination of extensive climate parameters and infrastructure indicators provide sufficient evidence for professionals to assess specific infrastructure responses to an identified climate condition.

Regional climate assessments in northern and remote communities

Given that northern and remote communities are disproportionately affected by Canada's changing climate, Engineers Canada recommends the funding of regional climate assessments to provide data that would be used to construct baseline measurements to understand future climate projections. These measurements then allow professional engineers and other practitioners to factor in future climate projections into their design, building, and maintenance of infrastructure in these northern and remote communities that are most susceptible to the effects of climate change.

This is a significant public policy issue that will greatly benefit from a range of federal government efforts that include:

- Continuing to fund climate research to assess impacts and adaptation, and inform the development and updating of codes, standards, and other instruments thereby increasing the confidence of climate design data used by engineers. This includes providing updates to the Federal Flood Mapping Guideline Series.
- Promoting information-sharing between engineers, scientists, and other key stakeholders regarding current best adaptive practices and regional climate data sets.
- Continuing efforts to improve the accuracy and resolution of climate change projection models and support provincial efforts to develop up-to-date, reliable regional climate data sets and trend analyses. This includes supporting demonstration projects and validating best practices to become standard practices.
- Continuing to support the Natural Resources Canada Climate Adaptation Platform, which continues to provide an excellent forum for collaboration, communication, and capacity-building between all stakeholders.
- Continuing to support the Canada Centre for Climate Services (CCCS) in its provision of climate data, information products, and advisory services to Canadians. Engineers require scientifically defensible climate information and future projections that are supported by the legal authority of the federal government through CCCS.

How Engineers Canada will contribute

Engineers must adapt their professional practice to consider the impacts of extreme weather and Canada's changing climate. As professionals develop strategies to reach public safety, reliability, sustainability, and resilience goals, it is vital that engineers adopt methodologies that use a life-cycle perspective to evaluate impacts and use that knowledge to generate strategic

paths moving forward. They should acquire the requisite knowledge, skills, and experience, and consult with other professionals including climate specialists to properly address this issue in each project.

Engineers Canada can advise the federal government on the research, information, and funding needed to safeguard infrastructure and communities that are vulnerable to the effects of climate change.

Engineers Canada will continue to actively:

- Work with engineering regulators to raise awareness of the needs and methods to consider extreme weather and longer-term climate change in engineering decisions. This includes developing guidance to embed climate adaptation and mitigation principles in professional practice and through our regulators, an engineer's standard of practice.
- Continue to take a leadership role in assuring that codes, standards, and practices embody principles that promote a low-carbon, clean environment and a sustainable economy through low-carbon, climate-resilient infrastructure and the services it provides.
- Provide advice and leadership to our regulators by developing and maintaining national practice guidelines. This effort includes the delivery of professional development to engineers in partnership with our regulators on national guidelines, as well as promoting tools, such as the PIEVC Protocol, and information needed for engineers to adapt their designs, improve operations and maintenance of public infrastructure, and improve measures to mitigate emissions that contribute to climate change[7].

[7] The Council of Canadian Academies (2019). "Canada's Top Climate Change Risks: The Expert Panel on Climate Change Risks and Adaptation Potential." Retrieved September 13, 2022 from: https://cca-reports.ca/wp-content/uploads/2019/07/Report-Canada-top-climate-change-risks.pdf