



net-zero
atlantic

PIER LABS

PRO-CLIMATE BEHAVIOURS IN ATLANTIC CANADA

LITERATURE REVIEW

Determining critical behavioural interventions for enabling an effective transition to net-zero emissions in Atlantic Canada

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Executive Summary

The literature review synthesizes key findings from a comprehensive literature review on barriers and opportunities toward pro-climate behaviours, focusing on behavioural science research, equity considerations, and research gaps in Atlantic Canada's journey towards achieving net-zero emissions by 2050.

Greatest Contributors to Greenhouse Gas Emissions

There is a critical need for tailored initiatives targeting sectors and behaviours driving greenhouse gas (GHG) emissions. Globally, industries and electricity generation emerge as major contributors, while oil and gas, transportation, and buildings lead in Canada. The Atlantic region faces unique challenges, notably in transportation and electricity-related emissions. Although specific regional studies are scarce, global insights highlight key behaviours exacerbating emissions, such as transport mode choices and food consumption patterns. Fortunately, the literature also presents numerous opportunities for emission mitigation through structural, technological, and behavioural changes.

Major GHG Contributors



Oil and gas



Transportation



Buildings

Mitigation strategies



Structure



Technology



Behaviour



Behaviour Science Research Related to the Climate Crisis

Effective interventions should prioritize making environmentally friendly choices the default option. Combining approaches targeting distinct barriers and utilizing timely opportunities can significantly enhance the efficacy of climate-related behaviour interventions. Sequential designs, integrating social comparison and incentive-based strategies, followed by information-based interventions, offer promising avenues for long-term behavioural change. By building on these findings, researchers and stakeholders can work together to create more effective strategies for encouraging pro-climate behaviours and fostering a sustainable future.

This work provides a foundation for future research on applying behavioural science to climate change mitigation and adaptation in Atlantic Canada. It aims to support the development of impactful behavioural research that fosters strategic, coordinated, and equitable climate policies by prioritizing evidence-based policies and equity considerations.

Considerations for Equity in Climate Change Mitigation Interventions

To ensure equitable outcomes, it is critical to engage with affected communities, particularly those who have been historically marginalized, in a genuine and meaningful way. Collaborative approaches are essential to prevent disproportionate impacts and ensure that adaptation and mitigation interventions are inclusive and equitable.



Research Gaps and Opportunities for Behavioural Climate Research in Atlantic Canada

Identifying opportunities for behavioural change interventions is crucial in achieving emissions reduction targets. Transportation, buildings and infrastructure, and agriculture and food consumption emerge as key sectors for intervention. Leveraging behavioural science insights, such as social norms interventions and default options, presents promising avenues for emissions reduction in Atlantic Canada. Collaboration among stakeholders and an equity lens are essential for effective intervention design, implementation, and evaluation.

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Introduction

Climate change remains one of the most urgent global challenges of our time, with human activities being the primary factor in this change (United Nations [UN], 2023a). The rise of GHG emissions leads to the intensification of the greenhouse effect, resulting in increasing global temperatures, melting ice caps, sea-level rise, and altered weather patterns (Environmental Protection Agency [EPA], 2021).

In response, international governments have committed to take action to reduce GHG emissions by more than 40 percent by 2030 to limit global warming to no more than 1.5°C (UN, 2023b; UNFCCC, 2023a). To guide global action to achieve these emissions targets, global frameworks such as the Paris Agreement (United Nations Framework Convention on Climate Change [UNFCCC], 2023a), Sustainable Development Goals (UN, 2023c), and the United Nations Framework Convention on Climate Change (UNFCCC, 2023b) have been created.



To be successful, these strategies will require seismic shifts in economic, environmental, and social systems (Anderson, 2012), including substantial behavioural change at both an individual and system level. As such, applying behavioural science to understand the barriers and enablers to the necessary behavioural changes will be an important aspect of meeting the international commitments to emissions reduction targets (e.g., Gifford, Lacroix, & Chen, 2018; Kaufman et al., 2021). This reality underpins the current research, which seeks to identify the behavioural barriers and enablers of achieving emissions reduction targets in Atlantic Canada.

The literature review detailed in this document is the first deliverable in a project entitled ‘Determining critical behavioural interventions for enabling an effective transition to net-zero emissions in Atlantic Canada.’ The initiative is the only Atlantic Canada-based initiative selected by the Net-Zero Advisory Body (NZAB) to receive support via the Environmental Damages Fund’s Climate Action and Awareness Fund, administered by Environment and Climate Change Canada.

The fund is designed to support projects aiming to contribute to the decrease of Canada’s greenhouse gas (GHG) emissions. In line with this objective, the current project seeks to understand how and at what cost a behavioural approach for net-zero emissions can be achieved by integrating the understanding of human behaviour within energy system modelling.

This project is being delivered by Net Zero Atlantic in collaboration with Pier Labs, the Societal Cognition Lab at Memorial University, the Purdy Crawford Chair in Aboriginal Business Studies at Cape Breton University, the School for Resource and Environmental Studies at Dalhousie University, the Faculty of Management at the University of New Brunswick, and the McDougall Faculty of Business at the University of Prince Edward Island.

Net Zero Atlantic is an organization driven by the purpose of advancing a sustainable and inclusive transition to a carbon-neutral future in Atlantic Canada, providing credible and objective data driven from collaborations with academia, governments, non-governmental organizations, private sectors, and Indigenous persons.

Pier Labs is a federally incorporated non-profit based in Halifax, Nova Scotia, seeking evidence-based practice to develop policy and program improvements that can be rigorously tested through experimentation. Conducting research and innovation on complex societal issues impacting Canadian’s well-being, Pier Labs works collaboratively with government, community organizations, post-secondary institutions, charities, foundations, and private sector organizations.



In recognition of the critical role that behavioural science can play in the effort to support global emissions reduction and climate change mitigation targets, the current project seeks to undertake research on the behavioural barriers to, and opportunities for, reaching low or zero emissions targets in the Atlantic Canadian region.

To support this research, the current literature review will act as a foundational document which seeks to identify the areas of opportunity and greatest potential for behavioural interventions to be applied to mitigate climate change activities in Atlantic Canada. As such, the literature review has been arranged as follows:

Section 1: Focuses on the identification of the main contributors to GHG emissions on a global scale and within Canada's national context, with a specific focus on the Atlantic region (which includes Newfoundland and Labrador, Nova Scotia, New Brunswick, and Prince Edward Island). This is intended to identify those sectors and behaviours that present the greatest opportunity for behavioural change interventions to reduce emissions in Atlantic Canada and more broadly.

Section 2: Outlines the literature which has explored the application of behavioural interventions to climate change mitigation. This aims to provide a summary of the existing evidence and research from the field of behavioural science and thus identify where there are opportunities and gaps for these theories and methods to be applied in the Atlantic Canadian context.

Section 3: Bringing together the insights gathered from Sections 1 and 2, this section seeks to identify the research gaps and opportunities which could be explored in subsequent phases of this research project. These focus on identifying those opportunities which have the most thorough basis in behavioural science as well as the greatest potential to reduce admissions in Atlantic Canada. This also includes a summary of some of the literature which explores the ways in which behavioural science can and should be applied to this challenge, ensuring an approach which considers equity and how interventions or policies have the potential to disproportionately impact some groups, particularly those already marginalized.



Methodology

This literature review focused on identifying both academic and grey literature exploring (1) the greatest sources of GHG emissions at multiple levels within the sectors of transportation, agriculture and food consumption, and infrastructure, (2) recent and impactful behaviour change research across the above-mentioned sectors, and (3) recommendations for equitable interventions on climate change impacts for vulnerable and marginalized populations.

Search strategies included relevant keywords for climate change main drivers, behavioural research, and impact equitability, and are displayed in *Appendix A*.

Selected sources were included based on their contribution towards the topics of interest and were analyzed to provide a comprehensive review of the most recent state of the art regarding greenhouse gas emissions, behavioural approaches towards mitigation, and equitable impacts within the broader scope of climate change.

Section 1. Greatest Contributors to Greenhouse Gas Emissions

Designing effective solutions and policies to mitigate and adapt to climate change requires a comprehensive understanding of the sources of GHG emissions at different levels – namely, global, national, and Atlantic regional scales.

This knowledge is crucial to ensure that policy initiatives and interventions are strategically selected to create the greatest reduction in emissions. Knowing the sectors, technologies, and behaviours which are the most intense emitters of anthropogenic GHGs is necessary to identify which initiatives are expected to create the greatest impact on emissions reduction, not only at a global level but also at a national and regional scale. The following section seeks to identify the current state of emissions by region and behaviours. This will inform the subsequent sections, which will seek to identify the gaps in behavioural science research that could be used to inform policies that have the greatest potential to mitigate behavioural emissions in the Atlantic region.

1.1 Overview of Emissions by Sector

In the global context, data compiled by Rivera et al. (2021), as shown in Figure 1, reveals that the Industrial sector (comprised of mining, manufacturing, construction, and waste management) is responsible for the largest share of global emissions (30 percent). This is closely followed by Electricity Generation, which is responsible for 26 percent of global emissions. Emissions from Agriculture, Forestry, and Other Land Use account for 21 percent, while the Transportation and Buildings sectors contribute 16 and 7 percent of emissions, respectively.



Figure 1. Representation of the 2019 global GHG emissions by sector compiled (Rivera et al., 2021).

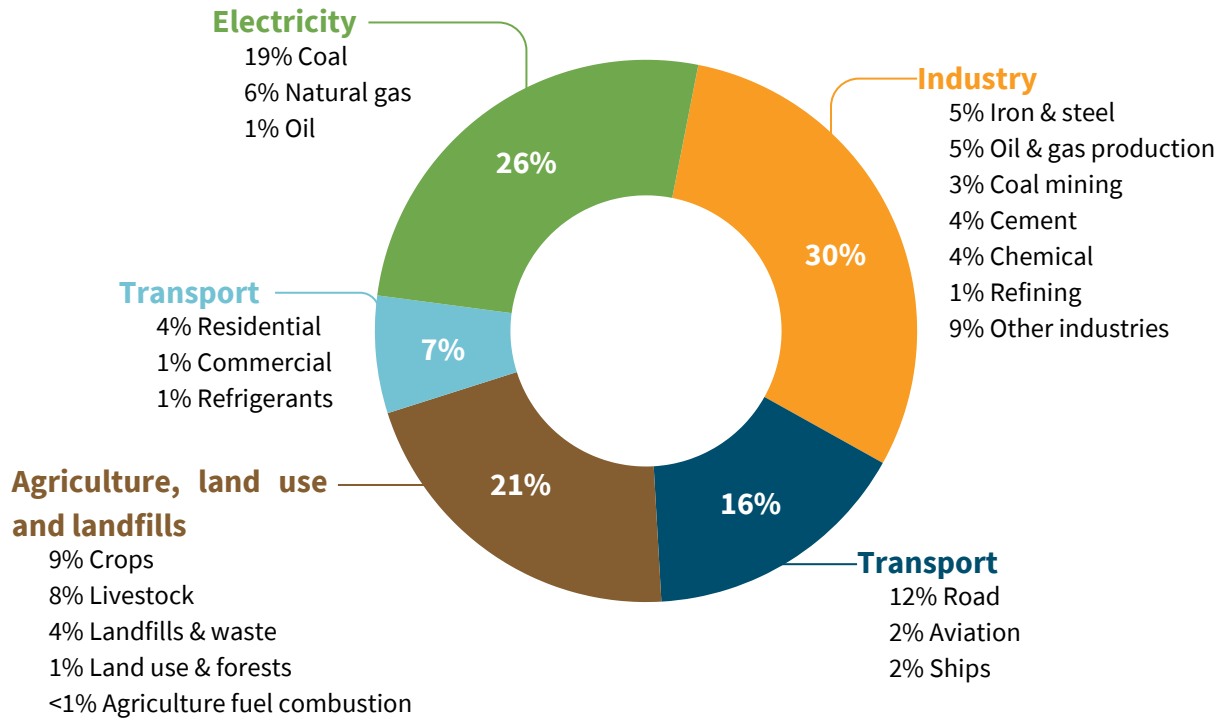
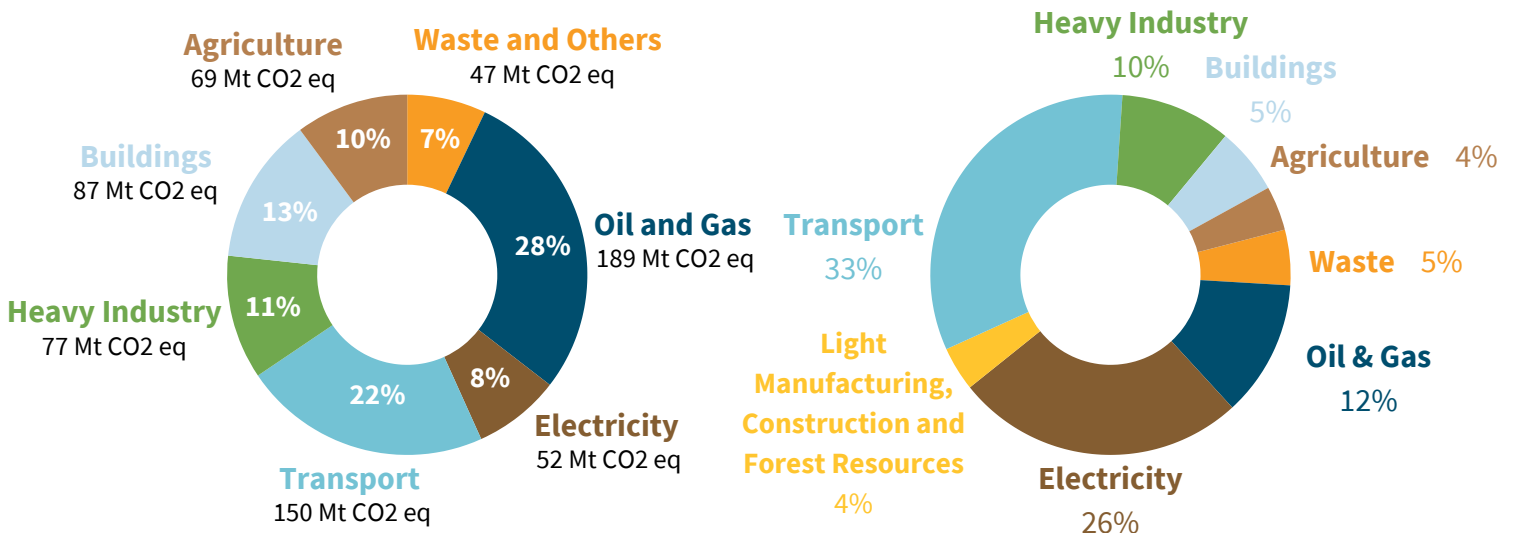


Figure 2. Representation of 2021 Canada GHG emissions from the National GHG Inventory Report (2023).

Figure 3. Representation of 2021 Atlantic Region GHG emissions by sector compiled by (Venkatachalam et al., 2023).

Total: 670 Mt CO₂ eq



The most heavily emitting sectors at a global level are mirrored by Canadian emission distributions. The primary sources of emissions in Canada are closely tied to energy production and consumption activities, with the oil and gas sector contributing the largest share (28 percent), followed by Transportation (22 percent).

Although the Buildings sector (both residential and commercial) contributes 13 percent of emissions, this increases to 18 percent when factoring in electricity consumption within building infrastructure. Other notable emissions sources include heavy industry (comprised of mineral, chemical, metal, halocarbon production, and other processes), which contributes 11 percent, the agricultural sector at 10.2 percent, and the electricity sector at 7.7 percent (National GHG Inventory, 2023), as presented in Figure 2.

This distribution reflects that in line with global trends, Energy Generation, Transportation, and Industrial Activities are some of the most emission-intensive sectors.



As such, successfully changing behaviours in these sectors may have the potential to create substantial reductions in emissions. Reflective of the unique sectors that drive the economy in the Atlantic Canadian region, the most emissions-intensive industries diverge somewhat from the distribution of emissions at international and Canadian levels. For example, the largest area for emissions in Atlantic Canada is the Transportation sector due to a heavy reliance on personal vehicles. This sector is responsible for a third of emissions in the region (33.3 percent).

The second most heavily emitting industry in the region is electricity generation (26.2 percent) due to a heavy reliance on fossil fuels, especially within the Nova Scotia and New Brunswick provinces. This is followed by industry (comprised of oil and gas and manufacturing) (21.6 percent), buildings (5.5 percent), and agriculture (4 percent) (ECCC data, cited by Venkatachalam et al., 2023).

The unique distribution of emissions in the Atlantic region highlights the importance of undertaking behavioural research in the region. Understanding the behaviours and lifestyles of the local population is crucial, not only for identifying the unique drivers of emissions but also for designing effective, targeted climate mitigation and adaptation interventions, thereby ensuring that resources are allocated to solutions that make the most significant impact in addressing behavioural emissions in the region.

1.2 Opportunities for Behavioural Change by Sector

The significant modifications needed to change the trajectory of GHG emissions are typically considered within the context of technology and large-scale governmental policies. Unfortunately, changes in lifestyle or behaviour are often relegated to an afterthought in the analysis of climate change mitigation aimed at meeting international targets (Creutzig et al., 2016).

Currently, individuals/households are accountable for nearly three-quarters of the global carbon footprint, and this share is increasing (Marchi et al., 2021). Likewise, Canada's behaviour/lifestyle carbon footprint is currently among the highest at 13.6 tCO₂e per year and needs to fall by 82 percent to reach its per capita emission target by 2030 (Akenji et al., 2021).

Within the literature, several high-impact areas, such as changing consumption patterns in transportation, agricultural, and building sectors, are identified. **Specifically, studies emphasize changes in mobility, housing energy use, and food/dietary choices as actions with the greatest potential to reduce emissions** (Hedenus et al., 2014; Wynes & Nicholas, 2017; Costa et al., 2021; Marchi et al., 2021; Bergquist et al., 2023).



Transportation Sector

Within the transportation sector, there are substantial opportunities for behavioural change interventions to have material impacts on emissions reduction (Shukla et al., 2022).

In Canada, individual transportation behaviours contribute significantly to transport-related emissions. According to Akenji et al. (2021), emissions from personal vehicles constitute the largest share (3.54 tonnes CO₂e per year) of per capita emissions. This is despite a range of opportunities which exist for individuals to shift their mode of transport from private vehicles (usually high-emission modes) to sustainable alternatives. These include increased use of public transportation, active transportation modes (cycling, walking), speed and distance reduction, ride-sharing practices, and adjustments in commuting patterns (e.g., telecommuting and remote work) (Ngo et al., 2009; Schrotten and Delft, 2012; Costa et al., 2021; Moriarty and Honnery, 2022).

For instance, research by Costa et al. (2021) suggests that altering travel behaviour could lead to significant emission cuts by 2050. The study suggests that increasing public transport use (trains, buses) could reduce emissions by around 50 percent and ridesharing by 30 percent.

Similarly, Schrotten and Delft (2012) find that switching to smaller cars could reduce emissions by 22 percent per passenger kilometre; adopting a more fuel-efficient driving style could result in a 7 percent reduction; and embracing practices like teleworking could lead to a 12 percent emissions reduction by 2050.

It is important to acknowledge that while these options are not accessible to all of a community due to geographic, economic, or physical barriers, there is a substantial portion of the Canadian community for whom modal shift is an option. As such, identifying and mitigating the behavioural and systemic barriers to modal shift presents a major opportunity for emissions reductions. This is particularly relevant in Atlantic Canada, where transportation is responsible for a third of overall emissions, particularly due to private vehicle use.



Building Sector

To reduce GHG emissions in the building and infrastructure sector, **significant emphasis has been placed on enhancing energy efficiency within buildings and improving appliance efficiency.** This is particularly the case because space heating and cooling activities constitute the largest share of building emissions. Indeed, heating accounts for approximately 64 percent of those emissions, followed by cooling at 15 percent, lighting and appliances at 14 percent, and cooking at 6 percent (Marchi et al., 2021).

Despite the focus on energy efficiency as an emissions reduction strategy, research has highlighted the substantial impact of occupant behaviour on energy use (e.g., Shukla et al., 2022; Ahmed et al., 2023). For example, Mata et al. (2022) project that within developed nations, changes in occupant behaviours could potentially lead to remarkable reductions of up to 50 percent in energy consumption by 2050.

Behaviours such as setting the heating system excessively high in winter or overusing air conditioning in the summer substantially contribute to emissions (Fabi et al., 2011; Laaroussi et al., 2019; Harputlugil & de Wilde, 2021). Similarly, leaving lights on in unoccupied rooms, using energy-intensive appliances excessively, or neglecting to turn off devices on standby mode all contribute to higher electricity consumption and, thus, GHG emissions.

As such, minor adjustments in occupant behaviour to adopt energy-saving practices can yield substantial reductions in emissions. These include adopting practices such as adjusting light usage, optimizing ventilation, and using appliances responsibly, as well as more significant changes like downsizing living spaces and embracing cohousing arrangements (Lopes et al., 2012; Faber et al., 2012; Zhang et al., 2018; Khan, 2019).



These realities highlight the significant potential that effective and sustainable behavioural changes could have on reducing emissions in the Buildings sector (Stankuniene et al., 2020).

Agriculture Sector

As highlighted in Section 1.1, the Agriculture sector is responsible for one-fifth of the world's global GHG emissions. The vast majority of this (77 percent) is linked to livestock production, including meat and dairy (University of Birmingham, 2023). **Similarly, in Canada, 53 percent of total agricultural emissions are attributable to beef and dairy production** (ECCC, 2020).



Accordingly, Auclair and Burgos (2021) have found that animal-based foods were responsible for three-quarters of Canadians' total diet-related GHG emissions, with red and processed meat alone contributing 82 percent per capita.

The decision to consume meat and dairy is one of the most significant decisions that individuals can make to have an impact on the emissions contributed by the agriculture sector (Hayeket et al., 2020; Willett et al., 2019).

The impact of a societal-level shift away from animal-based products towards plant-based products holds significant potential for emissions reductions in the agriculture sector (Risku-Norja et al., 2009; Clark & Tilman, 2017).

There is substantial opportunity for behavioural change interventions to identify the barriers to such shifts in these consumption patterns, particularly those who hold pro-environmental attitudes.

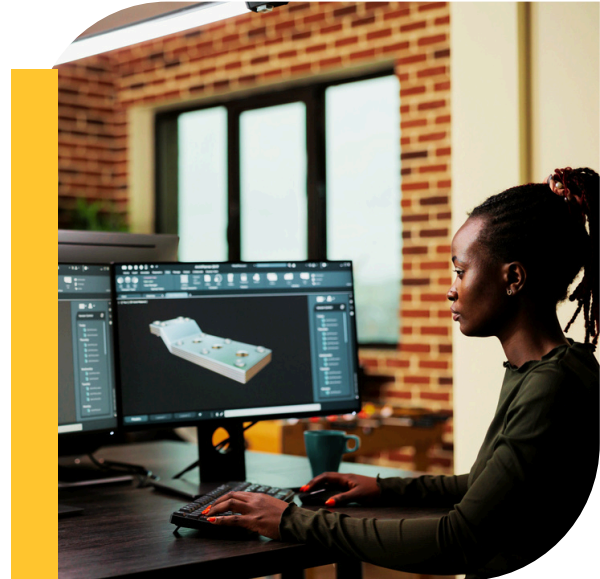
1.3 Key Conclusions

Examination of the current state of emissions highlights industries and electricity generation as major contributors to global emissions, while in Canada, emissions are most intensely contributed by the oil and gas, transportation, and building sectors. The Atlantic region faces unique challenges, with transportation and electricity-related emissions posing significant obstacles to achieving net-zero targets.

Although specific studies on behaviours in the Atlantic region are scarce, existing global and national-level research provides valuable insights that can be applied to the region.

Notable behaviours contributing significantly to GHG emissions include transport mode choices, food consumption patterns, and inefficient occupant behaviours in buildings.

At both global and national levels, the dominance of private vehicles, high meat and dairy consumption, and inefficient energy use in buildings exacerbate emissions in the transportation, agricultural, and building sectors.



Fortunately, the literature also highlights numerous opportunities for emission mitigation through structural, technological, and behavioural change.

By directing efforts toward these key sectors and behaviours, substantial progress in mitigating GHG emissions can be achieved by identifying, designing, testing, and scaling evidence-based behavioural interventions.

Section 2. Behaviour Science Research Related to the Climate Crisis

As explored in Section 1, people’s decisions have the potential to substantially influence decisions which have a direct impact on GHG emissions. As such, **behavioural science has increasingly been recognized as a pivotal tool in response to the climate crisis, with its potential to support policies and interventions to address environmental challenges by shifting human decision-making and action towards more pro-environmental behaviours.**

Behavioural science is a multidisciplinary approach grounded in empirical research, which provides evidence-based insights into human behaviour and what influences and shapes decision-making processes, including cognitive, emotional, and social factors.



Drawing from psychology, economics, sociology, and neuroscience, this field seeks to understand how individuals and groups respond to various stimuli, make choices, and interact within their social and environmental contexts (Organisation for Economic Co-operation and Development [OECD], 2022).

It challenges the assumption of purely rational decision-making that underpins classical economic theories, recognizing that human behaviour often deviates from perfect rationality due to various psychological factors (Becker, 1976).

In recognition of the potential that behavioural science has for mitigating climate change, the following section of this report seeks to provide an overview of the existing behavioural research as it relates to the climate crisis. This includes **summarising the psychological barriers to pro-environmental behaviours, the opportunities and evidence on behavioural interventions, specific research within particular sub-sectors, and a brief summary of the future opportunities for research.**

This is intended to lay the groundwork for Section 3, which will combine the insights from Section 1 to identify the research gaps and opportunities for behavioural science research and policy actions in Atlantic Canada.

2.1 Psychological Barriers to Climate Change Mitigation and Adaptation

The application of behavioural science to the climate crisis acknowledges that addressing climate change will require not just technological and policy solutions but also a deep understanding of human behaviour and decision-making processes (van der Linden & Weber, 2021).

Decision-making to engage in pro-environmental behaviours occurs not only at an individual level but also at a systems level (as will be discussed in Section 2.2). In all cases, the psychological phenomena can result in sub-optimal decision-making, such as a lack of pro-environmental behaviours. Section 2.1 seeks to explore some of these psychological barriers, as this theoretical grounding is critical to designing policies and interventions that intend to mitigate these behavioural barriers and thus enable sustained behavioural change.

Firstly, **emotional responses have been shown to prompt different outcomes concerning climate change adaptation.** Evidence suggests that emotional responses can lead to suboptimal responses, as well as have the opposite effect, resulting in an increase in pro-environmental behaviour adaptive actions.

In the first case, overwhelming feelings of guilt or despair in response to the prospect of climate change (often referred to as eco-guilt or climate anxiety) have been shown to lead to its denial or



prevent willingness to engage in pro-environmental behaviours. Nonetheless, the same emotional reactions have also been found to be associated with pro-environmental behaviours and environmental activism (Ágoston et al., 2022; Ogunbode et al., 2022; Orlove et al., 2020).

Regarding the different outcomes of climate anxiety, it has been reported that this negative emotion is more strongly associated with pro-environmental actions in more individualistic and affluent countries (Ogunbode et al., 2022).

Social factors such as social norms and cultural identity have also been reported to impact willingness to engage in pro-environmental behaviours.

On one hand, perceiving pro-environmental behaviour as normative within a social group can facilitate individual behavioural change. On the other hand, when a greener behaviour is seen as conflictive with an individual's cultural or social identity, this will constrain individual-level behavioural change (Shukla et al., 2022; Orlove et al., 2020).

Further research has sought to summarise the barriers to pro-environmental behaviours. Aiming to acknowledge the most significant psychological barriers, Gifford (2011) recognized obstacles to climate and sustainability behavioural change. This was derived from the question, 'Why is so little being done if so many people are in favour of environmental sustainability?'.
Six psychological barriers have been shown to inhibit pro-environmental behaviours (Gifford, 2011):

- disbelief on the existence of an environmental issue due to **denial, lack of self-efficacy, optimism and confirmation biases** and, as consequence, the need to take adaptation strategies to deal with climate change impacts;
- conviction that changing would collide with **personal goals**, mirroring **behavioural status quo**, perceived financial or temporal risks, and conflicting goals as obstacles;

- need to conform with socially established behaviours, inhibiting climate change initiative and **emphasising social norms and perceived social risk** as barriers;
- sense of lack of self-responsibility and **belief that major entities should step forward** to take action instead;
- conviction that, once one takes some sort of action, the mission to adapt to climate change has been accomplished, highlighting **tokenism** as an obstacle; and finally
- lack of knowledge on what to do and how to make pro-environmental changes, suggesting that being **unaware or even environmentally numb** to the climate crisis are both barriers to action.

The intention-action occurs when people have the desire to act but fail to follow through. These barriers are also obstacles to any attempt to bridge this gap.



2.2 Behaviour Change at Individual, Circumstantial and Systems Levels

It is critical to acknowledge that behavioural change is not only required at an individual level to create a substantial impact on emissions.

As highlighted in Section 1, many of the changes required to achieve net-zero targets will not sit at the individual level (i.e., transport modal shift, building energy use behaviours, dietary choices, etc.), but instead require systems-level shifts (i.e. changes to infrastructure, energy sources, and investments in R&D, etc.).



In recognition of this, the following section seeks to discuss behavioural change as it relates to three different levels: individual, circumstantial and systems (Park et al., 2023). Though interconnected, these three distinct levels require a specific evidence-based understanding of behaviour in order to develop an intervention which successfully promotes behavioural change.

Individual Level Behavioural Change

Individual behaviour changes, such as decreasing the use of fossil-fuel-based energy, purchasing fewer products, and consuming a plant-based diet, are all demonstrated to contribute to climate change mitigation (Shukla et al., 2022; Wynes & Nicholas, 2017). As such, interventions intending to increase adoption of these kinds of pro-environmental behaviours can be one approach to emissions reductions interventions (Park et al., 2023).

One of the primary intervention mechanisms that governments and organizations use to encourage behavioural change is communications campaigns and approaches.

Research suggests that taking a behaviourally informed approach to communications is an effective way to increase its efficacy and sustainability.

Understanding the target audience,

acknowledging their constraints, and building a compelling narrative based on sustainable adaptation and mitigation scenarios are important features to consider (Park et al., 2023).

Despite behavioural research increasing the efficacy of communications campaigns, information-based interventions have been reported as generally less successful in creating sustainable behavioural change than other types of interventions (Abrahamse & Matthies, 2012).

Recent meta-analyses demonstrated that the **effectiveness of behavioural interventions increases when information provision is followed by mechanisms considering other contextual determinants of behaviour, with information delivery alone creating minor shifts in behaviour** (Cadario & Chandon, 2020; Nisa et al., 2019; van der Linder & Goldberg, 2020).

With practical barriers such as the real cost and inconvenience of many greener choices, information-based interventions are reported to have little impact on changing the behaviours of unmotivated individuals (Bergquist et al., 2023).

Communications and public engagement can play a critical role in influencing and guiding behaviour when there is high motivation and capability to act but poor knowledge of how to properly take action (Nisa et al., 2019).

A classification system was developed, associating types of behavioural interventions with determinants of pro-environmental behaviours



These psychological variables mediate the effects of interventions on individuals' behaviour (e.g., beliefs, perceptions, attitudes, and emotions).

These included the theory of planned behaviour (Ajzen, 1991), the protection motivation theory (Rogers, 1983), the norm activation model (Schwartz, 1977), the value-belief-norm theory (Stern et al., 1999), and the focus theory of normative conduct (Cialdini et al., 1990).

These determinants (such as knowledge, risk perception, and self-efficacy) were linked to six types of interventions (e.g., information provision, incentives, and goal setting) and their corresponding subcategories (e.g., the incentives-based interventions include rewards and penalties as subcategories).

This classification system helps to identify which determinant can be tackled by each intervention type. Nevertheless, contextual features and population targets need to be considered for intervention effectiveness.

The associations between the above-mentioned determinants and intervention types assume that individuals make a conscious decision about the behaviour to be acted upon. **Yet the vast majority of decisions that a person makes each day are the result of behavioural heuristics, meaning that even if someone has an intention to act in accordance with their pro-environmental values, their behaviour does not necessarily align (intention-action gap).** Instead, decisions are often driven by ‘automatic’ heuristics like status quo bias, mental accounting, or loss aversion.

‘Choice architecture’ and ‘nudge’ interventions are designed to target heuristics that create such intention-action gaps. These interventions refer to intentional changes to the context in which an individual makes a decision in.

These changes aim to either mitigate or leverage the behavioural heuristics which result in suboptimal decisions. Importantly, these



interventions need to be designed without limiting any options or interfering with the perceived benefits and costs of selection options, but instead **by making the pro-environmental choice the easier option for the decision-maker** (Mertens et al., 2022; Thaler & Sunstein, 2008, 2021; van Walkengoed et al., 2022).

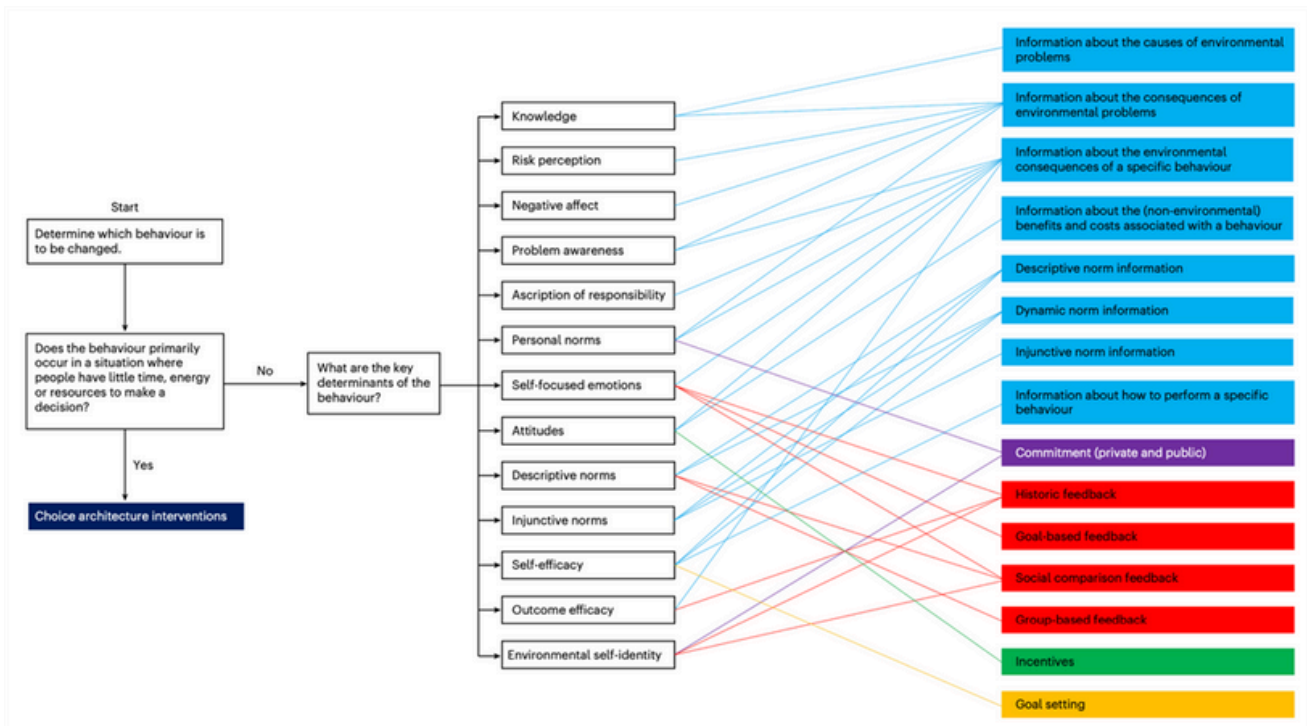
In the context of climate change mitigation, **choice architecture interventions aim to shape people’s behaviour by making pro-environmental options easier, more available, convenient, socially accepted, or the default choice** (Lehner et al., 2016; Park et al., 2023).

Research has shown that such interventions can successfully increase pro-environmental behaviours by leveraging heuristics to encourage people to make deliberate decisions which align with their intentions (Chater & Loewenstein, 2022; Jenny & Betsch, 2022; Park et al., 2023; Rau et al., 2022).

Promoting behaviour change at scale is challenging, particularly when the behaviours to be changed are prompted, reinforced, and sustained by the social, physical, economic, and digital environments in which they occur.

As outlined, there is a range of approaches to implementing behavioural interventions which are supported by behavioural science research. These are discussed further in relation to specific pro-environment behaviours in Section 2.3.

Figure 4. Representation of the link between behavioural determinants to interventions (van Valkengoed et al., 2022).



Note: The colour coding of type of interventions is as follows. Dark blue – Choice architecture interventions; Light blue – Information provision; Purple – Commitment (including private and public commitment); Red – Feedback; Green – Incentives (including reward and penalty); Yellow – Goal setting.

Systems Level Behavioural Change

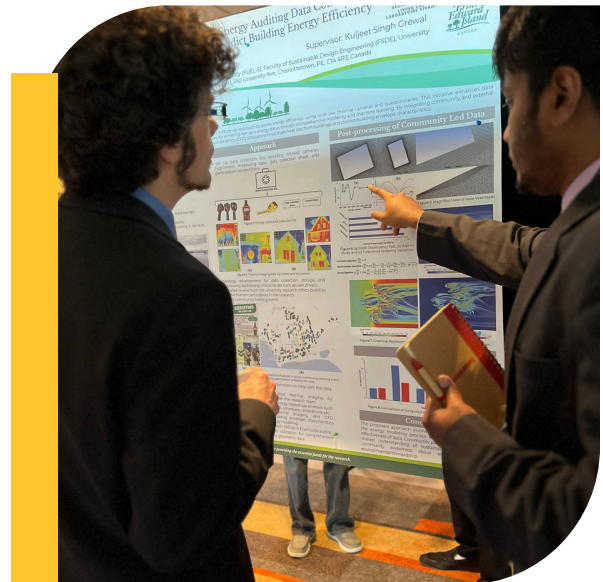
Although individual-level behavioural changes have a role to play in responding to the climate crisis, they are projected to have a relatively limited impact as compared to systematic changes that are required (Jenny & Betsch, 2022; Marteau et al., 2021; Park et al., 2023).

Some sectors and industries require structural and economic transformations rather than individual-level behavioural change to reduce emissions. For example, in the energy sector, there is minimal opportunity for individual-level behavioural change if an economy is heavily dependent on emissions-intensive energy sources, particularly if there is currently no option for an individual to choose an alternative, lower-emissions energy source. Such changes would require broader structural and economic shifts.

As such, individual-level behavioural change interventions are only part of the picture when it comes to responding to the climate crisis. Modifying taxes and subsidies, investments in green energy technologies, and setting regulations which support net-zero targets, among many other economic, political, legal, and societal measures, are all integral to achieving emissions reduction targets.

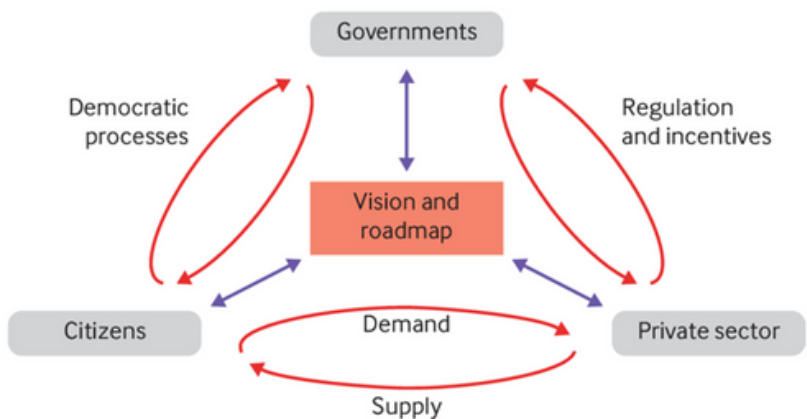
As these decisions sit with governments, corporations, not-for-profit sectors, and a range of other institutional stakeholders, top-down behavioural change plays an important role alongside individual behavioural change.

As the decisions of individuals, policymakers, corporate executives, and other relevant parties are all subject to behavioural biases and heuristics (such as framing, loss and risk aversion, status quo, and confirmation bias), there is a significant opportunity for behavioural change at the systems level. Some of these opportunities are explored in the section below.



Governmental and political entities have started to acknowledge the need to develop and administer climate action plans (e.g., European Council, 2023; Government of Canada, 2022; United States Environmental Protection Agency, 2023). Nonetheless, aligning governmental and political climate-related agencies with private sectors, non-governmental organizations, and consumers in a coherent and robust action plan is yet to be achieved (Varley & Lewis, 2021; Park et al., 2023).

Figure 5. Representation of the authors’ conceptualization of the association between the government, private sector, and consumers needed to reach out to the proposed climate change agenda: “Interconnected behaviours of government, private sector, and citizens to achieve net-zero.” (Marteau et al., 2021).



With activities from high-carbon industries representing a significant threat to the implementation of effective policies, Marteau et al. (2021) have appealed to governmental entities and UN bodies to safeguard policymaking and its implementation of a transition to net-zero pathway. The authors identify a list of actions to protect pro-environmental policies from corporate interference:

- Deny corporate entities the power to develop and enact policies, as implemented for the tobacco industry (World Health Organization [WHO], 2003).
- Develop strategies to manage conflicts of interest within policy making, such as the designation of external advisement panels for corporate engagement in policy (Buse et al., 2021).
- Institute statutory registers to monitor corporate lobby across governments and allow for public inquiries on those records (Shone & Wilkinson, 2015).

- Use regulations to prevent corporations from causing negative environmental impacts (Thornton & Covington, 2016).

Consumer choices and market pressures, along with governmental regulations and incentives, can encourage private sector organizations to undertake a faster transition to lower GHG emissions (Marteau et al., 2021; Park et al., 2023; Swinburn et al., 2019). **Systems-level behavioural changes have the potential to have major impacts on the scale of carbon emissions at an international, national, and Atlantic Canadian level.**

Understanding the options for applying behavioural change interventions among these stakeholders can present a significant opportunity for relatively low-cost investments with high impacts on emissions reduction. Therefore, there is an opportunity to identify institutional behaviours that could be effective for behavioural interventions.

2.3 Behavioural Change Interventions

While understanding the psychological principles that lead to behavioural barriers is important, understanding which techniques and interventions are effective to change these behaviours is most critical to successfully mitigating and adapting to climate change. As such, the following section seeks to (i) specify diverse types of behaviour change interventions that are effective and (ii) highlight behavioural research on applying behavioural interventions to target behaviours by sector.

Types of Behaviour Change Interventions

Information and Feedback

Information and education-based interventions are powerful tools to raise awareness of climate change, aiming to use the provision of information to promote behavioural change, which optimizes decision-making (Bergquist et al., 2023; Whitmarsh et al., 2021). Identified strategies to prompt informational interventions' effectiveness include:

1. Tailoring its content and format to the target population's values and beliefs.
2. Promoting self-efficacy and empowering climate action (instead of appealing to risk perception).
3. Communicating broader collateral benefits of climate action (for example, by informing that air pollution reduction will have positive health impacts).

Similarly, **feedback interventions aim to incite behavioural change by providing feedback to individuals and households about their own behaviour to reinforce and/or modify future actions** (Karlin et al., 2015).



Feedback interventions have been found to be effective in increasing pro-environmental behaviours when (i) obstacles to performing the target behaviour are low, and the benefits of taking action are high, (ii) individuals are motivated and willing to act, and (iii) specific criteria of providing direct, real-time, and frequent feedback are used (Bergquist et al., 2023; Sanguinetti et al., 2020; Verplanken, 2018)

As one of the most common strategies used to reduce energy use, providing feedback can also strengthen individuals' environmental self-identity by gaining awareness of their previous

Incentives

Noted across the literature as one of the most effective approaches to promote energy conservation and prompt climate change mitigation (e.g., Bergquist et al., 2023; Khanna et al., 2021), incentives refer to rewarding individuals for taking more sustainable actions. In their most prevalent form of financial rewards (including reimbursements, cash payments, and monetary discounts), incentives may include discounts for pro-environmental behaviours or fiscal measures to dissuade unsustainable choices (Whitmarsh et al., 2021).

Incentives can also be applied in non-financial forms, such as providing free internet on public transportation. To promote pro-environmental actions, incentives are indicated to be most effective when there is an opportunity to act but a lack of willingness to do so, as individuals with low motivation and high opportunity are unlikely to be influenced by communication and empowerment-based approaches (such as narratives or commitment strategies; Verplanken, 2018).

mitigation actions, motivating them to engage in further sustainable behaviours (Chater & Loewenstein, 2022; Shukla et al., 2022; Wynes et al., 2018).

However, **using financial incentives has also been reported to create conflict between two negatively correlated values: materialism and environmentalism.**

The use of economic rewards can discourage people from developing non-materialist, intrinsic motivation to prefer pro-environmental options and, if consistently relying on extrinsic incentives, even disturb pre-existent attachments to the desirable behaviour (Bergquist et al., 2023; Brown & Kasser, 2005; Deci, 1971; Deci et al., 1999; Markowitz & Shariff, 2012; Vohs et al., 2006).

Despite these risks, interventions structured around financial incentives have presented positive results when applied to behavioural change to increase the uptake of low-carbon options (e.g., shifting demand towards the use of public transportation; Agarwal & Koo, 2016)

Social Norms

Social norms are found to be one of the strongest single influences on people's behaviours (Whitmarsh et al., 2021). Identified as the predominant set of beliefs, attitudes, behaviours, and conduct codes of a group, social norms can be distinguished as (Cialdini & Jacobson, 2021; Farrow et al., 2017):

- Actual or perceived, concerning a verified norm or an unverified norm that is believed to be true.
- Descriptive or injunctive, describing how most people behave or how most people believe one should behave.
- Prescriptive or proscriptive, concerning norms underlining the appropriateness of desired behaviours or norms about the inappropriateness of undesirable behaviours.

The impact of social norms has been studied significantly in the scope of environmentally protective behaviours, with evidence showing their influence on energy conservation, water usage, recycling, and sustainable food choices (Allcott, 2011; Cialdini & Jacobson, 2021; Mitchell et al., 2013; Park et al., 2023; Salmivaara et al., 2021).

To promote climate change-related behaviours, different strategies can be used to enhance the effectiveness of interventions that leverage social norms, such as public commitment and social modelling. The use of persuasive messages that employ both descriptive and injunctive norms instead of relying on a single norm type is reported to increase these interventions' success (Cialdini & Jacobson, 2021).



By emphasizing both the behaviour that is common and approved by a social group (e.g., having a plant-based diet during most weekdays) and the one that is uncommon and frowned upon (e.g., eating meat more than twice a week), independent motivational pathways are targeted (Cialdini, 2003; Cialdini & Jacobson, 2021; Schultz et al., 2008).

Accentuating trends in the descriptive norm for behaviour has also been linked to increased intervention effectiveness, with studies reporting that emphasizing recent changes in how most people behave has a greater impact than merely indicating a static level of the behaviour prevalence (Cialdini & Jacobson, 2021; Sparkman & Walton, 2017). As such, social norms show strong potential to be leveraged to influence the uptake of pro-environmental behaviours.

Commitment Devices



Commitment devices focus on strategies such as goal setting, commitment, and implementation intentions and have been shown to reduce energy use by an average of 10 percent (Andor & Fels, 2018; Bergquist et al., 2023; Nisa et al., 2019).

Requiring the capacity to envision and commit to pro-environmental behaviours in the future, these interventions are pointed out as most suitable for a target population that has either already adopted sustainable lifestyles (to support their continuity) or who may be more effortlessly persuaded to shift to greener options (Schultz, 2013; Verplanken, 2017).

Considering that even individuals who self-identify as “sustainable consumers” can struggle to align environmental values with actions, pledging to an eco-friendly agenda can also empower further action (Young et al., 2010).

Recognized as one of the most effective techniques for interventions focused on environmental sustainability, goal setting has been used at system-level (e.g., Sustainable Development Goals; UN, 2023c) and across a multitude of contexts, such as energy consumption (e.g., Brandsma & Blasch, 2019), public transportation (e.g., Bamberg, 2002), waste reduction and recycling (e.g., Lingard et al., 2001; Schmidt, 2016).

At an individual level, consciously setting a goal prompts the intention to attain a desired behaviour or outcome, regulating individuals’ focus toward goal-related activities through time (Staples et al., 2020).

Individuals’ commitment towards that goal is reported to be strong when people feel the goal outcome is aligned with their personal values and when they have strong self-efficacy beliefs (i.e., believe that, despite challenging, they are able to achieve the goal; Staples et al., 2020).

Furthermore, research indicates that commitment-based approaches tend to be most effective when goals are self-set, realistic, and publicly shared (Andor & Fels, 2018; Lokhorst et al., 2013). Often combined with other strategies such as feedback, incentives, and persuasive communication, commitment approaches are demonstrated to contribute towards sustained behaviour change both alone and in tandem with other methods (Lokhorst et al., 2013).

Choice Architecture

As previously outlined, choice architecture interventions aim to change behaviour by (re)designing the physical, social, economic, and digital environment in which individuals make choices, increasing the likelihood of a preferred option without depriving people of the freedom to make their own decisions.

As such, this approach involves ‘nudging’ people into a particular socially or individually desirable course of action (Mertens et al., 2022; Verplanken, 2017).

Recent research describes a climate nudge as an intentional modification of the choice environment to prompt individuals’ behaviour towards more sustainable actions, motivated by environmental concerns and encouraging conduct that contributes to climate change mitigation (Siipi & Polaris, 2022).

According to the authors, climate nudges (i) emphasize behaviours that are beneficial for the

climate (e.g., nudging towards planting a tree), and (ii) are developed with the primary purpose of tackling the climate crisis (e.g., nudging towards the use of active transportation for climate reasons, not to intentionally benefit physical health).

Considering the gap between individuals’ positive attitudes and intentions towards pro-environmental actions and their actual behaviour, choice architecture interventions are reported as an effective tool to narrow this gap by guiding people towards more sustainable practices (Siipi & Polaris, 2022).

Either by setting greener defaults, using opt-out strategies, or adding constraints to unsustainable behaviours, climate nudges have achieved successful outcomes in the contexts of energy consumption, transportation, and water conservation (e.g., Brick et al., 2023; Byerly et al., 2018; Nisa et al., 2019; Park et al., 2023).

Combining Behavioural Approaches

As evidenced throughout this review, successful behavioural interventions need to consider various factors to ensure their effectiveness and appropriateness of the intervention, such as behavioural determinants, cultural relevance and ethical considerations, among others (e.g., French et al., 2012; Marteau et al., 2021; Park et al., 2023; van Valkengoed et al., 2022).

Since each approach targets different nuances of behavioural change, the use of a singular approach when aiming to alter behaviour can have limited effectiveness.

To tackle these limits, evidence from the field of climate change and related areas strongly emphasizes the need to combine multiple

approaches to potentially increase interventions' effectiveness (e.g., Bergquist et al., 2023; Mertens et al., 2022; Nisa et al., 2019; Whitmarsh et al., 2021).

Both information and incentives provision have been demonstrated to be more effective when combined with broader contextual and social interventions to encourage low-carbon lifestyles (United Nations Environment Program [UNEP], 2020), and the impact of incentive-based

interventions has shown to be enhanced through the additional use of choice architecture (Mertens et al., 2022; Nisa et al., 2019).

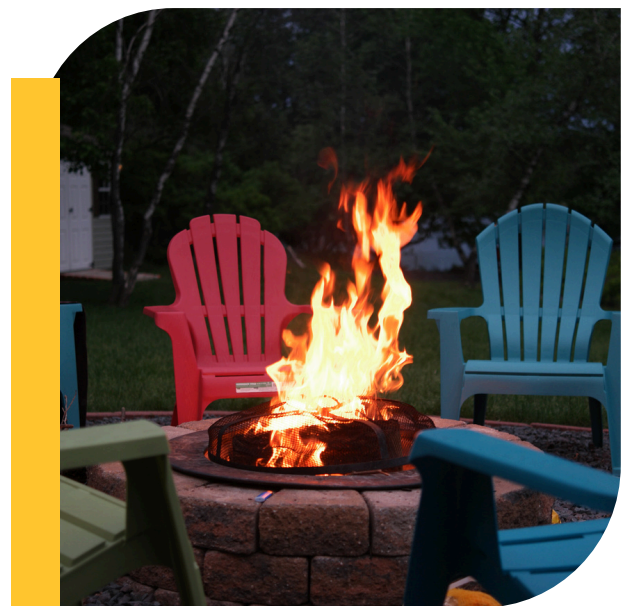
Furthermore, along with an interactive focus on combining different behavioural approaches, the development of interventions that encompass a synergetic relation between individual, choice environment, and system level changes can also increase the potential of effectively achieve and sustain climate behavioural change (Park et al., 2023; UNEP, 2020).

Timeliness and Habit Discontinuity

While behavioural approaches are crucial to disrupt habits and prompt a shift of individual actions, **delivering an intervention at a timely moment of change has also been demonstrated to be an important consideration to amplify the impact of behavioural interventions.**

Times of change or transition in which habits are momentarily disrupted by life-course events (e.g., moving home, changing job location) or structural events (e.g., extreme weather events, economic recession) have been identified as key opportunities to reconfigure lifestyles and self-identities, and leveraging long-term behaviour changes which align more closely with attitudes (Kwasnicka et al., 2016; Park et al., 2023; Song et al., 2017; Thompson et al., 2011; Verplanken et al., 2008).

As such, considering where and when to target a behavioural intervention to increase the adoption of pro-environmental behaviours is likely to be a key aspect of a successful behavioural change initiative.



Behaviour Change Interventions by Sector

In addition to the types of interventions that have been applied to the climate crisis, the field of behavioural science has undertaken specific research on behaviours that relate to different sectors of the economy. As such, the following section seeks to provide an overview of some of the evidence that exists on behavioural interventions by sector, focusing on some of the highest emitting sectors in a Canadian and Atlantic Canadian context: transportation, agriculture and food consumption, and buildings and infrastructure.

Transportation

Behavioural change in the transportation sector is a critical to emissions reduction. This includes modal shift from the use of private vehicle (fossil fuel-dependent or electric), air travel, and pan increased uptake of lower carbon emission modes of transport (e.g., walking, cycling) (BIT, 2022; Park et al., 2023; UNEP, 2020).

With significant potential to reduce emissions by avoiding and shortening emissions-intensive travel, a multilevel approach can also identify the required mechanisms to shift behaviour at both the systems and individual levels.

At the systems level, objectives for behavioural change in the transportation sector include reduction of car use and promotion of both public and active transportation, and adoption of more energy-efficient vehicles.

Each of these will be heavily reliant on economic policies, legal frameworks, and transport infrastructure to be achievable (UNEP, 2020).



For the reduction of personal vehicle use and usage of public and active transportation as an alternative, the global provision of public bike-sharing programmes has become a popular strategy (Meddin et al., 2020).

In addition to cycling incentives, parking restrictions, introducing car-free residential zones, and implementing public mobility services have all been widely implemented measures

regarding legal frameworks and infrastructures (Institute for Transportation and Development Policy, 2022; Kuss & Nicholas, 2022; Ornetzeder et al., 2008).

The importance of infrastructure quality (e.g., pavements, crossings, bicycle lanes, transit signage) was also noted as significant to promote active transportation, with the accessibility and maintenance of pavements as well as street connectivity identified as facilitators (Aubrey & Batista-Ferrer, 2015; Larouche et al., 2018).

To support the adherence to more efficient and low-emission vehicles, the implementation of differentiated taxes based on emissions and fee exemptions for electric vehicles are two of the most used economic policies (Ciccone, 2018; Li et al., 2019).

Evidence from a tax implementation in Norway to promote the acquisition of more fuel-efficient cars reports that the average CO₂ intensity of new vehicles was reduced by about 7.5 g of CO₂/km in the year of its implementation (Ciccone, 2018).



Strategies in the scope of transport infrastructure, such as increasing the availability of charging stations and prioritizing parking for electric vehicles, are also identified as key drivers of consumers' intentions to shift to energy-efficient and/or electric vehicles (Chhikara et al., 2021; ENUP, 2020)

Providing information is the most common strategy to reduce the use of personal vehicles in the scope of transportation (Arnott et al., 2014). However, a broader overview of the literature underlines some mixed outcomes for its effectiveness.

A review of information and education-based interventions targeting the shift to public and active transportation, including campaigns and marketing communication on active travel and public transportation, highlights mixed impacts on behaviour change (Park et al., 2023).

With contrasting findings, a recent intervention to promote the electrification of personal mobility demonstrates that providing tailored compatibility information that meets individual driving behaviours can be a viable approach to reduce people's concern about transitioning to electric vehicles (Herberz et al., 2022).

Findings from this research show a significant increase in individuals' willingness to pay for electric vehicle batteries that provide for longer battery ranges as well as for environmental benefits. Social norms are also a common approach to aim for reducing the use of private vehicles (UNEP, 2020).

By providing information on others' successful shift to sustainable transportation, participants of a month-long field experiment decreased their usual commute-related personal vehicle use by about 500 percent when compared with baseline (Kormos et al., 2015).

Focusing on both social norms and nudging a recently developed large-scale field experiment demonstrated a significant increase in the use of public transportation by incorporating messages that labelled passengers as 'sustainable travellers' (Franssens et al., 2021).

Receiving social norm-based information on both sales and popularity intensification of electric personal vehicles in the local area has also been shown to be effective, increasing the willingness to adopt an electric vehicle by 5 percent when compared with the absence of the social norm communication (Park et al., 2023).

Agriculture and Food Consumption

Significant long-term transformations in the agricultural sector are acknowledged to be crucial to reaching global net-zero GHG emissions targets, including improved agricultural management and innovation, as well as demand-side measures to enable consumption shifts towards more sustainable diets and reduced food waste. Both objectives require both system-level and individual-level changes (Park et al., 2023; UNEP, 2020).

Related to agricultural practices, there is a clear opportunity to apply behavioural science to (i)

Relevant to both system-level and individual-level approaches, intervening in timely moments of change can leverage the shifting of mobility behaviours towards more pro-environmental behaviours.

A recent randomized controlled trial promoting active mobility reported that people who had recently moved houses were almost four times more likely to adhere to a bike-sharing scheme than existing residents (Kirkman, 2019).

Relocating, changing jobs, or retiring can temporarily disrupt mobility habits, creating a suitable occasion for habit disruption and, particularly, pro-environmental behaviour change (Kirkman, 2019; Song et al., 2017; UNEP, 2020).



the development of legal frameworks to promote sustainable use of pesticides and support organic production and (ii) economic policies to incentivize local options and ensure their affordability has been acknowledged (UNEP, 2020).

Cost, scarce knowledge, lack of clear communication, and limited perceived benefits are major challenges to the adoption of improved management practices in the agricultural sector, specifically when addressing fertilizers (The Canadian Agri-Food Policy Institute [CAPI], 2023).

To tackle these barriers, research has shown positive effects in program adoption by farmers with respect to improving the way that information is presented and framed. A scoping review conducted by Piñeiro et al. (2020) included close to 18,000 papers to explore if incentives made available to farmers motivated increased

adoption of more sustainable agricultural practices. Findings from this research demonstrated that, independently of the incentive type, programmes associated with short-term economic benefits have a higher adoption rate than those solely aiming to provide ecological services (Piñeiro et al., 2020).

Incentive types included market-based incentives (such as subsidies and compensations), non-market incentives (such as technical support and technology transfer), and regulatory incentive measures (such as certifications and environmental standards).

Additionally, perceived benefits for either their farms, the environment’s sustainability, or both were identified as motivational factors for farmers to adopt sustainable agricultural practices in the long run.

These findings emphasize the importance of framing incentives according to their target population and accounting for balanced trade-offs between social, economic, and environmental outcomes (CAPI, 2023; Piñeiro et al., 2020).

In addition to agricultural practices, food consumption is an important behavioural change lever that can significantly reduce emissions in the agricultural sector. There is a range of system-level actions identified as essential to this objective, including incentivizing suppliers to decarbonize their products rather than penalizing consumers with higher costs.



Recently published research added more detail to the labelled information at one of the biggest university canteens in Munich (Beyer et al., 2023). In a 10-day field experiment, the researchers introduced a food menu displaying its CO₂ footprint with a design of different credentials, including:

- The CO₂-equivalent emissions in grams (i.e., the absolute number of CO₂ grams equivalent emitted per 100 grams of the dish).
- The percentage of a person's daily CO₂ budget for food (i.e., the carbon footprint of 100 grams of the respective dish as the relative percentage share of a stylized person's daily CO₂-equivalent emission budget for food).
- The environmental cost in Euros (i.e., the carbon footprint of 100 grams of the respective dish as a Euro estimate of the environmental costs caused).
- A colour coding (in the colours of a traffic light that depend on the carbon footprint, with green for low, yellow for medium, or red for high).

The main findings from this research reported a **decrease in the demand for CO₂-intensive meals, resulting in almost 10 percent less emissions when compared to days on which the labelling scheme was not displayed on the menus.**

These results suggest that there is value in implementing information interventions in order to empower consumers to choose lower-emitting food options where those options are available.



In addition to food labels, other choice architecture strategies have also been demonstrated to be effective in changing food consumption and food waste behaviours.

According to a self-reported intervention aimed at reducing red meat consumption, text messaging consumers with reminders was effective in inciting Italian university students to consume less red meat (Carfora et al., 2017).

Social norms have also been used in promoting food-related behaviour change, with evidence suggesting that individuals might differ in the degree to which they are susceptible to being socially influenced (Abrahamse, 2020; Park et al., 2023).

In a study implemented at a campus cafeteria (Sparkman & Walton, 2017), individuals who received information on a dynamic social norm concerning meat consumption (e.g., “30 percent of Americans have started to make an effort to limit their meat consumption”) were

demonstrated to be significantly more prone to opt for a meatless meal when compared to those who received a message in the format of a descriptive social norm (i.e., describing how most people behave).

Nonetheless, a more recent quasi-experimental study in the Netherlands used social influence to promote vegetable purchases (Huitink et al., 2020). The research included the placement of a social norm message in shopping trolleys and a purposely designated place to put vegetables.

Buildings and Infrastructure



Within the building and infrastructure sector, some of the primary opportunities for **behavioural interventions include the uptake of energy-efficient technologies (e.g., heat pumps) and infrastructure (i.e., improved insulation and construction), the household use of greener and renewable energy sources, and the use of technological innovation to promote lower energy consumption** (Park et al., 2023; UNEP, 2020).

Findings from this experiment reported that 73 percent of the customers on the intervention days noticed the inlay used to place vegetables, with the social influence experiment leading to a statistically significant increase in the number of grams of vegetables consumed.

These interventions **highlight the beneficial impact that social norms-based interventions can have on promoting pro-environmental food consumption behaviours**, though notably, they are often context dependant and thus require testing before broader-scale roll-out.

System-level actions and approaches to tackle these challenges include information-based and economic policies, with applications including energy-efficiency labels, incentives for purchasing energy-efficient home appliances, and benefiting homeowners and landlords who retrofit their infrastructures towards more sustainable energy consumption.

Aiming to guide consumers in the pursuit of more energy-efficient products, the European Union (EU) energy label was recently updated to provide for a clearer comparison between products and was reported to be considered by 79 percent of consumers when acquiring energy-efficient products (European Commission, 2023).

To promote the effectiveness of any policy intervention or programme, it is essential to account for clear and user-friendly communication, framing the information to be easily understandable in its diverse formats

(e.g., efficiency labels, monthly bills, or home energy reports; International Energy Agency [IEA], 2021).

As information-based approaches may not suffice to prompt action, policymaking can tackle the status quo bias by nudging energy users towards more sustainable options as an automatic choice. A field study in Switzerland reported that a more environmentally friendly standard subscription in an electricity package increased the share of consumers using solely renewable electricity from less than 5 percent to more than 80 percent (Liebe et al., 2011).

With a greener default able to generate large-scale behaviour change, this approach is strongly advised to be implemented by system-level stakeholders, such as governments, businesses, and other organizations (Park et al., 2023).

Financial incentives, such as providing compensation for climate-conscious practices and lifestyles, are also an approach that can foster pro-environmental choices (IEA, 2021; Park et al., 2023). With its efficacy yet to be explored, the recent German initiative is an example of a financial incentive. To offset the initial high cost of energy-efficient solutions for residential heating, Germany adopted a scrapping scheme for old oil heaters to facilitate households' transition towards sustainable heating (Clean Energy Wire, 2023; IEA, 2021).

Comprising both systems-level and individual-level interventions, a recent interdisciplinary meta-analysis of interventions aiming for behavioural change toward reducing households'



energy consumption was conducted (Khana et al., 2021). Though excluding incentives for equipment acquisition (such as residential heaters) and structural transformations, this study included a total of 1.1 million households in 25 countries across 122 studies.

Five different types of interventions were reviewed: monetary incentives (e.g., rewards and rebates), information (e.g., tips and reminders), feedback (e.g., in-home displays), social comparison (e.g., home-energy reports and norms-based comparison), and motivation (e.g., commitment and goal setting). With monetary incentives identified as the most impactful strategy, non-monetary approaches from most to least impactful were information, feedback, and social comparison strategies.

A combination of multiple strategies into a single intervention was also reported. Within this approach, studies that simultaneously combined motivation, feedback, and monetary incentives had an additive effect, with a higher impact than the sum of individual impacts for each strategy.

To reduce electricity usage, the most frequently implemented strategies were delivering feedback, providing accessible information, and communicating a social norm.

To promote investments in energy efficiency, commonly used strategies were providing information, making behaviour observable, reframing consequences, and communicating a social norm.

The meta-analysis identified setting pro-environmental defaults as the behavioural strategy with the highest impact (Composto & Weber, 2022).

This research highlights that increased effectiveness is linked to the use of specific strategies which include a social component and are applied to the targeted behaviour in a short time frame. **Including consumer usage data to provide feedback, providing tips on energy saving that are tailored to the user’s prior behaviour, and highlighting social norms that include a reference group with whom the consumer is known to self-identify are mechanisms suggested to be implemented in further studies.**

Moreover, accounting **for times of transition as moments that are more susceptible to behaviour changes was also stressed as a feature that can promote sustained change.**

Providing immediate feedback on consumer energy usage in a salient and clear way to nudge individuals towards more sustainable energy consumption patterns is often difficult given the intangible nature of energy - quantifying the

amount of water used while showering or the amount of energy needed to maintain a room temperature can be challenging (Green Nudges, 2023).

Consequently, this lack of knowledge can hinder people’s ability to make informed and conscious choices about their energy usage. To tackle this challenge, a natural field experiment was conducted at six different Swiss hotels where the rooms were equipped with smart shower meters that measured the energy and water consumption of every shower (Tiefenbeck et al., 2019).

Feedback displayed in real-time included (i) water consumption (in Liters) and energy use (in kWh), (ii) a dynamic rating of energy-efficiency class, and (iii) a four-stage animation of a polar bear on top of an ice floe that melted according to the energy usage. Findings from this research report a significant 11.4 percent reduction in energy use when compared with the control group (with access to a shower that solely displayed water temperature).



This choice architecture intervention, including a feedback-based approach, demonstrates how intervention design and implementation time can efficiently promote behaviour change towards environmentally friendly habits. These kinds of

nudges demonstrate the potential to use behaviourally-informed interventions and choice architecture to have significant impacts on people’s consumption decisions, particularly as they relate to pro-environmental options.

2.4 Key Conclusions



As outlined in this section, future action should focus on making the green option the default (or more convenient) one as a strategy for high levels of compliance (Rau et al., 2022). With each approach targeting distinct barriers (e.g., tailored information to raise awareness and prompt engagement, feedback provision to promote long-term commitment), the use of combined approaches is also strongly recommended when implementing climate-related behaviour interventions (Rau et al., 2022; Nisa et al., 2019).

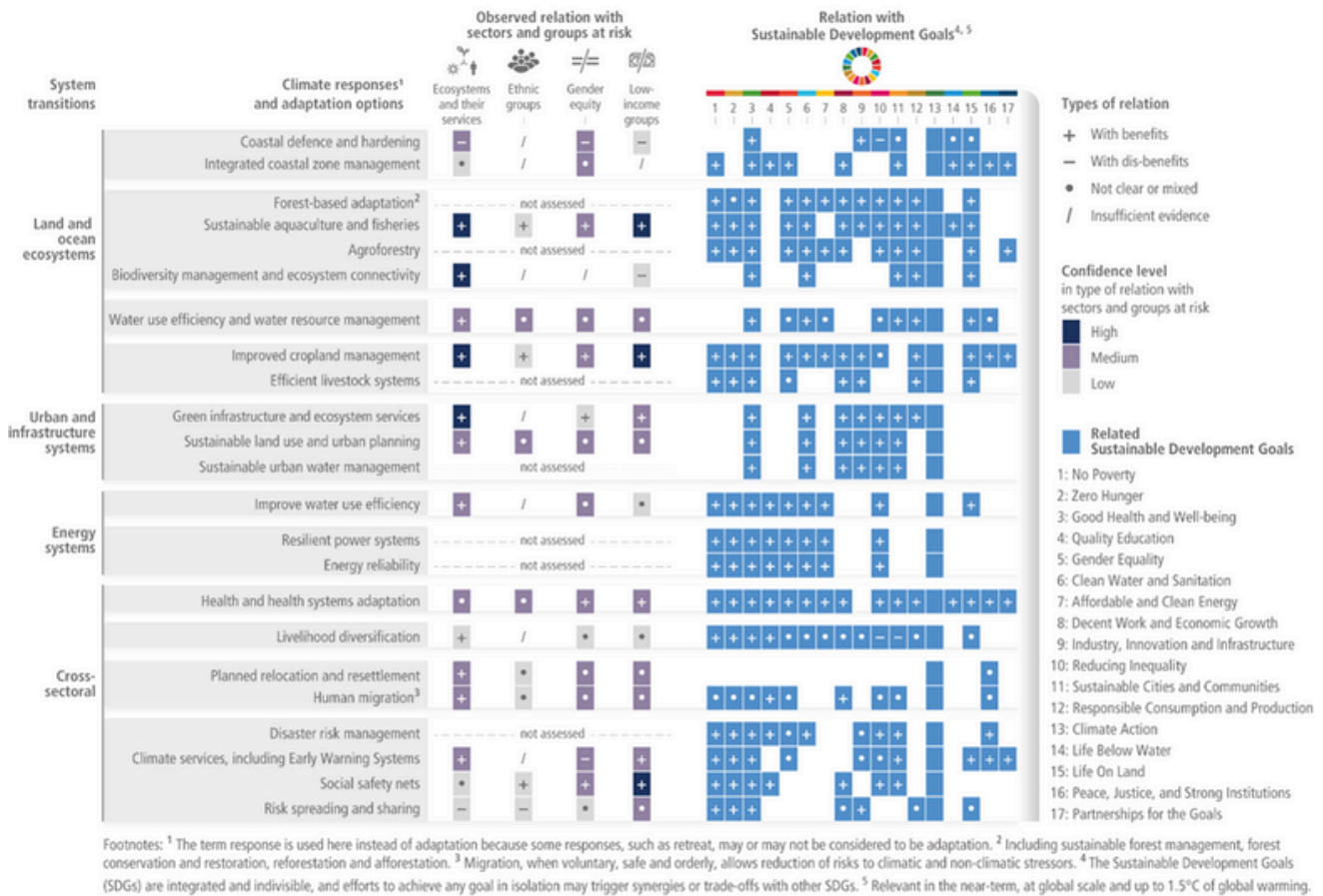
In the longer term and more resource-intensive intervention strategies, research suggests that sequential designs are optimal. These can initially provide social comparison and incentive-based strategies to capture consumers’ motivation, followed by information-based strategies once interest and awareness towards climate change have been demonstrated (Nisa et al., 2019).

As timely opportunities have been demonstrated to boost the efficacy of behavioural change interventions (Kwasnicka et al., 2016; Park et al., 2023; Song et al., 2017; Thompson et al., 2011; Verplanken et al., 2008), targeting transition times and considering disrupting routines as part of the design of pro-environmental behaviour interventions will increase the potential for effective change (Rau et al., 2022). This summary provides a range of insights upon which further research can be undertaken to design behavioural interventions which are effective in increasing pro-environmental behaviours.

Section 3. Considerations for Equity in Climate Change Mitigation Interventions

Figure 6. Climate responses and adaptation options from an EDIA lens

(b) Climate responses and adaptation options have benefits for ecosystems, ethnic groups, gender equity, low-income groups and the Sustainable Development Goals (SDGs) (relevant in the near-term, at global scale and up to 1.5°C of global warming) with climate responses and adaptation options



While a significant amount of research explores the effects of climate change on vulnerable and marginalized groups across the globe, literature that bridges behavioural change theory, the climate crisis, and an equity lens is limited. Nonetheless, the integration of multiple disciplines to tackle climate change impacts with an equity perspective that focuses on both vulnerability and resilience is advocated by the IPCC (2022) report on Climate Change 2022: Impacts, Adaptation, and Vulnerability (see Figure 6 – Climate responses and adaptation options from an EDIA lens). When considering climate change impacts and behavioural change strategies, it is critical to not only acknowledge how interventions affect the overall population but also to explore and mitigate the potential for equity-deserving groups to be

disproportionately impacted - including women, Indigenous Peoples, persons with disabilities, members of visible minorities/racialized groups, and members of LGBTQ2+ communities. Historically, governments or international collectives (like the G7, including Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, and the European Union) have failed to adequately consider whether proposed or implemented interventions and policies have had the potential to disproportionately impact populations which are vulnerable and/or historically marginalized.

To avoid perpetuating inequitable policies and practices, equity-deserving groups need to be deliberately considered and consulted with before co-designing climate justice interventions, including those which leverage behavioural science. This is critical to ensure an equitable approach in which the costs or potential negative impacts of new policies and interventions are not disproportionately distributed across society. As such, the following section outlines some of the research and literature which has considered the ways in which both climate change policy and behavioural interventions can and should apply an equity lens.

3.1 Equity-related Considerations

The review of the literature that follows first examines international considerations, followed by Canadian considerations, and then it concentrates on the Atlantic Canadian context. The final section examines equity concerns as they relate to behavioural change approaches.

International Considerations

One of the first considerations for equity in international climate change policy is the reality that some groups and geopolitical locations are more susceptible to the negative impacts of climate change (Bouyé et al., 2020). Despite this, research suggests that climate-related adaptation interventions frequently exclude marginalized groups and consequently skew their positive outcomes in favour of affluent socio-economic groups (Eriksen et al., 2021). Prone to be implemented in a top-down outlook that benefits privileged groups, climate interventions often exclude marginalized populations, disadvantaged socio-economic groups, and those

most vulnerable to climate risks from their adaptation scope. Identified reasons include intervention design (e.g., requiring commitments of time, land, or material inputs, which marginalized populations frequently lack), unequal distribution of decision-making authority, the legacy of colonialism, and geographic inaccessibility.

This is compounded by an inadequate understanding of contextual vulnerability, including uneven socio-political-economic relations and gender inequality. Inequitable participatory processes in interventions' design,

planning and implementation approaches are therefore problematic. Disregarding collaborative approaches to fighting the climate crisis, definitions of ‘adaptation success’ according to dominant or Western/Global North development agendas further risk excluding local knowledge and could disregard how the meaning of such successes varies between different groups.

Members of equity-deserving groups are more vulnerable to climate change and social injustice for many reasons, such as historical and present-day colonialism, gender discrimination (e.g. women are over-represented as the world’s poor), and/or geopolitical location. **Importantly, climate change mitigation initiatives have the potential to amplify vulnerability.**

Serious and meaningful consultation, collaboration, and co-design with vulnerable groups and marginalized communities is therefore necessary when implementing climate change mitigation and/or adaptation strategies.

With adaptation initiatives often addressing solely the observable symptoms of vulnerability rather than its cause, promoting the development of learning processes within organizations and with marginalized populations is critical (Scoville-Simonds et al., 2020).

A just transition to a carbon-neutral future focuses not only on the outcomes but also on the process.



A case example of significant efforts being made on energy equity with a participatory process is the first community-owned solar cooperative in the state of New York.

Linking environmental justice with climate solutions, the implementation of a solar project within a Latino community group will provide access to renewable energy at a reduced cost and locally hire low-income and at-disadvantage community members for its development (Gardiner, 2020).

An example of an inequitable climate strategy is California’s commitment to source carbon-neutral energy. Despite evidence on how lower-income people and Native Americans in California are 50 percent more vulnerable to wildfires and less likely to afford fire mitigation services (Davies et al., 2018), this climate strategy was developed without the consideration of “any large-scale policy that addresses the housing shortage, rising housing costs, or displacement due to recurring wildfires” (Versey, 2021).

The literature also asserts that the hazards of place can likewise be seen in the disproportionate impacts of climate change on marginalized communities. **These disproportionate effects on marginalized and underserved communities translate environmental racism as a result of historical and present-day injustices and emphasize the current higher risk of environmental health hazards of racialized groups** (Gardiner, 2020).

Case examples of environmental racism include marginalized communities living near landfills, incinerators, and hazardous waste disposal areas (Gardiner, 2020; Waldon, 2018). In her recent interview, Yeampierre (Gardiner, 2020) links present-day environmental degradation with the legacy of slavery and colonialism, suggesting that social and environmental justice hinges on changing attitudes about and behaviours towards nature and racialized groups simultaneously. Current literature also suggests that intersectionality is a required framework for an equitable approach to climate change (Crenshaw, 1989, 1991, 2014).

Intersectionality provides a useful lens to understand the multidimensionality of identity (i.e., how identity markers like race, gender, or socio-economic background intersect or overlap) and contextualize individual and structural axioms of power and oppression in relation to climate change (Kaijser & Kronsell, 2014; Mikulewicz et al., 2023; Versey, 2021).

Integrating intersectional approaches in further climate change research and policy development will allow us to recognize groups at high risk for negative outcomes, including distress and displacement (Versey, 2021).

Intersectional approaches can also help with documenting mental health outcomes associated with climate change and facilitate interdisciplinary strategies to reduce mental health disparities (Versey, 2021). Considering the escalating impacts of climate change due to anthropogenic action, any mitigation and adaptation actions should use an intersectional framework that assesses their cumulative risks and impacts on vulnerable groups (Kaijser & Kronsell, 2014). Kaijser and Kronell (2014) suggest that because norms are maintained and reproduced through everyday behaviour and practice, combining climate scholarship with social justice initiatives is necessary.



Intersectionality has therefore been used to draw attention to behavioural change strategies in conjunction with assessments of who is included/excluded and why from climate change intervention strategies and policies.

Economic considerations also play a role in designing interventions to respond to the climate crisis. The report *Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation* makes two central claims concerning (i) the permanent disproportionate increase in climate change impacts over poorer populations and (ii) the need for appropriate measures on climate change adaptation to ensure sustainable development and eradicate poverty (Abeygunawardena et al., 2009).

While the report underscores that adaptation cannot be a substitute for the mitigation of GHG, it notes that barriers to adequate adaptation for impoverished individuals in geographically vulnerable places include (but are not limited to)

inequalities in resources, low education rates, civil disorder, limited technology, and/or incapacity to cope.

Similarly, the research also suggests climate issues must be included in development policies to meet the needs of adaptation and reduce poverty.

Appropriate infrastructure and technology are identified as strategies to decrease maladaptation (Abeygunawardena et al., 2009). Incorporating local knowledge into policy actions is likewise key for successful adaptation and helps ensure that strategies for behavioural changes are culturally relevant and that the change is driven by and taken up by local communities.

At the same time, strategies to combat the climate crisis must involve systemic change. A proposal for a Standing Working Group (Adler et al., 2021-2024) for Organization Studies in the Anthropocene contends that research on the environment in management and organization science has spent too much energy and time concentrating on change within individual companies and in individual behaviour.

The group, therefore, stresses the need to focus on radical change at the system level and look for alternative systems (Adler et al., 2021-2024). These kinds of economic considerations are critical when evaluating the strategies that are expected to make real impacts towards adaptation and mitigation, particularly in ways which do not further exacerbate inequalities, both at an international and regional level.



Canadian Considerations

In Canada, the literature remains somewhat limited when it comes to current climate mitigation and/or adaptation practices, though it emphasizes the need for meaningful participatory processes that are committed to equity and inclusivity.

For example, the Canadian Research Institute for the Advancement of Women (CRIAOW) contends that gender considerations are remarkably absent in climate plans and policies across the country (Williams et al., 2018). The research also largely points to a commitment to the calls to action in the Truth and Reconciliation Commission's (TRC) report (2015), amongst other decolonizing practices and pedagogies, as vital to the development of equitable climate change mitigation and adaptation in Canada.

To identify how environmental policies and strategies can disproportionately impact different communities and exacerbate existing inequities, Reed et al. (2021) conducted a critical policy analysis of two climate plans in Canada. The first was the Pan Canadian Framework on Clean Growth and Climate Change (Government of Canada, 2016), a federal government-led, top-down plan to reduce GHG emissions.

The second was the Québec ZéN (zero émissions nette, or net-zero emissions) Roadmap (2019), a province-wide, bottom-up energy transition plan established by civil society and environmental groups in Quebec. Released in 2016, the Pan-Canadian Framework is referred to as a collective

plan to grow the economy, reduce emissions, and build resilience to adapt to a changing climate, and aims to assist Canada's emissions reduction goal of 30 percent by 2030 (Reed et al., 2021). The Québec ZéN was developed collaboratively by a network of more than 70 environmental unions, organizations, and community groups, intending to create an equity-based energy transition in Quebec.

Yet, the analysis provided by Reed et al. (2021) reports that both frameworks failed to sustain Indigenous people's rights, such as the right to self-determination and to free, prior, and informed consent. The authors also identify inconsistencies between commitments to reconciliation and a 'Nation-to-Nation' relationship.

Considering this as an effort to contribute to an agenda for Indigenous-led climate policies, the authors identify six components to be considered:

- Urgency for climate policy to prioritize the land and emphasize the need to rebalance our relationships with Mother Earth.
- Positioning of Indigenous Nations as Nations with the inherent right to self-determination.
- Indigenous Nations, Peoples, and representative organizations to be positioned as leaders with direct decision-making.
- Prioritizing Indigenous knowledge systems and accounting for equal consideration of diverse knowledge systems.



- Reflecting the diversity of Indigenous Nations.
- Advancing climate solutions that are interconnected, interdependent, and multi-dimensional.

As a starting point for an equity approach to climate change policies and interventions, this research emphasizes the essential need to integrate meaningful engagement with Indigenous Peoples and Nations to reflect all Nations' history, culture, jurisdiction, and legal systems (Reed et al., 2021).

One example of such engagement is research by Mussett et al. (2023), in which the authors call for decolonizing methods that profoundly respect Indigenous ways of knowing and being, especially Indigenous Ecological Knowledge (IEK). Respect, responsibility, relationality, and reciprocity are essential to this environmental work; for instance, there is a need to shift away from 'management' into the care of and relationality of water and its inhabitants.

The authors further draw on the strengths of 'Wise practices,' which are context-specific, dynamic, and centred on a congruence of lived experience, as opposed to traditional, Western scientific approaches that require reductionism and reproducibility (Mussett et al., 2023).

Alternatively to the term 'best practices,' the notion of 'wise practices' reflects a set of contextual, not standardized, and locally-appropriated principles, tools, actions, and recommendations that aim to contribute towards sustainable and equitable conditions (Wesley-Esquimaux & Calliou, 2010). Wesley-Esquimaux and Calliou (2010) highlight that the concept of 'best practices' illustrates hierarchical evaluative criteria, excluding local and Indigenous knowledge and reflecting a specific ideological lens that raises the issue of universality.

On the contrary, 'wise practices' acknowledge community-specific wisdom and recognize the importance of culture. Though rooted in Indigenous knowledge and leadership, 'wise practices' are not typically applied to conservation strategies, yet the authors show how and why they should be (Mussett et al., 2023; Wesley-Esquimaux & Calliou, 2010).

The 'wise practice' method facilitates coming together through a set of guiding principles for both Indigenous and non-Indigenous peoples to co-create ethical space (Ermine, 2007) in research and decision making" (Mussett et al., 2023, S13).

Supporting the Indigenous traditional value of learning from past stories before making a decision, Wesley-Esquimaux and Calliou (2010) identify seven crucial factors of success for Indigenous communities' economic development:

1. Identity and culture,
2. Leadership,
3. Strategic vision and planning,
4. Good governance and management,
5. Accountability and stewardship,
6. Performance evaluation, and
7. Collaborations, partnerships, and external relationships.

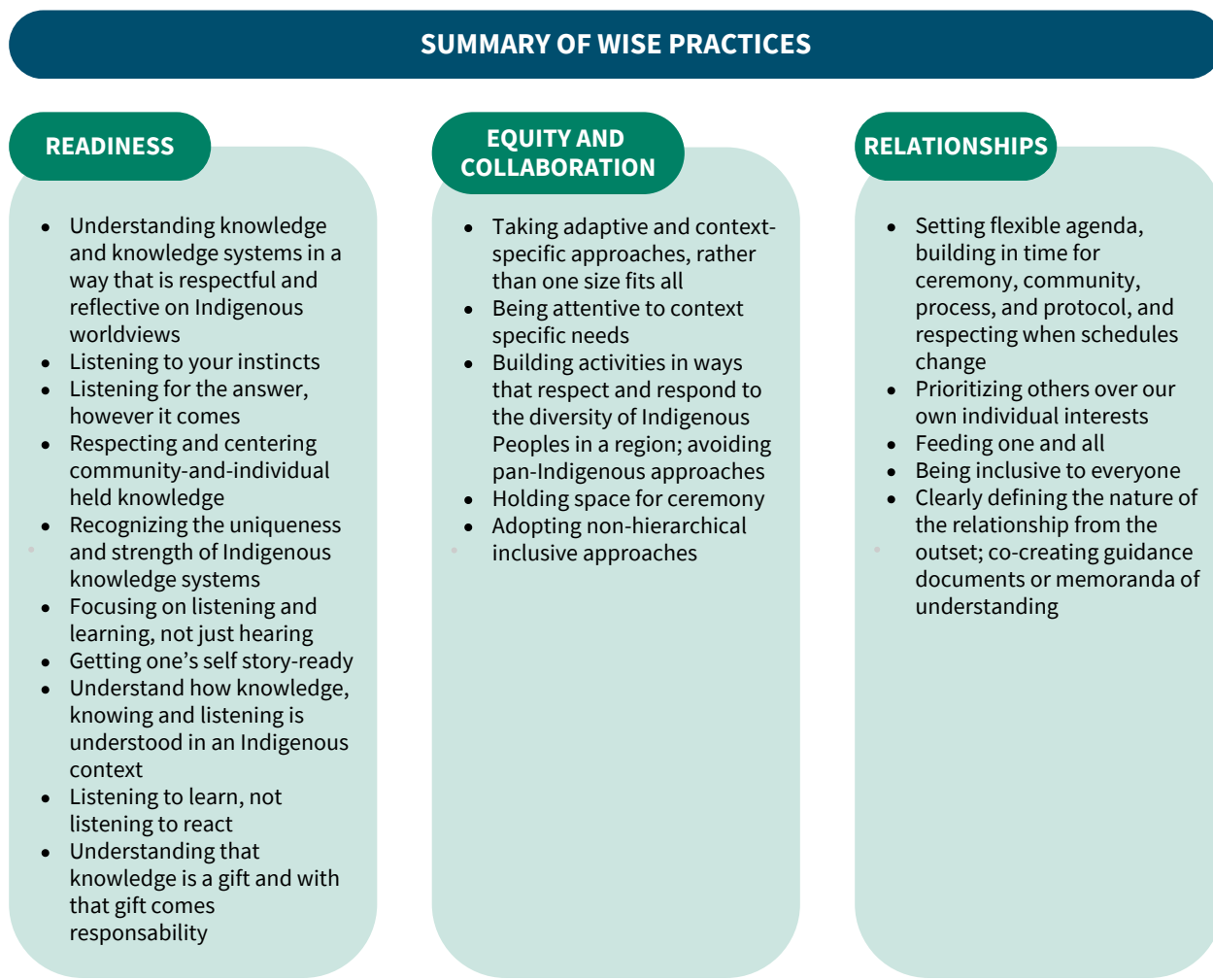
Additional literature (Native Women's Association of Canada (NWAC), 2023; Sanchez-Pimienta et al., 2021) advocates for an Indigenous gender-based relationality framework or an Indigenous GBA approach to research. Indigenous GBAs seek to address and redress the traditional GBA approach in Canada, which fails to take into consideration colonialism and the lived experiences of Indigenous women. Indigenous perspectives are commonly overlooked in gender-based policymaking across the globe (Fleras, 2010; Radcliffe, 2003; Sanchez-Pimienta, 2021).

The NWAC thus empowers and represents the political voice of Indigenous women, girls, Two-Spirit, transgender, and gender-diverse (WG2STGD+) people (e.g., on environmental issues such as land stewardship and water protection).



The NWAC is currently completing a project called Engaging Indigenous People in Climate Change Policy, which will focus on climate change impacts, adaptations, and mitigations on Indigenous WG2STGD+ people within the context of the Pan-Canadian Framework on Clean Growth and Climate Change. Particularly, this project aims to measure and reduce emissions, adapt to the impacts of climate change, and build resilience (Shining the Spotlight, 2023). The literature also points to the Indigenous Clean Energy (ICE) Network's work, whose evidence demonstrates that "Indigenous leadership is essential to the realization of the Sustainable Development Goals (SDGs) in Canada, and our country's economic development, clean energy future, and reconciliation with Indigenous peoples" (Indigenous Clean Energy, 2020).

Figure 7: Summary of Wise Practices along main themes compiled from IAGLR panel discussion.



Atlantic Canada Considerations

All four Atlantic provinces have climate action plans and contribute to the Climate Change Services Centre for Atlantic Canada, CLIMAtlantic. When it comes to equity-deserving groups, the literature on Atlantic Canada’s climate change mitigation and adaptation strategies focuses primarily on partnering with Indigenous people and communities and less on other groups such as low-income individuals, LGBTQ2S+ and women. Nonetheless, some research does touch upon other equity-seeking groups, acknowledging that identities are not singular but rather multifaceted.

For example, in New Brunswick’s Our Pathway Towards Decarbonization and Climate Resilience Climate Action Plan (2022-2027), the province’s goal is net-zero GHG emissions by 2050. The province recognizes, however, the challenges people with lower incomes may face. In reference to the transportation sector, “rural and lower-

income households face greater challenges in reducing transportation emissions, and programs will need to be designed to reflect this reality” (Province of New Brunswick, 2022). The province also acknowledges that it must determine how to ensure the impacts of the province’s growing demand for electricity are not transferred too heavily onto electricity ratepayers.

Similarly to Newfoundland and Labrador’s Climate Action Plan (2019-2024), New Brunswick’s action plan further notes the need to move away from oil-heated homes and for equitable access to energy efficiency programs, such as financing or rebate systems.

Nova Scotia’s Plan (Our Climate, Our Future: Nova Scotia’s Climate Change Plan for Clean Growth, 2022) is also committed to reducing heating oil and adds that it plans to continue with the Mi’kmaw Home Energy Efficiency Project and pilot a similar program for African Nova Scotian communities.

Prince Edward Island’s Building Resilience: Climate Adaptation Plan (2022) offers a concrete roadmap to better prepare for the future while improving equity and resilience through lessening climate change’s impacts on its inhabitants. One of the province’s adaptation initiatives is the Resilient Agricultural Landscapes Program (RALP), which supports carbon sequestration and addresses other environmental co-benefits on farms. The program also supports work carried out by the Department





of Agriculture and Land's Alternative Land Use Services (ALUS) program. The report further notes that a potential barrier to climate action can be making sense of complex data. To facilitate green solutions and decisions, the province claims that it will (i) launch public outreach campaigns, (ii) ensure data and information are presented in a way that both individuals and industries can easily understand, and (iii) require all information, tools, and resources to be available in multiple languages and formats, including accessible formats.

Prince Edward Island worked closely with the Mi'kmaq and Indigenous organizations on its Climate Change Risk Assessment (CCRA; 2021), while the province of New Brunswick has made a commitment to establishing a working group with Indigenous communities and organizations to foster information sharing and to set climate change priority areas by 2024.

In Nova Scotia, the summary report Community Sector Council of Nova Scotia: Decolonization Learning Journey (DLJ; Doucette, 2021) summarizes the learnings from a series of webinars – namely, Pre-Contact and Early History, Models of Mi'kmaq Governance and Organizing, Indigenous Rights in the Canadian context (e.g. Residential Schools, Murdered and Missing Indigenous Women and Girls, and Two-Eyed Seeing), and Taking Action for Reconciliation and Decolonization.

Although focused on the non-profit sector, this research suggests that **transformative learning models (such as Theory U and Head, Heart, Hand) can benefit behavioural change and climate action projects committed to justice, equity, diversity, decolonization, and inclusion (JEDDI)**. The summary report (Doucette, 2021) also recommends “Continuing to differentiate between the historically disenfranchised groups and their context-specific claims relating to (in)justice... For example, with respect to Indigenous peoples, the issues and priorities derive from treaty promises, and specifically Treaties of Peace and Friendship”.

Another example from the literature (Doucette, 2020) is a multi-year, collaborative research project focused on accelerating the path toward a net-zero island economy in Unama'kii (Cape Breton) by prioritizing clean energy research. This project highlights that though “clean energy is an emerging priority in Unama'ki commercial and non-profit efforts designed to address climate change or reduce carbon footprints have been piecemeal and disconnected” (Doucette, 2020).

The research uses Etuaptmumk/Two-Eyed Seeing as a guiding principle to set achievable yet aggressive goals to reduce carbon emissions in Unama'ki. This research also applies an exploratory approach to gather and share wise practices in renewable energy projects.

To influence Atlantic Canada policymaking and strategic action into integrating an equity lens that effectively provides for inclusive climate change adaptation approaches, **it is crucial to understand the diverse risks and impacts that Indigenous, Black, and other racialized and equity-deserving communities are currently exposed to in these regions.** Environmental racism in the Atlantic region can be linked not only to the disproportionate exposure of these communities to environmental impacts but also to long-standing social and economic inequalities identified as outcomes of the country's colonial legacy (Waldron, 2022). Several case studies (Waldron, 2022) on environmental racism in the Atlantic region emphasize the need to account for the voices and mobilize these under-served and racialized communities to address environmental racism.

One example is the effluent disposal that happened for over 50 years into Boar Harbour in Pictou Landing First Nation in Nova Scotia. The involuntary accommodation of multiple environmental and social hazards – such as an open dump, a fertilizer plant, tar and cotton factories, a slaughterhouse, a stone and coal crushing plant, and a prison – by expropriated African Nova Scotians from Africville also exemplifies a case of environmental racism.



Historically marginalized and under-served communities in Atlantic Canada are documented to be disproportionately vulnerable to the impacts of the climate crisis due (i) to their likely increased exposure to pollution from nearby industry activity and (ii) to other environmental effects (such as rising sea levels, coastal erosion, flooding) that are adjacent with the Atlantic region being one of Canada's most vulnerable regions to climate change (Kinay et al., 2023; Waldron, 2022).

These forms of spatial violence emphasize climate change impacts affect these communities first and worst – and translate the need to broaden the discourse of climate change mitigation and adaptation to include a more profound discussion on climate justice and human rights implications for equity-deserving communities (Waldron, 2022).

The literature shows that more research is needed for the impact of net-zero initiatives on other communities like African Nova Scotians, who, despite contributing substantially to the province for over 400 years, have historically faced and continue to face environmental and place-based racism (e.g., Africville; Waldron, 2022).

The development of the Clean Energy and Equity Network, however, is designed to support a community-driven and community-owned initiative that builds knowledge, skills and tools needed to support clean energy solutions and leadership in Mi'kmaw and African Nova Scotian communities.

3.2 Behavioural Change Research and Ethical Considerations

When implementing behavioural science, it is critical to ensure that appropriate consideration is given to whose behaviour is being influenced and whether this is both ethical and equitable in the context of the particular society that is seeking to change.

There is relatively limited literature that looks specifically at equitably applying behavioural science to climate change adaptation and mitigation, although there is more that discusses applying behavioural science in an ethical way more generally.

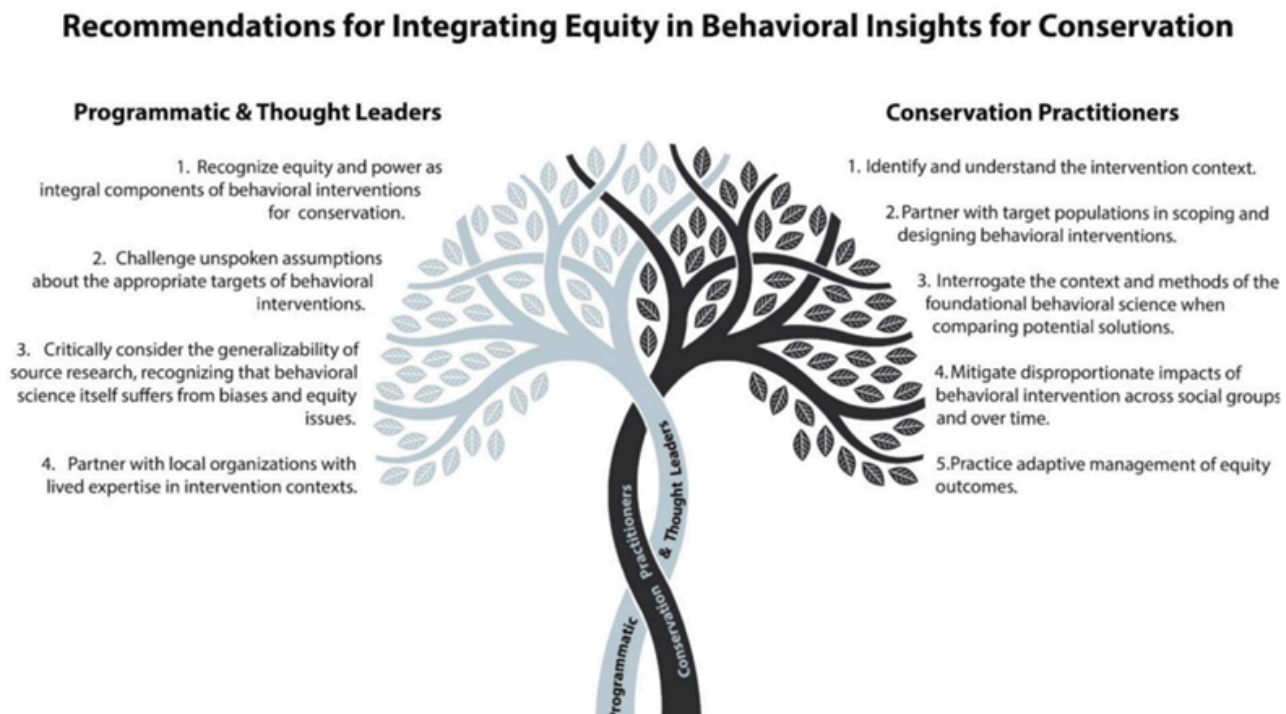
Nonetheless, recent research notes that equity and power are not given sufficient attention in the literature on behavioural science and environmental conservation, with behavioural science too often targeting the individual alone and not structural or systemic change (e.g., Crossman et al. 2021).

This results in a misalignment between behavioural interventions and the actual drivers of emissions, incurring unanticipated negative

social welfare and distributional costs, all of which may undermine conservation success. The authors (Crossman et al., 2021) also highlight **behavioural science's overreliance on Western, educated, industrialized, rich, democratic (WEIRD) participant and scholar populations, with research practices centred on nonrepresentative perspectives** (Henrich et al., 2010; Roberts et al., 2020; Tam & Milfont, 2020).

Research on ethical approaches, therefore, cautions against applied behavioural interventions that target resource-reliant, less wealthy, and less powerful populations (Finkbeiner et al., 2018; Jones et al., 2019; Simmons et al., 2020). With individual-level behaviour change targeting resource users, a **higher burden for conservation is placed on those already most impacted by and vulnerable to environmental change, potentially leading resource-reliant populations into economic marginalization and undermining the sustainability of any behaviour change achieved.**

Figure 8. Strategies to assess and incorporate equity when applying behavioural science insights to conservation.



Such targeting also reinforces the power-laden social structures and social inequities that form the context in which conservation has become necessary. Crosman et al. (2021), therefore, advocate for centring equity within conservation theory and practice (for example, see Figure 8).

Similarly, Bowie et al., 2020 argue for the need to co-design user-centred behavioural change intervention. The authors suggest co-design as a useful and effective approach for gathering audience insights relatively quickly, allowing conservation practitioners to integrate end-user voices when they would otherwise be excluded from intervention design.

Their contribution showcases the value of user-centred design approaches to behaviour change interventions for environmental preservation.

Specific behavioural intervention types are also pointed out as more prone to ethical risks than others. In a recent systematic literature review, Kuyer and Gordijn (2023) analyze over 130 articles concerning potential ethical issues of climate nudges as a particular type of behavioural intervention.

The authors identify four major ethical concerns raised from the literature on the use of nudging interventions, namely the violation of autonomy, the uncertain improvement of welfare, the potential long-term adverse impacts, and the harm to democracy and deliberation.

The acknowledgement of these issues raises the need to include an ethical lens on further behavioural interventions using choice architecture in order to provide for effective and

equity-based approaches to tackle climate-related concerns. The integration of ethical considerations in the design and implementation of behavioural interventions will improve their effectiveness and signalize the multiple ways in which their use can encourage sustainable behaviours (Hilton et al., 2018).

Ethical assessments of climate nudges for future behavioural interventions should specifically identify any morally relevant concerns and involve situation-specific ethical considerations to ensure that climate nudges are part of an effective and equity-based approach to promote pro-environmental behaviours (Siipi & Koi, 2021). Hilton et al. (2018) identify four different factors that support the development of ethical climate nudges:

- **Targeting the decision-makers construction of preferences:** As tools for behaviour change, nudges' flexibility allows the integration of information on the target population's preferences in the decision-making context itself.
- **Helping the decision-maker to act on a decision according to expressed values:** Given the obstacles of some decision-making contexts to support pro-environmental behaviours, consumers are often challenged to act on their environmental values. Nudges can help close that environmental intention-action gap.

- **Informing consumers that they are being nudged can lead to greater commitment:** Directly addressing the concern of manipulation against individuals' will and transparency about potential influences on their choices are demonstrated to promote motivation for pro-environmental behaviours.
- **Ensuring information reliability can increase long-term nudges' effectiveness:** Messages that are provided by reliable sources such as international environment agencies are reported to be more accepted and effective in promoting behaviour change in the long term.

Extensive literature has explored the ways in which behavioural science needs to be applied to ensure ethical and equitable outcomes beyond the field of climate change policy. The report Good Practice Principles for Ethical Behavioural Science in Public Policy (OECD, 2022) also



provides a comprehensive overview of how ethical concerns in behavioural science, according to the following four themes below, can be recognized and addressed:

- **Checking the relevance of behavioural science:** Concerning the identification of a behavioural lens as an appropriate approach for the development of interventions and policies, and the definition of clear criteria on why the change should improve public welfare.
- **Integrating ethics into intervention design:** Regarding the need for transparency on the interventions' objectives, the relevancy of each stakeholder in the intervention design, the identification of ethical risks and their mitigation strategies, and the preservation of fairness, equality, and dignity throughout the intervention.
- **Gathering behavioural evidence responsibly:** Concerning the relevance of anticipating and planning for unintended consequences, registering the intervention's hypothesis and methods before their outcomes' observation, obtaining informed consent protecting data's privacy and confidentiality, and sharing the respective results.
- **Preserving ethics when implementing and scaling behavioural insights results in public policy:** Ensuring ethical continuity, collaborative communication, and public accessibility.



As highlighted, there are many aspects which need to be considered to ensure that climate change adaptation and mitigation interventions do not disproportionately impact certain groups, particularly those who are vulnerable and/or historically marginalized.

There are many factors that need to be taken into consideration, but most research suggests that active and authentic consultation is required with those who will be impacted either directly or indirectly by a new intervention, particularly those that involve behavioural change objectives.

As mentioned throughout this literature review, collaborative approaches are essential to ensure that climate change adaptation and mitigation interventions do not disproportionately impact specific groups – particularly those who are vulnerable and/or historically marginalized.

Section 4. Research Gaps and Opportunities for Behavioural Climate Research in Atlantic Canada

As outlined in Section 1, international GHG emissions reduction targets will require substantial efforts to reduce emissions across international, national and regional economies. While these changes will require technological, economic, and other systems-level changes, there will be a large role for behavioural change to drive much of the required shifts.

As such, understanding which behavioural interventions could be implemented to have the greatest impacts on emissions reduction is an important first step in implementing effective behavioural change strategies. As such, the following section seeks to bring together the insights from sections 1 and 2 of this report to identify the opportunities for behavioural change interventions that could have the most impact in an Atlantic Canadian context. This is intended to guide future research to those behavioural change opportunities that can have the greatest impact, based upon an understanding of the most heavily emitting sectors and the evidence that exists on how to leverage behavioural insights to change behaviours in these sectors.

4.1 Transportation



Within the transportation sector, changes in behaviours related to the use of private vehicles present a substantial opportunity for emissions reduction in the Atlantic Canadian context. This could include a focus on policies that reduce travel (i.e., increase ‘work from home’ practices) or those that encourage a shift to lower emission modes of transport (i.e., public transport, cycling, or walking).

Such changes would require both systems-level behavioural change (i.e. decisions to invest in public transport and cycling infrastructure and systems, economic tariffs on private vehicle use,

regulation of work-from-home policies, etc.), as well as individual behavioural change (i.e. uptake of such alternative transport/ working options where available). Fortunately, the transport sector has a substantial base of behavioural science research upon which to base further research and policies to achieve these objectives. Behavioural biases and heuristics such as social norms, habitual behaviour, and commitment devices have all been effectively applied to change behaviours in the transport sector and, as such, form a strong evidence base upon which to undertake research in the Atlantic Canadian context.

4.2 Buildings and Infrastructure



In the building and infrastructure sector, there are also substantial opportunities for behavioural change. At a systems level, changing fundamental decisions on the sources of energy used to heat and cool homes would have a substantial impact on emissions, as well as decisions to offer programs and systems which would support investment and uptake of more efficient technologies for buildings and infrastructure.

At an individual level, there are ample opportunities to substantially reduce emissions by encouraging minor behavioural changes in building occupants, such as more efficient practices for heating spaces, lighting rooms and using appliances (noting, however, that such individual changes are likely to create a relatively smaller impact than system-levels changes in this sector).

The behavioural science literature provides a range of techniques that have been employed to encourage these kinds of pro-environmental behaviours in the building and infrastructure sector.

Namely, these include strategies that include information and feedback intervention (i.e. to decrease energy and water consumption), social norms interventions, and default options (i.e. making renewable energy sources the default option for home energy sources).

These kinds of successful behavioural interventions and policies demonstrate the potential for innovative research and evidence-based policies to minimize emissions from the buildings and infrastructure sector in Atlantic Canada.

4.3 Agriculture and Food Consumption



In the agriculture and food consumption sector, the implementation of sustainable agricultural practices and the consumption of low-carbon food products (e.g., plant-based options) are some of the options which present the greatest opportunities for high-impact behavioural change interventions.

At the systems level, there are opportunities to influence behaviours which relate to decisions such as pesticide use, regulations on agriculture production practices, and economic tariffs on high-emission food options.

At the individual level, switching dietary practices from heavily meat-and-dairy-intensive options to plant-based diets is one of the most impactful decisions that people can make to reduce emissions from the agriculture sector. In this sector, substantial behavioural research has been undertaken to understand how to bridge the so-called ‘intention-action gap,’ which exists

between people’s intention to demonstrate pro-environmental behaviours and their actual demonstrated behaviour, particularly as it relates to food consumption decisions.

Some interventions shown to be effective in this area include those that increase the salience of carbon emissions (i.e., information) through food labelling policies, among a number of others.

Whether these types of policies would be effective in Atlantic Canada, among which groups is yet to be researched, and thus constitutes an important gap in research that could help inform future policies in the region.

Appendix A

Keywords used: greenhouse gas emissions, drivers, contributors; Global emissions; Canada, Atlantic Canadian emissions; Greenhouse gases (carbon dioxide, methane, nitrous oxide, F-gases); Sectors (transportation, agriculture, Buildings/infrastructure). Additional search strategies: Studies published between 2010 and 2023.

Table 1. Sources of GHGs

Gases	Source
Carbon dioxide (CO ₂)	Burning of fossil fuel from natural gas, coal, and oil as well as solid waste from trees and other biological materials. Population growth and Human-induced influences on forestry and other land use, like agriculture land clearing, massive deforestation, and degradation of soils
Methane (CH ₄)	Burning of biomass, production and transport of natural gas, coal, oil, livestock, other agricultural activities, and waste management through decaying of organic waste in municipal solid waste landfills.
Nitrous oxide (N ₂ O)	Agricultural practices and industrial activities, like the massive use of fertilizers. The combustion of fossil fuels and solid waste, including the treatment of wastewater can also contribute to N ₂ O emission
F-gases	Industrial processes, refrigeration, and the use of a variety of consumer products which include hydrofluorocarbons (HFCs), sulphur hexafluoride (SF ₆) and perfluorocarbons (PFCs). These gases being emitted in smaller quantities only but still are considered as High Global Warming Potential gases because they are dominant greenhouse gases.

Appendix B

Keywords used: Behaviour Change/Science, Behavi*, Psycholog*; Nudge, Nudging; Choice architecture; Barrier(s); Mitigation; Risk(s); Meta-analysis, Systematic; Randomised Controlled Trial, RCT, Intervention; Literature Review; Climate, Climate change; Sustainability; Environmental; Net-zero; Emissions, Emissions reduction; Sectors (energy, transportation, agriculture, food, housing/infrastructure/infrastructure). Additional search strategies: AND/OR; in Title, in Abstract.

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