Executive Summary

The Role of Standards in Adapting Canada's Infrastructure to the Impacts of Climate Change

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This report is intended to provoke further thought and dialogue amongst policy-makers and practitioners on the role that standards play in developing and moving climate change adaptation solutions into mainstream practice.

Standards have a profound impact on Canada's diverse range of infrastructure systems. This report describes for policy-makers the role and influence of Canada's standards, the relationship of these standards to the design and operation of infrastructure works, and their impact upon climate change adaptation issues. The document underscores the importance of outreach strategies aimed at standards organizations, and suggests practical tools for outreach implementation. The climate change impacts and adaptation/ infrastructure file is broad and complex, and no single organization or authority has jurisdiction for all categories of infrastructure or all regions.

Although often invisible to the public, standards affect safety, performance, environment, economics and service levels.

This report focuses on climate-sensitive built infrastructure, with a particular emphasis on the role of the Canadian Standards Association (CSA) in developing infrastructure standards. Various elements and perspectives are used to describe the issues related to climate change impacts and how these affect Canada's infrastructure systems. Each section of the report is written to describe an element in a self-contained manner.

CSA, Infrastructure and Climate Change impacts

Within CSA's network of 9,000 members, there are 1,800 experts working on 83 individual technical committees. They deliver and maintain more than 260 existing publications that are directly related to infrastructure systems.

Approximately half of these CSA infrastructure standards (48%), are aimed at commercial buildings and residential housing. The other half is comprised of standards covering Water (20%), Energy (17%), Transportation (11%), Occupational health and safety (2%), Communications (1%) and Culture, Recreation & Tourism works (1%).

The influence of Canada's standards network

Canada's standards network is broad, effective and inclusive. It is well suited to meet the complex challenges associated with adapting many facets of Canada's infrastructure. A combination of sustainable support, along with effective outreach and engagement, will further harness the energy and capacity of this network within the climate change adaptations file.

Infrastructure Definition, Categories and Lifecycle Phases

The report begins with a description of the categories of infrastructure and their lifecycle phases. This establishes the breadth, depth and boundaries for discussion and analysis. Categories for infrastructure works and systems include transportation, water, energy, communications, solid waste management, and buildings, as well as facilities for culture, recreation and tourism.

The typical infrastructure lifecycle phases are:

- Design/Build;
- Operations and Maintenance;
- Overhaul/Retrofit/Upgrade;
- De-commissioning or divestiture;
- Transformation.

Many of CSA's infrastructure standards are used during the design-build lifecycle phase. Decisions made during initial design often have an influence on issues in later lifecycle phases. Designers are faced with a multitude of trade-offs. Total lifecycle considerations are sometimes subordinated as a result of initial cost constraints. Yet, decisions made at the time of initial design can make it easier or more difficult to build adaptive capacity in later lifecycle phases. For example, a future major overhaul and retrofit can provide an opportunity to incorporate new technology and practice into existing infrastructure. An understanding of the infrastructure lifecycle is essential to building climate change adaptation capacity.

The National Standards Network and the Role of CSA

The elements of the national standards network, the players within the network, and the role of CSA serve to illustrate the breadth and depth of issues influenced by standards.

The global and national standards network includes organizations that are formally accredited to develop standards as well as numerous organizations that develop standards, but that are not formally accredited by national or international standards accrediting bodies.

In situations where international standards are employed in Canada, they must be reviewed by Canadian stakeholders and, where necessary, adapted to ensure that changing or unique Canadian safety, climatic and geographic conditions are accommodated.

Canada's National Standards System

Canada's National Standards System (NSS) includes four Standards Development Organizations (SDOs): Canadian Standards Association, Bureau de Normalisation du

Québec, Underwriter's Laboratories of Canada, and the Canadian General Standards Board. The Standards Council of Canada (SCC), a federal Crown Corporation reporting to the federal Minister of Industry, accredits their standards development process. There are also links to other international standards development organizations such as ISO, the International Organization for Standardization, and IEC, the International Electrotechnical Commission.

In addition to Canada's four accredited SDOs, more than 400 organizations have been accredited by the Standards Council of Canada to provide conformity assessments, testing and calibration, audits and training services that support the implementation of standards.

Non-accredited Canadian codes and standards developers

Many non-accredited organizations develop standards as well, and they are an integral part of the national standards network.

A significant number of standards impacting Canada's infrastructure originate from the United States and/or from the International Organization for Standardization (ISO). In 2003, out of 267 new standards that were incorporated into the National Standards System, more than 70% were either adopted directly or adapted from international standards.

Standards Development in the U.S.

The American National Standards Institute (ANSI) is the accrediting organization in the U.S. for American Standards developers and plays a similar role to that of the Standards Council of Canada. There are more than 1,000 accredited standards development organizations in the U.S. Requirements for accreditation of U.S.-based standards development organizations often differ significantly from Canadian requirements and furthermore, not all U.S.-based SDOs meet the requirements of international organizations such as ISO.

Regulatory Authorities and Jurisdictions

Standards are often referenced by regulators and infrastructure owner/operators, particularly on issues such as safety and performance. A basic understanding of how regulators use and reference standards helps to round out the picture of how and where standards influence the climate change impacts and adaptations file.

Regulatory authorities vary by infrastructure category as well as by region. Depending on infrastructure category, they may be government agencies, or independent organizations "at arms length" from industry and government.

Man-made and Natural Phenomena Acting on Infrastructure

Extreme weather events and incidents of chronic infrastructure deterioration are discussed from the perspective of infrastructure system design, operation and level of service. Further context is provided by describing climate change impacts as a subset of all the external forces that act on infrastructure systems.

Numerous individual and combinations of man-made and natural phenomena (i.e. loads) are identified and listed. Their influence on the resilience of infrastructure is explained through use of examples. Implications for infrastructure design and operations experts are discussed as well.

Extreme Weather Events and their Impact

Mainstream infrastructure design establishes a prudent balance between capacity, resilience, cost, reliability and durability without compromising safety. Furthermore, many existing standards and codes rely heavily on statistical models that are based on historical weather data in order to establish infrastructure design parameters and thresholds. This is a fundamental building block of the current practice and is proven to be effective. However, the literature reviewed points to evidence that historical weather patterns may not be as relevant in the future as they were in the past. Since climate-related weather data is so essential to the design of many infrastructure works, it is essential to maintain Canada's capability to observe and analyze changing climate patterns.

Examples are provided of recent extreme weather events that have had an impact on infrastructure. A discussion is also included, of how forensic studies in response to such incidents often result in new knowledge and updates to standards.

The Need for Multi-disciplinary Collaboration

Much of CSA's network and community of infrastructure experts come from the science and engineering community. Technology, statistical and risk management processes are part of most CSA standards related to infrastructure. Furthermore, many of these standards rely on climatic data. Climate science is an essential element of state-of-the-art structural and systems design. Cross-disciplinary collaboration is critical to enhancing the adaptive capacity of infrastructure systems.

Prospects for Outreach and Engagement Tools

Finally, a proposal is made for simple outreach and engagement tools for use within the standards community. To illustrate the proposal, the results of a scaled-down pilot trial are documented, along with suggestions as to how this tool could be further developed and deployed.

CSA committees and volunteer expert members come together to form a dynamic, engaged network. Harnessing their expertise and decision-support capabilities will accelerate adaptive capacity-building. Specialized workshop-based settings, as well as their routinely scheduled committee meetings are ideal forums to analyze, debate and ultimately reach consensus on solutions. This type of dialogue and collaboration will further help to establish meaningful patterns, priorities and trade-offs. This is an effective way to to further engage these stakeholders in climate change adaptation issues.

Findings

The implementation of these findings would help in the development of a coordinated national standards strategy for enhancing adaptation to climate change:

1. The existing framework related to infrastructure systems regulatory jurisdictions, laws, codes and standards is complex. A more comprehensive understanding and overall mapping of the codes and regulatory landscape for infrastructure would be helpful. Additional focus and investment in this area would result in a more complete decision-support toolkit for policymakers.

2. Opportunities for enhanced adaptation and capacity building are created as standards are reviewed and updated. A multitude of CSA infrastructure standards have review cycles of between two and five years. This enables new research, technology and practices to be incorporated into mainstream practice on a continual basis.

   The cross-functional, multi-disciplinary and balanced nature of the CSA technical committee system provides effective and accessible forums for tackling complex issues. Committee meetings, augmented with specific workshops and symposiums are highly effective outreach tactics.

3. Further evaluation of the needs related to the development of new national standards could enhance adaptive capacity-building. Examples of high priority issues already identified are, storm-water management, rehabilitation of existing infrastructure systems, and acute vulnerabilities in Northern infrastructure and coastal regions. National standards do not presently exist in these areas.

4. Climatic load data that is referenced and/or used by codes and standards is critical to infrastructure designers and operators. As climate continues to change, predictive models with sufficient detail and resolution to be useful at the local community level has become more and more important.

   Presently, the climatic loads used by designers are sometimes based on historical data that is no longer representative of future conditions. This is of great concern to infrastructure designers since many infrastructure works are intended for extremely long service life – up to 100 years in some cases.

Canada's infrastructure designers rely on a strong climatic observation network, its coordination across jurisdictions and world-class analytical expertise. Access to high quality, reliable climatic load data is an essential element of designing resilient infrastructure.

5. Canada's codes and standards network is ubiquitous and influential. However, awareness of the implications of climate change impacts and adaptation varies amongst its stakeholders. Implementation of coordinated outreach efforts will help to ensure that the full potential of the codes and standards network is harnessed toward improving the resilience of Canada's infrastructure.

   There are effective, proven tools and techniques for engaging codes and standards stakeholders. Further consideration should be given on how to deploy them as part of outreach and awareness initiatives. Examples of such tools and techniques include: facilitated workshops during standards committee meetings, as well as supplemental workshops, symposiums and facilitated discussions.

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