UNIVERSITY OF WATERLOO

INTACT CENTRE
ON CLIMATE ADAPTATION

Industry-specific
CLIMATE RISK
MATRICES

# TRANSITIONING FROM RHETORIC TO ACTION: INTEGRATING PHYSICAL CLIMATE CHANGE AND EXTREME WEATHER RISK INTO INSTITUTIONAL INVESTING

Supported by:

intact

GRI GLOBAL RISK INSTITUTE

clearsum

Kathryn Bakos
Dr. Blair Feltmate

July 2023

## About the Intact Centre on Climate Adaptation

The Intact Centre on Climate Adaptation (Intact Centre) is an applied research centre at the University of Waterloo. The Intact Centre was founded in 2015 with a gift from Intact Financial Corporation, Canada's largest property and casualty insurer. The Intact Centre helps homeowners, communities, and businesses to reduce risks associated with climate change and extreme weather events. For additional information, visit: www.intactcentreclimateadaptation.ca

## About the University of Waterloo

The University of Waterloo is Canada's top innovation university. With more than 42,000 full and part-time students (Fall 2022), the university is home to the world's largest co-operative education system of its kind. The university's unmatched entrepreneurial culture, combined with an intensive focus on research, powers one of the top innovation hubs in the world. For additional information, visit: www.uwaterloo.ca

## About the Global Risk Institute

Global Risk Institute in Financial Services (GRI) is a premier organization that defines thought leadership in risk management for the financial services sector. We bring together leaders from industry, academia and government to draw actionable insights on risks worldwide. We are a non-profit, public and private partnership with 45 government and corporate members from asset management, banking, credit unions, insurance and pension management. Our goal is to be a critical resource to government and the financial industry to mitigate and adapt to risks focused on ensuring the stability of the financial ecosystem.

## About Clearsum

Clearsum is a multidisciplinary, business management and strategy advisory firm with deeply rooted expertise in climate change and risk management. Our experienced advisors have helped develop climate strategies, assess and manage risk, and integrate climate change considerations in investment processes for the financial and real estate sectors, with energy producers, in the agro-manufacturing sector, and in the transportation sector. Our clients include corporate issuers, asset owners, investors, investment managers and leadership/educational institutions.

Our mission is to help organizations create enduring financial and societal value. We achieve this by offering industry-leading, science-based, and data-driven strategy services that place climate-resilience, organizational performance, and sustainability principles at the core of organizational strategy. For more information visit: www.clearsum.com or email: info@clearsum.com

## About Intact Financial Corporation

Intact Financial Corporation (TSX: IFC) is the largest provider of property and casualty (P&C) insurance in Canada, a leading provider of global specialty insurance, and, with RSA, a leader in the U.K. and Ireland. Their business has grown organically and through acquisitions to over $21 billion of total annual premiums. In Canada, Intact distributes insurance under the Intact Insurance brand through a wide network of brokers, including its wholly-owned subsidiary BrokerLink, and directly to consumers through belairdirect. Intact also provides affinity insurance solutions through the Johnson Affinity Groups. In the U.S., Intact Insurance Specialty Solutions provides

a range of specialty insurance products and services through independent agencies, regional and national brokers, and wholesalers and managing general agencies. In the U.K., Ireland, and Europe, Intact provides personal, commercial and specialty insurance solutions through the RSA brands.

All findings and recommendations of this study are those of the Intact Centre.

## Acknowledgments

The Intact Centre thanks GRI, CLEARSUM and IFC for their support of the report. We are grateful to all industry professionals who provided expertise on the development of the Climate Risk Matrices and offered feedback on the report. A special thanks to Joanna Eyquem, Melie Monnerat, Anabela Bonada, Sarah Van Veen, George Sutherland and Sarasin and Partners' Ben McEwen for offering expert advice and feedback on the report.

## Citation

Bakos, K. & Feltmate, B. (2023). Transitioning From Rhetoric to Action: Integrating Physical Climate Change and Extreme Weather Risk Into Institutional Investing. Prepared by the Intact Centre on Climate Adaptation, University of Waterloo.

**For information about this report, contact Kathryn Bakos: kbakos@uwaterloo.ca**

## Disclaimer

# Table of Contents

"Physical climate risk – think flooding, wildfire and extreme heat – is impacting companies across all sectors. Institutional investors need to factor these growing risks into portfolio management. This report offers a very practical tool – Climate Risk Matrices – that portfolio managers can use to assess the exposure of investee companies to extreme weather."

**The Honourable Rosa Galvez**
Ph.D., P.Eng., FEC, FCSCE, FCAE

# Executive Summary

Irreversible climate change and extreme weather events are affecting companies across all industry sectors with increasing severity (UNEP, 2022). Impacts differ based on geographic location, and generally manifest either episodically (e.g., extreme flooding, drought, wildfire, wind, hail) or gradually (e.g., permafrost loss in northern regions, sea level rise) (IPCC, 2022; Bush & Lemmen, 2019).

In this report, *climate risk* refers to the magnitude of a peril (e.g., flooding, wildfire, etc.) positioned relative to its probability of occurrence (including tail risk). Due to escalating climate change impacts, institutional investors must incorporate climate risk into portfolio management to satisfy fiduciary duty.

To meet this duty, this report presents **Climate Risk Matrices (CRM)**. CRMs identify industry-specific top tier climate perils, their impacts, and risk mitigation strategies, that institutional investors should consider when deciding to include, exclude or adjust the weighting of a company in a portfolio.

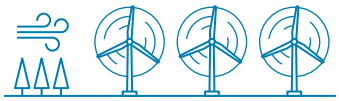
Six CRMs are profiled in this report, belonging to the following sectors/subsectors:

## UTILITIES

### Electricity Transmission & Distribution

### Hydro Electricity Generation

### Wind Electricity Generation



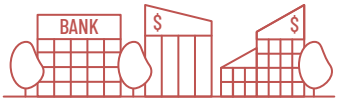
## REAL ESTATE

### Commercial Towers

## FINANCIALS

### Property and Casualty Insurance

### Banking




Climate perils and risk mitigation actions profiled in the CRMs were developed based on expert advice of 5-10 chief operating officers (or similarly experienced individuals), each with a minimum of 15 years of experience in the sector under consideration.

The utility of CRMs is not limited to the fiduciary needs of institutional investors – for example:

- **Retail Investors:** CRMs offer simple guidance to inform retail investors on the physical climate risks facing their investment portfolios
- **Securities Commissions:** CRMs can provide guidance to assess the adequacy of industry-specific climate risk disclosure by issuers
- **Credit Rating Agencies:** CRMs can enable credit rating agencies to incorporate climate risk into rating adjustments, and
- **Boards of Directors:** board members may apply CRMs to oversight of management relative to climate risk.

CRMs offer a practical means to account for physical climate risk in portfolio management. Accordingly, **the Canadian investment community (e.g., a coalition of leading institutional investors) may wish to develop CRMs, beyond those covered in this report.**

# Introduction

Human-induced climate change results in extreme weather events (e.g., floods, wildfires, extreme heat, droughts, permafrost loss, etc.) that have caused widespread adverse impacts to individuals, communities, governments and businesses (IPCC, 2022). Transitioning to a low-carbon global society is imperative to avoid the worst impacts of climate change. However, due to the cumulative emissions of greenhouse gases (GHGs) to date, a certain degree of climate change is irreversible (IPCC, 2022; Bush & Lemmen, 2019). To manage these impacts, physical climate perils must be identified, mitigation measures must be applied, and remaining risk must be disclosed.

The objective of this report is to present a risk management protocol that will aid financial market participants (e.g., institutional investors, retail investors, securities commissions) in incorporating physical climate risk into investment decision-making and disclosure and guide the implementation of adaptation measures across industry sectors to minimize losses. Before turning to this protocol, a review of the evolving relevancy of climate change applied to the capital markets is in order.

## Impact of Physical Climate Risk Across the Capital Markets

In response to irreversible climate change, global warming, exacerbated extreme weather events, and the global response to these threats, the safety and soundness of the global financial system will continue to be significantly impacted (OSFI, 2022; Brunetti, et al., 2021; TCFD, 2021; Krueger, et al., 2019; Roman, 2019).

Physical climate change and extreme weather adversely affect economic and financial outcomes across industry sectors through loss and damage to private and public infrastructure, negative supply chain shocks, disruptions to the continuity of business operations, reduced labour productivity, and rising mortality rates (OSFI, 2022; Andersson, et al., 2020; Brunetti, et al., 2021).

This prompts the reassessment of asset values, changing the cost or availability of credit and insurance, and/or may affect the timing or reliability of cash flows (OSFI, 2022; Andersson, et al., 2020; Brunetti, et al., 2021). Micro and macro-economic trends (i.e., jobs creation/loss, household income/debt, inflation, etc.) could also be impacted by a changing climate - creating, and amplifying, financial risks[1] [2] (BOC, 2023; BOC, 2021).

To support efficient capital allocation toward companies responding to these threats, financial markets must price risk appropriately and to do so they must have accurate information to inform market participants (SEC, 2022a; OECD, 2021). Comparable, reliable, and timely disclosure from companies, across all industry sectors/subsectors, will provide the information needed to properly price and value assets (OECD, 2021).

## Global Disclosure Frameworks and Standards

Within the growing field of sustainability and climate-related disclosure, multiple frameworks and standards exist to establish a foundational layer of data required to inform investment and business decision making. Disclosure *frameworks* provide a set of principles-based guidance for how information should be structured and prepared across broad topics, while disclosure *standards* provide specific and detailed requirements of what should be reported for each topic. Disclosure frameworks and standards are complementary and designed to be used together.

As a principles-based framework, the Task Force on Climate-Related Financial Disclosures (TCFD) was created to help investors, lenders, insurance underwriters, etc. identify and understand the information needed to assess and price climate-related risks and opportunities (TCFD, 2022; UNEP FI, 2022).

1 Micro-economic example: weather-related property destruction can lead to financial institution losses, resulting in less lending and reduced investment (ECB, 2020; Brunetti, et al. 2021).

2 Macro-economic example: rebalancing portfolios to account for a greater probability of chaos/black swans/tail events within a 12-month forward looking economic outlook (ECB, 2020; Brunetti, et al. 2021).

To action frameworks such as the TCFD, the Sustainability Accounting Standards Board (SASB) developed specific metrics and targets, across 77 industry sectors, that identify environmental, social and governance (ESG) issues most relevant to financial performance and enterprise value (SASB, 2022).

The TCFD and SASB are two examples of disclosure frameworks and standards that characterize the disclosure landscape. Companies and financial institutions utilize a variety of disclosure standards and frameworks, often referred to as the "ESG alphabet soup" (IFRS, 2023a; Watkin, 2023; Kirkland & Ellis, 2022; Whieldon, 2021; Metz & Bakos, 2021; Jones et al., 2020).

> Companies and financial institutions utilize a variety of disclosure standards and frameworks, often referred to as the "ESG alphabet soup".

Growing pressure from governments, consumers and investors has compelled companies to respond to climate change through voluntary disclosures, which are often seen as inadequate (Jessop et al., 2022, Halper et al., 2021). Voluntary disclosures experience significant gaps in reporting as not all issuers disclose risks that may be material to operations (SEC, 2022a; Whieldon, 2021; OSC, 2018). For example, many companies fail to consider the strategic and financial impacts physical climate risks have on their business, assessing only the impact their business has on the environment and climate (or vice versa) (CDSB, 2020).

Mandatory climate-related disclosure standards are necessary to drive standardization for capital markets to reduce fragmentation, simplify the disclosure landscape and increase standardization (CSA, 2022; Fairfax et al., 2022). Accordingly, the Canadian regulatory body, the Office of the Superintendent of Financial Institutions (OSFI), issued "Guideline B-15: Climate Risk Management", a mandatory climate-related financial disclosure that aligns with the TCFD (OSFI, 2023; OSFI, 2022). The guideline is intended to "incentivize improvements in the quality of federally regulated financial institutions governance and risk management practices related to climate – increasing transparency and public confidence in the Canadian financial system" (OSFI, 2023; OSFI, 2022). Additionally, a newly formed organization in Canada, the Canadian Sustainability Standards Board, will oversee adoption of global corporate sustainability standards and tailor the new standards for the domestic market (Jones, 2023).

In the United States, the Securities and Exchange Commission (SEC) is proposing amendments to the Securities Act of 1933 ("Securities Act"), which would require registrants to provide climate-related information in their registration statements and annual reports (which aligns with the TCFD) (SEC, 2022b; Federal Register, 2022). Similarly, the European Commission has adopted a technical standard to be used by financial market participants when disclosing sustainability-related information under the Sustainable Finance Disclosures Regulation (SFDR) (EU Commission, 2022a).

Even as regulatory requirements become commonplace, there is still an over saturation of disclosure frameworks and standards in the market that do not provide stakeholders with complete, consistent, and comparable information (Table 1).

To streamline sustainability and climate disclosure requirements, the International Financial Reporting Standards Foundation (IFRS) announced the creation of a new standard-setting board - the International Sustainability Standards Board (ISSB). The ISSB was created to develop a comprehensive global baseline of sustainability and climate-related disclosures to meet the information needs of the capital markets (IFRS, 2023a; IFRS, 2022a; Kirkland & Ellis, 2022; Grimaldi et al., 2020).

**Table 1:** Comparative Overview of ESG Frameworks (areas of focus differ sharply between reporting frameworks)

| Names of Frameworks and Standards | Structural Differences between Frameworks and Standards | | | | | |
|---|---|---|---|---|---|---|
| | Extent of Adoption | Metrics & Targets | Environmental Considerations | Social Considerations | Governance Considerations | Indigenous Considerations Indigenous Peoples (IP) |
| **Organization for Economic Co-operation and Development Guidelines for Multinational Enterprises** | 50 governments representing two-thirds of global trade adhere to the Guidelines | Include targets as part of internal environmental control system | Environmental impacts of activities, products, and services | • Workers & Relationships with Workers<br>• Human Rights | Governance Structures & Policies | Human Rights Impacts on IP |
| **Task Force on Climate-Related Financial Disclosures** | >3,000 organizations are TCFD supporters | Metrics and targets used to assess and manage risks and opportunities, Scope 1, 2, 3 (if appropriate) GHG emissions | Climate Risks & Opportunities | • Reputation Risk<br>• Supply Chains<br>• Employee Safety<br>• Workforce Management & Planning | Governance around climate-related risks & opportunities:<br>a. Board's Oversight of Risks & Opportunities<br>b. Management's Role in Assessing & Managing Risks & Opportunities | No mention |
| **Global Reporting Initiative** | Thousands of reporters in more than 100 countries | • Universal: human capital metrics, compensation<br>• Topic-specific metrics (e.g., emissions, energy intensity) | • Materials<br>• Energy<br>• Waste<br>• Supplier Environmental Assessment<br>• Emissions<br>• Biodiversity<br>• Water & Effluents<br>• Environmental Compliance | • Employment<br>• Labour/Management Relations<br>• Occupational Health & Safety<br>• Training & Education<br>• Diversity & Equal Opportunity<br>• Non-Discrimination<br>• Freedom of Association and Collective Bargaining<br>• Child & Forced Labour<br>• Security Practices<br>• Local Communities<br>• Supplier Social Assessment<br>• Public Policy<br>• Customer Health & Safety<br>• Marketing & Labeling<br>• Customer Privacy | • Anti-corruption<br>• Anti-competitive Behavior<br>• Procurement Practices<br>• Indirect Economic Impacts<br>• Economic Performance<br>• Market Presence<br>• Tax | Rights of IP |
| **Carbon Disclosure Project** | 9,600 companies disclose globally, including more than 2,500 North American companies. 800 regions disclose worldwide | • Emissions and climate-related metrics and targets<br>• Water consumption<br>• Commodity, land, consumption metrics | • Climate<br>• Water<br>• Forests | • Employee Engagement Related to Topic<br>• Employee Incentives for Management of Topic Issues<br>• Social Criteria of Public Commitments | • Board Oversight of Topic<br>• Board Member Competence Related to Topic<br>• Management Responsibility for Topic<br>• Incentives for Management on Topic | UN Declaration on the Rights of IP Remediation of Adverse Impacts on IP |
| **Sustainability Accounting Standards Board** | Standards are available for 77 industries. 1858 unique SASB reporting companies | Topic-related metrics and targets | • GHG Emissions<br>• Air Quality<br>• Energy Management<br>• Water & Wastewater Management<br>• Waste & Hazardous Materials Management<br>• Ecological Impacts | • Human Rights & Community Relations<br>• Customer Privacy<br>• Data Security<br>• Access & Affordability<br>• Product Quality & Safety<br>• Customer Welfare<br>• Selling Practices & Product Labeling<br>• Labour Practices<br>• Employee Health & Safety<br>• Employee Engagement, Diversity & Inclusion | | Security, Human Rights, & Rights of Indigenous Peoples |

| Names of Frameworks and Standards | Structural Differences between Frameworks and Standards | | | | | |
|---|---|---|---|---|---|---|
| | Extent of Adoption | Metrics & Targets | Environmental Considerations | Social Considerations | Governance Considerations | Indigenous Considerations Indigenous Peoples (IP) |
| **International Integrated Reporting Framework** | Over 2,500 businesses in 75 countries | • Monetized metrics helpful<br>• Targets and indicators with respect to targets | Natural Capital | Human Capital | • Governance Structure, Processes, and Practices<br>• Leadership Structure<br>• Remuneration and Incentives Linked to Value Creation | No Mention |
| **Climate Disclosure Standards Board Framework** | 374 CDSB Framework users | • Monetized metrics helpful<br>• Targets and indicators with respect to targets | • GHG emissions<br>• Energy<br>• Non GHG pollutants<br>• Deforestation and Ecosystems<br>• Resource Use<br>• Water Use<br>• Waste and Spillages | • Internal Workforce<br>• Value Chain Workforce<br>• Community Members<br>• Consumers | • Environment & Social Policies and Strategies | Impact on Indigenous communities is mentioned under social disclosures |
| **Green, Social, and Sustainability-Linked Principles, and Sustainability Bond Guidelines** | Canadian ICMA member firms include Arteria AI Inc, Bank of Montreal, Export Development Canada, and National Bank of Canada | • Measurable and benchmarked KPIs<br>• Targets based on performance | *Green Projects include:*<br>• Renewable Energy & Energy Efficiency<br>• Pollution Prevention & Control<br>• Environmentally Sustainable Management of Living Natural Resources and Land Use<br>• Terrestrial & Aquatic Biodiversity<br>• Clean Transportation<br>• Sustainable Water and Wastewater Management<br>• Climate Change Adaptation<br>• Circular Economy Adapted Products, Production Technologies, and Processes and/or Certified Eco-Efficient Products<br>• Green Buildings | *Social Projects include:*<br>• Affordable Basic Infrastructure<br>• Access to Essential Services<br>• Affordable Housing<br>• Employment Generation<br>• Food Security & Sustainable Food Systems<br>• Socioeconomic Advancement & Empowerment | N/A | No Mention |

**Source:** OECD, 2023; TCFD, 2021; GRI, 2023a; CDP, 2023; SASB, 2023a; SASB, 2023b; IFRS, 2023b; IFRS, 2023c; ICMA, 2023.

The ISSB's "*International Financial Reporting Standards S2 Climate-related Disclosures*" builds on the recommendations of the TCFD and incorporates industry-based disclosure requirements from SASB to simplify the disclosure landscape (IFRS, 2023a; IFRS, 2022a). ISSB's Climate-related Disclosure sets out requirements to identify, measure and disclose climate-related risks and opportunities through data-based and narrative-driven disclosures (IFRS, 2023a; IFRS, 2022a). This streamlines the process for organizations like the Carbon Disclosure Project (CDP) - an international organization helping companies and cities disclose environmental impact - to ensure its 17,000+ voluntary users align disclosure data correctly (IFRS, 2022b; CDP, 2022).

The ISSB is also working with the European Commission, European Financial Reporting Advisory Group (EFRAG), International Organization of Securities Commissions Organization (IOSCO) and Global Reporting Initiative (GRI) to ensure alignment of all climate-related disclosures (IFRS, 2022c; EU Commission, 2022b, EBA, 2022; IOSCO, 2022; GRI, 2022).

The problem is there are no industry specific metrics and targets, within an industry sector/sub-sector, against which a company can be benchmarked.

Disclosure requirements for ISSB (and TCFD) fall into four broad pillars — governance, strategy, risk management, and metrics and targets (IFRS, 2023a; IFRS, 2022a; TCFD, 2022). The issuer is responsible for disclosing how a company would approach these four pillars in the context of climate-related risks and opportunities. In addition to general reporting guidance, the ISSB recommends that entities rely on industry-specific guidance for disclosures to be provided on a timely basis, maintain consistency over time, and comparability among companies within similar sectors, industries, or portfolios (IFRS, 2023a; IFRS, 2022a; Deloitte, 2022).

The problem is there are no industry specific metrics and targets, within an industry sector/sub-sector, against which a company can be benchmarked. SASB and GRI have taken the lead to develop industry specific standards but offer limited explanation as to the actions investee companies should take to reduce these disclosed risks (SASB, 2023b; SASB, 2023c, GRI, 2023b). To ensure investment and business criteria in the ESG landscape are not misleading, investors need credible ways to understand issuer risk, while demonstrating how climate risks are incorporated into decision making (Vasil, 2023; IFRS, 2023a; Nguyen & Goldstein, 2022; TCFD, 2022; Fairfax et al., 2022; CCRI, 2021; Metz & Bakos, 2021).

Relative to the physical risks of climate change, the outstanding challenge for market participants is to: (1) **identify** which extreme weather events have the highest probability of affecting individual industry sectors/sub-sectors, and (2) **assess** whether potential investee companies have implemented appropriate actions to mitigate extreme weather risks specific to sectors/sub-sectors.

The primary purpose of this paper is to present a protocol and risk management framework that will act as (1) a template against which companies can self-evaluate their management of physical climate risk, and (2) an industry-wide benchmark that financial market participants can use to compare company efforts to reduce risks with an industry sector.

The primary purpose of this paper is to present a protocol and risk management framework that will act as

1. a template against which companies can self-evaluate their management of physical climate risk, and
2. an industry-wide benchmark that financial market participants can use to compare company efforts to reduce risks within an industry sector.

This protocol complements frameworks and standards that already exist (e.g., TCFD, SASB, GRI, ISSB, etc.), by providing a means for companies to identify and mitigate risks. The protocol also directly addresses Canada's National Adaptation Strategy by allowing businesses to include adaptation to climate change in plans and strategies to strengthen their competitiveness, while communicating the business case for adaptation to clients (GOC, 2023).

The protocol expands on work previously completed by the Intact Centre on Climate Adaptation (Intact Centre) in the 2020 report, "*Factoring Climate Risk into Financial Valuation*". The protocol prioritizes the top means by which severe, yet plausible, climate-related disasters (e.g., flood, wildfire, wind, etc.) may negatively impact business continuity for each industry sector/sub-sector, while simultaneously identifying actions a company should take to mitigate prioritized risks (including probable and tail risk) (Feltmate et al., 2020).

## Climate Risk Matrices (CRMs)

The risk prioritization framework is profiled in easily interpretable industry-specific ***Climate Risk Matrices (CRMs)***, which convey utility to users by describing exactly how a company should identify and manage climate change and extreme weather risks.

Furthermore, **by way of a case study**, this report demonstrates market-level impacts associated with extreme weather on the commercial real estate sector and the predisposition to incorporate physical climate risk into share price and asset valuation.

## Applicability to Stakeholders

Although the target audience for the Climate Risk Matrix framework is institutional investors, the matrix is also of value to:

1. **Retail Investors:** individual or private investors can incorporate this guidance into ESG investment strategies to ensure physical climate risk is included in investment decision making,

2. **Securities Commissions:** calling for material climate risk disclosure by issuers (e.g., CSA Staff Notice 51-358, 2019a; OSC National Instrument 51-107: Disclosure of Climate-related Matters, 2021),

3. **Credit Rating Agencies:** under circumstances where extreme weather events might impact the capacity of a borrower to repay a loan (Tigue, 2019),

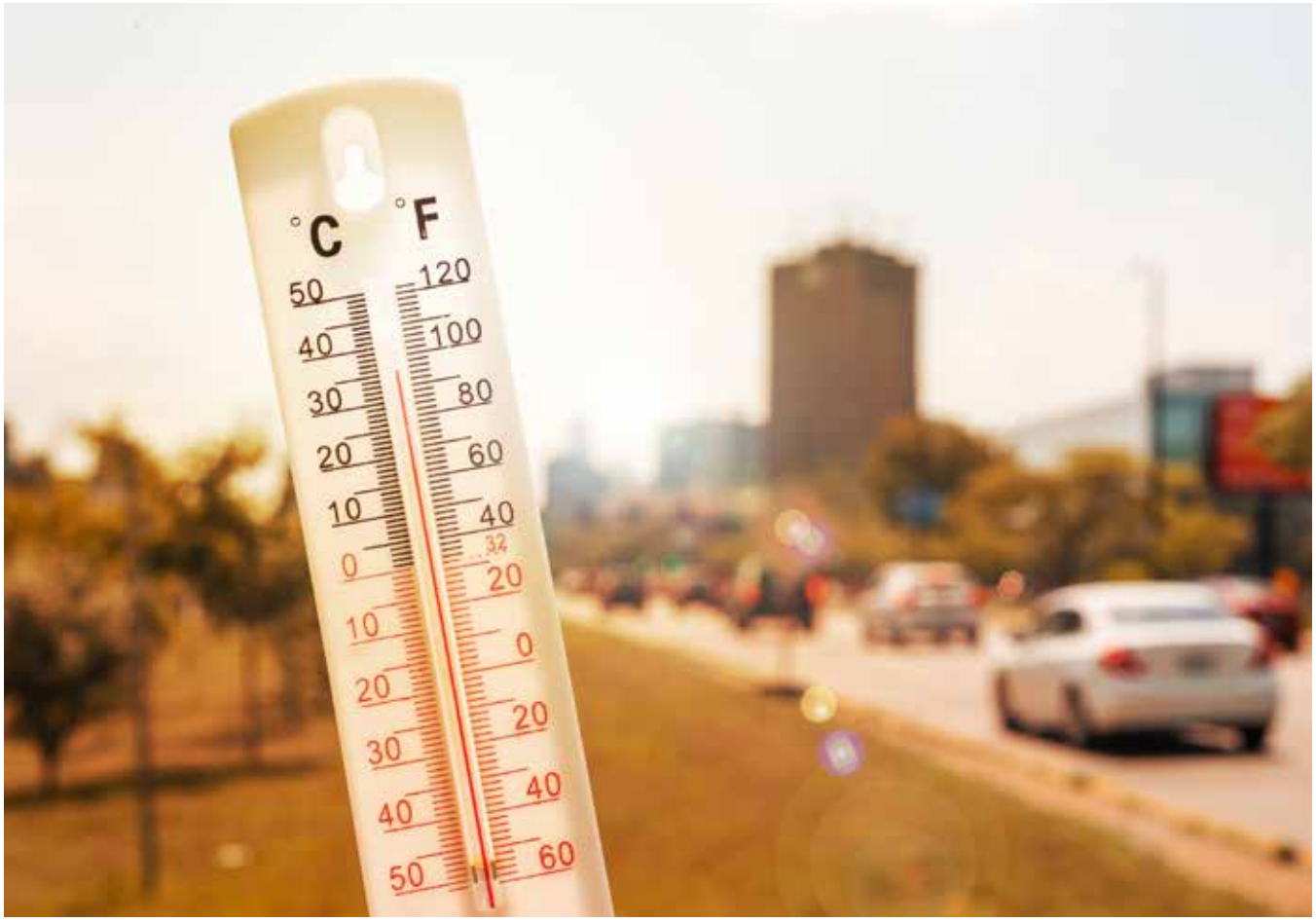
4. **Boards of Directors:** requiring concise guidance on the physical manifestation of climate change risk; and

5. **Financial Institutions**, and the financial system more broadly: participating in the global response to the threats posed by climate change (OSFI, 2022) (Box 1).

In sum, a concise encapsulation of industry-specific climate change and extreme weather risks, presented in a standardized user-friendly form, will provide high-quality, reliable, and accurate information to serve the needs of a range of users (i.e., sufficiently granular to guide specialized users (institutional investors), while high-level enough to provide information to the general public (retail investors)), and support stakeholders in developing greater resilience to, and management of, physical climate risks.

In this study, six industry sectors/subsectors are profiled to illustrate how climate change and extreme weather risk can be incorporated into portfolio management and business decision making:

- Electricity Transmission & Distribution ("T&D")
- Commercial Real Estate ("CRE")
- Property and Casualty ("P&C") Insurance (Personal Home Insurance)
- Banking (Residential Mortgage Providers)
- Hydroelectricity Generation
- Wind Electricity Generation




These six industry sectors were selected as "model or illustrative sectors", based on four requisite criteria (TCFD, 2019):

- **Operational Impacts:** Model sectors experience substantial impacts due to climate change and extreme weather events (e.g., Chen, 2021; Pryor et al., 2020; Kovacs, 2019; Burillo, 2018; USDE, 2017; Bienert, 2016),
- **Mitigation Actions:** relative to the model sectors, means to mitigate climate change and extreme weather risks are reasonably well understood (e.g., BOMA, 2022; IBC, 2022; S&P, 2022; IEA, 2021; CSA, 2019a),
- **Geographical Range:** climate change and extreme weather risks (e.g., flood, wildfire, wind) can impact model sectors in virtually any populated region of Canada (IPCC, 2022; Bush & Lemmen, 2019), and
- **Subject Matter Expertise:** subject matter experts, generally drawn from professional industry associations, are/were accessible to identify the impact(s) of climate change on the sector.

Before describing the framework to establish a Climate Risk Matrix, it is necessary to first understand how climate risk will continue to become more severe, and thus of greater relevance to stakeholders across the capital markets.

### Box 1: Climate Risk Matrices (CRMs) can mobilize OSFI's **Guideline B-15: Climate Risk Management - Sound Business Practices and Prudential Limits**

The **Office of the Superintendent of Financial Institutions** (OSFI) Guideline B-15: Climate Risk Management – Sound Business Practices, emphasizes that "building resilience against climate-related risks requires vulnerabilities to be addressed throughout business models, operations, and balance sheets" (OSFI, 2023).

**Federally Regulated Financial Institutions** (and other businesses) should "identify, collect, and use reliable, timely, and accurate data pertaining to physical risk concentrations (e.g., geophysical location of exposures, sectors, products or counterparties) relevant to its business activities to inform risk management and decision making" (OSFI, 2023). This information can also be used to "measure and assess climate-related risks" (OSFI, 2023).

Climate Risk Matrices (CRMs) provide a means to mobilize Guideline B-15.

CRMs identify and prioritize extreme weather (e.g., flood, wildfire, wind, etc.) impacts specific to the operations of an issuer, and the actions the company should take to limit those risks. Importantly, the risks identified in the CRMs are "truth-tested" based on consensus by subject matter experts.

When tools are developed by external third parties, such as the CRMs, OSFI advises that "businesses should understand the data, methodology, assumptions and limitations" of the information being provided (OSFI, 2023). The value CRMs provide is that they are non-technical in nature, so interpretation of physical climate risks does not require in-depth expertise. Anyone, from retail investors to portfolio managers, with or without expertise in a given industry sector, could utilize this information.

Additionally, CRMs offer 100% transparency – they are not shrouded in "black box" algorithms.

Finally, OSFI advises that "climate-related risks should be incorporated into internal monitoring and reporting to assess effectiveness of climate risk management" (OSFI, 2023). CRMs offer a practical, cost-effective, and user-friendly method to incorporate physical climate risk into investment and business decision-making that complements frameworks and standards such as TCFD, SASB and ISSB (IFRS, 2023a; TCFD, 2022).

The CRMs reflect the direction of ISSB and TCFD's pillars of:

- **Governance** - integrating climate change risks and opportunities into governance protocols
- **Strategy** - incorporating climate-related risks and opportunities into the organization's business, strategy, and financial planning
- **Risk Management** - disclosing how organizations identify, assess, and manage climate-related risks
- **Metrics and Targets** - assessing and managing relevant climate-related risks and opportunities where material (IFRS, 2023a; TCFD, 2022).

## Growing Costs of Climate Change

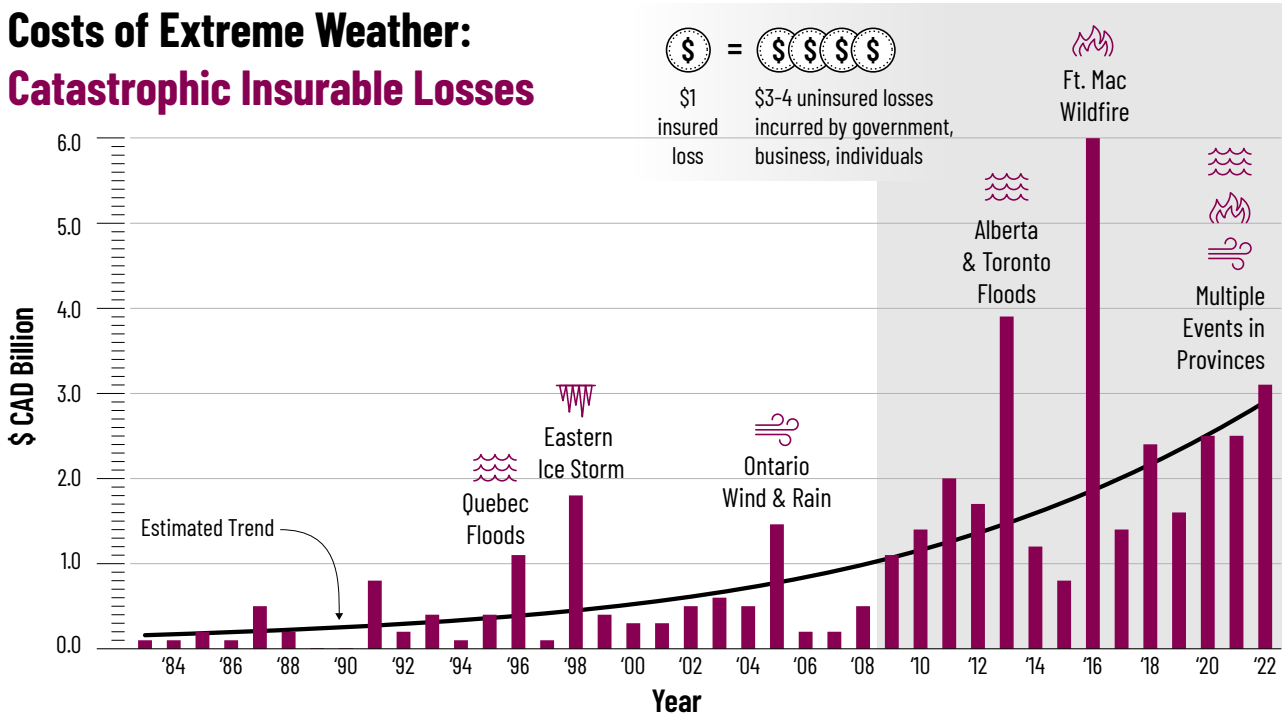
As profiled in Canada's Changing Climate Report 2019 (Bush & Lemmen, 2019), and in *Climate Change 2022: Impacts, Adaptation and Vulnerability* (IPCC, 2022), a certain degree of climate change and extreme weather is effectively irreversible, and will continue to challenge many, if not all, industry sectors across Canada. Although initiatives within Canada, and globally, to mitigate greenhouse gas emissions (e.g., Canadian Net-Zero Emissions Accountability Act 2021) (GOC, 2021; GOC, 2020a) and sequester carbon (GOC, 2022) are commendable, these efforts will slow, but not stop, climate change.

The term "**new normal**" is often used to describe weather that today is more extreme than was commonplace prior to 2010 (Ludden, 2021; Moore, 2019) – however, caution should be exercised relative to this terminology, as it can instill a sense of complacency that could unintentionally add risk to investment and business decision-making.

Extreme weather, driven in concert with a changing climate, will continue to evolve and become increasingly severe over time, thus generally rendering greater costs across industry sectors. That is to say that **there will be nothing normal about the weather of the future** (UCAR, 2022; GCA, 2019). Market participants and stakeholders must, therefore, be vigilant and cognizant of the increasing potential for severe weather to impact investments over time.

For example, Figure 1 presents catastrophic insured losses (i.e., events that trigger > $25 million in claims) associated with extreme weather in Canada over

**Figure 1:** Catastrophic Insurable Claims ($ Can/billions) in Canada, 1983-2022. Red bars represent loss + loss adjusted expenses. $1 in insured loss reflects an "insurance gap" of $3-4.




**Source:** IBC, 2023; CatIQ, 2023 **Note:** claims have been normalized for inflation ($2022) and per capita wealth accumulation.

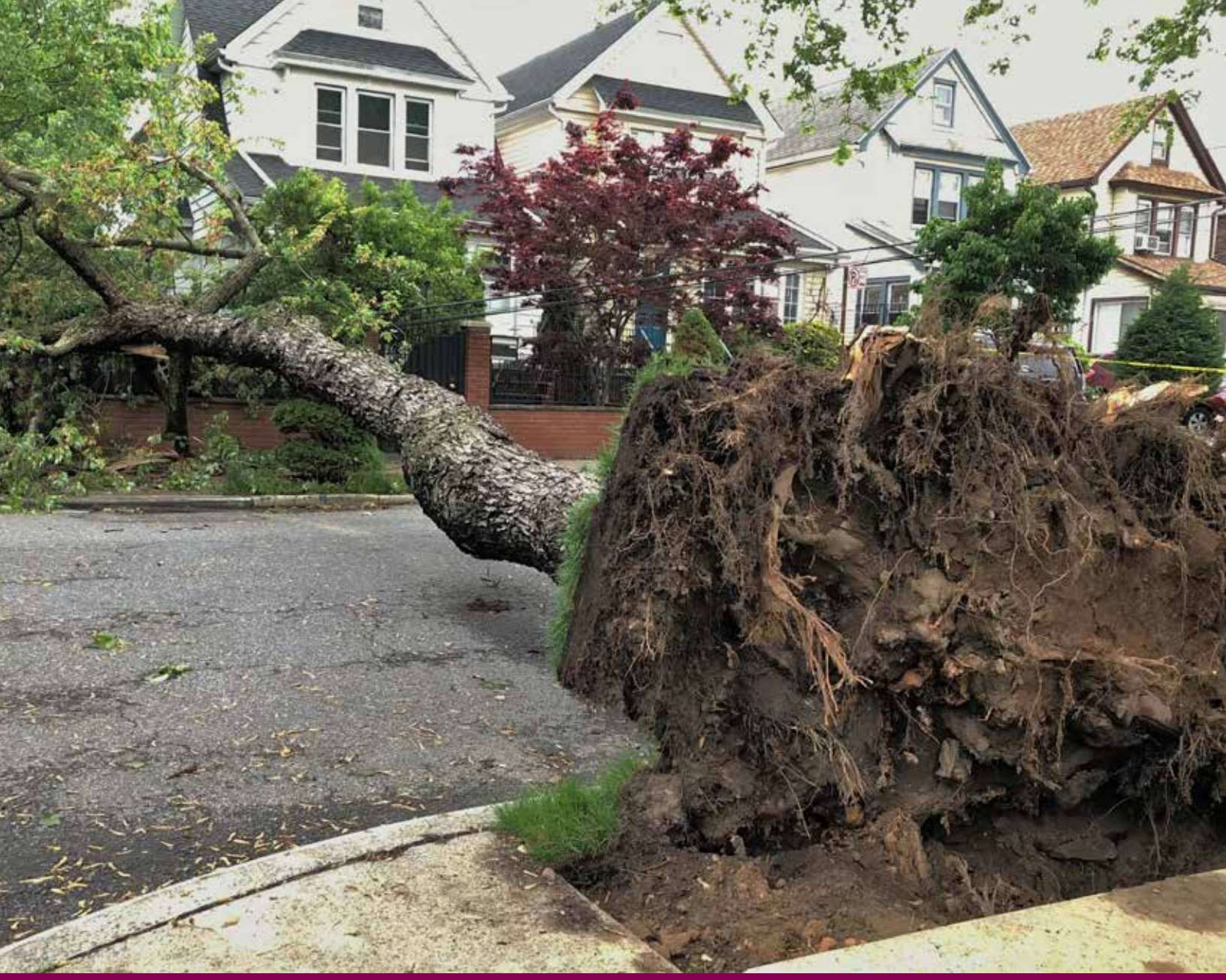
the period 1983-2022. From 1983-2008, insurance losses ranged from $250-$450 million per year (IBC, 2020). From 2009-2022 losses increased, averaging approximately $2 billion per year, and for 13 of those 14 years, annual losses exceeded $1 billion. For 2022, losses reached $3.1 billion, ranking it as the 3rd worst year for insured losses in Canadian history (IBC, 2023). Unlike 2016, the highest loss year on record, where the Fort McMurray, Alberta, wildfire accounted for about 75% of national losses, the disasters of 2022 were widespread and variable (IBC, 2023). Climate change models predict geographically dispersed impacts, and that is what Canada is experiencing (Feltmate & Shukle, 2023).

Compounding factors that can affect claims include loss of natural habitats (i.e., wetlands, grasslands, forested areas, etc.) due to development, aging municipal infrastructure and housing construction practices that in the past did not adequately incorporate resilience considerations.

As a cautionary note, the upward claims trend in Figure 1 is not solely due to escalations in extreme weather events. For example, compounding factors that can affect claims include loss of natural habitats (i.e., wetlands, grasslands, forested areas, etc.) due to development, aging municipal infrastructure and housing construction practices that in the past did not adequately incorporate resilience considerations (Eyquem & Bakos, 2022; Bakos et al., 2022; Moudrak & Feltmate, 2019).

Further evidence of the growing costs associated with extreme weather is evident in escalating payments made by the Federal Government of Canada through Disaster Financial Assistance Arrangements (DFAA) - funds transferred from the federal to provincial or territorial governments, principally to provide relief when the costs associated with extreme weather events are exceptional. According to Public Safety Canada, since the inception of the program in 1970, the Government of Canada has contributed more than $5.97 billion in post-disaster assistance (PSC, 2021; PBOC, 2016). From 2020-2021, the estimate for payments through this program was $445.75 million, up from $345.8 million in 2018-2019, substantially in excess of the nominal DFAA budget of $100 million (per year) (PSC, 2021; PBOC, 2016). Escalating insurance claims combined with substantial increases in DFAA transfer payments presage the growing risk of climate change and extreme weather.

The discussion of this paper now turns to a practical means to prioritize risks in user-friendly format that can be used in investment and business decision-making.



# Method: Developing Climate Risk Matrices

## The method used to develop the CRMs is described below. The protocol to establish climate risk prioritization applies to all industry sectors.

The method to establish a Climate Risk Matrix was based on two axioms. First, Operating Officers, or similarly experienced senior persons, who have worked in specific industry sectors for an extended period of time (which in this study was deemed to be > 15 years of service), are best positioned to identify and prioritize climate change and extreme weather risk for their industry. Second, when 5 to 10 of the aforementioned subject matters experts agree on the prioritization of industry specific risks, this lends assurance to the outcome (i.e., *no one understands the business of a business better than the business*).

Based on the above criteria, subject matter experts, with at least one representative drawn from eastern, central, western, and northern regions of Canada, were engaged virtually (due to COVID-19) in the following generalized protocol to create the CRMs:

1. each expert was asked to identify physical climate change risks/hazards they deemed to be most material to their business operation (e.g., flood, wildfire, wind, etc.),

2. each expert was asked to describe up to 5 ways business continuity/operations could be impacted by each of the identified hazards (e.g., access to facilities, service disruption, power outage, equipment damage, etc.), and

3. experts were asked to identify the most material hazards and associated operational challenges impacting the industry as a whole (accomplished vis-à-vis a voting exercise, where only 2-3 operational challenges were permitted per hazard).

Once the climate change and extreme weather concerns were established, participants performed three additional tasks:

4. identified what action, if any, could be reasonably taken to limit the identified risk/hazard,

5. established a question/challenge that a portfolio manager could present to an investee company/issuer to determine if the issuer is aware of the risk; and

6. provided direction as to what would constitute an "excellent response" or "good response" by the issuer in reference to the point of risk mitigation under consideration.

> The protocol applied to establish climate risk prioritization is applicable across all industry sectors.

Additionally, the protocols to establish CRMs draw upon climate risk factors identified through such organizations as (but not limited to) ISO, Standards Council of Canada, National Research Council, Canadian Standards Association, Sustainability Accounting Standards Board, Global Reporting Initiative, and the International Electro-technical Commission Standards.

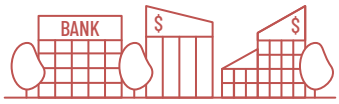
This generalized protocol was first profiled in the Intact Centre (2020) report, "*Factoring Climate Risk into Financial Valuation*", where CRMs were completed for the following industry sectors:

**Utilities: Electricity Transmission and Distribution (T&D)**

**Real Estate: Commercial Real Estate**

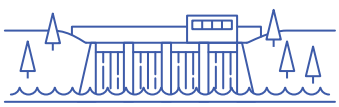
Utilizing the same protocol and complementing the CRMs already created, four new matrices were developed to convey standardized climate risk information in a user-friendly manner to ensure maximum uptake of data by technical and non-technical audiences for the following sectors:

**Financials: Banking**

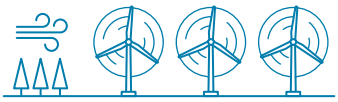



**Financials: Property and Casualty (P&C) Insurance**

**Utilities: Hydro Electricity Generation**



**Utilities: Wind Electricity Generation**



Finally, in this paper, the assumption is that the manifestation of extreme weather would likely be of risk to an issuer, more so than a benefit.

# Results: Climate Risk Matrices for Six Industry Sectors

Material presented in Tables 2 and 3 was initially published in the report, "*Factoring Climate Risk into Financial Valuation"* (Feltmate et al., 2020). CRMs should be updated, minimally every five years, unless material changes in risk merit more frequent adjustments. Tables 2 and 3 have been updated (since 2020) based on subject matter expert consultation (2022-2023).

13 international institutional investors, with a combined $2 trillion of Assets Under Management (AUM), were surveyed and agreed that industry-specific CRMs are a useful tool to inform investment decision-making from the perspective of portfolio management.

Tables 2 and 3 were field tested with investment professionals to determine their utility and ease of use, with results published in the report, "*Institutional Investors Find Alpha in Climate Risk Matrices: Global Survey Find"* (Moudrak et al., 2020). In this report, a group of 13 international institutional investors, with a combined $2 trillion of Assets Under Management (AUM), were surveyed and agreed that industry-specific CRMs are a useful tool to inform investment decision-making from the perspective of portfolio management.

Another outcome of the survey was the request from institutional investors to expand the level of detail provided in the CRMs to include more information, particularly in the "risk reduction measures" section of the matrices. Tables 2-7 incorporate that request.

**Table 2.** Climate Risk Matrix – Electricity Transmission and Distribution ( ! = prioritized areas of focus)

## Electricity Transmission and Distribution (T&D)

| Key Climate Risk Impacts | | | | | |
|---|---|---|---|---|---|
| **Flood** | **Wildfire** | **Extreme Heat** | **Windstorm** | **Snow and Ice Loading** | **Thawing Permafrost** |
| Flood-induced high-water levels result in inadequate electrical clearances below lines that are hazardous to the public. | Wildfire along T&D corridors can cause outages if corridors are not adequately clear of brush.<br><br>! Vegetation/tree contacts with transmission lines can cause arcing, fires, and outages. | Extreme heat can increase the risk of power outages. Very high temperatures make the likelihood of technical failure greater, at a time when operators may already be challenged in their ability to meet peak demand. | Vegetation/tree branches can fall onto T&D lines causing outages.<br><br>Distribution poles and overhead lines can be brought down by wind forces. | ! T&D lines and structures can collapse under heavy ice loading (emphasis on distribution poles and lines). | Thawing/discontinuous permafrost can displace transmission tower foundations, causing structural collapses and outages. |
| **Risk Reduction Measures** | | | | | |
| Ensure structures are tall enough for safe clearance under foreseeable flood levels, or T&D lines are installed underground.* | Conduct patrols (visual and/or drone** inspection of utility equipment and structures) in wildfire prone areas.<br><br>! Clear vegetation along transmission corridors. | Enhance the system's capacity to deal with higher demand under high temperature conditions. | Clear vegetation along transmission corridors.<br><br>Install anti-galloping devices on conductors and ensure structures are designed to withstand winds. | ! Install visual monitors to detect ice loading. Before ice loads build, boost current to melt ice (i.e., short the line). | Modify structure/ designs to readily permit adjustment of towers when line patrols identify permafrost thaw displacement. |
| **Key Questions and Responses to Determine Readiness to Mitigate Physical Climate Risk** | | | | | |
| What percentage of T&D lines in flood-prone areas have sufficient clearance to safely accommodate a 1:200-year flood without de-energizing the line? | ! Have companies taken action to address wildfire mitigation? | Has system capacity been enhanced (i.e., is there sufficient capacity) to fulfil higher demand during heat waves and avoid outages? | What percentage of total length overhead T&D lines in treed areas are closer than 10 metres horizontally to tree branches that are higher than the conductors? | ! Are overhead lines that are susceptible to icing monitored during winter months? | Do transmission structures, in discontinuous permafrost areas, have enough redundant capacity available? |
| *Excellent response*<br>> 75% | *Excellent response*<br>yes | *Excellent response*<br>System has already been enhanced | *Excellent response*<br>< 5% | *Excellent response*<br>yes | *Excellent response*<br>yes |
| *Good response*<br>50% or more | | *Good response*<br>Enhancements have been scheduled and budgeted | *Good Response*<br>< 25% | | |

*As of July 2023, underground lines are not a cost-effective risk reduction measure.
**Utilities need funding and/or rate increases to purchase drones, as visual inspections are not always practical.

**Table 3.** Climate Risk Matrix – Commercial Real Estate ( ! = prioritized areas of focus)

## Commercial Real Estate

### Key Climate Risk Impacts

| Flood | Wildfire | Windstorm | Extreme Heat | Ice, Hail, Snow Loading | Thawing Permafrost |
|---|---|---|---|---|---|
| ! Major or minor flooding can lead to property damage, business continuity disruptions, critical equipment damage and/or rendering it unworkable, and potential for loss of life. | Wildfire can lead to property damage, business disruption and loss of life.<br><br>Smoke from wildfires contains fine particulate matter and gases (i.e., carbon monoxide, carbon dioxide), which when concentrated impact respiratory health and may aggravate pre-existing heart and lung conditions. | ! High winds can loosen the perimeter flashing of the roof leading to roof detachment or "peel off".<br><br>Windborne debris can shatter windows.<br><br>High winds increase the probability of water being brought into the buildings. | Extreme heat can increase likelihood of HVAC failure, damage heat-sensitive equipment (e.g., servers, freezers), cause business disruption and loss of life (cold storage and data centres of greatest concern).<br><br>Extreme heat will exacerbate water stress impacting water supply and quality used for irrigation, potable water, and cooling demands of buildings. | Snow and ice can accumulate on flat roofs, increasing the risk of roof collapses.<br><br>As snow and ice melt on the roof, leaks can cause water damage and mould.<br><br>Outdoor pipes and pipes in unheated areas (basements, garages, crawl spaces) can burst under extreme cold.<br><br>Hail can shatter windows and damage glass façade buildings. | Thawing permafrost can lead to structural building collapses. |

### Risk Reduction Measures

| | | | | | |
|---|---|---|---|---|---|
| Emergency Management Plan, including flood procedures, tested annually with operations staff and tenants.<br><br>Elevators are equipped with water sensors to automatically return to higher floors if water is in the basement or the underground parking.<br><br>! Critical equipment such as HVAC, electrical and communication systems and server rooms are elevated above expected flood levels. If not feasible to elevate, these systems are wet flood-proofed. | "Wildfire-resistant zone" is established within 10 metre perimeter of property.<br><br>Roofs and gutters kept free of combustible materials, and openings and vents are equipped with non-combustible screen mesh.<br><br>HEPA/Activated Carbon filters are installed on HVAC system to cleanse air from wildfire smoke. For new construction, fire resilient materials should be used. | ! Roof is reinforced and additional fasteners are applied at the perimeter and corners.<br><br>Impact-resistant glass is installed to prevent shattering from debris. | HVAC system is designed to effectively condition air (keep temperature and humidity within appropriate levels of thermal comfort) under foreseeable extreme heat conditions.<br><br>Emergency Management Plan, including extreme heat procedures, is tested annually with operations staff and tenants.<br><br>Provision is made for emergency backup during potential power outages. | Snow and ice are proactively removed from roofs.<br><br>Snow removal items are available (e.g., heating cables and chemical deicers) and snow/ice removal contractors are secured.<br><br>Thermal imaging cameras are installed to detect leaks and prevent mould.<br><br>Outdoor pipes and pipes in unheated areas are insulated and/or drained and turned off during winter months. | Building foundations are strengthened with piles, backfilled with coarse- grained soil under the foundation. |

Power back-up generation should be installed across all facilities.
Adaptation/Resilience Plans should complement Emergency Management/Response Plans

| Key Questions and Responses to Determine Readiness to Mitigate Physical Climate Risk | | | | | |
|---|---|---|---|---|---|
|  |  |  |  |  |  |
| ! Are HVAC, electrical, communication systems, and server rooms elevated or otherwise flood protected? | Does HVAC system have capacity to cleanse air from smoke? | ! Is roof reinforced for severe wind around upper perimeter and corners? | Does HVAC system have capacity to deal with foreseeable extreme heat conditions?* | Are snow and ice proactively removed from roofs? | Are measures present to limit damage where permafrost loss may affect structural integrity? |
| *Excellent response*<br>Yes, for 100% of facilities within an investment portfolio.<br><br>*Good response*<br>>75 of facilities in investment portfolio, with plans and funding to integrate for outstanding facilities. | *Excellent response*<br>Yes, for 100% of facilities within an investment portfolio. | *Excellent response*<br>Yes, for 100% of facilities within an investment portfolio. | *Excellent response*<br>Yes, for 100% of facilities within an investment portfolio.<br><br>*Good response*<br>>50% of facilities within an investment portfolio. | *Excellent response*<br>Yes, for 100% of facilities within an investment portfolio.<br><br>*Good response*<br>> 75% of facilities in high snowfall regions (higher % required for buildings with flat roofs). | *Excellent response*<br>Yes, for 100% of facilities within an investment portfolio. |

* Extreme heat: An event exceeding heat warning criteria - considering minimum/maximum temperatures, humidity, and duration. **Heat Warning Criteria:** Heat warnings issued in provinces/territories according to criteria outlined by the federal government, in co-ordination with local health authorities. Based on regional relationships between climate and health (GOC, 2020b).

**Table 4.** Climate Risk Matrix – **Canadian Banking Sector, Extreme Weather Risk Considerations** (applicable to Residential Mortgage Lending) ( ! = prioritized areas of focus)

## Banking (Residential Mortgages)


### Key Climate Risk Impacts

| Flood | Wildfire | Hail | Snow/ice | Wind |
|---|---|---|---|---|
| ! River overflow, intense rainfall, and/or coastal flooding events increase occurrence of urban/sewer backup, basement flooding, long-term rot/mould issues and/or total property loss. | ! Wildfire events cause property damage and/or total property loss of homes located in the wildland-urban interface. | Hail events cause property damage (e.g., damage to roof surfaces and siding, shattered windows, etc.). | Snow and ice events cause property damage (e.g., roof collapse, frozen/burst pipes, etc.). | Wind events cause property damage (e.g., damage to roofs, shattered windows, etc.). |

### Risk Reduction Measures - Short Term

| | | | | |
|---|---|---|---|---|
| ! Provide customers with home flood protection guidance in annual mortgage mail outs to promote deployment of risk reduction measures.<br><br>Example of home flood risk reduction measures. | ! Provide customers with wildfire protection guidance in annual mortgage mail outs to promote deployment of risk reduction measures.<br><br>Example of wildfire risk reduction measures. | Provide customers with extreme weather protection guidance in annual mortgage mail outs to promote deployment of risk reduction measures.<br>**Examples of responsive measures in hail zones:** installation of hail-resistant roofing, hail nets, siding materials and window shutters made from impact-resistant materials.<br>**Examples of responsive measures for snow/ice:** pipe insulation, removal/seasonal cleanup of dead/dangerous tree branches extended over house and power lines, snow removal from roofs and balconies, etc.<br>**Examples of responsive measures for wind:** installation of hurricane straps/clips, window shutters made from impact-resistant materials, removal/seasonal cleanup of dead/dangerous tree branches extended over house and power lines, secure loose outdoor items such as patio furniture, etc. | | |

Signal to borrowers their risk exposure to a hazard(s), while noting insurance coverage is one tool that can be used to mitigate losses.

### Risk Reduction Measures - Long Term

| | | | | |
|---|---|---|---|---|
| ! Up-to-date flood risk maps assist lenders in assessing the degree to which properties with mortgages fall within flood risk zones.<br><br>Encourage (or require) homeowners in high-risk flood zones to install flood mitigation measures such as sump pumps and/or backwater valves to reduce the flood risk profile of the home. | ! Up-to-date wildfire risk maps assist lenders in assessing the degree to which properties with mortgages fall within wildfire risk zones.<br><br>Encourage (or require) homeowners in wildland-urban interface zones to install wildfire mitigation measures such as Class A fire-resistant roofing (steel roof), move combustible materials (bushes, firewood) 10m away from the home, etc. | Up-to-date extreme weather risk maps assist lenders in assessing the degree to which properties with mortgages fall within extreme weather risk zones.<br><br>Encourage homeowners in high-risk hail, snow/ice, and wind zones to install extreme weather mitigation measures such as windows/roofs made from impact-resistant materials, window and pipe insulation, cleanup tree branches that extend over house and power lines, secure loose items (e.g., patio furniture, firewood, garbage bins, BBQ's), etc.* | | |

### Key Questions and Responses to Determine Readiness to Mitigate Physical Climate Risk

| | | |
|---|---|---|
| 1. What percentage of housing stock falls within extreme weather risk zones? | *Good response:* < 10% | *Poor response:* > 10% |
| 2. What percentage of customers receive guidance on means to reduce the extreme weather risk profile of a home? | *Good response:* > 90% | *Poor response:* < 90% |

* Mitigation measures should be applied at a property level (as shown above) and at a broader community level.

**Table 5.** Climate Risk Matrix – **Canadian Property and Casualty (P&C) Insurance Sector; Extreme Weather Risk Considerations** (applicable to personal home insurance) ( ! = prioritized areas of focus)

## Property and Casualty Insurance - Personal Home Insurance

### Key Climate Risk Impacts

| Flood | Wildfire | Hail | Wind | Snow/Ice |
|---|---|---|---|---|
| ! River overflow, intense rainfall, and/or coastal flooding events increase occurrence of urban/sewer backup, basement flooding, long-term rot/mould issues and/or total property loss. | ! Wildfire events cause property damage and/or total property loss of homes located in the wildland-urban interface. | Hail events cause property damage (e.g., damage to roof surfaces and siding; shattered windows, etc.). | Wind events cause property damage (e.g., damage to roofs, shattered windows, etc.). | Snow and ice events cause property damage (e.g., roof collapse, frozen/burst pipes, etc.). |

### Risk Reduction Measures - Short Term

| | | | | |
|---|---|---|---|---|
| ! Up-to-date flood risk maps assist insurers in assessing the degree to which insured properties fall within flood risk zones.<br><br>Provide customers with home flood protection guidance in annual policy mail outs to promote deployment of risk reduction measures.<br><br>Example of home flood risk reduction measures. | ! Up-to-date wildfire risk maps assist insurers in assessing the degree to which insured properties fall within wildfire risk zones.<br><br>Provide customers with wildfire protection guidance in annual policy mail outs to promote deployment of risk reduction measures.<br><br>Example of wildfire risk reduction measures. | Up-to-date extreme weather risk maps assist insurers in assessing the degree to which insured properties fall within extreme weather risk zones.<br><br>Provide customers with extreme weather protection guidance in annual policy mail outs to promote deployment of risk reduction measures:<br>**Examples of responsive measures in hail zones:** installation of hail-resistant roofing, hail nets, siding materials and window shutters made from impact-resistant materials.<br>**Examples of responsive measures for wind:** installation of hurricane straps/clips, window shutters made from impact-resistant materials, removal/seasonal cleanup of dead/dangerous tree branches extended over house and power lines, secure loose outdoor items such as patio furniture, etc.<br>**Examples of responsive measures for snow/ice:** pipe insulation, removal/seasonal cleanup of dead/dangerous tree branches extended over house and power lines, snow removal from roofs, balconies, etc. | | |

Utilize climate-specific stress-testing, beyond traditional catastrophe models, which analyze current and future climate hazards to inform pricing and portfolio adjustments*

### Risk Reduction Measures - Long Term

| | | | | |
|---|---|---|---|---|
| ! Encourage (or require) homeowners in high-risk flood zones to install flood mitigation measures such as sump pumps, backwater valves, water alarms**, etc. to reduce the flood risk profile of the home. | ! Encourage (or require) homeowners in wildland-urban interface zones to install wildfire mitigation measures such as Class A fire-resistant roofing (steel roof), move combustible materials (bushes, firewood) 10 m away from the home, etc. | Encourage homeowners in high-risk hail, snow/ice, and wind zones to install extreme weather mitigation measures such as windows/roofs made from impact-resistant materials, window and pipe insulation, cleanup tree branches that extend over house and power lines, secure loose items (e.g., patio furniture, firewood, garbage bins, BBQ's), etc.*** | | |

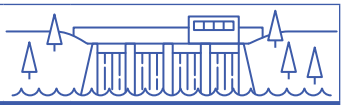
### Key Questions and Responses to Determine Readiness to Mitigate Physical Climate Risk

| | | |
|---|---|---|
| 1. What percentage of housing stock falls within extreme weather risk zones (e.g., flooding, wildfire, etc.)? | *Good response:* < 10% | *Poor response:* > 10% |
| 2. What percentage of customers receive guidance on means to reduce the extreme weather risk profile of their home? | *Good response:* > 90% | *Poor response:* < 90% |

* BOE, 2021.
** Tools like water alarms cannot prevent flood damage but can significantly reduce the severity of impact based on response times.
*** Mitigation measures should be applied at a property level (as shown above) and at a broader community level.

**Table 6.** Climate Risk Matrix – **Canadian Hydroelectricity Generation Sector; Extreme Weather Risk and Maintenance Considerations** ( ! = prioritized areas of focus)

## Hydroelectricity Generation



### Key Climate Risk Impacts

| High Temperatures | Heavy Rain/Flooding | Ice | Drought | Erosion/Thawing Permafrost |
|---|---|---|---|---|
| ! Premature structural component failure and/or decreased performance due to thermal limits being exceeded. | ! Extreme precipitation combined with snowmelt events can trigger flooding, landslides, and/or excessive silting, which can cause overtopping (water levels exceeding the top of the dam/levee) and downstream impacts. | Supercooled water temperatures can result in frazil ice (loose, randomly oriented ice crystals) which could cause ice jams that substantially impede water flow through the turbines and ice up intakes. | ! Longer and more intense droughts will deplete stream flow resulting in lower generation capacity.<br><br>Decreases in average rainfall and changes in rainfall seasonality could affect margins and operations in the long term. | Debris from shorelines (tree branches, plants, etc.) that fall into waterways can impede water flow through turbines and intakes. |

Changes to water temperature and levels may impact fish and other aquatic habitats and populations, which could lead to regulatory changes that may have ramification for hydroelectric generation (note: this is outside the control of utilities).

### Risk Reduction Measures

| | | | | |
|---|---|---|---|---|
| ! For portfolio diversification, ensure generating stations selected for investments are located across climatically diverse water sources to the extent feasible. | ! To ensure the safety of communities and infrastructure downstream, dam spillways and stream supply channels may require re-design and rebuild to accommodate the increase of water.<br><br>During times of increased rainfall, dam operators will have to allow some water to bypass the turbines to limit downstream flooding which reduces generation capacity. | Ensure a mitigation plan is in place and available for use/ distribution to key personnel in the event of frazil ice conditions.<br><br>Reservoirs, at and above the intake side of the generating station, need operational monitoring of ice formation and conditions. | ! For portfolio diversification, ensure generating stations selected for investments are located across climatically diverse water sources to the extent feasible. | Ensure a mitigation plan is in place and available for use/ distribution to key personnel in the event of debris buildup. |

### Maintenance Measures

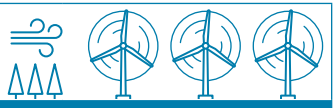
Ensure dams meet the guideline requirements of the Canadian Dam Association (or similar) for the safety of dams and supply reservoirs, especially for the safety of downstream communities and infrastructure.

### Key Questions and Responses to Determine Readiness to Mitigate Physical Climate Risk

| | | |
|---|---|---|
| 1. Do privately funded hydroelectric generation facilities have sufficient financial resources to remain solvent if extreme weather risk conditions limited cash flow? | *Excellent response :* Yes | *Poor response:* No |
| 2. Do publicly funded hydroelectric generation facilities have support from government (i.e., federal, provincial, and municipal) and energy boards (i.e., regulators) to implement climate adaptation at site level? | *Excellent response :* Yes | *Poor response:* No |
| 3. How much production has been affected by physical risk (extreme heat, flooding, drought, etc.) in the past 10 years? | *Excellent response:* <10%<br>*Good response:* 10% - 30% | *Poor response:* >30% |

**Table 7.** Climate Risk Matrix – **Canadian Wind Electricity Generation Sector; Extreme Weather Risk and Maintenance Considerations** ( ! = prioritized areas of focus)

## Wind Electricity Generation



| Key Climate Risk Impacts | | | | |
|---|---|---|---|---|
| **Wind** | **Cold Temperature** | **Ice Accumulation** | **Lightning** | **High Temperature** |
| ! Highly variable wind speed (<15km/h or > 80km/h) results in decreased turbine productivity.<br><br>! Optimal wind speed range would be 20km/h – 60 km/h. | ! Extreme cold temperatures (below -20°C) requires turbine shutdown resulting in zero productivity.<br><br>! Cold temperatures (-10°C to -20°C) cause turbines to slow resulting in decreased productivity. | Severe icing causes turbine blade imbalance requiring shutdown resulting in zero productivity. | Severe lightning strikes result in material damage to turbine blades negatively influencing productivity. | High temperatures (> 50°C) accelerate battery decay and reduces productivity. |
| **Risk Reduction Measures** | | | | |
| ! Ensure turbines are adjusted based on current variable wind speeds to ensure proper pitch of blades. | ! Below -20°C, shutdown turbines to prevent equipment failure and limit/reduce need for maintenance activities.<br><br>! Between -10°C and -20°C, turbines should be heated to ensure mechanical systems function well. | Utilize deicing systems, anti-icing materials and mechanisms to reduce occurrence of shutdown. | Install surge arresters to prevent damage. | Utilize component cooling systems to reduce occurrence of shutdown. |
| **Maintenance Measures** | | | | |
| Ensure turbine manufacturers adhere to the "recommendations for preventative maintenance" as a critical minimum response.<br>Plan for replacement of aging turbines (> 15 years) to ensure continued high-level performance.<br>Urgent corrective maintenance is crucial to reduce failure of turbines – site maintenance workers should reside within commuting distance from the turbines (less than one day) and specialized technicians should be located within a day drive of the site. | | | | |

| Key Questions and Responses to Determine Readiness to Mitigate Physical Climate Risk | | |
|---|---|---|
| 1. What percentage of total unavailability (productivity loss) is due to wind issues? | *Excellent response :* < 20% | *Poor response:* > 20% |
| 2. What percentage of total unavailability (productivity loss) is prevented due to heating turbines during extreme cold temperature events? | *Excellent response :* > 80% | *Poor response:* < 80% |
| **Key Questions and Responses to Determine Readiness to Mitigate Maintenance Risk** | | |
| 1. What is the average age of the turbine fleet? | *Excellent response :* 5-13 yrs<br>*Good response :* 13-18 yrs | *Poor response:* >18 yrs (plan for replacement should be available) |
| 2. What is the turbines fleet's annual availability (productivity) percentage (assumption: a maintenance program is available)? | *Excellent response :* > 80%<br>*Good response :* 60%-80% | *Poor response:* < 60% |
| 3. How quickly are companies responding to technical issues (i.e., how quickly can maintenance technicians arrive on site to resolve technical issues)? | *Excellent response :* < 1 day<br>*Good response :* 1-2 days | *Poor response:* > 2 days |

# Case Study: Impacts of Extreme Weather Applied to Financial Valuation in Commercial Real Estate

This case study details how adaptation to climate change and extreme weather risk can be incorporated into portfolio management by institutional investors – this example focuses on Commercial Real Estate ("CRE")[3]. The analysis illustrates that CRE owners/operators should invest in adaptation to increase the resiliency of business operations to protect financial value and share price.

When considering the financial impacts of climate adaptation, investors must go beyond assessing the direct impacts on **assets and operations.** They must consider and account for the potential risk materialization of wider market-level impacts on **rental rate growth**, **long-term occupancy rate**, and the availability and affordability of **commercial property insurance**. Investors need to understand how market-level impacts linked to climate adaptation can be systematically integrated into asset valuation.

The analysis illustrates that CRE owners/operators should invest in adaptation to increase the resiliency of business operations to protect financial value and share price.

This case study proposes a scenario-based approach for exploring these impacts in CRE. Given the uncertainty of key market stakeholder responses to the timing, magnitude, and duration of increasing extreme weather risks, we propose that institutional portfolio management allow asset valuation and share price to reflect the future desirability of selected buildings and geographies. We propose that this be based on actual and perceived vulnerability of CRE to extreme weather. Utilizing scenario analysis, with risks identified in the Climate Risk Matrix for CRE (Table 3, Page 25), investors can evaluate how, and to what extent, these impacts could materialize, given their high uncertainty. This requires identifying key CRE variables, anticipating potential climate risk pathways, and designing scenarios for conducting quantitative scenario analysis.

## 1. Anticipating Climate Risk Pathways in CRE

Identifying and assessing the impact of climate change on key variables is a critical first step, which entails taking stock of recent market dynamics, recognizing emerging trends and weak signals[4], and identifying pathways for climate adaptation. Given the uncertainty and unknowns, hypothesizing plausible future operating conditions and

3 CRE was appropriate to serve as a "model sector", based on three requisite criteria (TCFD, 2019): (a) Operational Impacts: CRE is experiencing substantial impacts due to climate change and extreme weather events (Bienert, 2016; Burillo, 2018); (b) Mitigation Actions: means to mitigate climate change and extreme weather risks are reasonably well understood in CRE (BOMA, 2022; CSA, 2019b); and (c) Geographical Range: climate change and extreme weather risks (e.g., flood, wildfire and wind storm) can impact CRE in virtually any populated region of Canada, with potentially larger consequences in cities with a high concentration of high-value assets (CCA, 2019).

4 A weak signal is an indicator of a potentially emerging issue that may become significant in the future. Weak signals supplement trend analysis and they can be used to expand on alternate futures (Dufva, 2019).

stakeholders' responses to increasing extreme weather must precede this analysis[5].

Table 8 illustrates how market-level impacts influence key CRE variables over time. To expand the scope of analysis, the impact of climate on operating expenses would need to be assessed.

**Table 8.** Influence of market-level impacts on key CRE variables

| Key CRE variable | Weak signal or emerging trend | Potential risk pathways for adaptation |
|---|---|---|
| **Net rental rate** | Rising demand for resilient buildings leads to a 4% to 7% rental premium above market rate (UNEP FI, 2021). The impact could be more pronounced in areas at high risk of extreme weather events. | Changes in total net rent due to changes in demand and in the net rental rate. Changes could be influenced by the benefits of occupying a climate-ready building, including reduced business interruption, operating costs, and potential for large, unexpected losses. |
| **Occupancy rate** | Amplified demand for flexible, shorter-term leases (due to COVID), vis-à-vis building-level climate adaptation could flow through the occupancy rate and affect lease roll-over a key risk to CRE. | Changes to long-term future occupancy rates driven by changes in demand, which may be abrupt. |
| **Discount rate / Weighted average cost of capital (WACC)** | Higher risk premium applied on properties in urban areas directly or indirectly impacted by climate change, and those sharing similar climate risk profiles (UNEP FI, 2021). | Cost of equity and debt could increase if operating in riskier environments, especially if climate adaptation cannot be readily demonstrated. |
| **Capitalization rate** | Consideration of the next buyer's exit point in purchasing decisions, with adjustments to the terminal capitalization rates explored in response to climate change (ULI, 2020). | Fair value of assets may be reassessed given climate-related considerations at exit pricing; greater cash flow volatility may reduce liquidity, impacting future capitalization rates and salability of assets. |

## 2. Simulating Plausible Futures and Scenarios

Having identified key potential risk pathways, *quantitative* analysis can be used to incorporate market-level impacts into financial valuations. In this case study, building-level climate adaptation costs and operating cash flows for a hypothetical[6] REIT are modelled in four different scenarios (Table 9), based on the timing of building-level climate adaptation and the timing of market-level climate change pricing-in.

Because the timing of climate-related market-level impacts (pricing-in) is unknown, cash flows in each scenario are simulated under different years of market-level pricing-in (at every year between 2023 and 2029), to demonstrate how the timing of building-level climate adaptation could influence overall financial performance.

5 Multiple scenarios can be hypothesized by organizations; the scenario presented here represents one option among many other plausible ones.

6 The hypothetical REIT was developed using available financial information found on Canadian office REITs.

**Table 9.** Building-level adaptation scenarios

| Assumptions and Inputs | Scenario 1 Historical view / Status quo | Scenario 2 No adaptation | Scenario 3 Early adaptation | Scenario 4 Late adaptation |
|---|---|---|---|---|
| Climate-related market-level impacts | No. Climate change is not incorporated into financial valuations. | Yes. Climate change is incorporated into financial valuations. | Yes. Climate change is incorporated into financial valuations. | Yes. Climate change is incorporated into financial valuations. |
| Building-level adaptation | No. | No adaptation. | Early (2022) adaptation. | Late adaptation (3 years after market-level pricing-in). |

# 3. Analysis and Results

### a. Financial impact of building-level climate adaptation costs on share price

In this case study, following an asset-level physical risk assessment, 50% of investment properties in a hypothetical Canadian REIT are prioritized for building-level climate adaptation, and the other 50% are 'climate-ready' or need no further adaptation efforts due to geography. Using a market-level pricing-in year of 2025 as an example[7], the per share impact of building-level climate adaptation for scenarios 3 and 4 is derived using the assumptions in Table 10.

**Table 10.** Assumptions

| Model assumptions and inputs | Value or calculation |
|---|---|
| Illustrative cost of building-level climate adaptation (2022) | $50/square foot (illustrative 'hard CapEx')[8] |
| % of REIT undergoing building-level climate adaptation | 50% (over two years) |
| Inflation rate for building-level climate adaptation | 3.5% |
| Gross leasable area (2022) | 13M square foot |
| Shares outstanding and share price (2022) | 125M shares @ $40/share |
| Discount rate (WACC) | 6.35% (scenario 3), 6.85% (scenario 4) |
| Discounted cost of building-level climate adaptation per share | 301.5M (scenario 3), 247.3M (scenario 4) |
| Per share impact ($ and %) | $301.5M/125M = $2.41 (scenario 3: 6.0% of share price)<br>$247.3M/125M = $1.98 (scenario 4: 4.9% of share price) |

7 Asset-level quantitative modeling (e.g., physical risk assessment), which considered the future likelihood and intensity of extreme weather across multiple climate scenarios, and relative to the vulnerability of these assets, was performed at the REIT level to identify at-risk assets with the greatest risk mitigation benefits.

8 The aim is to prepare CRE office buildings to better withstand the financial impacts of physical risks over the next 25 to 30 years, considering the increasing frequency and intensity of extreme weather events. Climate risk matrices can help identify and prioritize adaptation actions specific to CRE (Feltmate et al, 2020).

### b. Illustrative market-level impacts linked to building-level climate adaptation on share price

Operating income cash flows for the REIT across the four scenarios are then simulated using long-term occupancy rate, net rent[9] growth, and uplift, as key CRE variables to illustrate market-level impacts (Table 11). Due to sharp discontinuities that typically characterize climate risks, these variables are modelled to experience a sudden, one-off impact in the short-term (immediately following the pricing-in effect of market-level impacts), followed by a longer-term, sustained impact that may differ between buildings with and without building-level climate adaptation. The 20-year horizon covers a typical 10-year holding period and another follow-on 10-year holding period (to simulate ownership by a subsequent asset owner). Finally, discounted cash flow analysis is used to estimate the per share impact, using a simulated market-level pricing-in shock in 2025.

For a more complete view, the effect of market-level impacts on property operating expenses and taxes (*e.g.,* common maintenance areas, realty taxes, insurance rates, etc.) could be added to the model.

9 Net rent income excludes any property operating expenses.

**Table 11.** Model assumptions used to simulate operating income cash flows for the REIT across scenarios.

| Assumptions and Inputs | Scenario 1 Historical view / Status quo | Scenario 2 No adaptation | Scenario 3 Early adaptation | Scenario 4 Late adaptation |
|---|---|---|---|---|
| Year of climate adaptation | N/A | N/A | 2022 | 2028 |
| Long-term occupancy rate | 90.0% (baseline rate pre-market-level impacts) | | | |
| Immediate market-level impact on occupancy rate | 0.0% (no pricing-in) | -5.0% | 5.0% | -5.0% |
| Note on impact duration | N/A | Sustained | Progressively removed | Progressively removed |
| New long-term occupancy rate[10] | 90.0% | 85.0% | 91.25% | 91.25% |
| Average in-place net rent | $24.36 / occupied square foot (2022) | | | |
| Average annual growth | 2.0% (based on historical data, pre-market-level impacts) | | | |
| Immediate impact on annual net rent growth | 0.0% (no pricing-in) | -0.5% | 0.5% | -0.5% |
| Immediate rental uplift | 0% (no pricing-in) | -5.0% (in 2025) | 5.0% (in 2025) | -5.0% (in 2025) |
| Note on impact duration | N/A | Sustained | Progressively removed | Progressively removed |
| Shares outstanding (2022) | 125M @ $40/share | | | |
| Discount rate (WACC) | 6.35% | 7.35% | 6.35% | 6.85% |
| Total discounted net rent | $3,989M | $3,329M | $4,272M | $3,764M |
| Difference relative to Scenario 1 (status quo) | - | -$660M | $283M | -$225M |
| Per share impact ($ and %) | - | -$660M/125M = -$5.28 (-13.2%) | $283M/125M = $2.26 (5.7%) | -$225M/125M = -$1.80 (-4.5%) |

**These results demonstrate that adaptation must precede market-level pricing-in of perceived value for climate adaptation as shown by the per share impact in each scenario - early adaptation (scenario 3) is more cost-effective than both no adaptation (scenario 2) and late adaptation (scenario 4).**

Figure 2 expands on the results shown in Table 11, showing the difference in discounted net rent income relative

10 The new long-term occupancy rate was developed with the assumption that 20% of buildings will not go through building-level climate adaptation and will thus continue to sustain negative financial impacts. The overall weighted occupancy rate remains constant at 90.0%.

to scenario 1 (status quo) across all years of market-level pricing-in under consideration (years 2023 to 2029), illustrating variability in cash flows as timing of market-level pricing-in shock changes.

**Figure 2.** Difference in discounted net rent income relative to Scenario 1 (historical view/status quo) shown across all years of market-level pricing-in under consideration (years 2023 to 2029).

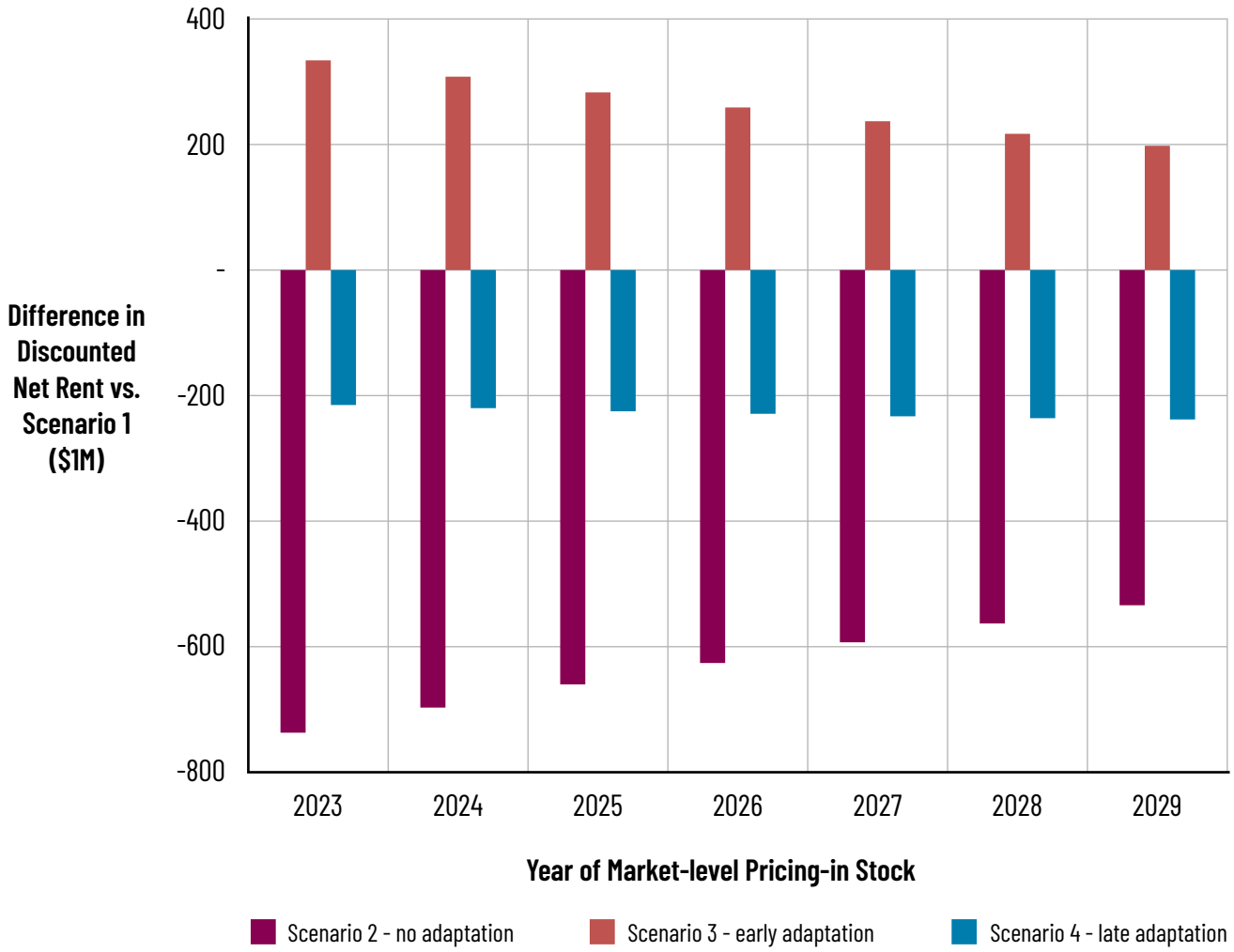



**Figure 2 demonstrates that the cost-effectiveness of adaptation is inversely correlated to the time between adaptation and market-pricing in - the closer adaptation is to market pricing-in, the more cost-effective for the REIT. In practice, market pricing-in is difficult to predict.**

### c. Implications for liquidity and investment properties value

REITs can rely on a discounted cash flow approach to estimate the fair value of rental investment properties, among other methods. In this case study, annual net rental income for the next 10 years is projected, then discounted, and a terminal value, based on a capitalization rate applied to the net operating income at 10 years, is added.

Recognizing that market-level impacts could influence the capitalization rate, two sets of rates are presented for consideration to show how market-level impacts could alter the risk profile of investments (Table 12). A market-level pricing-in shock in 2025 is again used, and the same scenario-specific weighted average cost of capital (WACC) presented in Table 11 is applied.

**Table 12.** Market-level impacts and potential influence of capitalization rates showing how climate adaptation could change the risk profile of investments.

| Model Parameters | Scenario 1 Historical view / Status quo | Scenario 2 No Adaptation | Scenario 3 Early Adaptation | Scenario 4 Late Adaptation |
|---|---|---|---|---|
| Terminal capitalization rate (B - baseline) | 5.4%, applied across scenarios to show the sole impact of the changes in net rent cash flows on investment properties value. | | | |
| Terminal capitalization rate (A - alternate) | 5.4% | 6.4% | 5.4% | 5.9% |
| Investment properties | $5,883M | $4,846M (B)<br>$4,397M (A) | $6,370M | $5,433M (B)<br>$5,147M (A) |
| % Difference relative to Scenario 1 | - | -17.6% (B)<br>-25.3% (A) | 8.3% | -7.6% (B)<br>-12.5% (A) |

**These results demonstrate that *early adaptation* (scenario 3) leads to less perceived risk and thus to higher property values (and lower capitalization rates) with respect to *no adaptation* (scenario 2) or *late adaptation* (scenario 4).**

In conclusion, this case study demonstrates the pertinence of incorporating potential market-level impacts linked to climate adaptation into asset valuation and share price in CRE. Most importantly, it sheds light on the evolving context in which actors who favour early and orderly adaptation will reap the rewards of their investments, while laggards will bear the full financial consequences of the pricing-in of climate-related market-level impacts. These results demonstrate that CRE actors need to invest in adaptation to increase the resiliency of their business operations, protect financial value and share price, and ensure the viability of their business model in a climate-constrained economy.

These results demonstrate that CRE actors need to invest in adaptation to increase the resiliency of their business operations, protect financial value and share price, and ensure the viability of their business model in a climate-constrained economy.

# Portfolio Risk Utilizing Climate Risk Matrices

Now is the time to integrate physical climate risk into institutional investing. The impact of extreme weather events will continue to challenge all businesses – "net zero" will only soften the blow.

Institutional investors should view climate change on par with political instability, violent conflicts, cybersecurity and volatile interest rates. However, there is one exception – these other factors will eventually reverse course – climate change will not.

To support informed and efficient capital-allocation toward companies responding to climate risks, financial markets must appropriately price risk through climate risk disclosures. Fulsome disclosures must not only identify risks but must also identify **what measures need to be (or have been) implemented to reduce those risks.**

CRMs offer industry-specific standardization and are a practical tool to prioritize the top means by which climate-related events may negatively impact business continuity, while simultaneously identifying actions investors should expect a company to take to mitigate prioritized risks. This system reflects the direction of the ISSB and TCFD's pillars of (as illustrated in Figure 3):

- **Governance -** integrating climate change risks and opportunities into governance protocols
- **Strategy -** incorporating climate-related risks and opportunities into the organization's business, strategy, and financial planning
- **Risk Management -** disclosing how organizations identify, assess, and manage climate-related risks; and,
- **Metrics and Targets -** assessing and managing relevant climate-related risks and opportunities where material (IFRS, 2023a; TCFD, 2022).

**Figure 3.** Key elements of ISSB and TCFD are addressed within Climate Risk Matrices (see points a-d)

*International Sustainability Standards Board and Task Force on Climate-Related Financial Disclosures Framework*

Source: PwC, 2023a, IFRS, 2023a, and TCFD, 2022.


*Climate Risk Matrix*

**a. Governance**
The organization's governance around climate-related risks and opportunities can be informed by the CRM within that given industry sector.

**b. Strategy**
The CRMs represent the actual climate-related risks and opportunities that can inform an organisation's business strategy and financial planning.

**c. Risk Management**
Processes used to identify, assess, and manage climate-related risks.

**Wind Electricity Generation**

| Key Climate Risk Impacts | | | | |
|---|---|---|---|---|
| Wind | Cold Temperature | Ice Accumulation | Lightning | High Temperature |
| Highly variable wind speed (<15km/h or > 80km/h) results in decreased turbine productivity. Optimal wind speed range would be 20km/h - 60 km/h. | Extreme cold temperatures (below -20°C) requires turbine shutdown resulting in zero productivity. Cold temperatures (-10°C to -20°C) cause turbines to slow resulting in decreased productivity. | Severe icing causes turbine blade imbalance requiring shutdown resulting in zero productivity. | Severe lightning strikes result in material damage to turbine blades negatively influencing productivity. | High temperatures (> 50°C) accelerate battery decay and reduces productivity. |
| **Risk Reduction Measures** | | | | |
| Ensure turbines are adjusted based on current variable wind speeds to ensure proper pitch of blades. | Below -20°C, shutdown turbines to prevent equipment failure and limit/reduce need for maintenance activities. Between -10°C and -20°C, turbines should be heated to ensure mechanical systems function well. | Utilize deicing systems, anti-icing materials and mechanisms to reduce occurrence of shutdown. | Install surge arresters to prevent damage. | Utilize component cooling systems to reduce occurrence of shutdown. |
| **Maintenance Measures** | | | | |
| Ensure turbine manufacturers adhere to the "recommendations for preventative maintenance" as a critical minimum response. Plan for replacement of aging turbines (> 15 years) to ensure continued high-level performance. Urgent corrective maintenance is crucial to reduce failure of turbines - site maintenance workers should reside within commuting distance from the turbines (less than one day) and specialized technicians should be located within a day drive of the site. | | | | |
| **Key Questions and Responses to Determine Readiness to Mitigate Physical Climate Risk** | | | | |
| 1. What percentage of total unavailability (productivity loss) is due to wind issues? | | | *Excellent response :* < 20% | *Poor response:* > 20% |
| 2. What percentage of total unavailability (productivity loss) is prevented due to heating turbines during extreme cold temperature events? | | | *Excellent response :* > 80% | *Poor response:* < 80% |
| **Key Questions and Responses to Determine Readiness to Mitigate Maintenance Risk** | | | | |
| 1. What is the average age of the turbine fleet? | | | *Excellent response :* 5-13 yrs *Good response :* 13-18 yrs | *Poor response:* >18 yrs (plan for replacement should be available) |
| 2. What is the turbines fleet's annual availability (productivity) percentage (assumption: a maintenance program is available)? | | | *Excellent response :* > 80% *Good response :* 60%-80% | *Poor response:* < 60% |
| 3. How quickly are companies responding to technical issues (i.e., how quickly can maintenance technicians arrive on site to resolve technical issues)? | | | *Excellent response :* < 1 day *Good response :* 1-2 days | *Poor response:* > 2 days |

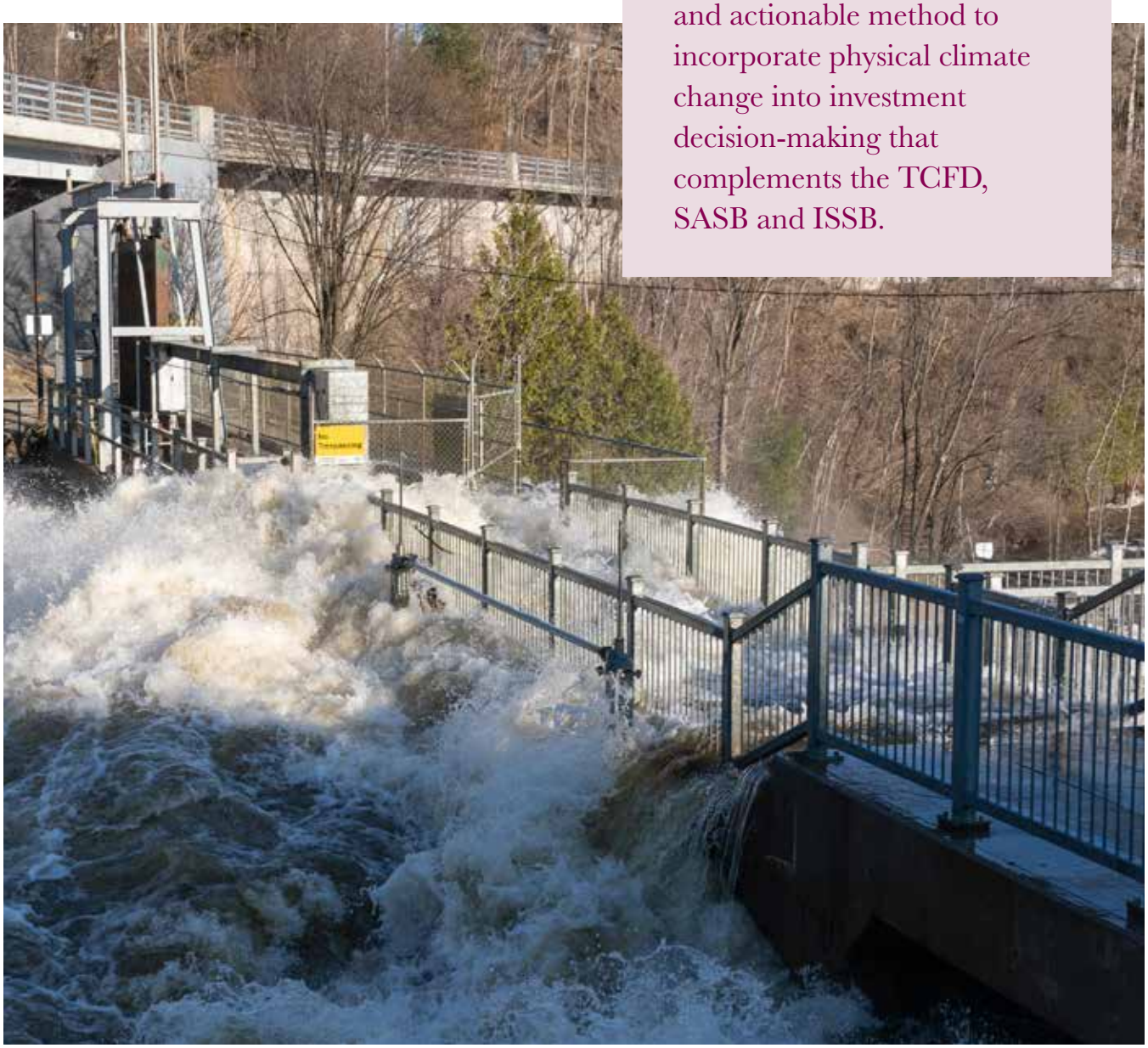
**d. Metrics and Targets**
Metrics and targets to identify, assess, and manage relevant climate-related risks and opportunities.

CRMs offer a practical, cost-effective, and user-friendly method to incorporate physical climate change into investment and business decision-making that complements frameworks and standards such as the TCFD, SASB and ISSB.

## Next Steps: A Call to Action

This report should catalyze action – and diminish complacency – by the majority of institutional investors who do not factor physical climate risk into portfolio management. More broadly, the financial community (e.g., Chartered Financial Analyst (CFA) Society, DBRS Morningstar, SASB or similar organizations) should lead the way in developing CRMs for all 77 SASB-recognized industry sectors, and in so doing enable investors and other market participants to price climate risks, and investment opportunities. To ensure institutional investors have access to this information, CRMs should be available to any portfolio manager within reach of a Bloomberg Terminal.

> CRMs offer a practical and actionable method to incorporate physical climate change into investment decision-making that complements the TCFD, SASB and ISSB.



# References


Andersson, M., Baccianti, C., and Morgan. J. (2020). Occasional Paper Series: Climate Change and the Macro Economy. European Central Bank. https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op243~2ce3c7c4e1.en.pdf

Bakos, K. Feltmate, B., Chopik, C., C. Evans. (2022). Treading Water: Impact of Catastrophic Flooding on Canada's Housing Market. University of Waterloo. https://www.intactcentreclimateadaptation.ca/wp-content/uploads/2022/04/UoW_ICCA_2022_02-Treading-Water_Flooding-and-Housing-Market.pdf

Bank of Canada [BOC]. (2021). Climate Change and the Bank of Canada. https://www.bankofcanada.ca/2021/10/climate-change-bank-of-canada/

Bank of Canada [BOC]. (2023). Bank of Canada Disclosure of Climate-Related Risks 2022. https://www.bankofcanada.ca/2023/04/bank-of-canada-disclosure-of-climate-related-risks-2022/

Bank of England [BOE]. (2021). The 2021 biennial exploratory scenario on the financial risks from climate change Financial Policy Committee and Prudential Regulation Committee. https://www.bankofengland.co.uk/stress-testing/2021/key-elements-2021-biennial-exploratory-scenario-financial-risks-climate-change.

Bienert, S. (2016). Climate Change Implications for Real Estate Portfolio Allocation. Industry Perspective. Urban Land Institute. https://europe.uli.org/climate-change-implications-real-estate-portfolio-allocation-industry-perspectives/

Brunetti, C., Dennis, B., Gates, D., Hancock, D., Ignell, D, Kiser, E.K., Kotta, G., Kovner, A., Rosen, R., and N.K. Tabor. (2021). Climate Change and Financial Stability. Board of Governors of the Federal Reserve System. https://www.federalreserve.gov/econres/notes/feds-notes/climate-change-and-financial-stability-20210319.htm

Building Owners and Managers Association of Canada [BOMA]. (2022). Resilience in the Commercial Real Estate Industry: Protecting Value for an Uncertain Future. https://bomacanada.ca/wp-content/uploads/2023/04/ResilienceInTheCommercialRealEstateIndustry_EN_220713_small.pdf

Burillo, D. (2018). Effects of Climate Change in Electric Power Infrastructures. DOI: 10-5772/intecopen.82146. https://www.intechopen.com/chapters/64723

Bush, E. and Lemmen, D.S., editors (2019): Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p. https://changingclimate.ca/CCCR2019/

Canadian Securities Administrators [CSA]. (2022). Canadian securities regulators consider impact of international developments on proposed climate-related disclosure rule. https://www.securities-administrators.ca/news/canadian-securities-regulators-consider-impact-of-international-developments-on-proposed-climate-related-disclosure-rule/

Canadian Securities Administrators [CSA]. (2019a). CSA Staff Notice 51-358 – Reporting of Climate Change-Related Risks. Canadian Securities Administrators. https://www.osc.ca/en/securities-law/instruments-rules-policies/5/51-358/csa-staff-notice-51-358-reporting-climate-change-related-risks

Canadian Standards Association [CSA]. (2019b). NRC – CSA Group Canadian Electrical Code (CE Code) Climate Change Adaptation Project. CSA Group, Toronto, Ontario. https://www.csagroup.org/store/search-results/?search=all~~c22.2&gclid=EAIaIQobChMInM-RzuH7-AIVL-bjBx3bFAMrEAAYASAAEgL9wvD_BwE

Carbon Disclosure Project [CDP]. (2022). CDP to incorporate ISSB climate-related disclosure standard into global environmental disclosure platform. https://www.cdp.net/en/articles/companies/cdp-to-incorporate-issb-climate-related-disclosure-standard

Carbon Disclosure Project [CDP]. (2023). What we do. https://www.cdp.net/en/info/about-us/what-we-do

CatIQ. (2023). Canadian Insured Losses From Catastrophic Events Total CAN $3.1 Billion In 2022. https://public.catiq.com/2023/01/18/canadian-insured-losses-from-catastrophic-events-total-can-3-1-billion-in-2022/

Chen, Y. (2021). The Fundamentals of Financial Risks from Climate Change Mortgage Banking Institutions. New York State of Opportunity. https://www.dfs.ny.gov/system/files/documents/2021/03/fundamentals_of_financial_risks_from_climate_change_industry_mortgages.pdf#:~:text=on%20Banking,losses%20of%20up%20to%2060%25.&text=%E2%80%9COver%20half%20the%20syndicated%20lending,exposed%20to%20climate%20transition%20risk.%E2%80%9D

Climate Disclosure Standards Board [CDSB]. (2020). Falling short? Why environmental and climate-related disclosures under the EU Non-Financial Reporting Directive must improve. https://www.cdsb.net/sites/default/files/falling_short_report_single_page_spread.pdf

Coalition for Climate Resilient Investment [CCRI]. (2021). Risk and Resilience: Addressing physical climate risks in infrastructure investment. https://resilientinvestment.org/

Council of Canadian Academics [CCA]. (2019). Canada's Top Climate Change Risks. The Expert Panel on Climate Change Risks and Adaptation Potential. https://cca-reports.ca/wp-content/uploads/2019/07/Report-Canada-top-climate-change-risks.pdf

Deloitte. (2022). What is the TCFD and why does it matter? https://www2.deloitte.com/ch/en/pages/risk/articles/tcfd-and-why-does-it-matter.html

Dufva, M. (2019). What is a weak signal. Sitra Articles. https://www.sitra.fi/en/articles/what-is-a-weak-signal/

European Banking Authority [EBA]. (2022). The EBA responds to the public consultations on sustainability-related disclosure standards launched by the International Sustainability Standards Board and the European

Financial Reporting Advisory Group. https://www.eba.europa.eu/eba-responds-public-consultations-sustainability-related-disclosure-standards-launched-international

European Central Bank [ECB]. (2020). Financial Stability Review. https://www.ecb.europa.eu/pub/financial-stability/fsr/html/index.en.html

European Commission [EU Commission]. (2022a). Corporate Disclosures and Climate-Related Information. https://finance.ec.europa.eu/sustainable-finance_en

European Commission [EU Commission]. (2022b). Opening remarks by Commissioner McGuinness at the European Parliament plenary debate on the Corporate Sustainability Reporting Directive. https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_22_6747

Eyquem, J., and K., Bakos. (2022). The Financial Benefit of Wetlands. Save Ontario Wetlands – Waterloo Wetland Lab. November 11, 2022. https://saveontariowetlands.weebly.com/wetland-info

Fairfax, J., MacDougall, A., Ross, N., Sherman, J., Valley, J., and Muise, S. (2022). International Sustainability Standards Board releases draft sustainability and climate change disclosure proposals for public comment. Osler, Hoskin and Harcourt. https://www.osler.com/en/resources/governance/2022/international-sustainability-standards-board-releases-draft-sustainability-and-climate-change-disclo

Federal Register. (2022). The Enhancement and Standardization of Climate-Related Disclosures for Investors. https://www.federalregister.gov/documents/2022/04/11/2022-06342/the-enhancement-and-standardization-of-climate-related-disclosures-for-investors

Feltmate, B., Moudrak, N., Bakos, K. and B. Schofield. (2020). Factoring Climate Risk into Financial Valuation. Prepared for Global Risk Institute and Scotiabank. Intact Centre on Climate Adaptation, University of Waterloo. https://www.intactcentreclimateadaptation.ca/wp-content/uploads/2020/03/Factoring-Climate-Risk-into-Financial-Valuation.pdf

Feltmate, B., and P. Shukle. (2023). Extreme weather cost us $3.1-billion in 2022 – this is Canada's climate wake-up call. Globe and Mail. https://www.theglobeandmail.com/business/commentary/article-extreme-weather-cost-canada-31-billion/

Global Commission on Adaptation [GCA]. (2019). Adapt Now: A Global Call for Leadership on Climate Resilience. Global Center on Adaptation/World Resources Institute. https://gca.org/reports/adapt-now-a-global-call-for-leadership-on-climate-resilience/

Global Reporting Initiative [GRI]. (2022). GRI and ISSB provide update on ongoing collaboration. https://www.globalreporting.org/news/news-center/gri-and-issb-provide-update-on-ongoing-collaboration/

Global Reporting Initiative [GRI]. (2023a). GRI Standards by Language. https://www.globalreporting.org/standards/download-the-standards/

Global Reporting Initiative [GRI]. (2023b). Reporting with the Sector Standards. https://www.globalreporting.org/standards/sector-program/

Government of Canada [GOC]. (2020a). Net-Zero Emissions by 2050. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html

Government of Canada [GOC]. (2020b). Criteria for public weather alerts: Heat. https://www.canada.ca/en/environment-climate-change/services/types-weather-forecasts-use/public/criteria-alerts.html#msc-map)

Government of Canada [GOC]. (2021). Canadian Net-Zero Emissions Accountability Act. https://laws-lois.justice.gc.ca/eng/acts/c-19.3/FullText.html

Government of Canada [GOC]. (2022). The Government of Canada invests up to $58 million in 24 projects that support Canada's goal of net-zero greenhouse gas emissions by 2050. https://www.canada.ca/en/environment-climate-change/news/2022/11/the-government-of-canada-invests-up-to-58-million-in-24-projects-that-support-canadas-goal-of-net-zero-greenhouse-gas-emissions-by-2050.html

Government of Canada [GOC]. (2023). Canada's National Adaptation Strategy: Building Resilient Communities and a Strong Economy. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/national-adaptation-strategy/full-strategy.html

Grimaldi, A., Javanmardian, K., Pinner, D., Samandari, H., and Strovink, K. (2020). Climate Change and P&C Insurance: The Treat and Opportunity. McKinsey & Company. https://www.mckinsey.com/industries/financial-services/our-insights/climate-change-and-p-and-c-insurance-the-threat-and-opportunity

Halper, J., Bussiere, S., and Shriver, T. (2021). Investors and Regulators Turning up the Heat on Climate-Change Disclosures. Harvard Law School Corporate Governance. https://corpgov.law.harvard.edu/

Insurance Bureau of Canada [IBC]. (2020). 2020 Facts of Property and Casualty Insurance Industry of Canada. http://assets.ibc.ca/Documents/Facts%20Book/Facts_Book/2020/IBC-2020-Facts.pdf

Insurance Bureau of Canada [IBC]. (2022). Studies. http://www.ibc.ca/nb/resources/studies

Insurance Bureau of Canada [IBC]. (2023). Severe Weather in 2022 Caused $3.1 Billion in Insured Damage – making it the 3rd worst year for insured damage in Canadian history. Media Releases. http://www.ibc.ca/on/resources/media-centre/media-releases/severe-weather-in-2022-caused-3-1-billion-in-insured-damage-%E2%80%93-making-it-the-3rd-worst-year-for-insured-damage-in-canadian-history

International Capital Market Association [ICMA]. (2023). Sustainability Bond Guidelines (SBG). https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/sustainability-bond-guidelines-sbg/

International Energy Agency [IEA]. (2021). Climate Resilience: Part of Electricity Security 2021. https://www.iea.org/reports/climate-resilience

International Financial Reporting Standards [IFRS]. (2022a). ISSB delivers proposals that create comprehensive global baseline of sustainability disclosures. https://www.ifrs.org/news-and-events/news/2022/03/issb-delivers-proposals-that-create-comprehensive-global-baseline-of-sustainability-disclosures/

International Financial Reporting Standards [IFRS]. (2022b). ISSB at COP27: CDP to incorporate ISSB Climate-related Disclosures Standard into global environmental disclosure platform. https://www.ifrs.org/news-and-events/news/2022/11/cdp-to-incorporate-issb-climate-related-disclosure-standard-into-global-environmental-disclosure-platform/

International Financial Reporting Standards [IFRS]. (2022c). ISSB at COP27: ISSB makes key announcements towards the implementation of climate-related disclosure standards in 2023. https://www.ifrs.org/news-and-events/news/2022/11/issb-cop27-progress-implementation-climate-related-disclosure-standards-in-2023/

International Financial Reporting Standards [IFRS]. (2023a). Climate-related Disclosure Final Stage. https://www.ifrs.org/projects/completed-projects/2023/climate-related-disclosures/

International Financial Reporting Standards [IFRS]. (2023b). Integrated Reporting Framework. https://www.integratedreporting.org/resource/international-ir-framework/

International Financial Reporting Standards [IFRS]. (2023c). Climate Disclosure Standards Board. https://www.ifrs.org/sustainability/climate-disclosure-standards-board/#:~:text=The%20CDSB%20Framework%20formed%20the,consolidated%20into%20the%20IFRS%20Foundation.

International Organization of Securities Commissions Organization [IOSCO]. (2022). IOSCO welcomes ISSB's publication of sustainability standards exposure drafts. https://www.iosco.org/news/pdf/IOSCONEWS638.pdf

Intergovernmental Panel on Climate Change [IPCC]. (2022). Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–33, doi:10.1017/9781009325844.001. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

Jessop, S., Wilkes, T., and Howcroft, E. (2022). Almost all climate-related corporate disclosures are inadequate, CDP says. Reuters. https://www.reuters.com/business/sustainable-business/almost-all-climate-related-corporate-disclosures-are-inadequate-cdp-says-2022-03-03/

Jones, J. (2023). Canadian Sustainability Standards Board names chair, directors. Globe and Mail. https://www.theglobeandmail.com/business/article-sustainability-standards-board-directors/

Jones, J., Milstead, D., Rendell, M., and K. Blaze Baum. (2020). Despite avalanche of corporate reports on climate change, investors still can't tell who's helping and who isn't. Globe and Mail. https://www.theglobeandmail.com/business/article-despite-avalanche-of-corporate-reports-on-climate-change-investors/

Kirkland & Ellis. (2022). ISSB's Proposed Framework Seeks to Unify Global Sustainability Disclosure Standards. https://www.kirkland.com/publications/kirkland-alert/2022/05/issb-proposed-framework

Kovacs, P. (2019). Climate change and Canada's property and casualty insurance industry. Canadian Institute for Actuaries. https://www.cia-ica.ca/docs/default-source/2019/erm-gre3e.pdf

Krueger, P., Sautner, Z., and L. Starks. (2019). The Importance of Climate Risks for Institutional Investors. ECGI Working Papers in Finance. Working Paper No. 610/2019. https://www.ecgi.global/sites/default/files/working_papers/documents/finalkruegersautnerstarks_1.pdf

Ludden, J. (2021). Your Weather Forecast Update: Warmer Climate Will Be The New 'Normal'. National Public Radio. https://www.npr.org/2021/04/07/983224262/your-weather-forecast-update-warmer-climate-will-be-the-new-normal

Metz, C., and Bakos, K. (2021). Sounding Board: How institutional investors can manage the physical risks of climate change. Benefits Canada. https://www.benefitscanada.com/canadian-investment-review/strategies/sounding-board-how-institutional-investors-can-manage-the-physical-risks-of-climate-change/

Moore, F. (2019). Climate Change is the New Normal but We Don't Seem to Notice. New Scientist. Article 2195471. Accessed at: https://www.newscientist.com/article/2195471-climate-change-is-the-new-normal-but-we-dont-seem-to-notice/

Moudrak, N., Bakos, K., Eyquem, J., O'Reilly, H., Monk, A., and S. Y. In. (2020). Institutional Investors Find Alpha in Climate Risk Matrices: Global Survey Finds. University of Waterloo. Intact Centre on Climate Adaptation. https://www.intactcentreclimateadaptation.ca/wp-content/uploads//2020/12/AlphaCRM.pdf

Moudrak, N. and Feltmate, B. (2019). Ahead of the Storm: Developing Flood-Resilience Guidance for Canada's Commercial Real Estate. Intact Centre on Climate Adaptation, University of Waterloo. https://www.intactcentreclimateadaptation.ca/wp-content/uploads/2019/10/Ahead-of-the-Storm-1.pdf

Nguyen, L., and Goldstein, M. (2022). Goldman Sachs Is Being Investigated Over E.S.G. Funds. The New York Times. https://www.nytimes.com/2022/06/12/business/sec-goldman-sachs-esg-funds.html#:~:text=The%20Securities%20and%20Exchange%20Commission%20is%20investigating%20Goldman%20Sachs%20over,The%20agency%20is%20examining%20E.S.G

Organization for Economic Co-Operation and Development [OECD]. (2021). Financial Markets and Climate Transition: Opportunities, Challenges and Policy Implications. OECD Paris. https://www.oecd.org/finance/Financial-Markets-and-Climate-Transition-Opportunities-Challenges-and-Policy-Implications.pdf

Organization for Economic Co-Operation and Development [OECD]. (2023). Operationalizing Responsible Business Conduct Due Diligence amongst financial sector practitioners. https://mneguidelines.oecd.org/rbc-financial-sector.htm

Office of the Superintendent of Financial Institutions [OSFI]. (2022). Climate Risk Management Draft Guidelines: Sound Business Practices and Prudential Limits B-15. https://www.osfi-bsif.gc.ca/Eng/osfi-bsif/med/Pages/b15-dft_nr.aspx

Office of the Superintendent of Financial Institutions [OSFI]. (2023). Guideline. Climate Risk Management: Sound Business Practices and Prudential Limits. https://www.osfi-bsif.gc.ca/Eng/Docs/b15-dft.pdf

Ontario Securities Commission [OSC]. (2018). CSA Staff Notice 51-354 Report on Climate change-related Disclosure Project. https://www.osc.ca/en/securities-law/instruments-rules-policies/5/51-354/csa-staff-notice-51-354-report-climate-change-related-disclosure-project

Ontario Securities Commission [OSC]. (2021). Consultation Climate-related Disclosure Update and CSA Notice and Request for Comment Proposed National Instrument 51-107: Disclosure of Climate-related Matters. https://www.osc.ca/en/securities-law/instruments-rules-policies/5/51-107/51-107-consultation-climate-related-disclosure-update-and-csa-notice-and-request-comment-proposed

Parliamentary Budget Officer of Canada [PBOC]. (2016). Estimate of the Average Annual Cost for Disaster Financial Assistance Arrangements due to Weather Events. Ottawa, Canada. https://qsarchive-archiveqs.pbo-dpb.ca/web/default/files/Documents/Reports/2016/DFAA/DFAA_EN.pdf

PricewaterhouseCoppers [PwC]. (2022). A new era for climate-related information disclosure: The ISSB published 2 exposure drafts on sustainability reporting standards for public consultation. https://www.pwccn.com/en/services/issues-based/esg/Issb-publishes-isds-draft-for-comments-may2022.html

Pryor, S.C., Barthelmie, R.J., Bukovsky, M.S., Leung, L.R., and K. Sakaguchi. (2020). Climate change impacts on wind power generation. Nat Rev Earth Environ 1, 627–643. https://www.osti.gov/servlets/purl/1678722

Public Safety Canada [PSC]. (2021). 2021-2022 Main Estimates – Increase to Funding under the Disaster Financial Assistance Arrangements (DFAA). https://www.securitepublique.gc.ca/cnt/trnsprnc/brfng-mtrls/prlmntry-bndrs/20210722/006/index-en.aspx

Roman, K. (2019). Climate Change Threatens Both the Economy and the Financial System, Says Bank of Canada. CBC News. https://www.cbc.ca/news/politics/climate-change-bank-of-canada-financial-system-review-1.5137625

S&P Global [S&P]. (2022). Case Study: A Bank Evaluates the Impact of Physical Climate Risk to its Mortgages. https://www.spglobal.com/esg/case-studies/a-bank-evaluates-the-impact-of-physical-climate-risk-to-its-mortgages

Sustainability Accounting Standards Board [SASB]. (2022). About. https://sasb.org/about/

Sustainability Accounting Standards Board [SASB]. (2023a). Standards Overview. https://www.sasb.org/standards/

Sustainability Accounting Standards Board [SASB]. (2023b). Download Sustainability Standards. https://www.sasb.org/standards/download/

Sustainability Accounting Standards Board [SASB]. (2023c). Find Your Industry. https://www.sasb.org/find-your-industry/

Task Force on Climate-Related Financial Disclosures [TCFD]. 2019. Task Force on Climate-related Financial Disclosures: 2019 Status Report. https://www.fsb.org/2019/06/task-force-on-climate-related-financial-disclosures-2019-status-report/

Task Force on Climate-Related Financial Disclosures [TCFD]. (2021). 2021 Status Report. https://www.fsb.org/wp-content/uploads/P141021-1.pdf

Task Force on Climate-Related Financial Disclosures [TCFD]. (2022). About: The challenges we're addressing. https://www.fsb-tcfd.org/about/

Tigue, K. (2019). Climate Change Becomes an Issue for Ratings Agencies. Inside Climate News. https://insideclimatenews.org/news/05082019/climate-change-ratings-agencies-financial-risk-cities-companies/

United Nations Environment Programme [UNEP]. (2022). Emissions Gap Report 2022: The Closing Window – Climate crisis calls for rapid transformation of societies. Nairobi. https://www.unep.org/resources/emissions-gap-report-2022

United Nations Environment Program Finance Initiative [UNEP FI]. (2021). UNEP FI REGIONAL ROUNDTABLES ON SUSTAINABLE FINANCE 2021. https://www.unepfi.org/events/roundtables/unep-fi-regional-roundtables-on-sustainable-finance-2021/

United Nations Environment Programme Finance Initiative [UNEP FI]. (2022). TCFD – Task Force on Climate-Related Financial Disclosures. https://www.unepfi.org/climate-change/tcfd/

University Corporation for Atmospheric Research [UCAR]. (2022). Predictions for Future Global Climate. https://scied.ucar.edu/learning-zone/climate-change-impacts/predictions-future-global-climate

Urban Land Institute [ULI]. (2020). Climate Risk and Real Estate: Emerging Practices for Market Assessment. https://knowledge.uli.org/en/Reports/Research%20Reports/2020/Climate%20Risk%20Markets

U.S. Department of Energy [USDE]. (2017). Effects of Climate Change on Federal Hydropower. Second Report to Congress. https://www.energy.gov/sites/prod/files/2017/01/f34/Effects-Climate-Change-Federal-Hydropower-Program.pdf

U.S. Securities and Exchange Commission [SEC]. (2022a). We are Not the Securities and Environment Commission - At Least Not Yet. https://www.sec.gov/news/statement/peirce-climate-disclosure-20220321

U.S. Securities and Exchange Commission [SEC]. (2022b). The Enhancement and Standardization of Climate-Related Disclosures for Investors. https://www.sec.gov/rules/proposed/2022/33-11042.pdf

Vasil, A. (2023). `Carbon neutral' and 'net-zero' claims face global greenwash crackdown. Corporate Knights. https://www.corporateknights.com/leadership/carbon-neutral-net-zero-global-greenwash-crackdown/

Watkins, S. (2023). The ISSB's battle to sort the alphabet soup of ESG reporting. Financial Times. https://enterprise.ft.com/en-gb/blog/the-issbs-battle-to-sort-the-alphabet-soup-of-esg-reporting/

Whieldon, E. (2021). SEC acting head explains why voluntary ESG disclosure regime is not enough. S&P Global. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/sec-acting-head-explains-why-voluntary-esg-disclosure-regime-is-not-enough-62934422

For further information about the report, please contact:

**Kathryn Bakos**
*Managing Director, Economics and Resilience*
Intact Centre on Climate Adaptation
Faculty of Environment, University of Waterloo
EV3 4334 - 200 University Avenue West
Waterloo, ON, Canada N2L 3G1
kathryn.bakos@uwaterloo.ca | 519-572-1463
www.intactcentre.ca | Twitter @ICCA_Canada

UNIVERSITY OF WATERLOO

INTACT CENTRE
ON CLIMATE ADAPTATION