Engineers Canada's Comments on Environment and Climate Change Canada's Draft National Climate Change Science and Knowledge Plan

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Overview

On November 26, 2019, representatives from Engineers Canada met with Ms. Nancy Hamzawi, Assistant Deputy Minister, Science and Technology Branch, Environment and Climate Change Canada (ECCC), to discuss the work of ECCC in the development of a draft National Climate Change Science and Knowledge Plan (NCCSKP).

Recognizing the foundational role of science and practical expertise in evidence-based decision-making, ECCC has developed a draft NCCSKP to support the delivery of the Pan-Canadian Framework on Clean Growth and Climate Change. The intended outcome of the draft NCCSKP will work to identify knowledge gaps and priorities that reflect the perspectives of experts and stakeholders within Canada's scientific community, including Indigenous communities across Canada and diverse levels of government.[1] The final NCCSKP, to be released in 2020-2021, will work to support better coordination and increased collaboration between the federal government and academics that is strengthened by Indigenous knowledge.

Engineers Canada is honoured to have the opportunity to provide an engineering perspective to the draft NCCSKP. The proposed draft NCCSKP includes several commendable outcomes as it aims to:

1. Build on the existing significant body of climate change science and knowledge.
2. Support multi-disciplinary discussions with the scientific community to address key climate change policy outcomes.
3. Support science that is oriented towards societally relevant outcomes.
4. Support Indigenous leadership in climate change science and action.

However, upon review, it is evident that certain aspects of the draft NCCSKP need to be expanded and strengthened to improve the scope, clarity, and technical expertise that is included within the plan.

Engineers across Canada work to uphold public safety, the economy, and the natural environment. Given the unique and objective perspectives of engineers in Canada, Engineers Canada recommends the following to improve upon the current draft NCCSKP:

Climate change science-policy context:

- That subsection one be expanded to further define and clarify the current scope of study.
- That monitoring and measurement benchmarks be set to increase transparency and accountability of work under the NCCSKP.
- That the Representative Concentration Pathways (RCPs) presented in the "Canada is Warming Graphic" be amended to define the low emissions scenario as RCP4.5 and the high baseline emissions scenario to be RCP8.5.

Strategic and cross-cutting themes:

- That up-to-date, reliable, consistent, and verifiable national climate data be included to support initiatives and projects under the NCCSKP.

[1] Government of Canada (2019). "Departmental Plan 2019 to 2020 report, Environment and Climate Change Canada, chapter 3." Retrieved January 20, 2020 from: https://www.canada.ca/en/environment-climate-change/corporate/transparency/priorities-management/departmental-plans/2019-2020/planned-results.html.

- That research on climate parameters be extended beyond temperature and rainfall precipitation to more fully support engineers' efforts to properly plan for and adapt public infrastructure through the design, operations, and maintenance life cycle.
- That subsections "Engagement" and "Implementation Considerations" of the draft NCCSKP be expanded to include consultations with climate scientists, engineers, and other practitioners in Canada.

Climate change science-policy context

Defined scope of study

From an engineering perspective, it is recommended that the scope of the draft NCCSKP be clarified; specifically, the framing along the three time periods and outcomes identified under section 1 of the draft, "Climate Change Science-Policy Context."

The current objectives of the draft NCCSKP include multi-disciplinary discussions that range between the development of a GHG emissions strategy to then identifying strategies to address mitigation, adaptation, resiliency, and economic growth. Engineers Canada understands the desire to leverage the full range of Canada's climate change science and knowledge capacity. However, this desire may waste resources and create wide-ranging and ineffective outcomes. For example, the medium-term goal for 2030-2050 to create Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy would produce different results than a strategy on Adaptation and Resilience.[2]

The current draft of the NCCSKP requires a clarified and prioritized approach for each initiative to support proper resource allocation at this stage of development. For this reason, Engineers Canada recommends that the short-, medium-, and long-term objectives within the draft NCCSKP be divided into three clearly defined and manageable scopes of study, such as:

1. Support to mitigation policy and emissions standards and guidelines.
2. Adaptation and resiliency practices and standards.
3. Research that benefits the first two scopes.

A defensible and credible consultation process is required to develop a fully vetted and widely supported NCCSKP. It is important that climate scientists, engineers, and other practitioners continue to be included in multi-disciplinary discussions with ECCC; specifically, to participate in a process of setting and validating the newly defined scopes of study with ongoing engagement and consultation during implementation.

Monitoring and measuring outcomes

Qualitative and quantitative performance measures need to be used at critical points to determine if a federal, provincial, or territorial project, initiative, or program is ready to proceed to the next phase of implementation. Monitoring metrics and measuring outcomes assess the progress of a desired objective in order to determine where additional efforts or corrective actions are needed.

When analyzing the draft NCCSKP, there is no identified benchmarking system to analyze, monitor, or measure the outlined objectives with planned outcomes, performance, or defined goals. For example, under subsection four of the draft titled, "NCCSKP Outcomes: spanning the three timeframes," it is unclear what metrics or indicators will be applied by ECCC to confirm that "risks and opportunities" are understood and identified in Canada's sustainable sector.[3]

[2] Environment and Climate Change Canada (2019). "National Climate Change Science and Knowledge Plan (NCCSKP)." Retrieved November 2019.
[3] Environment and Climate Change Canada (2019). "National Climate Change Science and Knowledge Plan (NCCSKP)." Retrieved November 2019.

To increase transparency and accountability, as well as to effectively plan for potential obstacles throughout the implementation phase of the NCCSKP, Engineers Canada recommends that a detailed description be provided regarding how the newly defined scopes of study in the NCCSKP will be implemented, monitored, and measured.

GHG Low-Global Emissions: Representative Concentration Pathway

Representative Concentration Pathways (RCPs) define four diverse pathways of greenhouse gas (GHG) emissions and atmospheric concentrations, land use and air pollutant emissions.[4] RCPs have been developed using Integrated Assessment Models as input to a wide range of climate model simulations to project their consequences for the climate system.[5] Oftentimes, these climate projections are used by engineers and other practitioners for adaptation and impact assessments.

Four pathways have been selected for climate modeling and research. These RCPs represent the range of GHG emissions, beginning with a stringent mitigation scenario of RCP2.6, followed by two intermediate scenarios of RCP4.5 and RCP6.0, and one scenario of RCP8.5 to represent high GHG emissions.[6]

When analyzing the GHG data presented in the "Canada is Warming" graphic in section 1, it is recommended that RCP4.5 be used instead of the current listed low forcing level of RCP2.6 in climate projections used by ECCC. RCP4.5 was originally intended as an intermediate scenario in the Intergovernmental Panel on Climate Change (IPCC). However, it is now being viewed as a more realistic low forcing level scenario given the course of current emissions trends.

Engineers Canada recommends that the draft NCCSKP be amended to begin climate projections with the medium stabilization scenario of RCP4.5 and a high baseline emissions scenario of RCP8.5.

[4] The Intergovernmental Panel on Climate Change (2020). "Topic 2: Future Climate Changes, Risks and Impacts." Retrieved January 20, 2020 from: https://ar5-syr.ipcc.ch/topic_futurechanges.php.
[5] Ibid
[6] Ibid

Strategic and cross-cutting themes

Reliable and consistent national climate data

Canada's changing climate has had widespread impacts on the natural environment, society, and the economy. In some cases, Canada's changing climate conditions can pose unaccounted for risks, particularly on Canada's vulnerable infrastructure. For example, thawing permafrost in Canada's North has had detrimental impacts on physical infrastructure, such as highways, railroads, and buildings.[7] Changes to Canada's southern communities have also occurred, including "temperature increases that pose a significant challenge for the energy sector to meet peak electricity load in summer months due to an increasing cooling demand."[8]

The IPCC, in its report *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* notes that climate extremes, or even a series of non-extreme events, combined with social vulnerabilities and their exposure to risks can produce climate-related disasters.[9] The current state of scientific knowledge concludes that Canada's climate is changing and will continue to change.

Historical climatic design data and projections are becoming less representative of the future climate that Canada will face. Historical climate data must be assessed with thoroughness and confidence, acknowledging that the length of record that is required depends on the climate parameter under consideration. For example, trends in extreme 15-minute rainfall events require periods of climate data to detect changes or trends, while other climate parameters, such as average temperatures or heating degree days, can be captured in trending situations by shorter periods of climate data. Depending on the climate parameters, there may be significant statistical skewing that results from the inclusion of either historical data or newer data. In the draft NCCSKP, there must be recognition of this potential effect; particularly when referring to national climate averages.

The need for up-to-date, accurate, justifiable, and reliable climate data must be addressed in the draft NCCSKP. An engineer's ability to apply adaptation measures, particularly when designing or building physical infrastructure across Canada, is influenced by the potential risks of inaccurate or unreliable climate data. A component of the research should focus on reducing the uncertainty of climate projections, which normally provide a range in the value based on confidence intervals.

In Canada, it is an engineer's duty to take reasonable measures to ensure that engineering work appropriately anticipates the impact of changing climate conditions. Engineers in Canada are bound by their code of ethics to:

[7] Li, G., Zhang, X., Cannon, A.J. *et al.* Indices of Canada's future climate for general and agricultural adaptation applications. *Climatic Change* **148,** 249–263 (2018)
[8] Ibid
[9] The Intergovernmental Panel on Climate Change (2012). "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation – Special Report of the Intergovernmental Panel on Climate Change." Retrieved January 22, 2020.

Be aware of and ensure that clients and employers are made aware of societal and environmental consequences of actions or projects and endeavor to interpret engineering issues to the public in an objective and truthful manner.[10]

Adaptation planning requires scientifically sound climate data. Where climate data is sparse or weak, the verification process is also weak. Consistent, reliable, and up-to-date national climate data will ensure that accurate climate projections are made, enabling effective planning for both present and future projects and initiatives under the NCCSKP. Climate data management is critical and requires the input of specialized climate scientists, engineers, and other practitioners.

ECCC will benefit greatly by working with this specialized input to further develop this section of the draft NCCSKP through a range of collaborative efforts that include:

1. Promoting the need for up-to-date, consistent, and accurate national climate data.
2. Promoting information-sharing between engineers, scientists, and other key stakeholders regarding current best adaptive practices and regional climate data sets.
3. 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.
4. 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.
5. Collaborating with the engineering profession on climate change policy. The profession can provide independent, objective and credible technical expertise on adaptation and mitigation that ECCC can use to continue to develop sound evidence-based reports.

Extend climate parameters to adapt public infrastructure

A climate index provides a diagnostic quantity that is used to characterize the state-of and/or changes in a climate system, such as a circulation pattern. There are a variety of methods that can be used to derive assorted indices, including classically, selected station, grid point, or regional average data.[11] Most indices use a single variable, such as sea level pressure, sea surface temperature, geopotential height, while others use a combination of variables (i.e. temperature and precipitation).[12] Each climate index has certain measurable parameters that influence the properties of a climate system.

While analyzing the draft NCCSKP, Engineers Canada recommends that ECCC work together with the engineering profession to align engineering needs with climate projections, as well as extend the draft NCCSKP to include specific climate parameters that go beyond temperature, rainfall, and precipitation. Extending the draft NCCSKP to include additional climate parameters will build confidence in climate projections, support accurate risk assessments, and will provide engineers and practitioners with defensible and authoritative climate data.

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[10] Engineers Canada (2018). "Public guideline: Principles of climate adaptation and mitigation for engineers." Retrieved January 21, 2020 from: https://engineerscanada.ca/publications/public-guideline-principles-of-climate-change-adaptation-for-professional-engineers.

[11] The National Center for Atmospheric Research (2019). "Overview: Climate Indices." Retrieved January 22, 2020 from: https://climatedataguide.ucar.edu/climate-data/overview-climate-indices.

[12] Ibid

There are several climate parameters that are not adequately addressed through the current draft NCCSKP. These include, but are not limited to:

1. Wind speed and direction
2. Fog
3. Snow accumulation, duration, and intensity
4. Freezing rain and hail
5. Freeze-thaw cycles

The role of various climate parameters on civil operations and building construction is of high importance and must be anticipated in the draft NCCSKP. Understanding meteorological and climate parameters, such as temperature, local changeability, heavy snow, fog, etc., is essential before designing and constructing physical infrastructure across Canada. For the engineering profession, the combination of extensive climate parameters and infrastructure indicators provides sufficient evidence for professionals to assess specific infrastructure responses to an identified climatic condition; evidence that is currently missing from the draft NCCSKP.

Engineers Canada has worked collaboratively with diverse levels of government to better inform climatic data for initiatives and projects. For instance, between November 1, 2009, through March 31, 2010, Engineers Canada worked with the Ministry of Transportation and Infrastructure in the Province of British Columbia to assess the engineering vulnerability of Coquihalla Highway (B.C. Highway 5) between Nicolum River and Dry Gulch. Engineers and practitioners involved in the project looked at identifying risks of failure, loss of service damage and/or deterioration from extreme climatic events and any significant changes to baseline climate design values. The project analyzed climate change effects from 2010 through to the year 2050.[13]

Initially, the team identified an extensive list of potential climate parameters to consider in project designs; however, with the assistance of engineers and practitioners, the team redefined the list of pertinent climate factors and parameters based on their understanding of relevant interactions between the changing climate and physical infrastructure. The list of climate parameters was adjusted throughout the assessment process, ultimately arriving at a conclusive list that upheld public safety, supported economically feasible design decisions, and allowed for accurate risk assessments on physical infrastructure.

Engineers Canada appreciates that the draft NCCSKP is research focused. However, the practical application of this research must be addressed and accounted for. ECCC should work with climate scientists outside of ECCC (e.g. OURANOS and Pacific Climate Impacts Consortium), engineers, and other practitioners to identify a more fulsome list and specification of climate parameters in the draft NCCSKP. Building infrastructure today without adequately addressing and planning for future climate impacts creates vulnerability gaps that will later cause service disruptions and failures, thus increasing costs to government, the private sector, and the public.

Additionally, it would be beneficial to see a database of climate impacts attributed to climate parameters, which provides strong forensic evidence that is often needed to support the development

[13] B.C. Ministry of Transportation and Infrastructure (2010). "Climate Change Engineering Vulnerability Assessment – Coquihalla Highway (B.C. Highway 5) Between Nicolum River and Dry Gulch." Retrieved January 24, 2020 from: https://pievc.ca/sites/default/files/coquihalla_highway_nicolum_river_and_dry_gulch_execsummary.pdf.

of new climate change-integrated standards for increased climate resiliency in decision-making. For example, a climate and infrastructure forensic database capturing high impact climate events and their failures of assets or services would help to inform many standards, risk assessments, decisions, and designs on important “breaking point” climate thresholds.

Engagement and implementation considerations

A successfully executed NCCSKP will have a significant impact on major projects in Canada, both in the short and long term. It is Engineers Canada's view that individuals performing climate and vulnerability assessments, infrastructure design, or otherwise practically applying the research in the NCCSKP, do so with high levels of technical skills and are held professionally accountable for their actions.

The draft NCCSKP articulates that stakeholders, including Indigenous leaders, municipalities, academia, industry, and diverse levels of government will be consulted; however, Engineers Canada believes that consultations should be expanded to include multi-disciplinary practitioners, such as engineers. Experienced engineers are available to provide technical expertise and impartial advice on adaptation and mitigation requirements and are available to advise on and help develop sound policies, appropriate processes, and feasible technical implementation strategies that are required in the development and application of the NCCSKP.

Translating knowledge and expertise into action requires resources as well as professional and objective individuals. Public confidence and safety are at risk when engineers are not involved in the development and implementation of a wide range of legislation and regulations that require the application of engineering principles.

In Canada, engineering is regulated under provincial and territorial law by the 12 provincial and territorial engineering regulators. The 12 engineering regulators are entrusted to hold engineers accountable for practising in a professional, ethical, and competent manner and in compliance with the applicable provincial or territorial engineering act, code of ethics, and legal framework in place. Technical and professional standards of conduct are set, revised, maintained, and enforced by the 12 regulators for all engineers under their jurisdiction.

By designating that only engineers undertake assessments of engineering work under the NCCSKP, the federal government can provide assurance to the public that decisions will be made appropriately and in the public interest. These levels of accountability will provide the best risk management process for ECCC going forward.

Engineers Canada therefore recommends that the "Engagement" and "Implementation Considerations" subsections of the draft NCCSKP be amended to provide greater clarity to ensure that engineers are specifically included in public consultations and decisions related to the design and implementation of projects under the NCCSKP. Incorporating the expertise of engineers in this process will support the draft NCCSKP's desires to provide investments that are "transformational to meet the needs of a national adaptation program that enhances mitigation ambition".[14]

[14] Environment and Climate Change Canada (2019). "National Climate Change Science and Knowledge Plan (NCCSKP)." Retrieved November 2019.

Who we are

Engineers Canada is the national organization of the 12 provincial and territorial associations that regulate the practice of engineering in Canada and license the country's more than 300,000 engineers. Together, we work to advance the engineering profession in the public interest.