Deep Decarbonization in Cities: Greenhouse Gas Emissions Measurement, Monitoring, and Reporting

by

Collin Neveroff

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Authors Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.
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Abstract

Municipalities have a significant role in reducing global emissions to net-zero by 2050. Local climate action has immense potential for driving the required emissions reductions, but the practices involved in measuring, target setting, monitoring, and reporting progress remain inconsistent and understudied. As a first step in improving these processes in Canadian municipalities, this study aims to develop an understanding of the current and historical state of measurement, target setting, monitoring, and reporting in the local climate action processes of Canadian municipalities and uncover insights into the best practices associated with higher emissions reductions. Qualitative data was collected from existing reports and documents from the Partners for Climate Protection (PCP) Program, developed and managed by ICLEI Canada and the Federation of Canadian Municipalities. Reports consisted of emission inventories, climate commitments, implementation updates, and other relevant documentation with information on measurement, target setting, monitoring, and reporting practices submitted as part of the PCP milestone review process. An evaluation framework was developed from the relevant literature on the topics and used to determine if the empirical results from Canadian municipalities validate or extend the literature on measurement, target setting, monitoring, and reporting. Through content analysis, this study contributed to several areas of the literature by validating previous findings and extending the literature to incorporate new findings on reporting levels, scope 3 emissions, and carbon sinks and storage. The results also extended the literature by identifying the involvement of council members and community-wide entities in monitoring procedures, the use of various reporting channels in sharing information, and the inclusion of monitoring procedure details in reporting, as additional key variables associated with high emissions reductions. These results will help inform the practices and strategies of municipal practitioners and provide information to government decision-makers to help identify policy opportunities. Finally, the evaluation framework from this study and the dataset developed in summarizing the empirical data can be used for triangulation, further analysis, or as a baseline comparison by future studies.

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Table of Contents

List of Figures

List of Tables

Chapter 1. Introduction

1.1 Background & Research Problem

Current scientific research on climate change reveals the importance of global decarbonization by 2050 to stop global warming at 1.5°C above pre-industrial levels and stabilize the climate (IPCC, 2018, 2021). Achieving this level of carbon reduction will require immediate and drastic emissions reductions to provide the best chance at minimizing climate impacts, such as heatwaves, droughts, heavy precipitation, and sea-level rise (IPCC, 2021). Countries, including Canada, have committed to significant emissions reductions in response to this challenge (Government of Canada, 2021; Höhne et al., 2021). As of 2022, Canada's updated commitment includes 40-45% emissions reductions by 2030 and a target of net-zero emissions by 2050 (Government of Canada, 2021).

While climate change remains a global issue, supported by national commitments to reduce emissions, cities may be the most influential party in decarbonizing the atmosphere and reaching net-zero emissions globally (Guterres, 2019; Romero-Lankao et al., 2018). By 2030, roughly 60% of the global population will live in urban areas (UN DESA - Population Division, 2018). Meanwhile, 71-76% of global emissions come from such spaces (IPCC, 2014). Further, local governments have direct or indirect control over nearly 52% of emissions (Tozer, 2013), revealing an enormous climate mitigation opportunity through deep decarbonization efforts in our local communities.

For decades, local municipalities in Canada have been implementing climate mitigation strategies and actions (Robinson & Gore, 2015). In response to Canada's increasing climate

ambition, hundreds of municipalities have set local emissions reduction targets and have developed and are implementing local climate action plans, many of which align with the national targets (FCM & ICLEI, 2020). The Partners for Climate Protection (PCP) program, created by ICLEI – Local Governments for Sustainability (ICLEI) and the Federation of Canadian Municipalities (FCM), helps these municipalities through a five-step milestone process to develop and implement local climate action plans (FCM & ICLEI, 2020). Municipalities measure their emissions through a greenhouse gas (GHG) emissions inventory (milestone 1), before setting emissions reduction targets (milestone 2), creating a climate action plan (milestone 3), implementing that plan (milestone 4), and monitoring progress and reporting results (milestone 5) (FCM & ICLEI, 2020). Setting emissions reductions targets and actively measuring, monitoring, and reporting the progress and results of these plans and their associated GHG emission reductions offers a means for assessing the impact of strategies, identifying areas of improvement and success, and leading to the continual improvement needed to reach climate goals (C40, 2020; Carbon Neutral Cities Alliance, 2015).

Throughout this thesis, "measurement" will be defined as the methods involved in generating a GHG emissions inventory. The development of a GHG emissions inventory is often considered the first step in developing and implementing a climate action plan, as it provides a baseline measurement of the GHG emissions in a particular region that can be used to quantify the impact of climate actions (Arioli et al., 2020). Targets are defined as the agreed upon number of emissions to be reduced within a specific timeframe (C40, 2020). Generally, there are two types of targets, a final target, which embodies the entire sum of emissions to be reduced by a certain end date, and an interim target, placed somewhere between the baseline year and the final

target year (C40, 2020). Monitoring, in this thesis, is defined as the systems involved in the continuous evaluation of local climate action and revising plans as needed (Seasons, 2003). Monitoring is thus a pivotal device for continual strategic decision-making, offering tools for assessing the progress of climate action implementation and identifying areas of opportunity (Delponte et al., 2017). Finally, in this thesis, reporting is defined as the sharing of GHG emissions inventories and other climate actions with external audiences (WRI et al., 2021). Reporting is essential in providing stakeholders with accurate climate action information and results (Mia et al., 2019). All key concepts are closely linked and directly affect the quality of each other (Mia et al., 2019).

The current literature on targets, measuring, monitoring, and reporting GHG emissions shows a consistent lack of comparability, transparency, and reliability of city carbon accounting processes (Marlowe & Clarke, 2022). Such hindrances threaten the climate mitigation potential of municipalities, as the visibility of tangible progress and identification of areas of improvement is limited. Consequently, there is a need to reveal insights into best practices for measuring, monitoring, and reporting GHG emissions in cities and align processes amongst communities with consistent and proven methods and tools to maximize community climate results. When focusing on the Canadian landscape, the first step is establishing the current state of these processes in Canadian municipalities and revealing insights on best practices. This study aims to accomplish such a feat, contributing to the literature on climate change, climate mitigation, local climate action, urban studies, and strategic management.

1.2 Statement of Purpose & Research Questions

The purpose of this qualitative multi-case study is to understand the current state of local emissions reduction targets and explore the practices used by Canadian municipalities to measure, monitor, and report on GHG emissions as part of the implementation and evaluation of their local climate action plans. The study will shed light on the current and historical practices in Canadian cities with a population of over 10,000 who participate in the PCP program and generate insights into the best practices in Canada. The following research question and sub-questions have been developed to guide the study of the research problem and fulfill the study's purpose.

1. What is the current and historical state of GHG emissions reduction targets, and measurement, monitoring, and reporting in the implementation and evaluation of Canadian municipal climate action plans?
    a. What GHG emissions measurement practices are used to assess corporate and community wide GHG emissions?
    b. How do current municipal GHG reduction targets compare to federal commitments?
    c. What systems are used to monitor progress towards reaching goals set in climate action plans?
    d. What reporting procedures are being used to disclose GHG emissions and/or climate action results?
    e. What measurement, monitoring, and reporting practices are evident in Canadian cities that are also achieving significant GHG emissions reductions?
    f. How has GHG measurement, monitoring, and reporting changed over time?

1.3 Contributions of Research

Through qualitative findings, this empirical study has four main research contributions. First, it provides a baseline understanding of GHG emission measurement, monitoring, and reporting practices in Canadian municipalities, which is currently not evident in the literature. The results contribute to the literature on climate change, deep decarbonization, and urban studies, as well as the measurement, monitoring, and reporting literature. Specifically, the empirical results validate several findings from the literature and extend the literature by indicating that variables, such as BASIC+ level reporting, scope 3 emissions, and carbon sinks and storage, are more evident in Canadian measurement practices than what the literature suggests. Additionally, several variables, such as the involvement of council members and community-wide entities in monitoring climate action, the use of various reporting channels in sharing information, and the inclusion of monitoring procedure details in the reporting process were all identified as key variables associated with higher emissions reductions. Meanwhile, other variables or concepts found in the literature, such as the lack of transparency in measurement practices, and the use of peer review as a tool for monitoring climate action were both scarcely found in the empirical results. In addition to these contributions, the collected and cleaned dataset can be further analyzed by other students to generate additional insights.

Second, this thesis will also inform a survey instrument to be utilized in working group 1 of a larger research project led by Dr. Amelia Clarke at the University of Waterloo in partnership with ICLEI Canada and FCM, and involving other partners, including Adriane MacDonald from Concordia University, who co-chairs working group 1. The survey results will lead to a publicly available database of key variables on measurement, monitoring, and reporting practices in

Canadian municipalities. Future studies can then utilize this dataset as a baseline when conducting research.

Third, this research generates tangible insights on best practices and areas of improvement for municipal practitioners to consider and offers a representation of the Canadian GHG emissions measurement, monitoring, and reporting landscape that government officials can review when making future strategic decisions.

Finally, the frameworks for evaluating measurement, monitoring, and reporting offered in this thesis can be used, modified, or built upon by future studies.

1.4 Study Methods

The study uses a qualitative multi-case study research approach (Yin, 2018) to collect documents in the form of reports from Canadian municipalities with a population of over 10,000 who participate in the PCP program. The gathered reports were sorted by municipality and milestone before deductively and inductively coding relevant data related to targets, and measurement, monitoring, and reporting practices. Detailed descriptions of the patterns, themes, and subsequent findings were generated to represent the current and historical state of GHG emissions targets and measurement, monitoring, and reporting practices in Canadian municipalities and explain relevant insights on best practices. These findings are presented using tables and frequency counts to support the narrative.

1.5 Thesis Outline

This thesis is composed of six chapters. The introduction (Chapter 1) is followed by a literature review (Chapter 2) that offers a comprehensive overview of the existing research and current understanding of GHG emissions reduction targets, and measurement, monitoring, and reporting practices. The literature review concludes with a summary of the literature, isolating gaps in the literature that are addressed through this thesis. Next, the methodology chapter (Chapter 3) explains the research approach, including the research design, sampling strategy, researchers' role, and collection and analysis procedures, before ending with an evaluation of reliability, validity, and the study's limitations. The results chapter (Chapter 4) summarizes the empirical findings, while the discussion chapter (Chapter 5) examines the significance of the findings in relation to the literature and offers answers to the study's research questions. Finally, the conclusion (Chapter 6) summarizes the thesis before describing the study's research contributions and design limitations. The final chapter also concludes with suggestions for future research.

Chapter 2. Literature Review

The following literature review provides an overview of the present knowledge on local climate action as a tool for climate mitigation, focusing on the importance and application of targets, measurement, monitoring, and reporting. This chapter synthesizes the literature that provides context on the research problem of inconsistencies in measuring, monitoring, and reporting GHG emissions. It begins with an overview of climate change, climate mitigation, and deep decarbonization before discussing the existing literature on local climate action planning, implementation, and evaluation, as a form of strategic management for climate mitigation. The next section focuses on the measurement, target setting, monitoring, and reporting of GHG emissions and local climate action, exploring the apparent aspects of each topic, and offering a framework for evaluating and describing the current state of such practices from the information found in the literature. An examination of the available literature on variables associated with emissions reductions in municipalities, and the change in measurement, monitoring, and reporting practices over time follow. Finally, this chapter concludes with a summary and establishes a gap in the literature demonstrating the absence and need for a comprehensive review of Canadian municipal emissions reduction targets, and measurement, monitoring, and reporting practices in the implementation and evaluation of local climate action plans.

2.1 Context

2.1.1 Climate Change

Planet earth is warming at unprecedented rates, fueled by a dramatic rise in GHG emissions from human actions (IPCC, 2021). Thus far, anthropogenic activities have caused approximately 1.0°C in global warming above pre-industrial levels, which will rise to 1.5°C

between 2030 and 2052 if current practices persist (Fawzy et al., 2020; IPCC, 2018). At existing levels of climate change, all parts of the world are experiencing many weather and climate extremes, such as heatwaves, droughts, heavy precipitation, and sea-level rise, which are forecasted to worsen as the planet continues to heat (IPCC, 2021). Recent reports from the Intergovernmental Panel on Climate Change (IPCC) demonstrate the stark difference in climate-related impacts at 2.0°C or higher levels of global warming compared with reduced warming levels closer to 1.5°C (IPCC, 2018, 2021). Specifically, limiting global warming to 1.5°C can radically mitigate risks related to freshwater sources, food security, food production systems, ecosystems, human health, urbanization, and poverty by mitigating the climate-related effects associated with higher global temperatures (Fawzy et al., 2020; IPCC, 2018). These scientific findings provide ample reason for the world to strive to limit climate change to 1.5°C above pre-industrial levels.

Since roughly 1750, concentrations of GHG emissions in the earth's atmosphere have been increasing directly due to human activities (IPCC, 2021). Through a process called the greenhouse effect, radiation is absorbed by GHG's and trapped in the atmosphere (Manabe, 2019). As more GHG's such as carbon dioxide, nitrous oxide, and methane are released, more radiation is confined to the atmosphere, ultimately leading to global warming (Manabe, 2019). Conversely, reducing GHG emissions as quickly as possible towards net-zero can prevent further anthropogenic global warming and place a cap on the maximum temperature to be reached (IPCC, 2018). The cumulative amount of GHG emissions emitted before reaching net-zero will thus determine the magnitude of global warming yet to come (IPCC, 2018).

2.1.2 Climate Mitigation

All scenarios indicating lower amounts of climate change, close to 1.5°C, involve immediate and rapid reductions in GHG emissions of roughly 45% by 2030 and net-zero by 2050 (IPCC, 2018; Rogelj et al., 2015). The Paris Agreement, established in 2015, represents a global breakthrough, with 197 countries committing to address climate change collectively (Kammerer & Namhata, 2018). The agreement aims to limit global warming to below 2°C and pursue efforts to limit it to 1.5°C (Fawzy et al., 2020; Kammerer & Namhata, 2018; Rogelj et al., 2016). Intended Nationally Determined Contributions (INDCs), generated by each country, convey the GHG emissions reduction targets per nation (Rogelj et al., 2016). Unfortunately, significant concern remains surrounding such targets' voluntary, non-legally binding nature (Spash, 2016). Furthermore, even if countries meet their active targets, scientists argue that the efforts will fall short and lead to warming much higher than 2°C (Burch, 2018; Rogelj et al., 2016).

With a breadth of conventional and emerging climate mitigation technologies, strategies, and tactics, a mitigation path to net-zero emissions by 2050 exists, but the window for achieving this goal is swiftly disappearing (Fawzy et al., 2020; IEA, 2021; Rogelj et al., 2015). Realizing a level of climate mitigation capable of limiting global warming to desirable levels will require more ambitious INDCs, or over-delivery on commitments through national, sub-national, and non-state actions (Rogelj et al., 2016). Deep decarbonization must be the concept leading these actions.

2.1.2.1 Deep Decarbonization

Deep decarbonization takes a broad goal, such as global emissions reductions, and looks to address the multi-level and independent nature of carbon lock-in as a partitioned problem (Bernstein & Hoffmann, 2019). Carbon lock-in is described as the inertia of carbon emissions because of physical, economic, and social constraints that reinforce one another (Seto et al., 2016). Due to the significant investment in current processes and infrastructure, and the challenges involved in changing social and technological systems, carbon lock-in proves to be extremely difficult to overcome (Seto et al., 2016). Deep decarbonization is the process and strategies involved in breaking carbon lock-in and overcoming the political, economic, physical, and social dynamics that support the need for carbon emissions (Bernstein & Hoffmann, 2019). Fundamentally, deep decarbonization is a transformational process of integrating zero carbon into current systems while working towards central sustainability goals such as climate adaptation and social justice (Tozer, 2019). The transformational success of deep decarbonization will be led by a diverse collection of actors and implemented at various scales, including in cities (Burch, 2018).

Deep decarbonization in urban areas will be essential in achieving global climate goals, as cities are responsible for three-quarters of humanity's carbon emissions (Carbon Neutral Cities Alliance, 2015). Many cities have taken the initiative to develop strategies to reduce emissions by 80% or reach carbon neutrality by 2050 (Carbon Neutral Cities Alliance, 2015). Yet, until recently, cities lacked direction in developing the processes, strategies, practices, tools, and institutional structures to drive deep decarbonization (Carbon Neutral Cities Alliance, 2015; Tozer & Klenk, 2018). As a result, organizations such as the Carbon Neutral Cities Alliance

(CNCA) and the Deep Decarbonization Pathways Project (DDPP) have emerged to help connect cities, offer valuable resources and information, and expedite progress towards deep and long-lasting emissions reduction (Carbon Neutral Cities Alliance, 2015; Deep Decarbonization Pathways Project, 2015). In Canada, the Partners for Climate Protection (PCP) program offers a framework for developing, implementing, and managing local climate action plans, assisting Canadian municipalities in their deep decarbonization endeavours (FCM & ICLEI, 2020).

2.1.3 Strategic Management of Climate Action

Strategic management is a process in which an organization makes managerial decisions that affect future performance (Hunger & Wheelen, 2011) and can be used for sustainability and climate management (Darwazeh et al., 2021; Linton et al., 2021). The concept comprises several steps, including a scan of the environment, formulation of a strategy, strategy implementation, and the evaluation and control of the strategy or resulting strategic plan (Hunger & Wheelen, 2011). The processes of local climate action planning, implementation, and evaluation are closely linked to strategic management, as the milestones in the PCP program resemble the steps involved in strategic management. Starting with a GHG inventory, municipalities can understand the challenge they are up against, and set tangible targets to address their situation (C40, 2020; FCM & ICLEI, 2014a, 2014b, 2021a, 2021b; WRI et al., 2021). From there, municipalities can form a strategy or plan, begin to implement actions, and monitor and evaluate the results (C40, 2020; FCM & ICLEI, 2021a; WRI et al., 2021).

Given the complexity of transformative change required for municipalities to reach climate goals that align with scientific targets, deep decarbonization is an intimidating task

(Carbon Neutral Cities Alliance, 2015). However, many municipalities are leading by example, generating emissions inventories, adopting ambitious carbon reduction goals, and integrating detailed strategic climate planning and implementation processes into city systems (Carbon Neutral Cities Alliance, 2015). As is the case in any use of strategic management, the continuous evaluation and adjustment of strategies are necessary, especially in a rapidly changing field like climate mitigation, where the science is constantly evolving, and innovative solutions and best practices are increasingly revealed (Carbon Neutral Cities Alliance, 2015; Hunger & Wheelen, 2011). Thus, the cyclical nature of strategic management, where municipalities focus on continuously measuring, monitoring, evaluating, and reporting on progress is crucial to the continued emissions reduction progress needed to reach necessary levels of climate mitigation.

2.1.3.1 Local Climate Action Planning

Along with a growing consensus that urban areas have a prominent role in addressing climate change, an increasing number of cities around the world are developing local climate action plans to fight climate change (Deetjen et al., 2018; Guyadeen et al., 2019; Linton et al., 2021, 2022; MacDonald et al., 2020; Reckien et al., 2018; Zhou, Clarke, & Cairns, 2022). While these plans are generally not legally binding, they present tangible climate-related goals for the future and strategies and tactics to achieve such goals (Guyadeen et al., 2019; Reckien et al., 2018). Developing and implementing such strategies involves rethinking institutional structures, operational plans, budgets, and the approaches a city takes in working with the local community and businesses (Carbon Neutral Cities Alliance, 2015; Ordonez-Ponce et al., 2021). Fortunately, municipalities often utilize national and transnational city networks such as C40, the Global Covenant of Mayors for Climate and Energy (GCoM), or in Canada specifically, the Partners for

Climate Protection Program, to guide them through the evolving strategic management process of developing and managing climate action plans (Balouktsi & Lützkendorf, 2020; C40, 2020; Carbon Neutral Cities Alliance, 2015; FCM & ICLEI, 2021a; Hsu et al., 2020).

Climate action plans come in two different forms: corporate and community. Corporate plans focus on areas the local government has direct control over, such as public transportation and infrastructure, land use, and waste management (Clarke & Ordonez-Ponce, 2017; Linton et al., 2022). Conversely, community plans have a broader scope and address all GHG emissions from within a city's boundaries, including emissions from private transportation, heating of residential dwellings, industrial processes, etc. (Clarke & Ordonez-Ponce, 2017; Linton et al., 2022; Wong et al., 2020).

2.1.3.2 Deep Decarbonization Pathways in Municipalities

Deep Decarbonization in municipalities is driven by pathways, representing the strategies and tactics capable of reaching a predetermined future GHG emissions target (Deep Decarbonization Pathways Project, 2015). Pathways are developed through a back casting process of determining the necessary steps to achieve a specified result, or in this case, a target amount of GHG emissions reductions (Deep Decarbonization Pathways Project, 2015). They are an important planning tool cities can utilize to capture their vision and plan, track progress towards goals, and communicate and share approaches with other communities (Carbon Neutral Cities Alliance, 2015; Deep Decarbonization Pathways Project, 2015; Linton et al., 2022; O'Brien, 2018).

There is no definitive roadmap for building a climate action plan replicable by all municipalities, with each location facing unique challenges (Carbon Neutral Cities Alliance, 2015). However, pathways and strategies usually fall under four established primary sectors, making climate action planning and evaluating emissions more manageable (Clean Air Partnership, 2021). In addition, these sectors account for most city-wide emissions and represent areas that local governments have significant control over (Carbon Neutral Cities Alliance, 2015; Linton et al., 2022; Robinson & Gore, 2005).

The four primary sectors include electricity or energy, buildings, transportation, and waste (Carbon Neutral Cities Alliance, 2015; FCM & ICLEI, 2020; Linton et al., 2022). Other possible sectors include carbon sinks and offsets, land use, industry, agriculture, and forestry (Carbon Neutral Cities Alliance, 2015; Clean Air Partnership, 2021; Linton et al., 2022). Municipalities form pathways by crafting strategies that address their unique circumstances and priorities (Linton et al., 2022). The chosen strategies do not necessarily target the highest emitting sectors, as other sectors may be more accessible for municipalities (Linton et al., 2022).

The size of a city generally dictates the level of control a municipality has over the main emitting sectors, with more populous locations typically having greater influence than smaller municipalities (Linton et al., 2022). Smaller municipalities tend to compensate for this lack of power by engaging in partnerships with the private sector or other community organizations, which ultimately may provide added value (Eang et al., 2023; Linton et al., 2022). Once the pathways are decided upon, and a local climate action plan is created, the next step is implementing the agreed-upon strategies through actions.

2.1.3.3 Plan Implementation

Moving toward the climate targets set by municipalities requires that strategies outlined in climate action plans become actions to reduce emissions. Transitioning into an implementation phase can be challenging for municipalities, as they face several barriers related to capacity, lack of information, prioritization, costs, jurisdiction, and behaviour change (Robinson & Gore, 2005; Tozer, 2013; Zhou et al., 2020). Nevertheless, municipalities are deploying climate actions and thus are inching closer to climate targets through visible emissions reductions (Carbon Neutral Cities Alliance, 2015; Clean Air Partnership, 2021; Damsø et al., 2017; Linton et al., 2021; Tozer, 2013). However, progress on community-wide emissions reductions has been less promising than the reductions in emissions tied directly to municipal operations, otherwise known as corporate emissions (Tozer, 2013).

There are several successful strategies and governance tactics to advance climate action implementation, including oversight and accountability, improving technical capacity and innovation, stakeholder and community engagement and collaboration, influencing other levels of government, the generation of funding, and sustaining long-term commitment (Carbon Neutral Cities Alliance, 2015; Clean Air Partnership, 2021; Linton et al., 2021). Linton et al. (2021) also detail several best practice municipalities that use engagement and green economy strategies and policy and financial tools. Once municipalities begin to implement their plans, evaluation of progress is imperative (Carbon Neutral Cities Alliance, 2015).

2.1.3.4 Plan Evaluation

Consistent and accurate evaluation of implementation is a vital tool for local climate action as it aids in understanding how strategies are performing and points to areas for improvement (C40, 2020; Carbon Neutral Cities Alliance, 2015; Clean Air Partnership, 2021; Guyadeen et al., 2019; Lara-Morales & Clarke, 2023; Linton et al., 2021; Robinson & Gore, 2015). In addition, evaluation creates an opportunity to continuously improve the plan, share successes and barriers with others, and provide transparency to stakeholders (C40, 2020; Carbon Neutral Cities Alliance, 2015). It is a crucial part of sustained decarbonization success, and emissions reduction target setting, and measurement, monitoring, and reporting of climate action are all key pieces to be utilized in the process of evaluation. This thesis aims to add to the empirical understanding of the target setting, measurement, monitoring, and reporting practices in Canadian municipalities, using an evaluation framework derived from the literature on the topic.

2.2 Evaluation Framework

Target setting and measuring, monitoring, and reporting GHG emissions are key aspects of plan evaluation, each contributing to the quality of plan evaluation and overall climate mitigation success (C40, 2020; Carbon Neutral Cities Alliance, 2015). However, several variables contribute to the effectiveness of GHG emission measurement, monitoring, and reporting, adding to the complexity of these processes. Furthermore, as relatively new processes in a growing but young field, many studies have pointed to the inconsistencies and deficiencies in the measurement, monitoring, and reporting of GHG emissions (Damsø et al., 2017; Delponte et al., 2017; Gurney et al., 2021; Guyadeen et al., 2019; Marlowe & Clarke, 2022; Mia et al.,

2019; Robinson & Gore, 2015). The following sections dissect these three processes to uncover the variables of each topic and build a proper framework to capture the current state of these practices in local climate action planning in Canada. The final three sections explore the topics of emissions reduction targets, apparent variables in municipalities with significant emissions reductions, and the trends of measurement, monitoring, and reporting over time.

2.2.1 GHG Emissions Measurement

The measurement of GHG emissions is often described as a GHG emissions inventory. Establishing an inventory is the first step in creating a climate action plan (Wright et al., 2011). It sets an emission baseline that municipalities can use to identify opportunity sectors, develop strategies, track the effectiveness of implemented actions, and measure total mitigation impact (Arioli et al., 2020). Inventories should be generated regularly to evaluate progress, assess the potential of strategies, highlight achievements through reporting, and continue the ongoing strategic management process (Erickson & Morgenstern, 2016; FCM & ICLEI, 2014a). Several leading municipalities conduct inventories yearly (Linton et al., 2021).

To complete a holistic GHG emissions inventory, a municipality needs access to accurate and recent activity data representing both production and consumption-based emissions and a standardized method or approach to calculate the emissions (Arioli et al., 2020; Mi et al., 2019). However, due to a lack of data, confusion related to defining and selecting boundaries, and variability in calculation methods, a widely accepted standardized method for GHG measurement remains elusive, forming a problem of comparability between the inventories of locations (Arioli et al., 2020; Creutzig et al., 2019; Lombardi et al., 2017; Marlowe & Clarke,

2022; Martire et al., 2018). Progress has been made in the standardization of GHG emissions measurement with the development of internationally recognized protocols such as the Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC) (WRI et al., 2021). However, studies have shown that due to limited access to data and the complexity of such protocols, municipalities opt to utilize a variety of both established and customized methodologies to measure emissions (Arioli et al., 2020). This scattered approach to measuring emissions leads to issues of uncertainty, accuracy, consistency, and comparability of GHG emissions measurement between municipalities (Arioli et al., 2020; Baltar de Souza Leão et al., 2020; Chen et al., 2019; Harris et al., 2020; Marlowe & Clarke, 2022; Sperling & Ramaswami, 2018).

With the immense potential impact of municipalities on reducing global warming, the accurate and consistent measurement of GHG emissions is crucial, and the standardization of measurement is pivotal in achieving this (Arioli et al., 2020). The literature points to several areas of measurement where variability transpires. These areas of divergent practices form a basis for evaluating GHG emissions measurement in municipalities. However, a broad review of the measurement or inventory practices of Canadian municipalities remains unstudied, underscoring a gap in the literature that this study addresses.

2.2.1.1 Protocols & Methodology for Measurement

For several years municipalities relied on inventory guidelines from the IPCC to measure their GHG emissions (Arioli et al., 2020; Erickson & Morgenstern, 2016). Recent methodologies, such as the GPC, are compliant with the IPCC guidelines (WRI et al., 2021). However, studies point to the use of a variety of inventory methods between cities (Arioli et al.,

2020; Ibrahim et al., 2012). Additionally, scholars have been developing or adapting new frameworks (Martire et al., 2018; Wiedmann et al., 2021) while countries generate regional models for their cities to use (Arioli et al., 2020; Dahal & Niemelä, 2017). As a result, recent years have seen a surge in the number of methodologies and protocols proposed and utilized worldwide as cities aim to find a practical solution and researchers aim to deliver a universally functional framework (Arioli et al., 2020).

In Canada, many municipalities, representing most of the country's population, participate in the Partners for Climate Protection (PCP) program (FCM & ICLEI, 2021a). The PCP program supplies its constituents with the PCP protocol, a supplemental framework for conducting city-based emissions inventories derived from the GPC protocol (FCM & ICLEI, 2014a). The two protocols are provided to program participants as resources. Using either document, municipalities can create inventories based on the scope of emissions and the emissions-producing activities within a city's boundaries, partitioned into well-defined sectors (FCM & ICLEI, 2014a; WRI et al., 2021).

In the GPC, two reporting levels exist, "BASIC" and "BASIC+." The BASIC level covers emission sources present in most cities, such as stationary energy, in-boundary transportation, and in-boundary waste, which are relatively easy to retrieve data for and calculate emissions (WRI et al., 2021). The BASIC+ standards broaden the coverage of emissions sources and include sources that are difficult to retrieve data for and calculate emissions, such as industrial processes and product use (IPPU), agriculture, forestry, and other land use (AFOLU), transboundary transportation, and energy transmission and distribution losses (WRI et al., 2021).

Most municipalities tend to limit their focus to the sectors and scope of emissions associated with BASIC reporting over BASIC+ reporting, although leading municipalities are starting to incorporate BASIC+ level reporting in their inventory processes (Linton et al., 2022). While the PCP protocol does not explicitly mention the BASIC and BASIC+ reporting levels, the protocol allows cities to include an elevated or base level of emissions sources in an inventory (FCM & ICLEI, 2014a). As such, a more comprehensive view of the sectors included in the inventory can help establish the level of reporting when it is not overtly apparent.

While the PCP and GPC protocols supply the inventory methodology for most Canadian municipalities, others may opt to utilize an alternative or adapted option. Thus, it is essential to note the protocol and methods used in generating an inventory to understand the comparability and breadth of the inventory. These details remain relatively unstudied in Canadian municipalities.

2.2.1.2 Corporate & Community Inventories

Two distinct types of inventories coincide with the two types of local climate action plans: corporate and community. Corporate inventories measure the emission sources that local governments have direct control over (Clarke & Ordonez-Ponce, 2017; FCM & ICLEI, 2014a; Linton et al., 2022; Robinson & Gore, 2005), while community inventories include all emissions emitted within a municipality's boundaries (Clarke & Ordonez-Ponce, 2017; FCM & ICLEI, 2014a; Linton et al., 2022). Since the community inventory covers all emissions within a community, a community inventory also captures all emissions in a corporate inventory (FCM & ICLEI, 2014a). As a more straightforward and achievable process, municipalities often complete

a corporate inventory before attempting a community inventory (FCM & ICLEI, 2014a, 2021a). However, opting to conduct a corporate inventory, and forego a community inventory, can only provide visibility of a fraction of the emissions in a municipality. Thus, it is important to uncover the use of both types of inventories within Canadian municipalities.

2.2.1.3 Scope of Emissions

Emissions can be grouped into three distinct categories known as scope 1, scope 2, and scope 3. Scope 1 consists of all emissions that physically come from sources within the city, scope 2 includes the emissions that occur due to the use of grid electricity or district energy, and scope 3 encompasses all other GHG emissions that exist outside of city boundaries but are a result of activities within the city boundary (Linton et al., 2022; WRI et al., 2021). The inclusion of emissions from each scope in an inventory is dependent on the protocol or methodology used, the level of reporting selected within a protocol and the boundaries agreed upon for the inventory (Chen et al., 2019; WRI et al., 2021). Linton et al. (2022) mention that scope 1 and 2 emissions are generally the primary focus for local governments. While scope 3 emissions are not widely calculated and targeted in climate action planning, several leading municipalities are beginning to include some of these emissions in their planning processes (Linton et al., 2022). However, a broad understanding of the number of municipalities in Canada to include the various scopes of emissions remains unclear.

2.2.1.4 Emission Sources by Sector

Emissions are often calculated in inventories by sector. The priority sectors for most cities include electricity, buildings, transportation, and waste (Linton et al., 2022). The GPC

offers a slightly expanded list of sectors, grouping electricity and buildings under stationary energy and adding industrial processes and product use (IPPU), agriculture, forestry and other land use (AFOLU), and other scope three emissions to the group of sectors (WRI et al., 2021). Sectors can be further divided into sub-sectors or sub-categories (WRI et al., 2021). For example, the PCP protocol mentions five sectors for corporate inventories (buildings, fleet, streetlights, water and sewage, and waste) and three sectors for community inventories (buildings, transportation, and waste) (FCM & ICLEI, 2014a). Municipalities can include additional sectors in their inventories, such as IPPU or AFOLU, although these sectors may not apply to some locations, while others may not have access to relevant data to do so (FCM & ICLEI, 2014a; WRI et al., 2021). Ideally, municipalities include all emissions sources from all relevant sectors. However, it is difficult for external reviewers to discern whether all sectors are included in the inventory. Providing a breakdown of the sectors included in inventories can provide a holistic picture of the measured sectors that is not currently available.

2.1.1.5 Setting Boundaries

Establishing boundaries is essential in generating a GHG emissions inventory as it allows municipalities to monitor and manage carbon emissions properly by understanding where emissions come from and, thus, where emissions can be reduced (Kennedy & Sgouridis, 2011; WRI et al., 2021). Municipalities must identify the geographic area, time span, gases, and emission sources to be covered by the inventory (WRI et al., 2021). Emission sources can be categorized by sector (stationary energy, buildings, transportation, waste, IPPU, AFOLU, and other scope three emissions) and scope 1, 2, or 3 (WRI et al., 2021).

The protocols and boundaries used by a municipality impact inventory results, as different protocols and methods of determining boundaries have inconsistent requirements for the emissions sources and scope of emissions to include in an inventory (Chen et al., 2019). Further, municipalities can choose to set their boundaries at the corporate or community levels (Wright et al., 2011). Municipalities are encouraged to include as much detail as possible in their inventories, expanding their boundaries as feasibly possible. However, restrictions on data and resources limit the boundaries municipalities can explore, leading to inconsistencies and uncertainty in GHG measurement (Arioli et al., 2020; FCM & ICLEI, 2014a; Marlowe & Clarke, 2022; WRI et al., 2021; Wright et al., 2011).

2.2.1.6 Consumption & Production Based Inventories

There are two distinct methodologies for generating GHG emission inventories, production-based (PB) and consumption-based (CB). PB inventories, which are currently the basis for most inventory frameworks, including the PCP and GPC protocols, assign responsibility for GHG emissions based on where emissions are produced (Andrade et al., 2018; Harris et al., 2020; Sudmant et al., 2018; WRI et al., 2021). CB inventories, conversely, assign responsibility for GHG emissions based on where goods and services are consumed (Andrade et al., 2018; Harris et al., 2020; Sudmant et al., 2018; WRI et al., 2021). Studies have shown a dramatic difference between inventory results from PB and CB inventories, with CB inventories showing much higher amounts of GHG emissions than PB inventories (Baltar de Souza Leão et al., 2020; Harris et al., 2020; Meng et al., 2017; Sudmant et al., 2018). CB inventories are also more complex to complete and commonly require access to data that is unavailable (Chen et al., 2019). With the apparent difficulty of conducting CB inventories and the less favourable

outcome of higher GHG emissions, studies conclude that cities will opt to use a PB method if given a choice (Chen et al., 2019; Harris et al., 2020). However, scholars caution that the use of PB over CB inventories may depict reductions in GHG emissions when overall emissions that account for consumption are rising (Chen et al., 2019; Harris et al., 2020; Sudmant et al., 2018).

While a growing number of municipalities are considering their production and territorial emissions, few pay attention to their consumption-based emissions (Sudmant et al., 2018). More advanced reporting levels, such as the BASIC+ level in the GPC protocol, include the measurement of some scope 3 emission sources (WRI et al., 2021). However, the protocol does not cover several other scope 3 emissions sources, especially those that would require consumption-based measurement. Instead, The GPC recommends supplementing with consumption-based accounting practices, although no instruction on completing such practices is given (WRI et al., 2021).

As municipalities continue to develop climate action plans and measure the impact of their actions, it will be essential to ensure their inventories accurately represent the trends in GHG emissions. Linton et al. (2022) outline that several local governments are developing strategies that stretch beyond territorial boundaries and address scope 3 emissions. Understanding how such municipalities are utilizing PB and CB inventories to measure the impact of these strategies will provide important insights for measurement practice.

2.2.1.7 Transparency of Data Sources & Reporting Details

Transparency of data sources and the completeness of reporting are two additional troubling trends in GHG emissions measurement (Baltar de Souza Leão et al., 2020). The transparency of data sources is compromised when municipalities lack the supporting documentation to illustrate how data was gathered and emissions were calculated (Baltar de Souza Leão et al., 2020; Mia et al., 2019). Using the PCP and GPC protocols, municipalities must include information on their data sources and emissions intensity values or coefficients utilized (FCM & ICLEI, 2014a; WRI et al., 2021). Additionally, the completeness of an inventory is heavily reliant on the availability of data. Since data can be challenging for municipalities to retrieve, especially when resources are limited, municipalities may be selective in the data they include in their inventory and omit key emission sources (Baltar de Souza Leão et al., 2020; Mia et al., 2019). As such, it is imperative that municipalities include any assumptions, omissions, and other relevant data to help signify the completeness of the inventory, even if it acknowledges that emissions sources are missing (FCM & ICLEI, 2014a; WRI et al., 2021). While studies indicate a lack of transparency in the data sources used and reporting details provided (Baltar de Souza Leão et al., 2020; Mia et al., 2019), the level of inclusion of these features in the Canadian context remains unknown.

2.2.1.8 Carbon Sinks & Storage

Sequestration of carbon sources through nature-based solutions and other carbon capture and storage methods will play a sizeable role in reaching net-zero climate goals (Griscom et al., 2017; IEA, 2021; Keith et al., 2021). Various municipalities with strong climate action plans include targets in their plans related to carbon sinks and nature-based solutions (Linton et al.,

2022). However, no specific directions for measuring these carbon stocks can be found in the PCP or GPC protocols (FCM & ICLEI, 2014a; WRI et al., 2021). Griscom et al. (2017) present several natural climate solutions and demonstrate the significant potential that these solutions hold through the quantification of scenarios involving the use of such tactics. Other scholars argue the need for adapting GHG emission measurement methodologies to incorporate the quantification of carbon stocks in addition to carbon flows, which are currently measured (Keith et al., 2021). While the measurement of flows of carbon emissions has proven valuable as a tool for climate mitigation policy and strategy development, municipalities can also consider how they plan on measuring and integrating stocks, or carbon sinks, storage, offsets, and nature-based solutions into their inventories (Keith et al., 2021). Ultimately, the use of carbon sinks and storage in Canadian municipalities remains uncertain.

2.2.1.9 Summary of the Measurement Evaluation Framework Variables

Table 1 summarizes the measurement variables included in the evaluation framework, and previously discussed. All the variables were identified as important topics in the literature on GHG emissions inventories. These variables are used as codes in the process of reviewing and coding gathered GHG emissions inventories to develop an understanding of the current measurement practices in Canadian municipalities.

Table 1: Measurement Evaluation Framework Variables

Parent Code	Child Code	Source
Protocols and Methodologies	PCP Protocol GPC Protocol Adapted or custom Protocol	(Arioli et al., 2020; FCM & ICLEI, 2014a, 2021a; WRI et al., 2021)

Reporting Levels	BASIC BASIC+	(WRI et al., 2021)
Corporate and Community Inventories	Corporate Inventory Community Inventory	**(Clarke & Ordonez-Ponce, 2017; FCM & ICLEI, 2014a, 2021a; Linton et al., 2022; Robinson & Gore, 2005)**
Scope of Emissions	Scope 1 Scope 2 Scope 3	(Chen et al., 2019; Linton et al., 2022; WRI et al., 2021)
Emission Sources by Sector	**General** Stationary energy Electricity Buildings Transportation Waste IPPU AFOLU Other scope 3 emissions **Corporate** Buildings Fleet Streetlights Wastewater and sewage Waste **Community** Buildings Transportation Waste	(Arioli et al., 2020; Chen et al., 2019; FCM & ICLEI, 2014a; Kennedy & Sgouridis, 2011; Marlowe & Clarke, 2022; WRI et al., 2021; Wright et al., 2011)
Consumption and Production-Based Inventories	Consumption-based inventory Production-based inventory	(Andrade et al., 2018; Baltar de Souza Leão et al., 2020; Chen et al., 2019; Harris et al., 2020; Linton et al., 2022; Meng et al., 2017; Sudmant et al., 2018; WRI et al., 2021)
Transparency	Data sources Emissions intensity values/coefficients Omissions Assumptions	(Baltar de Souza Leão et al., 2020; FCM & ICLEI, 2014a; Mia et al., 2019; WRI et al., 2021)

Carbon Sinks and Storage	Carbon sinks Carbon storage Carbon offsets Nature-based solutions	(FCM & ICLEI, 2014a; Griscom et al., 2017; IEA, 2021; Keith et al., 2021; Linton et al., 2022; WRI et al., 2021)

2.2.2 Emissions Reductions Targets

Setting and committing to emissions reduction targets provides countries and municipalities with a goal to work towards, and a benchmark for contextualizing emissions reduction results (C40, 2020). The ratification of the Kyoto Protocol sparked an increase in the adoption of targets on an international scale, with Canada selecting a 6% emissions reduction target below 1990 levels by between 2008 and 2012 (Doucet, 2004). With the amalgamation of the Paris Agreement in 2015, countries agreed to strengthen targets and pursue emissions reductions that would limit global warming to 2°C while endeavouring to limit warming to 1.5°C above pre-industrial levels (Rogelj et al., 2016). Canada responded with targets of 30% emissions reductions by 2030 and 80% reductions by 2050. Finally, as new scientific findings were unveiled in the IPCC special report on global warming of 1.5°C detailing the importance of limiting global warming to 1.5°C above pre-industrial levels and reaching net-zero emissions as soon as possible, Canada's targets were updated once again, to 40-45% emissions reductions by 2030 and net-zero emissions by 2050 (Government of Canada, 2021; IPCC, 2018).

While national targets provide high level direction for municipalities, and ultimately are what national and international progress on climate change will be measured against, sub-national actors, like municipalities, are an important catalyst for deep decarbonization, and as

such, require their own emissions reduction targets (Hsu et al., 2020). While the PCP program recommends that municipalities follow a comparable target structure to the national targets and include an interim and final target, only a final target is required in the program (FCM & ICLEI Canada, n.d.). Thus, some municipalities may only develop one emissions reduction target. Furthermore, Kramers et al. (2013) introduce methodological considerations for municipalities when setting emissions reduction targets. They present a main finding of an apparent variation in the temporal scope of targets in municipalities, indicating the use of different baseline and target years which ultimately reduces comparability of targets (Kramers et al., 2013).

As federal emissions reduction targets in Canada continue to change in favour of more ambitious goals, it is important to have a clear picture of the targets in the municipalities in Canada, who have a direct impact on federal emissions. A comparison of municipal and federal targets can provide insights into any gaps that may remain between targets set at the national and local levels. Furthermore, a review of municipal targets can expand our comprehension of the potential variation in the use of final and interim targets, as well as any difference in temporal scope used by municipalities. A broad examination of these variables in Canadian municipalities is not currently available. The results of this section will thus address this gap in the literature on GHG emissions reduction targets.

2.2.2.1 Summary of the Target Evaluation Framework

Table 2 summarizes the target setting variables included in the evaluation framework, and previously discussed. All the variables were identified as important topics in the literature on target setting. These variables are used as codes in the process of reviewing and coding gathered

reports that include information on target setting, to develop an understanding of the current emissions reduction targets in Canadian municipalities.

Table 2: Target Evaluation Framework Variables

Codes	Source
Interim & final targets	(FCM & ICLEI Canada, n.d.)
Target years (final and interim)	(Kramers et al., 2013)

2.2.3 Monitoring and Evaluating Local Climate Action Plans

The presence of a monitoring and evaluation framework is necessary for all local climate action plans, along with the deployment of key performance indicators, as they help measure progress and indicate areas of improvement (C40, 2020; Clarke, 2011; Guyadeen et al., 2019; Linton et al., 2021; Reckien et al., 2018; Robinson & Gore, 2015; Seasons, 2003; UN Habitat, 2015). They facilitate the possibility for regular plan adjustments or renewals based on measured plan outcomes and impacts (Sun et al., 2020). Continual monitoring and updating of the plan can provide an opportunity to re-evaluate scientific findings, financial and development capacity, and incorporate technological advancements (UN Habitat, 2015). While some examples of monitoring exist, usually found in large, early adopter cities (Damsø et al., 2017; Rivas et al., 2022), other studies point to the lack and poor quality of monitoring procedures in local climate action plans (Boehnke et al., 2019; Guyadeen et al., 2019; Rivas et al., 2022).

Some studies analyze the monitoring systems in Canada (Guyadeen et al., 2019; Robinson & Gore, 2015). However, they focus on plan quality (Guyadeen et al., 2019) and climate activities outside current monitoring processes (Robinson & Gore, 2015). Guyadeen et

al. (2019) evaluate the use of specific monitoring indicators in a municipality's climate action plan, such as the inclusion of a monitoring and evaluation section, and the identification of the responsible organization, timeline for plan updates, and quantifiable goals and policies. However, they focused on the details in the plans specifically, rather than the actual reports which showcase the operationalized monitoring systems. Robinson and Gore (2015), on the other hand, conducted a study to investigate if there is a discrepancy between the actual mitigation and adaptation actions being completed by municipalities, and the reported milestones completed. They ultimately found that there was a significant difference in the actions underway and the milestone completions, indicating a need for a more granular view of the actions and practices underway in municipalities. Both studies suggest a need for improvement in monitoring local climate action plans in Canada but do not offer a holistic view of the practices and procedures being utilized. Guyadeen et al. (2019) are interested in the planning stage, while Robinson and Gore (2015) emphasize the need for a deeper look into the current practices in municipalities. Thus, a gap remains in establishing a baseline understanding of the monitoring practices in Canada to use as a benchmark for gauging improvement, that will expand upon the work of previous studies.

Monitoring and evaluating the implementation of local climate action plans is a cyclical practice of assessing and controlling processes and recalibrating objectives and methods of execution for continuous improvement of a plan (Delponte et al., 2017). Klostermann et al. (2018) offer a framework to assess climate adaptation monitoring and evaluation systems. This framework is adapted and used in this section to outline the key aspects of climate mitigation monitoring and evaluation systems. The framework consists of four sections: 1) the system of

interest, 2) indicators, 3) organizations responsible for monitoring, and 4) monitoring procedures (Klostermann et al., 2018).

2.2.3.1 Defining the System of Interest

Defining the system of interest outlines the details of what is to be monitored, including the boundaries in time and space and the aspects of the system to be evaluated (Klostermann et al., 2018). This information is likely found in documentation from earlier planning stages during the creation of plan strategies and objectives (Klostermann et al., 2018). With climate mitigation planning, several details of the system of interest are predetermined, given that mitigation planning focuses specifically on reducing GHG emissions. However, several other elements are unique to each municipality, including the sectors of focus, specific functions of emission-producing activities within the sectors, the geographic areas, and the timeframe of evaluation (Klostermann et al., 2018). The measurement section of this thesis already captures these details. However, the monitoring stage of planning will re-emphasize the system of interest. It is important to understand if the system of interest is well defined in each municipality.

2.2.3.2 Selection of the Indicator Set

2.2.3.2.1 Updating the Emissions Inventory

Updating the emissions inventory is a fundamental step in monitoring and evaluating a local climate action plan, as it provides an overview of the progress towards total emissions reductions (Damsø et al., 2017; Delponte et al., 2017; Rivas et al., 2022). Most guidelines require municipalities to complete this process every three to five years (Delponte et al., 2017; FCM & ICLEI, 2014b; Rivas et al., 2022). Adequate inventories follow the same methodology used to

create the baseline inventory to promote direct comparability of the results (Delponte et al., 2017; FCM & ICLEI, 2014b). Emissions are again broken into sectors and sub-sectors to easily evaluate emission reductions by source (Delponte et al., 2017; FCM & ICLEI, 2014b). Similar issues in the baseline inventory process are evident when updating the inventory, including the lack of access to reliable data (Rivas et al., 2022). As a result, many municipalities fail to complete an updated inventory (Boehnke et al., 2019; Delponte et al., 2017; Rivas et al., 2022).

While an updated emissions inventory is a valuable policy tool for benchmarking performance, GHG reductions may result from changes outside of local activities, indicating a need for additional monitoring methods to comprehend further the influence of implemented actions or projects (Damsø et al., 2017).

2.2.3.2.2 Project-Based Results

Quantifying the results of a project enables municipalities to evaluate and showcase the impact and success of specific actions outlined in a plan (ICLEI Canada, 2020). It provides a tool to inform decision-making and priority setting or generate support and funding for future projects (FCM & ICLEI, 2014b; ICLEI Canada, 2020). Project-based results are supplementary to a city-wide inventory. Energy savings and emissions reductions from particular actions can be calculated using a bottom-up measuring approach, forming a base for project-based monitoring (Kaselofsky et al., 2014). However, scholars argue that the exclusive use of GHG emissions and energy savings as targets and indicators for monitoring climate action may be too narrow, pointing to the need for a more comprehensive set of targets and indicators for successful monitoring (Kramers et al., 2013). A monitoring framework that can track each project and its

relevant list of indicators is the recommended practice in the PCP program (FCM & ICLEI, 2014b). The practice helps municipalities monitor their project-based results.

2.2.3.2.3 Targets & Indicators

An emissions reduction target is often the standard for guiding progress in a local climate action plan (Damsø et al., 2017). However, assessment can also focus on a plan's planning progress and implementation, or actions, in addition to the effects, such as GHG emissions reductions (Boswell et al., 2012; Damsø et al., 2017). A breadth of indicators can help municipalities track progress toward targets (Neves & Leal, 2010). These indicators should be measurable and relevant from a policy perspective (Schepelmann et al., 2009). Damsø et al. (2017) highlight that Copenhagen, a local climate action leader, uses the measurement of GHG emissions to monitor and report on progress towards the overarching goal and activity-based indicators tied to specific initiatives for continual operational planning and monitoring of their plan.

The PCP program recommends the use of several indicators for activity-based monitoring, including 1) a description of the project, 2) implementation cost, 3) project partners, 4) environmental results, such as energy savings, waste diverted, or increase in active transportation, 5) social or economic benefits, and 6) annual cost savings, on top of GHG emissions reductions (FCM & ICLEI, 2014b). Evaluation of these indicators helps municipalities monitor the performance of actions and improve the implementation of actions moving forward (FCM & ICLEI, 2014b). In addition, the detailed review of activities in this manner allows for sharing best practices and disseminating finished initiatives (Damsø et al., 2017).

A review of all initiatives and their status of implementation, using classification systems, percentages of completion, and comparisons to previously generated projections, also helps provide a clear picture of implementation progress (Damsø et al., 2017; Delponte et al., 2017). With a strong understanding of implementation progress from a complete monitoring process, municipalities can discuss the difficulties of implementing actions and decide on the actions to continue to pursue or remove from the plan (Damsø et al., 2017).

Klostermann et al. (2018) suggest grouping indicators under three main categories: Process-based, output, and outcome indicators. Process-based indicators describe the steps and decisions taken in the mitigation process, output indicators show the progress toward implementing mitigation policies or tactics, and outcome indicators measure the effectiveness of mitigation actions (Klostermann et al., 2018). The types of indicators used in the climate action monitoring systems of Canadian municipalities remains unexplored. Klostermann et al. (2018) provide a framework for easily identifying and grouping these indicators to establish an understanding of the types of active indicators in local monitoring systems.

2.2.3.3 Organizations Responsible for Monitoring

The responsibility for monitoring a climate action plan depends on the type of plan (corporate or community). The oversight committee of a corporate plan should consist of various internal staff members from several departments within the municipality (Zhou, Clarke, & FCM, 2022). In larger municipalities, individual departments can be responsible for monitoring results and reporting directly to the oversight committee (Zhou, Clarke, & FCM, 2022). Conversely, community plans are best managed and monitored by a multi-stakeholder partnership, led by the

municipality or a third party entity, and consist of several community partners (Sun et al., 2020; Zhou, Clarke, & FCM, 2022). When monitoring corporate or community plans, a supportive governance structure should include consistent reports from the oversight committee to the council and an official system for monitoring and reporting progress, paired with a clear understanding of responsibilities for data gathering and evaluation (Klostermann et al., 2018; Zhou, Clarke, & FCM, 2022).

2.2.3.3.1 Involvement of Staff

The involvement of local staff throughout the planning, implementation, and monitoring of the local climate action plan can reinforce better monitoring procedures (MacDonald et al., 2020; Rivas et al., 2022). When staff members are part of the entire planning and implementation process, they can contribute to the plan and help set realistic targets paired with functional action items, empowering staff members to monitor a plan with feasible aspirations (Rivas et al., 2022).

In corporate and community action planning, staff can be a part of the oversight committee that monitors progress. In corporate plans, the oversight committee is generally made up of staff from diverse departments to influence change throughout the municipality and enhance coordination (Zhou, Clarke, & FCM, 2022). While municipal staff have less control over the actions in a community plan, individuals from several sectors and organizations make up the oversight committee, which can include municipal staff, especially in a municipal-led secretariat (Clarke, 2012; Sun et al., 2020; Zhou, Clarke, & FCM, 2022).

2.2.3.3.2 Involvement of Council Members

Council members should be involved in overseeing, monitoring, and evaluating any local climate action plan, with ultimate decision-making power resting with them for all corporate plans or actions (Clarke, 2012; Zhou, Clarke, & FCM, 2022). Council members can respond to reports from the oversight committee or directly embed themselves in the oversight committee (Zhou, Clarke, & FCM, 2022).

2.2.3.3.3 Involvement of Community-Wide Entity

A community-wide entity or partnership is established to oversee a plan's development, implementation, monitoring, and evaluation, particularly with community climate action plans (Clarke, 2012; Sun et al., 2020; Wong et al., 2020). This partnership can be led by the municipality or by a third-party organization (Zhou, Clarke, & FCM, 2022). Ultimately, the partnership should consist of municipal government representatives and various other community partners (corporations, chambers of commerce, universities, utilities, non-governmental organizations, citizens, etc.) (Clarke, 2012). This ensures that the entity can strategically collect action data from all partners to monitor and report on plan outcomes effectively.

2.2.3.3.4 Stakeholder Engagement

With any local initiative, the early and consistent engagement of all applicable stakeholders is an essential step in the planning, implementation, and evaluation process (FCM & ICLEI, 2014b). Monitoring and evaluating plan results allows for engagement with all stakeholders on the success and failure of actions, provides transparency, and inspires trust in the

plan's ability to reach climate goals (C40, 2020; MacDonald et al., 2019). Additionally, the inclusion of a broad number of stakeholders in the monitoring and evaluation of the plan ensures that all aspects of the plan are monitored, enhancing the impact of the monitoring and evaluation process and adding a deeper layer of accountability (Delponte et al., 2017; Rivas et al., 2022).

The number and types of stakeholders may vary depending on the size of the municipality and the kind of climate action plan (corporate or community). However, some form of stakeholder engagement is beneficial and necessary in all climate action plans. As such, the PCP program requires participants to outline their stakeholder engagement process as part of the monitoring and evaluation milestone (FCM & ICLEI, 2014b).

2.2.3.3.5 Peer Review

Although monitoring and evaluation of the plan are often conducted by municipal staff, council members, or the community-wide entity, external experts can act as an unbiased layer of review to scan action and results-based data and provide insights on the plan's performance (Delponte et al., 2017). The review process can be autonomous and informal or structured and formal, depending on the municipality's needs (Delponte et al., 2017). For example, the city of Copenhagen has built a regular review with external partners into their monitoring process. They complete an assessment several times yearly to ensure any challenges are appropriately managed (Damsø et al., 2017). On a more informal basis, national and international city climate action networks provide a way for municipalities to monitor and assist each other's progress through sharing insights, challenges, and best practices (C40, 2020; Rivas et al., 2022).

2.2.3.4 Monitoring and Evaluation Procedures

Monitoring and evaluation procedures are detailed explanations of how data are collected, managed, analyzed, and reported (Oakley et al., 2003). The framework by Klostermann et al. (2018) also includes the need for an explanation of how stakeholders are engaged and the approach to refine the monitoring system and the plan itself over time. Since there is no universally accepted monitoring system, the procedures for monitoring and evaluation should be transparent and technically sound, allowing stakeholders to understand and analyze the results for themselves (Brown et al., 2018; Klostermann et al., 2018). However, Guyadeen et al. (2019) indicate that the inclusion of monitoring procedures in planning processes may be an area of weakness for Canadian municipalities. Nevertheless, these procedures are discussed in international city climate action frameworks (C40, 2020) and are part of the PCP program monitoring and evaluation requirements (FCM & ICLEI, 2014b).

2.2.3.5 Revision of Plan

Management of a local climate action plan is a cyclical process requiring consistent and ongoing monitoring and evaluation to promote plan improvement and continual progress (Delponte et al., 2017). Local climate action leading municipalities have unique approaches to monitoring and evaluating the progress of their plan implementation, although they share a common theme in the consistent and relentless oversight of their plan implementation (Damsø et al., 2017; Linton et al., 2021). Some municipalities evaluate their implementation quarterly, allowing for quick and flexible decision-making (Damsø et al., 2017; Linton et al., 2021). In contrast, others adopt an annual or bi-annual approach, which can impede their reaction time and jeopardize the implementation of actions, slowing progress (Linton et al., 2021). Still, many

other municipalities struggle to incorporate monitoring and evaluation into their plans at all (Boehnke et al., 2019; Rivas et al., 2022), essentially removing their ability to assess the impact of their actions and thus update strategies as needed. With only 12% and 9% of PCP members reaching the monitoring and evaluation stage of their corporate and community plans as of 2021, respectively (FCM & ICLEI, 2021a), Canadian municipalities stand to benefit significantly by incorporating such practices into their planning process. A complete review of the current practices by municipalities ahead of the curve can provide valuable insights to help a growing number of other municipalities develop their own strategic monitoring and evaluation practices to ensure the widespread review and revision of all local climate action plans.

2.2.3.6 Summary of the Monitoring Evaluation Framework Variables

Table 3 summarizes the monitoring variables included in the evaluation framework, and previously discussed. All the variables were identified as important topics in the literature on monitoring and evaluating climate action. These variables are used as codes in the process of reviewing and coding gathered reports that include information on implementation and monitoring of climate action, to develop an understanding of the current monitoring practices in Canadian municipalities.

Table 3: Monitoring Evaluation Framework Variables

Parent Code	Child Code	Source
System of Interest	Sectors Functions of emission-producing activities Geographic area Timeframe	(Klostermann et al., 2018)
Selection of Indicator Set	Updating Emissions Inventory Project-based Results	(Boehnke et al., 2019; Boswell et al., 2012;

	Process-based indicators Output indicators Outcome indicators Other indicators (indicators that do not fall under one of the other three categories)	Damsø et al., 2017; Delponte et al., 2017; FCM & ICLEI, 2014b; ICLEI Canada, 2020; Kaselofsky et al., 2014; Neves & Leal, 2010; Rivas et al., 2022; Schepelmann et al., 2009)
Monitoring Responsibility	Staff Council members Community-wide entity Stakeholder engagement Peer review	(C40, 2020; Clarke, 2012; Damsø et al., 2017; Delponte et al., 2017; FCM & ICLEI, 2014b; Klostermann et al., 2018; Rivas et al., 2022; Sun et al., 2020; Wong et al., 2020; Zhou, Clarke, & FCM, 2022)
Monitoring and Evaluation Procedures	Data collection procedures Data management procedures Data analysis procedures Reporting procedures Refinement of the monitoring system Plan revision	(Boehnke et al., 2019; Brown et al., 2018; C40, 2020; Damsø et al., 2017; Delponte et al., 2017; FCM & ICLEI, 2014b, 2021a; Klostermann et al., 2018; Linton et al., 2021; Oakley et al., 2003; Rivas et al., 2022)

2.2.4 Reporting on Local Climate Action Progress

Reporting on the progress of local climate action is closely linked to measurement and monitoring practices, with the methods involved in both directly impacting reporting quality. Proper reporting of GHG emissions allows external stakeholders to understand a city's GHG footprint and gauge its climate mitigation efforts and accomplishments (Mia et al., 2019). Furthermore, it provides transparency and accountability to external stakeholders and helps outsiders pinpoint areas of improvement for vertical or horizontal multi-level collaborative

policies and programs (Mia et al., 2019; Robinson & Gore, 2015). However, for reporting to be useful, the measurement of GHG emissions and related climate mitigation actions must be accurate and comparable, as it must be in financial reporting (Gibassier & Schaltegger, 2015).

Quality reporting requires 1) completeness of data, with the inclusion of all types of GHGs, appropriate emissions sources, and scopes of emissions, 2) consistency of methodologies within and across municipalities, 3) timeliness, or recency of data, 4) accuracy of measurements, 5) reliability, through verification of measures, and 6) comparability, from reports that are complete, consistent, accurate and reliable (Mia et al., 2019). However, a recent study by Mia et al. (2019) found several issues with the reporting from municipalities, including a time gap between calculating and disclosing emissions, the use of diverse methodologies to develop measurements and reports, exclusion of types of GHGs, scope 3 emissions, and in some cases, scope 2 emissions, and resistance towards verifying data. Although few studies in the literature focus on the climate reporting quality of municipalities, with most research exploring reporting in corporations (Bui & de Villiers, 2017; Depoers et al., 2016), the examples focusing on reporting in municipalities reiterate these findings (Baltar de Souza Leão et al., 2020; Bertoldi et al., 2018; Hsu et al., 2019; Mia et al., 2018). The results show that information in municipal climate action reporting is incomplete, inconsistent, inaccurate, unreliable, outdated, and thus not comparable (Baltar de Souza Leão et al., 2020; Gurney et al., 2021; Mia et al., 2019).

Another aspect of reporting to be considered is the disclosure of information to external audiences. Municipalities are accountable to the public and provincial and federal governments and, as such, have a responsibility to share climate data with relevant parties (Mia et al., 2018).

While several channels exist for municipalities to disseminate climate data, and standardization of disclosure is starting to take form (Linton et al., 2022; Mia et al., 2018), a broader view of these reporting practices in the Canadian landscape remains unstudied.

Some studies on reporting include Canadian cities in their sample, although they generally only include the larger cities, namely Toronto and Vancouver (Mia et al., 2018, 2019). Still, several studies call for additional research on reporting and disclosure processes (Hsu et al., 2019; Mia et al., 2019; Perugini et al., 2021). Thus, a gap remains in the literature related to reporting and disclosure processes in the Canadian context, which this study will address.

2.2.4.1 Reporting Frameworks

Measuring, monitoring, and reporting local climate action progress are connected through complementary processes. Municipalities participate in multinational and national networks, such as the Global Covenant of Mayors (GCoM) and Partners for Climate Protection Program, that supply resources and support for measuring, monitoring, and reporting GHG emissions and other relevant local climate action information such as emissions reductions targets, and action implementation (Bertoldi et al., 2018; FCM & ICLEI, 2021a). These networks reinforce the use of specific methodologies, frameworks, and protocols for measuring, monitoring, and reporting climate action progress, which are not always consistent between networks (Balouktsi & Lützkendorf, 2020; Bertoldi et al., 2018; C40, 2020; Rivas et al., 2022). The variability in methods for measuring, monitoring, and reporting leads to inconsistent measurement of emissions, monitoring systems, and thus the quality and consistency of the data and information reported (Baltar de Souza Leão et al., 2022; Mia et al., 2019). The aspects of measurement and

monitoring contributing to reporting variability have been outlined in their respective sections of this literature review.

In Canada, many municipalities participate in the PCP program and thus use the PCP Protocol, which ultimately follows the same methodologies and frameworks as the Global Protocol for Community-Scale Greenhouse Gas Inventories (FCM & ICLEI, 2014a). Therefore, a large portion of municipalities in Canada use the same frameworks to measure, monitor and report emissions and climate action. However, as mentioned in the measurement section, options exist within the framework to customize processes based on data availability and city resources (FCM & ICLEI, 2014a; WRI et al., 2021). Thus, using the same framework can still produce variable results between municipalities.

2.2.4.2 Standardization of Reporting

Until recently, there was no standardized method for reporting local climate action progress to external audiences. In 2019 the Carbon Disclosure Project (CDP) introduced a streamlined platform for city climate reporting (Linton et al., 2022). As of 2021, over 1000 cities worldwide report their environmental impact through CDP (CDP, 2022). The platform permits cities to publicly disclose climate-related data (Mia et al., 2019). Concurrently, several municipalities also disclose climate related information through their involvement in the Global Covenant of Mayors. Reporting through CDP or GCoM provides advantages for cities, such as increased stakeholder engagement, a platform for centralized data, and the lure of progress tracking and benchmarking. However, while they offer a central source of city climate-related data, public disclosure is voluntary, data inclusion can vary, and data accuracy is not verified

(Mia et al., 2019). In response to these challenges, Mia et al. (2018) propose several ways that CDP can support adequate disclosure by encouraging cities to provide more detailed information and increasing regulation and standardization of disclosure.

In addition to CDP, several organizations and groups are acknowledging the need for standardization and working towards developing and integrating a standardized approach to carbon accounting and sustainability reporting. For example, accountants are beginning to embed carbon accounting procedures into their practice, and they will continue to be essential players, as their expertise is well suited to support the standardization of climate-related reporting (Cook, 2009; Engels, 2009; Lovell & MacKenzie, 2012; Mahmoudian et al., 2021; Marlowe & Clarke, 2022). Further, the International Financial Reporting Standards (IFRS) Foundation has consolidated several organizations under one entity. It develops global reporting standards through the International Accounting Standards Board (IASB) and International Sustainability Standards Board (ISSB) and is furthering the integration of carbon accounting in the accounting practice (Cook, 2009; IFRS, 2022). Additionally, the Task Force on Climate-Related Financial Disclosures (TCFD) is also working to standardize the process for organizations to report on their climate-related risks and opportunities (TCFD, 2022). Finally, the United Nations continues to conduct several initiatives that can be used to support the development of reporting standards. While many of these organizations and standards may focus on the private sector, the same standardization tools can be applied through a city lens.

2.2.4.3 Reporting Channels

Several channels exist for municipalities to disseminate or report climate-related information. Municipalities can share information through their own channels, using annual reports, sustainability reports, policy documents, climate action plan documents, or their website (Mia et al., 2018). They can also submit data to external or third-party channels such as CDP to be reported under a standardized, consolidated platform with data from other cities (Mia et al., 2018). On occasion, city emissions and action data are shared across networks that municipalities are members of through case studies, events, or summary reports (C40, 2020; Clean Air Partnership, 2021; FCM & ICLEI, 2021a; GCoM & ARUP, 2021). Finally, social media is an emerging channel that some cities utilize to report on climate action (Twitter, Facebook, Instagram). Social media broadens the capacity for a two-way conversation between the city and stakeholders (Mia et al., 2018).

Multiple studies demonstrate the importance of reporting through own channels and third-party platforms (Kolk et al., 2008; Lodhia, 2014; Mia et al., 2018). Social media shows promise for increased and expedited communication streams. However, it remains an underutilized tool, potentially resulting from the perceived reputation or legitimacy threat (Mia et al., 2018). While there is no obligation to report through any channel or to use more than one channel, Depoers et al. (2016) argue that sharing consistent information across multiple channels can improve credibility and reduce the cost of disclosing. Mia et al. (2018) show that emissions reduction targets are consistently reported across owned and third-party channels in cities. However, the information in reports on emissions reduction actions differs between channels, with some reporting more actions than others (Mia et al., 2018). Furthermore, the study describes

a lack of information related to the emission reduction impacts and cost of implementing actions, pointing to the need for improved and more consistent reporting of emissions reduction actions (Mia et al., 2018).

While these findings are useful, Mia et al. (2018) focus on a small group of megacities, indicating a need for a broader view of municipalities' reporting channels. As a young and growing field, few studies focus on city-based reporting or sharing of emissions and climate action data and the channels used to do so. Furthermore, most studies and grey literature sources emphasize the measurement and monitoring practices involved in generating accurate reports rather than the methods for sharing emissions and climate action data with external parties. This thesis will cover both topics.

2.2.4.4 Summary of the Reporting Evaluation Framework Variables

Table 4 summarizes the reporting variables included in the evaluation framework, and previously discussed. All the variables were identified as important topics in the literature on reporting climate action progress. Additional variables were discussed in this section. However, those variables are already captured in either the measurement or monitoring sections of this thesis. These variables are used as codes in the process of reviewing and coding gathered reports that include information on climate action reporting procedures, to develop an understanding of the current reporting practices in Canadian municipalities.

Table 4: Reporting Evaluation Framework Variables

Parent Code	Child Codes	Source
Reporting Quality Features	Timeliness/recency of data and reporting Report/data verification	(Mia et al., 2019)
Standardization	CDP GCoM	(Linton et al., 2022; Mia et al., 2018, 2019)
Reporting Channels	**Own Channels** Annual reports Sustainability reports Policy documents Climate action plan documents Website **Third-Party Channels** CDP Other **Social Media** Twitter Instagram Facebook	(Depoers et al., 2016; Kolk et al., 2008; Lodhia, 2014; Mia et al., 2018)

2.2.5 Practices Associated with Significant Emissions Reductions

The numerous variables outlined in the first, third, and fourth sections of the evaluation framework represent the practices involved in measuring GHG emissions and monitoring and reporting on climate action progress. Some sources suggest the importance of specific variables in their respective processes, while others outline the various options of measurement, monitoring, and reporting practices for municipalities to choose from. Mia et al. (2019) point to the significance of disclosing GHG information in improving GHG performance, specifically speaking to the value in CDP reporting. Further, Damsø et al. (2017) demonstrate the success of a single city in reducing emissions, using tactics such as persistent stakeholder engagement,

recurring review of the plan, and the use of process-based, output, and outcome indicators that evaluate project or action performance. Finally, Rivas et al. (2022) suggest that the involvement of staff in the planning, implementation, and monitoring process, frequent stakeholder engagement, and early development and deployment of the plan and its actions, can lead to successful climate action monitoring. All three sources provide tangible findings. However, none of the studies directly link the practices to measured emissions reductions on a broad scale. Thus, a gap remains in our understanding of the evident practices in municipalities that are achieving significant emissions reductions.

2.2.5.1 Summary of the Significant Emissions Reductions Practices Evaluation Framework

The variables from tables 1, 3, and 4 will be repurposed for this section. The data collected from the codes in tables 1, 3, and 4 will be reviewed for the municipalities with the highest percentages of emissions reductions to uncover any patterns and themes that may exist.

2.2.6 Change in Practices Over Time

The PCP milestone framework provides an estimation of the status of climate action in Canadian municipalities, with each milestone representing the key topics explored in this thesis. By reviewing the number of municipalities to reach each milestone, and the date at which those milestones were achieved, it is possible to develop a reasonable understanding of how municipalities have been progressing through their climate action processes over time. As of 2021, there have been 660 milestone 1 completions, 549 milestone 2 completions, 507 milestone 3 completions, 190 milestone 4 completions, and 103 milestone 5 completions (FCM & ICLEI, 2021a). However, the timeline for these milestone completions is unknown. While Robinson and

Gore (2015) demonstrate that the milestone process is not a complete representation of all climate action underway in Canadian municipalities, they also acknowledge the importance of the process in tracking general climate action progress or status. PCP summary reports showcase certain details about the milestones, and the municipalities achieving them. However, a complete review of the milestones achieved, and the timing of those accomplishments is not available. Therefore, to better comprehend how municipalities have progressed through the stages of measuring their emissions, setting emissions reduction targets, creating climate action plans, implementing their plans, and monitoring and reporting results, a summary of milestone achievement timing is necessary.

2.2.6.1 Summary of the Changes in Practices Over Time Evaluation Framework

Table 5 summarizes the variables included in the evaluation framework to review the changes in practices over time. These variables are used as codes in the process of reviewing and coding gathered reports, to develop an understanding of the change in climate action practices in Canadian municipalities over time.

Table 5: Change in Practices Over Time Evaluation Framework Variables

Codes	Source
Milestone 1, 2, 3, 4, and 5 achievements	(FCM & ICLEI, 2021a; Robinson & Gore, 2015)

2.3 Summary of Literature Review

The measurement, target setting, monitoring, and reporting of GHG emissions and climate action progress are all essential to the success of deep decarbonization at a local scale. Together, they allow municipalities to understand the current state of emissions in their territory, quantify their emissions reduction goals, identify areas of opportunity for action, evaluate the implementation of agreed-upon actions, and share progress with stakeholders and peers to create transparency and accountability (Arioli et al., 2020; C40, 2020; Carbon Neutral Cities Alliance, 2015; Delponte et al., 2017; Mia et al., 2019). The current literature on these topics explores several variables influencing the quality and consistency of measurement, target setting, monitoring, and reporting of GHG emissions and local climate action progress. The malleable nature of these variables and flexibility of practices involved, due to an absence of standardization, has led to inconsistencies in such processes, calling for an improvement in these areas of climate action planning and drawing attention to the practices that may need amendment or consistent deployment (Damsø et al., 2017; Delponte et al., 2017; Gurney et al., 2021; Guyadeen et al., 2019; Kramers et al., 2013; Marlowe & Clarke, 2022; Mia et al., 2019; Robinson & Gore, 2015).

In this relatively new and growing field of climate change research, up-to-date information and insights are essential to developing effective practices and deploying useful tools, methodologies, and strategies for municipalities to incorporate into their local climate action planning (Hsu et al., 2019; Mia et al., 2019; Perugini et al., 2021). When combined, the variables discovered in the literature create a framework for evaluating the state of GHG

emission and local climate action measurement, target setting, monitoring, and reporting practices.

Although some studies in the literature explore specific topics from a Canadian context (Guyadeen et al., 2019; Robinson & Gore, 2015), and others include a small number of Canadian cities in their sample (Mia et al., 2018, 2019), a comprehensive review of the Canadian climate action practices remains unstudied. This thesis looks to accept this challenge and determine the current and historical state of the critical aspects of implementing and evaluating local climate action plans, while also generating insights into best practices in the field.

Table 6 outlines the components of research from the literature review.

Table 6: Components of Research

Measurement	**Monitoring**	**Reporting**	**Targets**	**Practices Associated with High Emissions Reductions**	**Change Over Time**
Protocols and Methodologies Reporting Levels Corporate and Community Inventories Scope of Emissions Emission Sources by Sector Consumption and Production-Based Inventories Transparency and Completeness	System of Interest Selection of Indicator Set Organizations Responsible for Monitoring Monitoring and Evaluation Procedures	Reporting Quality Features Standardization Reporting Channels	Interim & final targets Target years (final and interim) Comparison of federal and municipal targets	Refer to the measurement, monitoring, and reporting columns	Milestone 1, 2, 3, 4, and 5 achievements, completions, or approvals

Carbon Sinks and Storage					

Chapter 3.0 Methodology

3.1 Introduction to Methodology

The following chapter discusses the research approach of this study. A qualitative, multi-case study approach provided a framework for the empirical exploration required to answer the study's research question.

The chapter begins by outlining the research approach and design, sampling strategy, and researcher's role before discussing the data collection, recording, and analysis methods. This is followed by a discussion of the study's limitations, reliability, and validity.

3.2 Research Approach & Design

This study utilized a qualitative research approach to explore the phenomenon of measurement, monitoring, and reporting practices in Canadian municipal climate action. Qualitative research is often a result of the needed exploration of a particular problem to develop a comprehensive understanding of a specific issue (Creswell, 2007). Researchers collect data from a natural setting and use multiple sources of open-ended data to make sense of a problem and offer relevant themes from the collected information (Creswell & Creswell, 2017). Unlike quantitative studies, the researcher is a key instrument in gathering and interpreting data (Creswell & Creswell, 2017). As such, inquirers must explain their background and role in the study as it may influence the findings (Creswell & Creswell, 2017). Both inductive and deductive data analysis drive the discovery of themes and patterns, resulting in identifying, interpreting, and discussing a real-life representation of the study problem (Creswell & Creswell, 2017).

For this study, a multi-case study design offered an in-depth analysis and comparison of specific case cities in Canada and provided a practical framework for addressing the research question (Creswell & Creswell, 2017). Case study research often explores a single case or multiple cases over time and aspires to describe the case findings through themes and patterns (Creswell, 2007). Adopting a descriptive rather than a critical role, case studies omit a hypothesis and instead look to develop positioning from the collected data and analysis (Creswell, 2007; Lambert & Lambert, 2012). This study explored data from 205 Canadian municipalities to provide an in-depth understanding and description of the practices involved in measuring emissions, GHG reduction target setting, and monitoring and reporting of climate action. Cross-case themes and insights were developed by analyzing several documents from each case city.

3.3 Sampling Strategy

Since the inception of the Partners for Climate Protection (PCP) program in 1994, Canadian municipalities have been reporting to ICLEI Canada after completing each PCP program milestone. These reports contain information on the practices municipalities leverage to develop, implement, and evaluate their climate action plans. The sample includes Canadian municipalities with a population of over 10,000 that have reached the program milestones related to measuring, target setting, monitoring, and reporting practices. Population numbers were gathered from the Municipal Energy and Emissions Database (MEED), when available, or directly from the municipality's website when these details were missing from the database. The sample documents related to measurement practices include corporate and community inventory submissions as part of milestone one requirements. The sample documents related to target setting include reports with target details submitted to the PCP program for milestone two

recognition, as well as other PCP documents that summarize the reported targets from these reports. The sample documents related to monitoring and reporting practices consist of various documents submitted to meet the milestone four and five requirements. Other PCP milestone summary documents, such as excel reports that summarize milestone completion details, are used to dictate the sample municipalities that portray the change in practices over time. Finally, a sample of the municipalities in the top ten percentile of corporate and community emissions reductions, from the municipalities included in the measurement sample, was selected to analyze the evident themes in municipalities with high emissions reductions. The sample documents from the rest of the samples, and the collected data from those documents, was repurposed for this sample.

As of 2021, roughly 500 municipalities, accounting for almost 70% of Canada's population, participate in the PCP program (FCM & ICLEI, 2021a). Thus, this sample provided a realistic representation of the Canadian municipal landscape. By including a population cut-off, this study was able to focus on a practical number of municipalities while capturing a large portion of the population and local GHG emissions in Canada. A master spreadsheet was created to track all sample municipalities and the essential evaluation criteria outlined in the evaluation framework, that was used to analyze the case municipalities.

3.4 Researcher's Role

As is the case in most qualitative studies, reflexivity, or the potential impact of a researcher's biases on the study's outcome, is important to recognize. I am a white male that grew up in an upper-middle-class community in the largest city in Canada. I have an educational and

professional background in business and have worked for several large corporations. I have an affinity for the outdoors and a passion for environmental and social justice, leading to my enrollment in a Master of Environmental Studies program in Sustainability Management at the University of Waterloo.

These aspects may shape how I interpreted the findings of this research. For example, the location where I grew up and the social group, I identify with may equip me with a broader educational understanding of climate impacts and a belief that resources are readily available to deal with the problem. Meanwhile, my business background may cause me to take a strategic and practical view on the topic, to enhance efficiency and performance. Finally, my affinity for the environment may lead me to have a critical viewpoint on the results from municipalities. Given that this is an exploratory study, I aimed to neutralize the impact of my social context to provide the most accurate representation of the findings. It is also important to mention my strategy for gaining access to the relevant research site. Over four months, I completed an internship with ICLEI Canada. This experience provided access to a wealth of data from municipal reports that have never been analyzed. In addition, this experience helped shape my understanding of the research topic as I developed and implemented this study with the support of ICLEI Canada representatives. It may, however, have biased me towards the PCP programs measuring, monitoring, and reporting preferences.

3.5 Data Collection

After exploring the available information in the municipal reports during an internship with ICLEI Canada, the exact number of participating case cities was confirmed based on report

availability. The broad sample consisted of 205 municipalities. The full list of included municipalities can be viewed in Appendix 1. All 205 were included in the measurement sample, with 173 providing a corporate and community inventory, 17 only including a corporate inventory, and 15 only including a community inventory. In total, 80 municipalities were included in the monitoring and reporting samples with 58 submitting corporate and community related reports, 15 only submitting corporate reports, and 7 only submitting community reports (see Appendix 2). Also, 160 municipalities were included in the target sample, which only included municipalities that had submitted reports on community GHG emissions reduction targets (see Appendix 3). In addition, 20 of the municipalities with the highest corporate emissions reductions, and 20 of the municipalities with the highest community emissions reductions made up the sample looking at evident trends in municipalities with high emissions reductions (see Appendix 4). Finally, the broad sample of 205 municipalities was included in the sample evaluating trends in practices over time. All the sub-samples were constructed from the list of municipalities in the total sample of 205.

Most of the data set is derived from existing reports municipalities have submitted to ICLEI Canada since the program's inception, except for data pulled from the CDP and GCoM websites to look at the reporting standardization variables. Municipalities with missing data in the ICLEI archives were omitted from the sample. Before the data collection, a case study protocol was developed to instill consistent procedures across case studies (Yin, 2018). Further, a case study database was created and managed to organize and provide access to all pertinent documents, notes, and materials (Yin, 2018). The database consists of case city GHG inventories, target reports, documents with information on climate action implementation,

monitoring, and reporting, CDP and GCoM emissions information summaries, and other relevant documentation submitted as part of the PCP milestone process.

3.6 Data Analysis

After collecting the reports from the ICLEI Canada archives and the CDP and GCoM websites, the gathered documents were sorted by municipality and milestone number, and read to develop an understanding of the material (Creswell & Creswell, 2017). A master spreadsheet was created with a summary tab that captures all sample municipalities and relevant baseline inventory data. Each sub-sample of municipalities pertaining to each research question was also given its own tab in the master spreadsheet. In each sub-sector tab, columns were created for all variables identified in the evaluation framework established in Chapter 2 (see table 1-6). Next, two rounds of coding were utilized to segment and label relevant data in the reports for each sub-sample (Creswell & Creswell, 2017). A round of deductive coding came first, as I searched for the keywords and concepts from the frameworks outlined in Chapter 2. A round of inductive coding was then used to uncover additional relevant data that was not originally captured in the evaluation framework. For example, in the monitoring section, information was collected pertaining to the use of standardized monitoring frameworks, and in the reporting section, reporting through BC's Climate Action Revenue Incentive Program (CARIP) was identified as another variable to be considered under standardized reporting. Both variables were added to the analysis process and are summarized in the results section, along with the predetermined variables.

Data that was deductively or inductively coded was recorded on the master spreadsheet and simple indicators, such as "yes", "no", or individual descriptive words for each variable were

used to depict whether certain variables were present in the respective reports. Coding of the indicators was slightly more complex, as the definitions of each indicator guided the coding process. Process-based indicators, that describe the steps and decisions taken in the mitigation process, included indicators such as the lead organization, funding sources, and stakeholders or partners involved. Output indicators, that show the progress toward implementing mitigation policies or tactics, included indicators such as the status or timeline of action implementation and description of completed actions or metrics. Outcome indicators, that measure the effectiveness of mitigation actions, included indicators such as GHG emissions reductions, cost reductions, and energy or resource efficiency results. Furthermore, project-based results were coded as outcome indicators measured at the project or action level, rather than the plan level.

Once all data was captured in the master spreadsheet, tables were generated that outline frequency counts for each variable in the evaluation framework, and values demonstrating the percentage of the sample population for each total. Finally, descriptions of the trends and patterns found in the tables were created to summarize and expand on the results (Creswell & Creswell, 2017).

This comprehensive qualitative multi-case study research approach generated patterns, themes, and insights from a sizeable number of Canadian municipalities. The collective trends and insights were analyzed, summarized, and thoroughly discussed, supported by tables and frequency counts. These results offer a current and historical view of target setting, measurement, monitoring, and reporting practices in implementing and evaluating Canadian municipal climate action plans through the evident patterns and themes. Further, the findings

uncover tangible insights into the current best practices in this field. A thorough literature review and consultation with industry experts provided me with the necessary context to interpret and explain the significance of the results.

3.7 Limitations, Reliability & Validity

This study has some limitations concerning the selected sample, methods, and overall research design. First, the chosen sample only included Canadian municipalities participating in the PCP program and excluded cities with a population of less than 10,000. This somewhat limits the ability to generalize the findings across different countries, communities that do not participate in the PCP program, and smaller municipalities. However, the decision to work with ICLEI Canada and focus on PCP members provided a breadth of data large enough for a reasonable representation of the Canadian landscape. The findings and insights at such a broad level are helpful to municipalities in all nations, big or small, though likely more relevant to cities in developed countries with populations of 10,000 or greater. Additionally, while it is not within the scope of this study to focus on smaller communities, the framework of this study can be replicated for smaller municipalities in the future.

Construct validity is the degree to which the form of measurement utilized can measure the concept being studied (Yin, 2018). To ensure construct validity and inform the study design, I conducted a detailed literature review and utilized key informants from ICLEI Canada to review the case measurement tools and results (Yin, 2018). Both tactics aided in determining an appropriate method of measurement. Internal validity represents the credibility of the research or how well the research findings represent reality (Merriam & Tisdell, 2015). To ensure internal

validity, I explored a vast number of case cities, utilized triangulation of multiple sources of data, identified any researcher bias, and included a peer review process through my supervisor and industry experts at ICLEI Canada (Creswell & Creswell, 2017; Merriam & Tisdell, 2015; Yin, 2018). External validity, or the generalizability of the findings, was developed by using detailed descriptions of the findings and including a variety of case municipalities to provide readers with a means for effectively assessing the transferability of the results (Merriam & Tisdell, 2015; Yin, 2018). Finally, reliability or the capacity to replicate the findings of this study was established by incorporating a case study protocol and database into the study, allowing for enhanced transparency of the processes and materials used in this research (Yin, 2018).

Chapter 4.0 Results

This chapter presents the empirical results from the data collection and analysis of various documents gathered from the Partners for Climate Protection Program archives. The types of documents include emissions inventories and reports containing details on each municipality's measurement, target setting, monitoring, and reporting processes. The chapter is broken into sections that align with the research questions of this thesis, and an initial section summarizes key details surrounding the municipalities in the sample. The findings of each section are presented in tables and figures, and further elaborated on through the text.

4.1 Sections

Sample Municipalities: Summarizes key details about the municipalities included in this thesis.

Measurement Practices: Looks at the specific practices municipalities use in conducting GHG emissions inventories.

GHG Reduction Targets: Demonstrates the level of climate action ambition in municipalities through their accepted GHG emissions reduction targets. A comparison between municipal and federal targets provides context for the results.

Monitoring Systems: Identifies the systems or processes that municipalities use to monitor their climate action endeavours.

Reporting Procedures: Examines the reporting procedures that municipalities use to share their climate action progress with external parties.

Municipalities with Significant Emissions Reductions: Identifies the municipalities with the most significant emissions reductions and showcases their measurement, monitoring, and

reporting practices. Data from municipalities with emissions reductions in the top ten percentile are gathered and analyzed for patterns and trends.

Change in Measurement, Monitoring, and Reporting over Time: Offers an overview of the progression of municipalities through the PCP milestone process over the last decade, indicating the trends of municipalities measuring GHG emissions and monitoring and reporting climate action in recent history.

4.2 Sample Municipalities

The complete sample of municipalities in this thesis is comprised of 205 municipalities. Figures 1 and 2 show the number of corporate and community milestones achieved by the 205 municipalities. All 205 municipalities have reached milestone 1, or completed a GHG emissions inventory, thus they are all included in the measurement sample. However, some have completed both corporate and community inventories, and others have only completed one of the two. The municipalities that have achieved milestone 2, or set emissions reduction targets, make up the sample for target setting. Finally, the municipalities who have achieved milestone 4 or 5, and are starting to implement actions, monitor their plans, and report on progress, make up the samples on monitoring and reporting. Given that the PCP program works on a step-by-step basis, there are logically more municipalities that have reached milestone 1 compared to the later milestones. As a result, the sample sizes shrink as the milestone numbers increase.

Figure 1: Summary of the Corporate Sample Municipalities

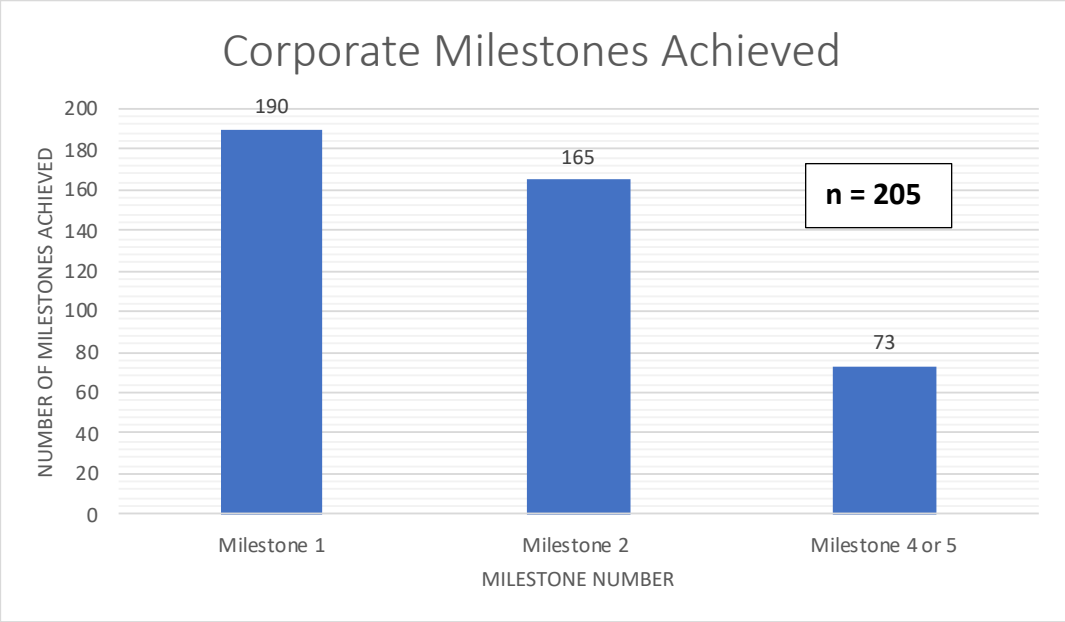
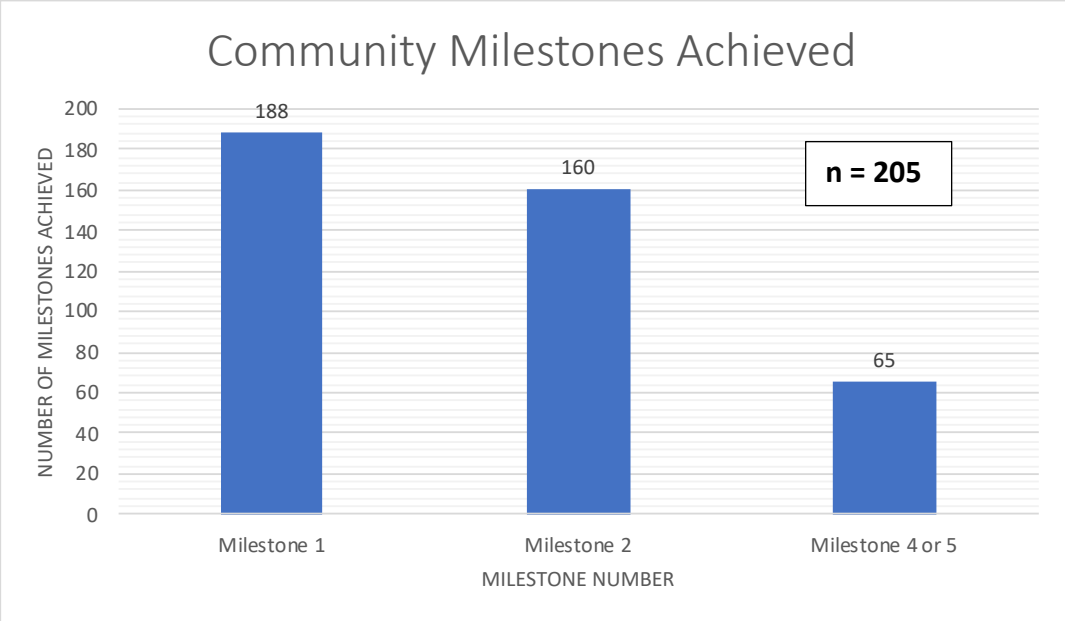


Figure 2: Summary of the Community Sample Municipalities



Municipalities have been joining the PCP program since its inception in 1994. Figure 3 showcases the trends of municipalities in this sample joining the PCP program, displaying a

noticeable increase in membership rates in 2018 and 2019. Of the 205 municipalities in the sample, 85 of them are small municipalities (between 10,000 and 29,999 population), 62 are medium municipalities (between 30,000 and 99,999 population), and 58 are large municipalities (more than 100,000 population). Figure 4 summarizes the number of municipalities in each size category. Finally, while there are a few provinces with much higher representation in the sample, namely Ontario, British Columbia, and Québec, most provinces and territories in Canada are included in the sample in some capacity. Figure 5 presents the results for the number of municipalities in the sample by province or territory.

Figure 3: Timeline for when Sample Municipalities Joined the PCP Program

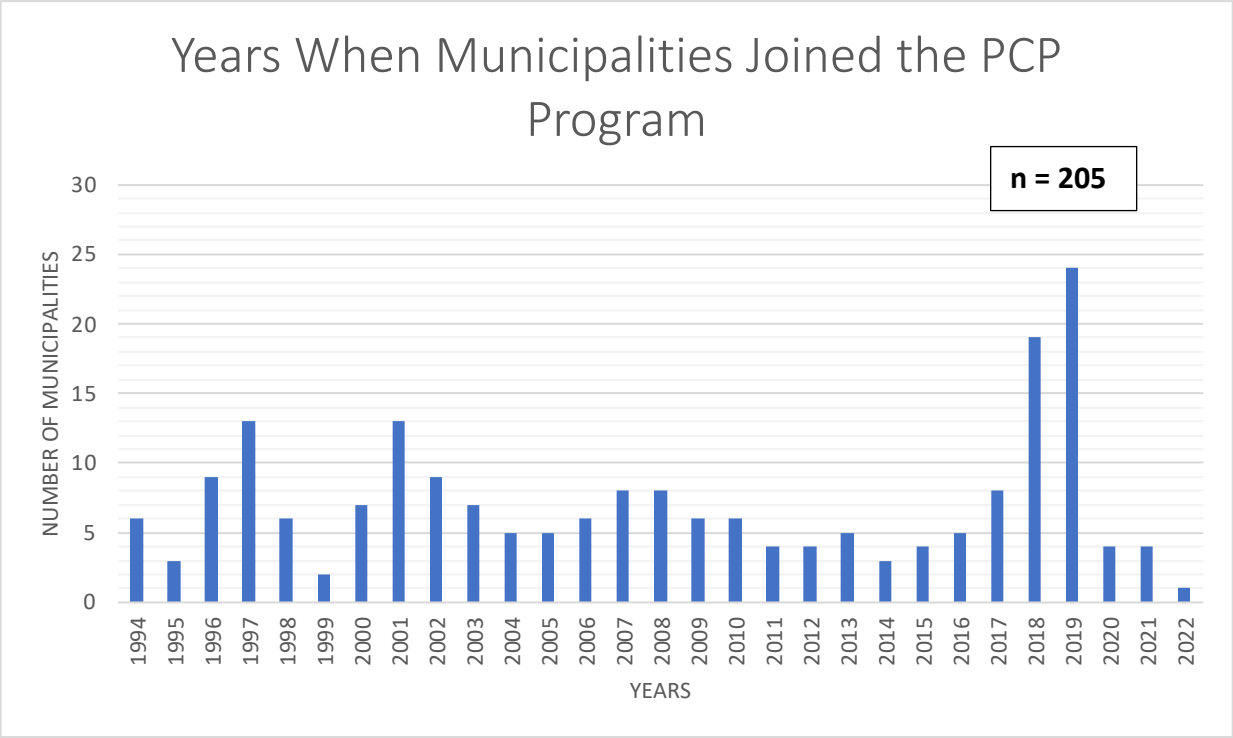


Figure 4: Sample Municipalities by Population Size

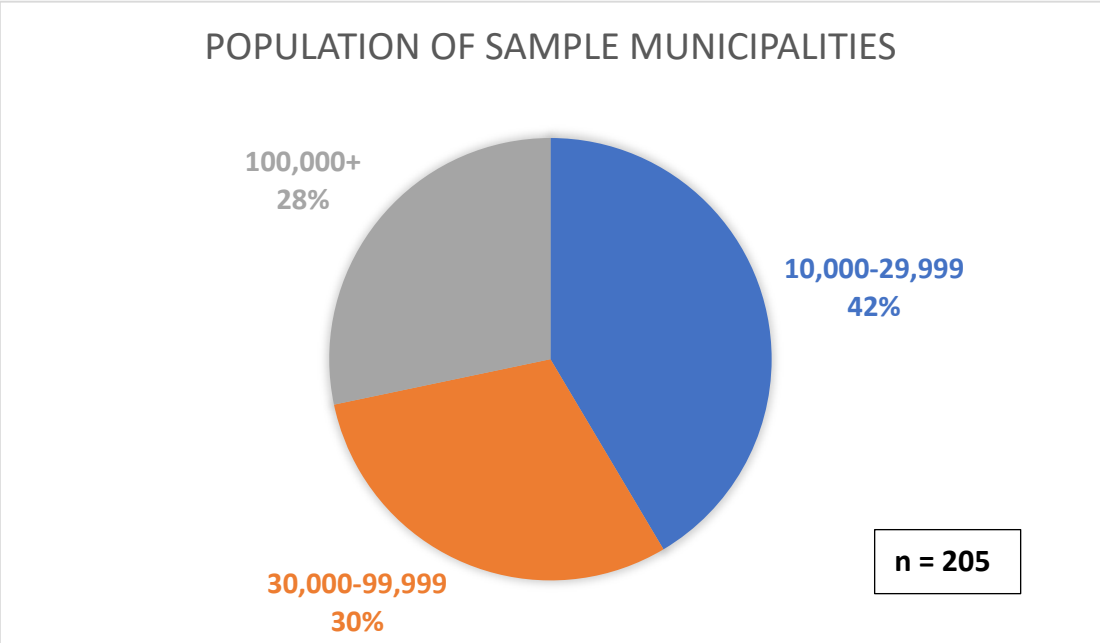
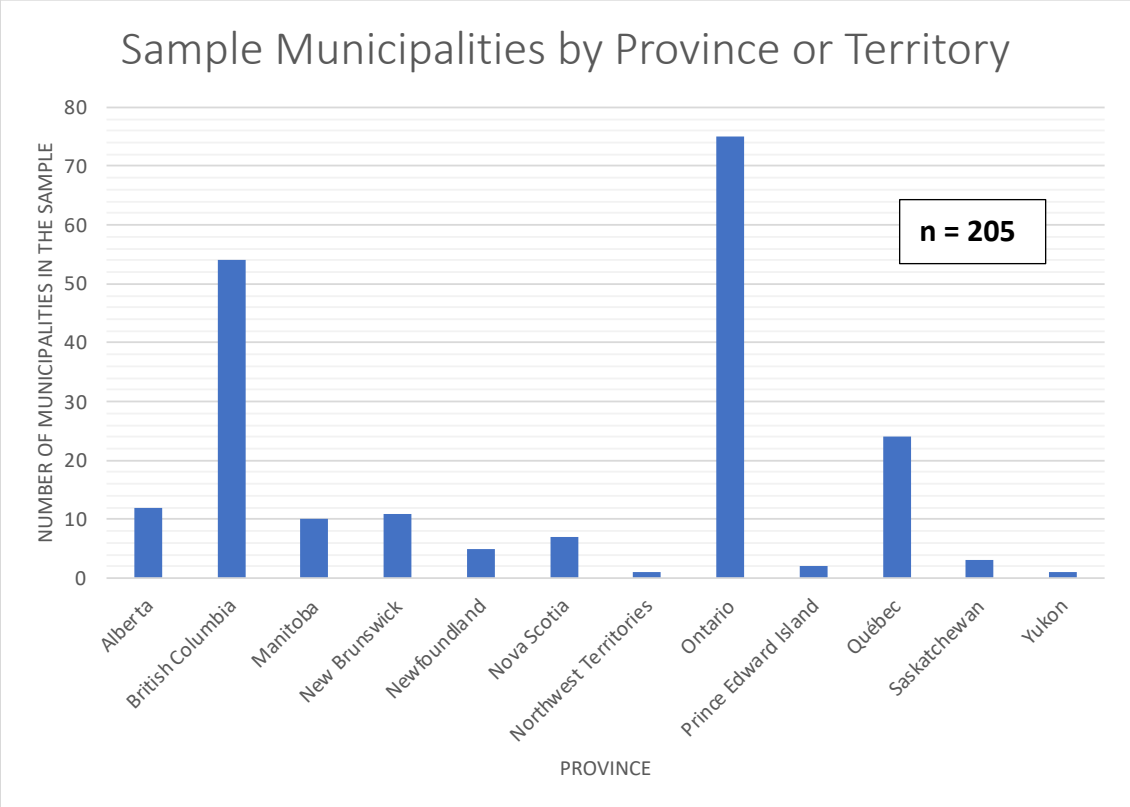


Figure 5: Sample Municipalities by Province or Territory



4.3 Measurement Practices

After reviewing the available PCP data, 205 municipalities had a population of 10,000 or more and had completed milestone 1 (completion of a GHG inventory). 173 of those municipalities completed both corporate and community inventories, while 17 municipalities only completed a corporate inventory, and 15 municipalities only completed a community inventory. These sample details are summarized in Table 7.

Table 7: Summary of Municipalities with GHG Emissions Inventories

MEASUREMENT SAMPLE		
	Number of Municipalities	**Percentage of the Sample**
Corporate Inventory Only	17	8.29%
Community Inventory Only	15	7.32%
Both Inventories	173	84.39%
Total	205	100%

Table 8 summarizes the measurement variables in the evaluation framework introduced in chapter 2, along with frequency counts of the number of municipalities that coincide with each variable for both corporate and community inventories. Additionally, Figures 6, 7, and 8 summarize the evident emission trends for the corporate and community samples and estimate the collective decrease in emissions across all sample municipalities. Figures 6 and 7 demonstrate the percentage of municipalities from the measurement samples that have recorded emissions increases, decreases, or have yet to conduct multiple inventories. Concurrently, Figure 8 provides an estimation of the total amount of emissions reductions for the corporate and community measurement samples, calculated by summing the total emissions increases and decreases reported by municipalities.

Table 8: Measurement Practices Results

PROTOCOL/METHODOLOGY				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of Sample**	**Number of Municipalities**	**Percentage of Sample**
Municipalities that referenced the PCP Protocol	169	88.95%	179	96.76%
Municipalities that referenced the GPC Protocol	17	8.95%	179	96.76%
Municipalities that referenced a different protocol or methodology	28	14.74%	16	8.65%
Unknown methodology or protocol	11	5.79%	2	1.08%
Total Number of Unique Inventories	190	N/A	185	N/A
REPORTING LEVEL				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of Sample**	**Number of Municipalities**	**Percentage of Sample**
BASIC Level Reporting	182	95.79%	135	72.97%
BASIC+ Level Reporting	8	4.21%	49	26.49%
Unknown Reporting Level	0	0%	1	0.54%
SCOPE OF EMISSIONS				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of the Sample**	**Number of Municipalities**	**Percentage of Sample**
Scope 1 Emissions included	190	100%	183	98.92%
Scope 2 Emissions included	190	100%	182	98.38%
Scope 3 Emissions included	13	6.84%	75	40.54%
CORPORATE SECTORS INCLUDED				
Variable	**Number of Municipalities**		**Percentage of Sample**	
Buildings	188		98.43%	
Fleet	187		97.91%	
Streetlights	172		90.05%	
Water & Sewage	147		76.96%	

Solid Waste	125	65.45%
Other	17	8.90%
COMMUNITY SECTORS INCLUDED		
Variable	**Number of Municipalities**	**Percentage of Sample**
Stationary Energy	183	98.92%
Transportation	184	99.46%
Waste	173	93.51%
Industrial Processes and Product Use	21	11.35%
Agriculture, Forestry, and Other Land Use	35	18.92%
Other Scope 3 Emissions	1	0.54%

TYPE OF INVENTORY				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of Sample**	**Number of Municipalities**	**Percentage of Sample**
Production-Based Inventory	190	100%	185	100%
Consumption-Based Inventory	0	0%	1	0.54%

TRANSPARENCY				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of the Sample**	**Number of Municipalities**	**Percentage of Sample**
Data sources				
Data sources provided	138	72.63%	156	84.32%
Some data sources provided	18	9.47%	14	7.57%
Data sources not provided	35	18.42%	15	8.11%
Coefficients				
Coefficients are provided	169	88.95%	155	83.78%
Some coefficients provided	5	2.63%	9	4.86%
No Coefficients provided	17	8.95%	21	11.35%
Omissions				
Omissions are provided	140	73.68%	87	47.03%
Some omissions are provided	29	15.26%	10	5.41%
Omissions not provided	21	11.05%	88	47.57%
Assumptions				
Assumptions are provided	140	73.68%	153	82.70%

Some assumptions are provided	29	15.26%	14	7.57%
Assumptions not provided	21	11.05%	18	9.73%
CARBON SINKS AND STORAGE				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of Sample**	**Number of Municipalities**	**Percentage of Sample**
Inclusion of carbon sinks and storage	5	2.63%	18	9.73%
No inclusion of carbon sinks and storage	185	97.37%	167	90.27%

Figure 6: Corporate Emissions Trends in Canadian Municipalities

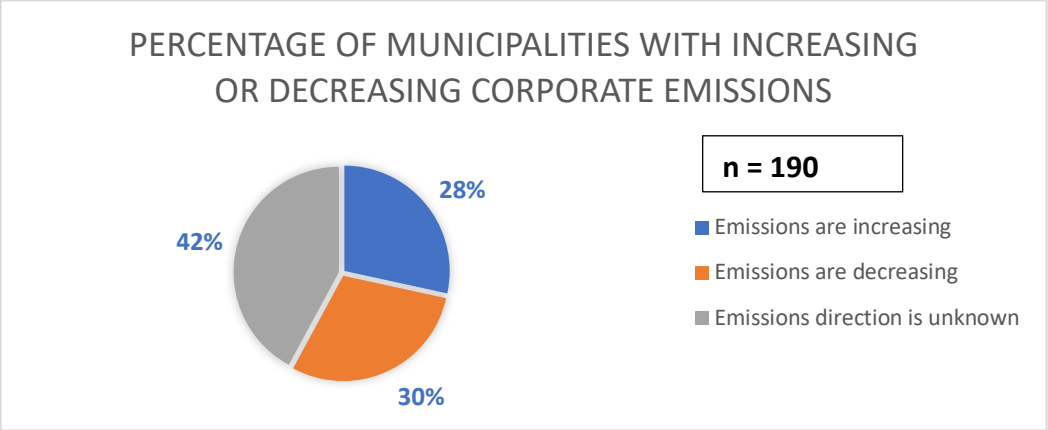


Figure 7: Community Emissions Trends in Canadian Municipalities

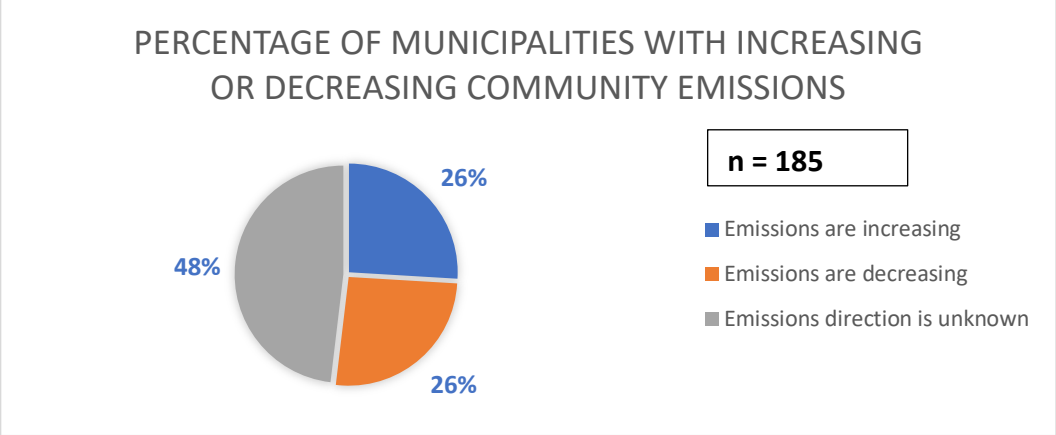
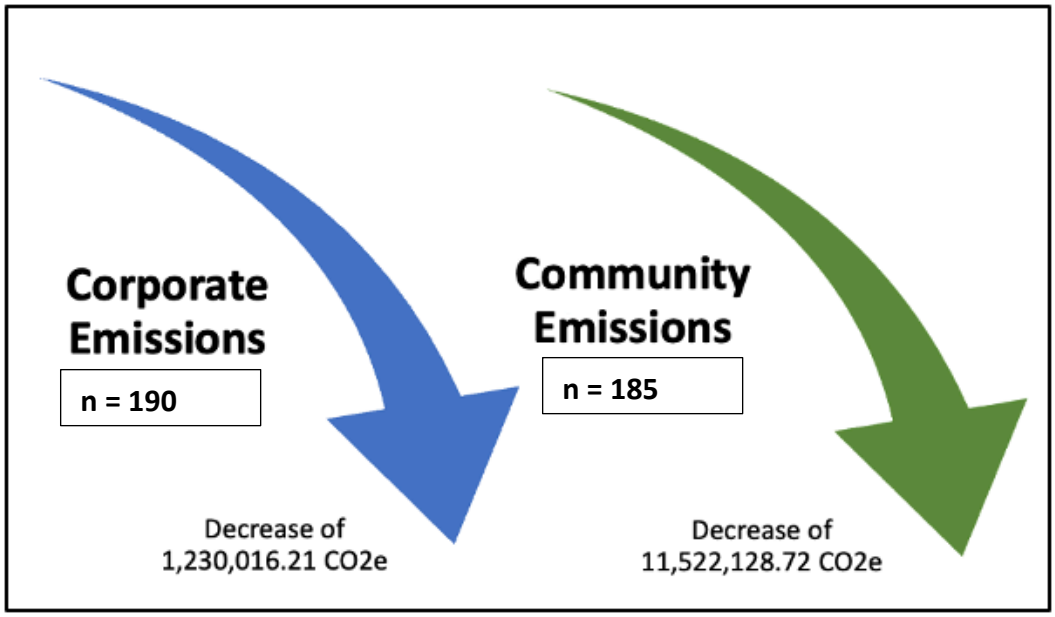


Figure 8: Estimated Emission Reductions Across Sample Municipalities



Out of the 205 municipalities in the sample, 190 completed a corporate inventory, and 188 completed a community inventory. However, 4 municipalities shared the same community inventory, bringing the total number of unique community inventories down to 185. Most municipalities for either type of inventory referenced the PCP Protocol as their methodology, with 88.95% of the corporate sample and 96.76% of the community sample using this protocol to conduct their inventory. Concurrently, only 8.95% of the corporate sample referenced the GPC protocol, while 96.76% of the community sample referenced this protocol. This result is likely because the GPC Protocol is designed as a methodology for measuring community emissions, while the PCP Protocol includes guidelines for both corporate and community-based emissions measurement. Furthermore, since the PCP Protocol is built to follow the GPC Protocol guidelines, these methodologies were grouped for the community inventory sample, driving the total for both PCP and GPC higher simultaneously. Another 14.74% of the corporate sample and 8.65% of the community sample referenced other methodologies, while 5.79% of the corporate

sample and 1.08% of the community sample had inventories where the methodology was unknown.

Every corporate inventory in the sample included scope 1 and 2 emissions, with only 13 municipalities including scope 3 emissions. Additionally, all inventories followed a production-based inventory method. Moreover, 182 of 190 corporate inventories in the sample used the equivalent of BASIC-level reporting, with only 8 inventories including measures that could be considered BASIC+. This translated to the inclusion of the building sector in 188 municipalities, the fleet sector in 187 municipalities, the streetlights sector in 172 municipalities, the water and sewage sector in 147 municipalities, and the solid waste sector in 125 municipalities. A total of 17 municipalities also included other sectors in their corporate inventories. The transparency of inventories varied between municipalities, with 138 providing data sources, 169 including emissions coefficients, and 140 including omissions and assumptions. In addition, 18 municipalities provided some data sources, 5 included some emissions coefficients, and 29 offered some omissions and assumptions. The rest included no details for each respective category. Finally, 5 out of 190 municipalities built-in some measure of carbon sinks and storage in their corporate inventory, while 185 did not.

While some of the trends found in the corporate sample remained constant in the community sample, some variation was evident. With an increase in the use of the GPC Protocol, which uses the BASIC and BASIC+ reporting levels, a much more considerable proportion of the community sample included BASIC+ measures. Specifically, 49 of 185 municipalities incorporated some aspect of BASIC+ level reporting. Consequently, 75 municipalities

representing 40.54% of the sample measured scope 3 emissions, while scope 1 and 2 were included in 183 and 182 inventories, respectively. The few municipalities that are shown as not including scope 1 or 2 emissions simply did not provide information to decipher what scope of emissions were included. Thus, it is likely that they also included these types of emissions.

The main three sectors for community inventories were well represented. The stationary energy sector was represented in 183 municipalities, while the transportation and waste sectors were evident in 184 and 173 municipalities. As in the corporate sample, 100% of the municipalities used a production-based inventory methodology. However, one municipality also conducted a consumption-based inventory, and another mentioned that a consumption-based inventory would be completed in 2023. Both municipalities were using the consumption-based inventory in support of their production-based inventory. Most transparency trends were relatively comparable to the corporate sample, apart from a decrease in the amount of information surrounding omissions provided in community inventories. In total, 156 municipalities included data sources, 155 included emissions coefficients, 87 included omissions, and 153 included assumptions. An additional 14 municipalities included some data sources, 9 included some coefficients, 10 included some omissions, and 14 included some assumptions. The rest included no details for each respective category. Finally, 18 municipalities, a much higher number than what was found in the corporate sample, included carbon sinks and storage in their inventory in some capacity.

Across the corporate and community samples, there is an even number of municipalities in which emissions are increasing and decreasing. For example, in the corporate sample,

emissions rose in 54 municipalities, decreased in 56, and were unknown in 80. Simultaneously, In the community sample, emissions were increasing in 48 municipalities, decreasing in 48, and unknown in 89. However, the emissions decrease in the corporate and community samples outweighed the increase, resulting in a total reduction of 1,230,016.21 CO2e for the corporate sample and 11,522,128.72 CO2e for the community sample. These totals were generated by subtracting the most recent inventory amount from the baseline inventory for all municipalities and adding all results together. The municipalities with only one inventory were omitted from this exercise. Using baseline inventory data from the PCP archives, this would equate to approximately 20.5% corporate emissions reductions and roughly 4.4% community emissions reductions. While this is an imperfect calculation method, it provides a snapshot of the emissions scenario in Canadian municipalities that are a part of the PCP program.

4.4 GHG Emissions Reduction Targets

A total of 160 of the 205 municipalities that have completed an emissions inventory have reached milestone two in the PCP program and have set emissions reductions targets. For this thesis, only community level targets were analyzed, as these targets cover all emissions within a municipality's boundaries, including corporate emissions. Table 9 summarizes these targets in relation to the current and historical federal targets found in the literature and showcases the number of municipalities that match these targets or fall between them. Figures 9 and 10 illustrate how municipal targets in this sample compare to Canadian federal targets of 40-45% emissions reductions by 2030 and net-zero emissions by 2050. Finally, Figures 11, and 12 offer a review of the variation in the final and interim target years selected by municipalities.

Table 9: GHG Emissions Reduction Targets Results

FINAL TARGET AMOUNT		
Number of municipalities with a final target	**160**	
Target Emission Reductions	**Number of Municipalities**	**Percentage of the Sample**
Increasing Target	2	1.25%
Below 6%	7	4.38%
6%	27	16.88%
7-79%	59	36.88%
80%	29	18.13%
80-99%	5	3.13%
100% or Net-Zero	31	19.38%
INTERIM TARGET AMOUNT		
Number of municipalities with interim target	**68**	
Target Emission Reductions	**Number of Municipalities**	**Percentage of the Sample**
Increasing Target	0	0%
Below 30%	20	29.41%
30%	10	14.71%
31-39%	16	23.53%
40-45%	6	8.82%
46-99%	16	23.53%
100% or Net-Zero	0	0%

Figure 9: Federal Final Target Comparison

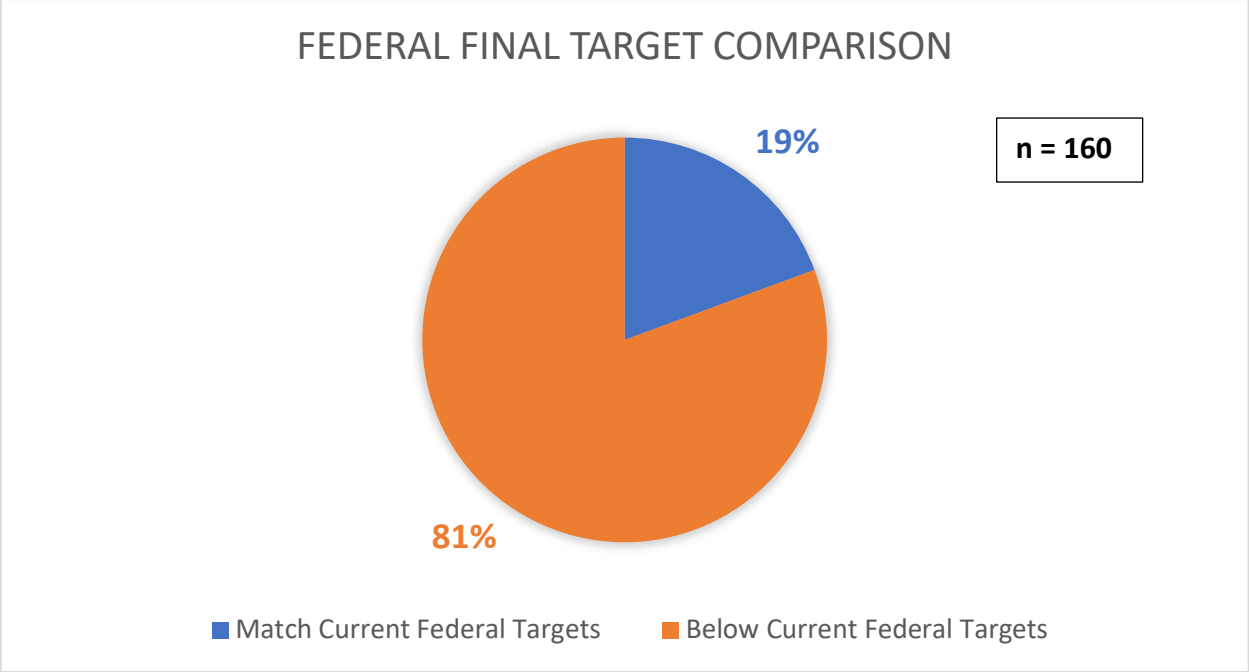


Figure 10: Federal Interim Target Comparison

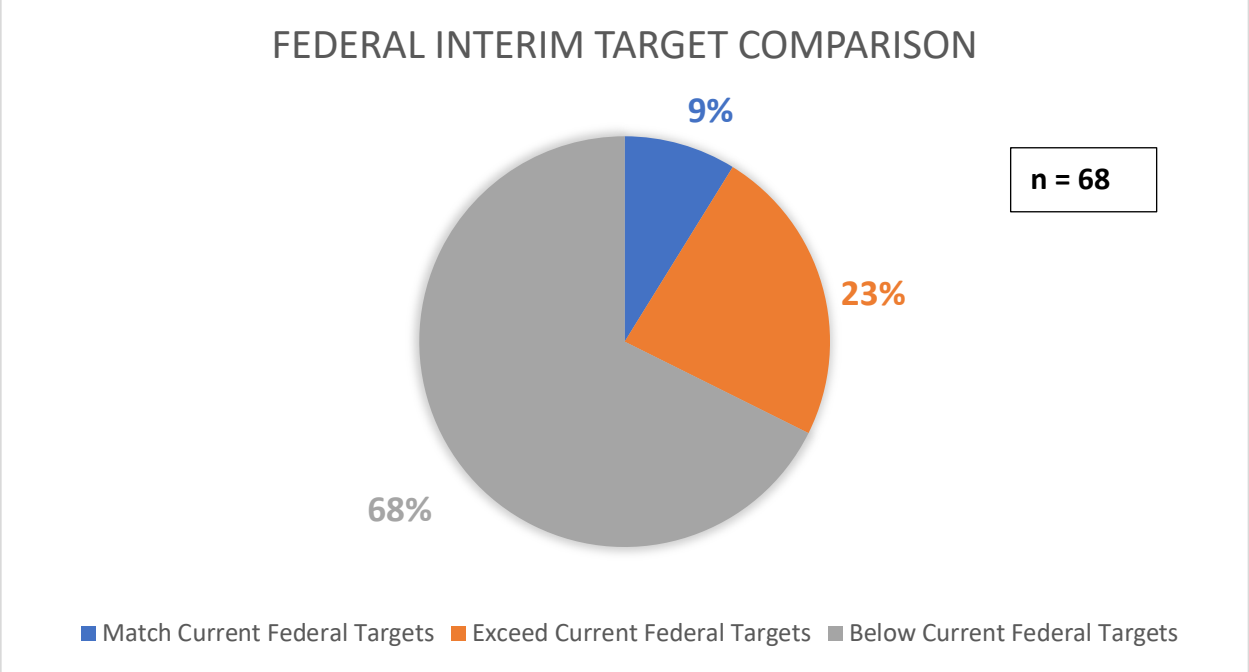


Figure 11: Variation in Final Target Years

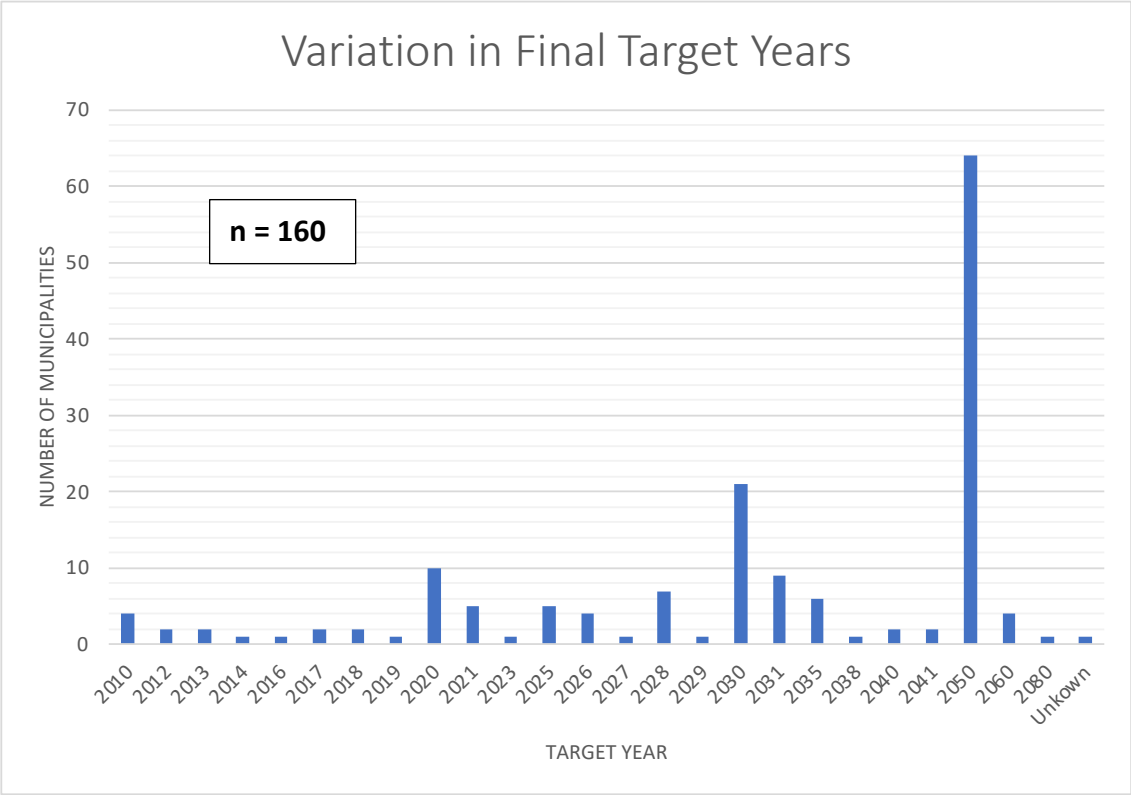
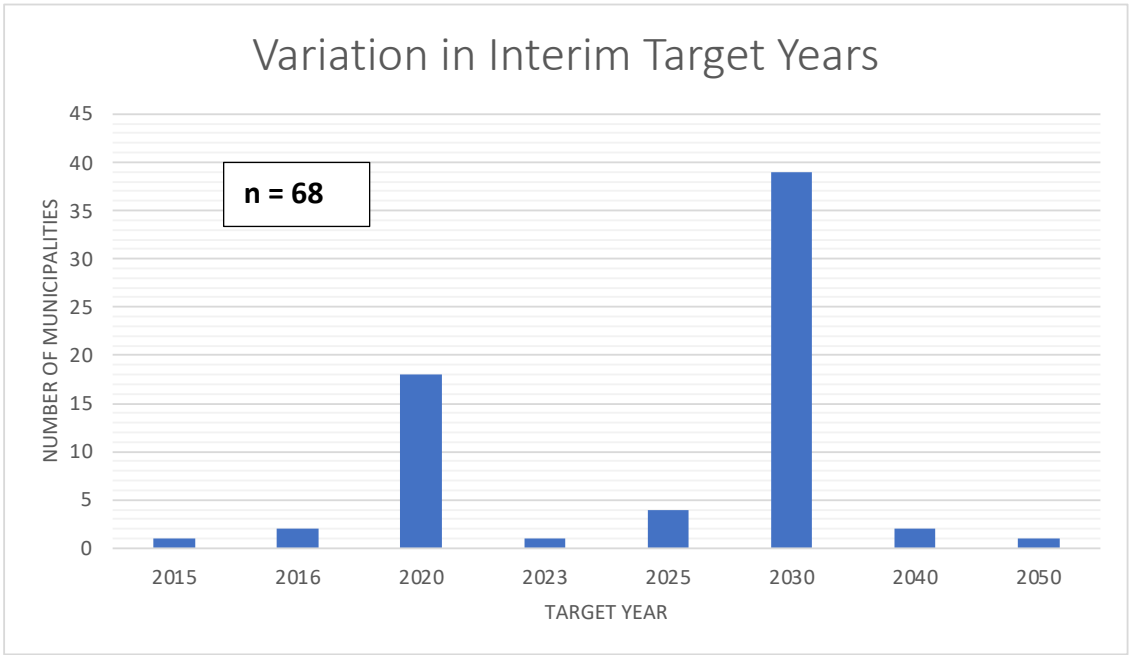


Figure 12: Variation in Interim Target Years



Municipalities generally set a final emissions reduction target and connect it to a specific year. Additionally, some municipalities choose to also include an interim target for a year between the baseline year and the final year. A significant amount of variation in the targets and target years exists amongst the municipalities in this sample. By reviewing these details, it shows how municipal and federal targets compare.

A similar number of municipalities have set targets identical to each of the three prominent Canadian federal targets. 31 municipalities (19.38% of the sample) have targets of 100% emissions reductions or net-zero, 29 municipalities (18.13% of the sample) have targets of 80% emissions reductions, and 27 municipalities (16.88% of the sample) have targets of only 6% emissions reductions. Most municipalities had targets between 6% and 80%, indicating that they are working towards targets that are more ambitious than the first federal targets, but not yet strong enough to meet current federal targets. Very few municipalities have targets of less than 6% (7 municipalities), or between 80% and 99% (5 municipalities), and only 2 municipalities had targets where emissions increased. The full details can be viewed in Table 9.

A total of 68 municipalities also included interim targets. Of those municipalities, 29.41% had targets less than 30% emissions reductions. Roughly 14.71% of the sample included interim targets of exactly 30%, 23.53% had interim targets between 31% and 39%, 8.82% had targets between 40% and 45%, and 23.53% had targets that were higher than 45%. No municipalities had either increasing targets or targets of 100% emissions reductions or net-zero.

When compared with federal targets, there were 31 municipalities, or 19.38% of the sample, that matched or surpassed the final federal target of reaching net-zero emissions by 2050. Of the municipalities that included interim targets, 32.36% matched or surpassed the federal interim target of reducing emissions by 40%-45% by 2030, with 23.53% of the 68 municipalities setting targets that were more ambitious than the federal targets. It is also worth noting that many municipalities have targets that match or surpass Canada's previous emissions reduction targets of 30% by 2030 and 80% by 2050. A total of 34 and 26 additional municipalities had targets that match or exceed these final and interim targets but do not reach the updated federal targets of net-zero by 2050 and 40-45% by 2030, respectively. Many of those municipalities mentioned setting targets in accordance with the federal targets. Therefore, it is possible that these municipalities have updated their targets, but the information is simply not reflected in the available reports yet.

Several, but not all, of the municipalities in the sample use the same final and interim target years as the federal targets. Some municipalities have not updated their targets, and thus have final and interim target years that have already passed. The earliest final target year in the sample was 2010, while the earliest interim target year was 2015. In total, 29 final target years and 21 interim target years from the sample have already passed. Concurrently, some municipalities used target years that are further in the future than federal targets. The latest final target year in the sample was 2080, while the latest interim target year was 2050. A total of 40% of the municipalities used the year 2050 for their final emissions reduction target, while 57.35% of the municipalities to include an interim target used the year 2030. There was a significant

amount of variation in the years used for both final and interim targets. However, this was much more predominant in the final targets.

Municipalities used 25 different final target years, and only eight different interim target years. This showcases the disparity in climate action timelines between municipalities which could be a symptom of municipalities having different baseline years, or varying capacities for updating their climate action targets and plans.

The average timeframe between baseline year and final target year was roughly 29 years, although there was a good amount of variation in these numbers, with the lowest number of years between baseline and final target being 5 years, and the highest number being 69 years. The average final target year was approximately 2037 with a standard deviation of 13.93 and a variance of 193.92, indicating significant variability in the target years in the sample. Further, the closest final target years to 2050 were 2041 and 2060, which are both far enough away from 2050 to produce significantly different results. The average interim target year was roughly 2027, three years before the federal interim target. The standard deviation and variance for the interim target years were much lower, at 6.13 and 37.57 respectively. These results indicate less variability in interim target years, as was likely to be expected given the reduced timeframe between now and the federal interim target year. However, as with the final target year results, the closest interim target years to 2030 were 2025 and 2040, pointing again to the potential for very different results if municipalities don't align with federal target years.

4.5 Monitoring Systems

Out of the 205 municipalities that make up the total sample, a smaller subset has reached milestone 4 or 5 in the PCP program, signalling that they are at a stage in their climate action process where they are monitoring climate action progress and reporting results. A total of 73 municipalities are at the phase of monitoring a corporate plan, and 65 are monitoring a community plan, but given that some are doing both, there are a total of 80 municipalities in this sub-set. Table 10 provides a summary of the municipalities included in the monitoring sample.

Table 10: Summary of Municipalities in the Monitoring Section

MONITORING SAMPLE		
Group	**Number of Municipalities**	**Percentage of the Sample**
Monitoring a corporate plan only	15	18.75%
Monitoring a community plan only	7	8.75%
Monitoring both types of plans	58	72.5%
Total municipalities in the sample	80	100%

Table 11 summarizes the monitoring system variables in the evaluation framework introduced in chapter 2, along with frequency counts of the number of municipalities that coincide with each variable for both corporate and community plan monitoring. The table is split into four categories derived from the work of Klostermann et al. (2018). These categories include the system of interest, indicators, the responsibility of monitoring, and monitoring and evaluation procedures.

Table 11: Monitoring Systems Results

SYSTEM OF INTEREST				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of Sample**	**Number of Municipalities**	**Percentage of Sample**
Sectors identified	72	98.63%	64	98.46%
Sectors not identified	1	1.37%	1	1.54%
Actions identified	73	100%	64	98.46%
Actions not identified	0	0%	1	1.54%
Timeline for actions identified	71	97.26%	63	96.92%
Timeline for actions not identified	2	2.74%	2	3.08%
Geographic region is clear	63	86.30%	55	84.62%
Geographic region is unclear	10	13.70%	10	15.38%
INDICATORS				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of Sample**	**Number of Municipalities**	**Percentage of Sample**
Includes updated inventory	65	89.04%	37	56.92%
No updated inventory	8	10.96%	28	43.08%
Includes project-based results	57	78.08%	35	53.84%
No project-based results	16	21.92%	30	46.16%
Includes process-based indicators	69	94.52%	62	95.38%
No process-based indicators	4	5.48%	3	4.62%
Includes output indicators	70	95.89%	60	92.31%
No output indicators	3	4.11%	5	7.69%
Includes outcome indicators	66	90.41%	44	67.69%
No outcome indicators	7	9.59%	21	32.31%
Includes other indicators	7	9.59%	6	9.23%
RESPONSIBILITY OF MONITORING				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of Sample**	**Number of Municipalities**	**Percentage of Sample**
Staff responsible	57	78.08%	46	70.77%
Council responsible	22	30.14%	14	21.54%
Community-wide entity responsible	9	12.33%	16	24.62%

Other responsible	4	5.48%	5	7.69%
MONITORING & EVALUATION PROCEDURES				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of Sample**	**Number of Municipalities**	**Percentage of Sample**
Data collection and management procedures included	39	53.42%	31	47.69%
Data collection and management procedures not included	34	46.58%	34	52.31%
Data analysis procedures included	34	46.58%	26	40%
Data analysis procedures not included	39	53.42%	39	60%
Reporting procedures included	61	83.56%	53	81.54%
Reporting procedures not included	12	16.44%	12	18.46%
Standardized monitoring framework used	34	46.58%	34	52.31%
Standardized monitoring framework not used	39	53.42%	31	47.69%
Stakeholder engagement	44	60.27%	35	53.85%
No stakeholder engagement	29	39.73%	30	46.15%
Peer review	3	4.11%	3	4.62%
No peer review	70	95.89%	62	95.38%
Plan revision mentioned	26	35.62%	17	26.15%
Plan revision not mentioned	47	64.38%	48	73.85%
Monitoring system revision mentioned	2	2.74%	0	0%
Monitoring system revision not mentioned	71	97.26%	65	100%

Most municipalities provided ample information on the system of interest. With all municipalities in this sample at a stage in their climate action process where they have already created an emissions inventory, set GHG emissions reduction targets, and created a climate action plan, it makes sense that the system they are monitoring would be well defined. On the

corporate side, 98.63% of the sample identified the sectors included in the monitoring process, 100% recognized the actions being monitored, 97.26% provided details on the timeline for actions, and 86.3% outlined the geographic region for which the monitoring would take place. Conversely, in the community sample, 98.46% of municipalities identified the sectors included in the monitoring process and recognized the actions being monitored, 96.92% provided details on the timeline for actions, and 84.62% outlined the geographic region for which the monitoring would take place. Since the documents reviewed in the analysis only included reports of operational monitoring practices and omitted planning documents before implementation began, it is likely that the system of interest is further defined in earlier documents of the planning process.

Different types of indicators were well represented across the corporate and community samples. However, the corporate monitoring systems seemed to integrate a more all-inclusive suite of indicators than the community monitoring systems. While a relatively equal number of municipalities in the corporate and community samples included process-based and output indicators, the use of other types of indicators varied between the corporate and community samples. Roughly 95% of municipalities in both groups included process-based indicators, while 95.89% of the corporate sample and 92.31% of the community sample included output indicators. Municipalities in the corporate sample generally included an updated inventory, specific action results, and outcome indicators more than municipalities in the community sample. Updated inventories were included in 89.04% of the corporate municipalities, with action results in 78.08% and outcome indicators in 90.41%. The community sample included updated inventories in 56.92% of municipalities, specific action results in 53.84%, and outcome

indicators in 67.69%. Finally, around 9% of corporate and community monitoring systems included other indicators.

The responsibility of monitoring was most frequently identified as a role for municipal staff, with staff referenced as being responsible in just over 78% of the corporate sample and 70.77% of the community sample. Council was recognized as responsible for 30.14% and 21.54% of corporate and community monitoring systems, respectively. A community entity was responsible in 12.33% of the corporate sample and 24.62% of the community sample. Lastly, 5.48% of the corporate sample and 7.69% of the community sample referenced other parties for monitoring responsibility.

Even though 73 municipalities in the corporate sample and 65 municipalities in the community sample provided information on their monitoring systems, a much smaller proportion of both samples offered detailed information on the procedures involved in the monitoring and evaluation process. In total, 53.42% of the corporate sample and 47.69% of the community sample provided details on their data collection and management procedures, and 45.58% of the corporate sample and 40% of the community sample included details on their data analysis procedures. Amongst the municipalities that integrated some of these details, many of them limited the information provided to emissions inventory collection and analysis details rather than including the methods tailored to measuring specific action progress and impact. Information on reporting procedures, however, was much more available across both samples, with over 80% of both samples including reporting procedure specifics.

Additional monitoring and evaluation procedure variables followed similar trends, while others were rarely found in both samples. For example, standardized monitoring frameworks were present in 46.58% of the corporate and 52.31% of the community municipalities. A large portion of these municipalities were from British Columbia and used their Climate Action Revenue Incentive Public (CARIP) report as their monitoring framework. Slightly higher percentages of 60.27% corporate and 53.85% community municipalities included details on how stakeholder engagement was used in the monitoring process. Meanwhile, only 35.62% of the corporate sample and 26.15% of the community sample presented information on plan revision, and almost no municipalities in either sample mentioned peer review or revision of the monitoring system.

4.6 Reporting Procedures

The same sample analyzed in the monitoring systems section was also used in the reporting procedures section, given that these municipalities are at similar stages of their implementation of climate action. Table 12 summarizes the municipalities in the reporting sample.

Table 12: Summary of Municipalities in the Reporting Section

REPORTING SAMPLE		
	Number of Municipalities	**Percentage of the Sample**
Reporting – Corporate only	15	18.75%
Reporting – Community only	7	8.75%
Reporting - Both	58	72.5%
Total municipalities in the sample	80	100%
Total municipalities reviewed for CDP and GCoM Reporting	205	N/A

Table 13 summarizes the reporting procedure variables in the evaluation framework introduced in Chapter 2, along with frequency counts of the number of municipalities that coincide with each variable for both corporate and community plan reporting. The table is split into three categories. These categories include reporting and quality features, standardization, and reporting channels. Table 14 summarizes the municipalities that are reporting to CDP or GCoM. All 205 municipalities included in the study were included in the CDP and GCoM sub-set.

Table 13: Reporting Procedures Results

REPORTING QUALITY FEATURES				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of Sample**	**Number of Municipalities**	**Percentage of Sample**
Reporting Timing				
Timing of reporting included	50	68.49%	41	63.08%
Timing of reporting not included	23	31.51%	24	36.92%
Annual reporting	47	64.38%	38	58.46%
Reporting every 2-5 years	3	4.12%	3	4.62%
Verification of Reporting Contents				
Reporting details verified	1	1.37%	2	3.08%
Reporting details not verified	72	98.63%	63	96.92%
STANDARDIZATION				
	Corporate		**Community**	
Variable	**Number of Municipalities**	**Percentage of Sample**	**Number of Municipalities**	**Percentage of Sample**
Standardized reporting included	45	61.64%	40	61.54%
No standardized reporting	28	38.36%	25	38.46%
BC's CARIP Program Reporting	26	35.62%	28	43.08%
REPORTING CHANNELS				
	Corporate		**Community**	

Variable	Number of Municipalities	Percentage of Sample	Number of Municipalities	Percentage of Sample
Reporting channels identified	63	86.30%	55	84.62%
Reporting channels not identified	10	13.70%	10	15.38%
Own channels used	45	61.64%	38	58.46%
Third-party channels used	50	68.49%	45	69.23%
Social media used	10	13.70%	11	16.92%

Table 14: CDP and GCoM Reporting Results

CDP and GCoM REPORTING	
CDP and GCoM reporting are not split by corporate and community	
CDP reporting with data	24
CDP reporting with no data	14
GCoM reporting with data	19
GCoM reporting with no data	22
Municipalities that report to CDP & GCoM (regardless of data or not)	26

The two reporting quality variables identified had very different results in both samples. Details on the timing of reporting were included in 68.49% of the corporate sample and 63.08% of the community sample. Of the municipalities that included timing of reporting details, roughly 94% of the municipalities cited the use of annual reporting. The remaining 6% referenced reporting between every two and five years. The second reporting quality variable, reporting verification, was rarely found in both samples. Only one municipality in the corporate sample mentioned reporting verification details, and two municipalities in the community sample provided such information.

Most of the municipalities in the corporate and community sample identified some type of reporting channel, with 86.30% of the corporate sample and 84.62% of the community sample providing some information on reporting channels. Third-party channels were the most frequent reporting channel method identified in both samples, primarily due to the number of municipalities that report to a standardized platform. This translated to 68.49% of the corporate sample and 69.23% of the community sample. Own channels were referenced the next most, with 61.64% of the corporate sample and 58.46% of the community sample using this reporting channel to share information on their climate action progress. Finally, social media channels were used in a much smaller number of municipalities, with 13.7% of the corporate sample and 16.92% of the community sample referencing this reporting channel in their reports.

Standardization of reporting was evident in roughly 62% of both the corporate and community samples. These examples mainly were municipalities reporting to CDP, GCoM, or BC's CARIP program. In total, 35.62% of the corporate sample and 43.08% of the community sample reporting to the CARIP program. Since standardized platforms for reporting, such as CDP and the Global Covenant of Mayors, don't follow the same process as the PCP program, the entire sample of 205 municipalities was also considered when looking at these two platforms for reporting. In total, 24 reported data to CDP, 19 reported data to GCoM, and another 14 and 22 municipalities were part of the CDP and GCoM platforms, respectively, but had provided zero or limited data to the platforms. Several of the municipalities (26) report to both platforms, as they are ultimately not mutually exclusive programs.

4.7 Municipalities with Significant Emissions Reductions

Some municipalities are reporting higher levels of emissions reductions in their GHG inventories than others. Tables 15 and 16 offer summaries of the top 20 municipalities for corporate and community emissions reductions, respectively, which equates roughly to the top 10% for both samples. These municipalities have recorded the highest levels of total emissions reductions in comparison to their baseline year, measured in the percentage of emissions decreased. Furthermore, a list of these municipalities can be found in Appendix 4. A select grouping of variables from the measurement, monitoring, and reporting sections are also provided, along with some key information surrounding the emissions reduced and the municipality's description. However, in instances where the municipality has yet to provide information to the PCP program on milestone 4 or 5, the columns for the monitoring and reporting sections are filled with an "?" for unknown. The selected variables can be reviewed and compared to detect evident patterns amongst the municipalities with significant emissions reductions.

Table 15: Municipalities with Significant Corporate Emissions Reductions Results

Municipality	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Approximate Population (1000's)	20	13	11	400	80	2800	20	340	185	39	24	1020	233	195	58	159	217	631	17	34
Province	QC	QC	PE	ON	QC	ON	ON	ON	ON	PE	QC	ON	ON	ON	NB	ON	ON	BC	NB	AB
Year Joined PCP	2010	2021	2008	1994	2020	1994	2011	2007	2002	2002	2019	1997	1997	2000	2001	2009	2002	1995	2003	2003
% Reduction	82	77	71	65	61	61	58	50	46	39	39	37	36	35	34	33	33	33	30	29
Year Spread Between Inventories	10	10	14	10	10	16	11	20	27	8	6	16	10	19	20	7	16	18	21	23
% Reduction per year	8.2	7.7	5.1	6.5	6.1	3.8	5.3	2.5	1.7	4.9	6.5	2.3	3.6	1.9	1.7	4.8	2.1	1.8	1.4	1.3
Measurement Variables																				
Most Recent Inventory	2018	2019	2021	2017	2019	2020	2018	2021	2021	2021	2015	2020	2020	2019	2020	2014	2021	2008	2021	2019
Methodology	PCP	PCP, GPC, Other	PCP	GPC	PCP, GPC, Other	PCP, GPC	PCP	PCP	PCP	PCP	PCP	PCP, GPC	PCP	PCP	PCP	PCP	PCP	PCP, Other	PCP	PCP
Reporting Level	B	B	B	B+	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Includes Community Inventory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Scope Included	1,2	1,2	1,2	1,2,3	1,2	1,2,3	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2
Sectors Included	All	All except waste	All	All	All except waste	All	All	All except waste, water, and	All except waste, water, and	All	All	All	All	All	All	All except water and waste water	All except waste	All except water and waste water	All	All except waste

								waste water	waste water											
Monitoring Variables																				
Reached Milestone 4/5	Yes	No	No	No	No	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes
Updated Inventory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Project-based Results	Yes	?	?	?	?	Yes	?	?	No	?	No	Yes	Yes	Yes	Yes	Yes	?	Yes	?	Yes
Process Indicators	Yes	?	?	?	?	Yes	?	?	Yes	?	Yes	Yes	Yes	No	Yes	Yes	?	Yes	?	Yes
Output Indicators	No	?	?	?	?	Yes	?	?	Yes	?	No	Yes	Yes	Yes	Yes	Yes	?	Yes	?	Yes
Outcome Indicators	Yes	?	?	?	?	Yes	?	?	Yes	?	Yes	Yes	Yes	Yes	Yes	Yes	?	Yes	?	Yes
Staff Responsible	No	?	?	?	?	Yes	?	?	Yes	?	Yes	No	Yes	Yes	Yes	Yes	?	Yes	?	Yes
Council Responsible	No	?	?	?	?	Yes	?	?	Yes	?	No	No	Yes	Yes	Yes	No	?	No	?	No
Community-Wide Entity Responsible	No	?	?	?	?	No	?	?	No	?	No	No	No	No	No	No	?	Yes	?	No
Data Collection Procedures	Yes	?	?	?	?	Yes	?	?	No	?	Yes	No	Yes	Yes	Yes	Yes	?	Yes	?	No
Data Analysis Procedures	No	?	?	?	?	Yes	?	?	No	?	No	No	Yes	Yes	Yes	Yes	?	Yes	?	No
Reporting Procedures	Yes	?	?	?	?	Yes	?	?	Yes	?	Yes	No	Yes	Yes	Yes	Yes	?	Yes	?	No
Stakeholder Engagement	Yes	?	?	?	?	Yes	?	?	Yes	?	Yes	Yes	Yes	Yes	Yes	No	?	Yes	?	No
Plan Revision	No	?	?	?	?	Yes	?	?	No	?	No	No	Yes	Yes	No	Yes	?	No	?	Yes
Reporting Variables																				

Timing Details	No	?	?	?	?	Annual	?	?	Annual	?	No	No	Annual	No	Annual	5 years	?	No	?	Annual
Standardization	No	?	?	?	?	CDP & GCoM	?	?	CDP & GCoM	?	No	CDP & GCoM	CDP & GCoM	No	CDP & GCoM	No	N/A	CDP & GCoM	?	No
Own Channels	Yes	?	?	?	?	Yes	?	?	Yes	?	Yes	No	Yes	Yes	Yes	Yes	N/A	Yes	?	Yes
Third-party Channels	Yes	?	?	?	?	Yes	?	?	Yes	?	Yes	Yes	Yes	No	Yes	Yes	N/A	Yes	?	No
Social Media	Yes	?	?	?	?	Yes	?	?	No	?	Yes	No	No	No	No	Yes	N/A	No	?	No

4.7.1 Corporate Significant Emissions Reductions Themes

The municipalities with the most corporate emissions reductions varied in population size, with representatives from small (10,000-29999 population), medium (30,000-99,999 population), and large municipalities (100,000+ population). However, municipalities with large populations made up a bigger proportion of the sample, followed by small municipalities and medium municipalities, respectively. There were municipalities from several provinces in the group, including Alberta, British Columbia, New Brunswick, Ontario, Prince Edward Island, and Quebec. However, half of the municipalities (10 total) were from Ontario, likely in part due to the province-wide phase out of coal as an energy source. Another four of the municipalities were from Quebec, with three being in the top five of emissions reductions. Most municipalities have a spread between the baseline and most recent inventory of ten years or more, indicating that this group has been aware of their emissions and likely working towards reducing them for over a decade. Furthermore, the smallest spread in years between the baseline and most recent inventory amongst this group was six years. Ultimately, most of these municipalities have seen a slow process of emissions reductions over several years, although the top five emissions reducers averaged over 5% of emissions reductions per year.

While there were no glaring measurement variable patterns amongst the top corporate emissions reducers that differed from the entire sample, several patterns were evident in the monitoring and reporting variables. However, of the 20 top corporate emissions reducers, only 11 are acknowledged for reaching milestone 4 or 5 in the PCP milestone process, shrinking the sample of municipalities with available monitoring, and reporting data considerably.

Several key monitoring variables were identified at a higher rate in the municipalities with elevated emissions reductions compared to the general sample. For example, 100% of the municipalities included outcome indicators, measuring the effectiveness of mitigation actions, compared to 90% of the municipalities in the entire sample. Furthermore, council members were identified as responsible for monitoring in 45% of the high-reducing municipalities compared to 30% for the whole sample. Data collection procedures were detailed in 73% of the smaller sample versus 53% of the total population. Stakeholder engagement was mentioned as part of the monitoring process in 82% of the high-reducing municipalities compared to 60% of the whole group. Various other monitoring variables were apparent slightly more in the high-reducing municipalities, while others were included less frequently than in the larger group of municipalities.

Other trends are evident in the reporting procedures of municipalities with more considerable emissions reductions. 55% of these municipalities are part of the CDP and GCoM reporting platforms, compared to 19% and 20% of the 205 municipalities in this study. Furthermore, these municipalities utilized all reporting channels more than the general population. 91%, 82%, and 36% of these municipalities mentioned using their own channels, third-party channels, and social media to disseminate information on their climate action progress to the public. On the other hand, 60% of the larger population of municipalities used their own channels for reporting, 68% used third-party channels, and only 14% used social media. Evidently, the municipalities with more emissions reductions seem to be involved in standardized reporting and utilize more reporting channels to share climate action information. Whether this change in reporting procedures is a result of recognized emissions reductions or a

catalyst for the emissions reductions remains unclear. Either way, there are several recognizable patterns amongst the example municipalities that could be explored on a deeper level.

Table 16: Municipalities with Significant Community Emissions Reductions Results

Municipality	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Approximate Population (1000's)	159	19	2800	217	20	18	162	183	249	108	32	17	17	537	12	401	339	20	125	18
Province	ON	ON	ON	ON	NL	NB	ON	ON	BC	ON	ON	NB	ON	ON	BC	ON	ON	AB	BC	BC
Year Joined PCP	2009	2011	1994	2002	2006	2005	1997	2002	1994	1997	2004	2003	2017	1996	2017	1994	2007	1997	1996	2019
% Reduction	61	47	43	42	41	38	38	36	31	29	28	27	24	24	22	22	21	19	17	16
Year Spread Between Inventories	8	11	30	15	10	20	26	27	15	13	14	21	1	5	9	30	10	6	13	13
% Reduction per year	7.6	4.3	1.5	2.8	4.1	1.9	1.5	1.4	2.1	2.2	2	1.3	24	4.7	2.4	0.7	2.1	3.2	1.3	1.3
Measurement Variables																				
Most Recent Inventory	2015	2018	2020	2020	2018	2019	2016	2021	1999	2018	2017	2021	2017	2011	2016	2020	2011	2021	2020	2020
Methodology	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC	PCP, GPC, Other	PCP, GPC	PCP, GPC	GPC	PCP, GPC	PCP, GPC	PCP, GPC
Reporting Level	B	B	B+	B	B	B	B+	B	B	B	B	B+	B	B	B	B	B+	B	B+	B+
Includes Corporate Inventory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Scope Included	1,2	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2	1,2	1,2	1,2,3	1,2	1,2	1,2	1,2	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Sectors Included	SE, T, W	SE, T, W	SE, T, W	SE, T, W	SE, T, W	SE, T, W	SE, T, W, IPPU	SE, T	SE, T, W	SE, T, W	SE, T, W	SE, T, W, AFOLU	SE, T	SE, T, W, AFOLU	SE, T, W	SE, T, W	SE, T, W	SE, T, W	SE, T, W, IPPU, AFOLU	SE, T, W, IPPU, AFOLU
Monitoring Variables																				

Reached Milestone 4/5	No	No	Yes	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	Yes	No
Updated Inventory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Action Results	?	?	Yes	?	?	?	Yes	No	Yes	Yes	?	?	?	?	?	?	?	?	Yes	?
Process Indicators	?	?	Yes	?	?	?	Yes	Yes	Yes	Yes	?	?	?	?	?	?	?	?	Yes	?
Output Indicators	?	?	Yes	?	?	?	Yes	Yes	Yes	Yes	?	?	?	?	?	?	?	?	Yes	?
Outcome Indicators	?	?	Yes	?	?	?	Yes	Yes	Yes	Yes	?	?	?	?	?	?	?	?	Yes	?
Staff Responsible	?	?	Yes	?	?	?	Yes	Yes	Yes	Yes	?	?	?	?	?	?	?	?	No	?
Council Responsible	?	?	Yes	?	?	?	Yes	Yes	No	Yes	?	?	?	?	?	?	?	?	No	?
Community-Wide Entity Responsible	?	?	No	?	?	?	Yes	Yes	No	Yes	?	?	?	?	?	?	?	?	Yes	?
Data Collection Procedures	?	?	Yes	?	?	?	No	No	No	Yes	?	?	?	?	?	?	?	?	No	?
Data Analysis Procedures	?	?	Yes	?	?	?	No	No	No	Yes	?	?	?	?	?	?	?	?	No	?
Reporting Procedures	?	?	Yes	?	?	?	Yes	Yes	Yes	Yes	?	?	?	?	?	?	?	?	Yes	?
Stakeholder Engagement	?	?	Yes	?	?	?	Yes	Yes	No	Yes	?	?	?	?	?	?	?	?	Yes	?
Plan Revision	?	?	Yes	?	?	?	Yes	No	No	No	?	?	?	?	?	?	?	?	Yes	?
Reporting Variables																				
Timing Details	?	?	Annual	?	?	?	No	Annual	Annual	Annual	?	?	?	?	?	?	?	?	Annual	?
Standardization	?	?	CDP &	?	?	?	CDP	CDP &	CARIP	CDP &	?	?	?	?	?	?	?	?	CDP &	?

			GCo M					GCo M		GCo M									GCo M	
Own Channels	?	?	Yes	?	?	?	Yes	Yes	Yes	No	?	?	?	?	?	?	?	?	Yes	?
Third-party Channels	?	?	Yes	?	?	?	Yes	Yes	Yes	Yes	?	?	?	?	?	?	?	?	Yes	?
Social Media	?	?	Yes	?	?	?	No	No	No	No	?	?	?	?	?	?	?	?	Yes	?

4.7.2 Community Significant Emissions Reductions Themes

The municipalities with the most significant sum of community emissions reductions also varied in population size, with representatives from small (10,000-29,999 population), medium (30,000-99,999 population), and large municipalities (100,000+ population). However, as in the corporate sample, large municipalities were most present in the sample, followed by small and medium municipalities. Once again, the group consisted of municipalities from several different provinces, including Alberta, British Columbia, New Brunswick, Newfoundland, and Ontario. Most municipalities predictably came from Ontario (12 total), likely due to the phasing out of coal and the sheer number of municipalities in the province. British Columbia had the second most municipalities represented in the community sample (4 total), mirroring the presence that Quebec municipalities had in the corporate sample. Most municipalities with the highest community emissions reductions also have a spread between the baseline and most recent inventory of 10 years or more. This information demonstrates that these municipalities have been aware of their community emissions and have been working towards reducing them for over a decade.

In the corporate sample, there were no apparent patterns in the measurement variables. However, in the municipalities with the highest community emissions reductions, a more significant percentage of 60% of the municipalities included scope 3 emissions in their inventories, demonstrating an increased effort to include all relevant emissions within the municipal boundaries. The municipalities with the highest community emissions reductions also had several other noticeable patterns in select monitoring and reporting variables. However, like in the corporate sample, fewer municipalities were recognized as reaching milestones 4 or 5. Out

of the top 20 municipalities in the community sample, only six have reached PCP milestone 4 or 5 and, thus, shared information on their monitoring systems and reporting procedures. Even with the smaller sample size, it is still possible to see clear patterns in the data.

Several details surrounding the monitoring systems in the municipalities with the highest community emissions reductions were more prominent than in the larger sample. 83% of the municipalities with higher emissions reductions included project-based results in their monitoring systems compared to 54% of the larger group. Additionally, process, output, and outcome indicators were evident in all 6 of the smaller sample of high emissions reducers, compared to 95%, 92%, and 68%, respectively, in the entire population. Furthermore, all three potential groups that could be responsible for monitoring climate action progress were identified as being responsible at a much higher rate in the municipalities with higher emissions reductions. In total, 83%, compared to 71%, mentioned staff being responsible, 67%, compared to 22%, cited council representatives as being responsible, and 67% versus 25% mentioned a community-wide entity being responsible for monitoring systems. As in the corporate sample, stakeholder engagement was also referenced in a much greater percentage of the community high emissions reducers. Finally, details surrounding the revision of the climate action plan were included in 50% of the municipalities with higher emissions reductions, compared to only 26% of the entire population. Various other monitoring variables were identified slightly more in the high-reducing municipalities, while others were included less frequently than in the whole sample.

The municipalities with higher community emissions reductions also showed similar reporting variable trends found in the municipalities with the highest corporate emissions

reductions, with an increase in the use of standardized reporting and various reporting channels. The sample of municipalities with the highest community emissions reductions also indicated the use of annual reporting in 83% of municipalities compared to 58% in the entire sample. Standardized reporting was used in 100% of the smaller sample compared to 62% in the larger group, with 83% of the highest emissions reducers reporting to CDP and 67% reporting to GCoM, compared to 19% and 20%, respectively. Own channels, third-party channels, and social media channels were used by 83%, 100%, and 33% of the municipalities with the highest community emissions reductions compared to 58%, 69%, and 17%, correspondingly, in the entire sample. Several parallel trends exist in the corporate and community samples, with some additional trends emerging in the community sample. Further investigation into such trends could strengthen the understanding of such trends and the causes behind them. Additionally, studies in the future could further explore and compare the trends in municipalities with high emissions reductions to the trends evident in municipalities struggling to reduce emissions.

4.8 Change in Measurement, Monitoring, and Reporting over Time

The PCP program tracks the number of municipalities that achieve milestones each year. Table 17 summarizes this information from 2014 to 2022 for all municipalities included in this study, to showcase the progression of municipalities that are measuring their GHG emissions and monitoring and reporting on their climate action progress. Figures 13 and 14 transfer the data to a visual format to easily view the evident trends. By looking at the trends of the last decade, emerging patterns can be determined. Unfortunately, due to a lack of data availability, reliable information was not available for the years prior to 2014.

Table 17: Change in Measurement, Monitoring, and Reporting Over Time Results

	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
CORPORATE										
Corporate Milestone 1 Approvals	2	5	10	10	18	19	13	18	11	**106**
Corporate Milestone 2 Approvals	5	6	4	11	9	16	9	17	4	**81**
Corporate Milestone 3 Approvals	4	5	7	9	11	16	6	18	3	**79**
Corporate Milestone 4 Approvals	9	5	6	4	8	4	2	5	6	**49**
Corporate Milestone 5 Approvals	3	7	5	4	1	3	1	3	1	**28**
COMMUNITY										
Community Milestone 1 Approvals	6	4	10	6	21	14	15	16	7	**99**
Community Milestone 2 Approvals	8	6	5	10	17	15	9	15	4	**89**
Community Milestone 3 Approvals	7	5	7	10	15	16	7	16	3	**86**
Community Milestone 4 Approvals	5	1	5	13	11	6	2	5	2	**50**
Community Milestone 5 Approvals	3	5	3	9	1	2	1	4	0	**28**

Figure 13: Corporate Milestone Approvals Over Time

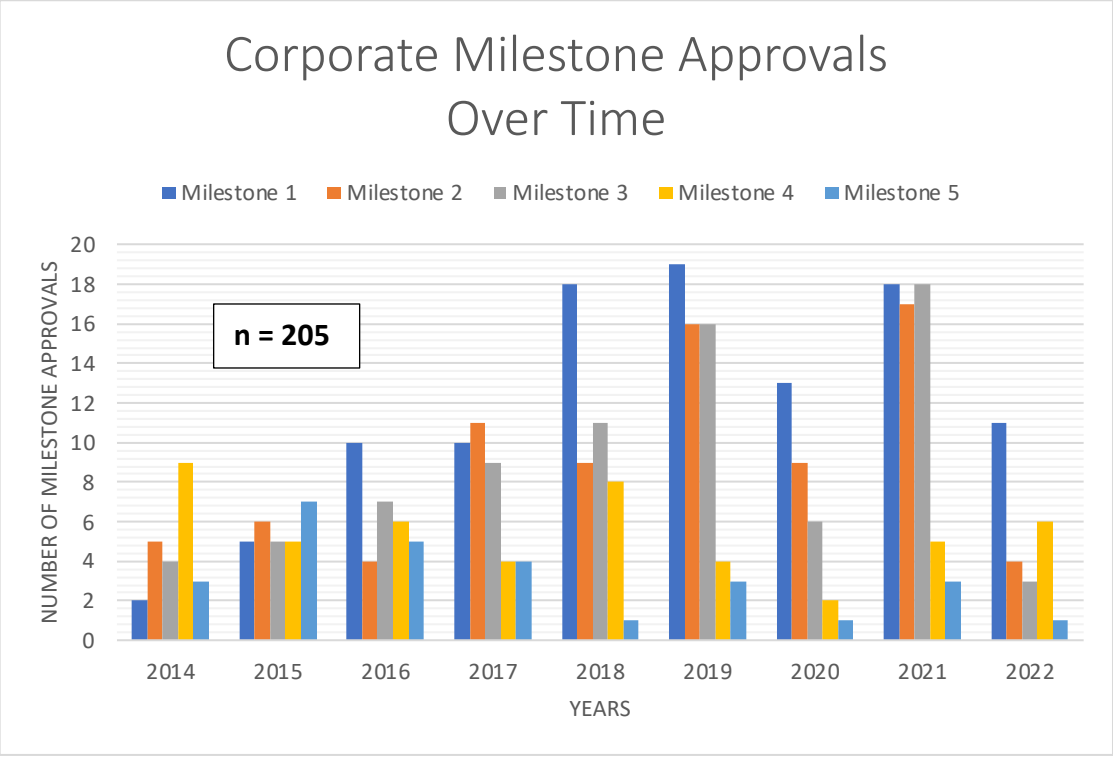
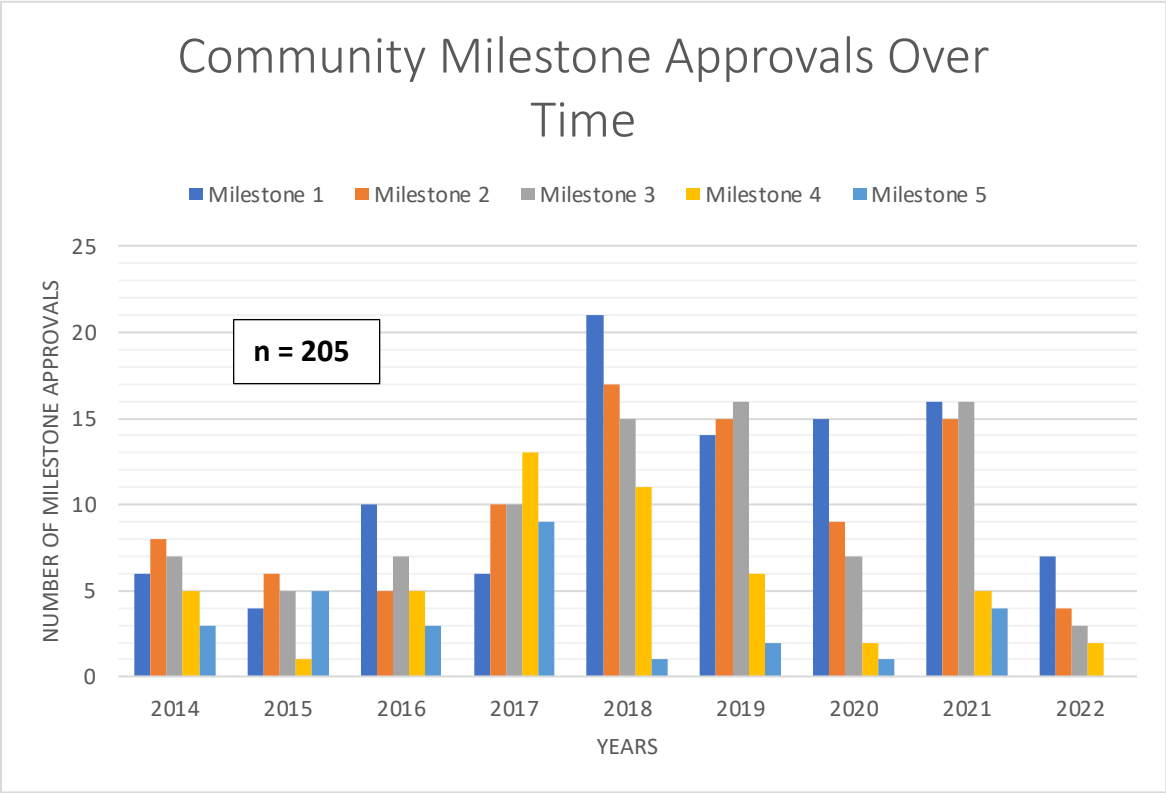


Figure 14: Community Milestone Approvals Over Time



4.8.1 Corporate Milestone Trends Over Time

Over the last decade, a sizeable number of municipalities have entered, and are progressing through, the corporate milestone process. Since 2014, the number of municipalities to complete milestones 1, 2, or 3 has been on an upward trend, with the most milestone 1 achievements coming in 2019 and the most milestone 2 and 3 achievements happening in 2021. The apparent advancement of municipalities through these stages of the milestone process suggests that many municipalities are beginning to measure their GHG emissions, set GHG emissions reduction targets, and create climate action plans. For example, since 2018, 79 municipalities have conducted a GHG inventory, 55 have set emissions reduction targets, and 54 have developed a climate action plan. With that said, the number of milestones 1, 2, and 3

achievements declined in 2022, potentially indicating a deceleration in the growth of municipalities beginning their climate action journeys.

The number of municipalities achieving corporate milestones 4 and 5, which represent the implementation, monitoring, and reporting of climate action, do not follow the same upward trend of the first three milestones. From 2014 onward, fewer municipalities are completing milestones 4 and 5. However, the decrease in these milestone completions could result from the pioneer municipalities of the PCP program already achieving these milestones and the new entrants to the program not yet being at a stage to implement, monitor, and report on their climate action. With a large influx of municipalities completing milestones 1, 2, or 3 between 2018 and 2022, there could be a surge of municipalities in the coming years to achieve milestones 4 and 5. Alternatively, it may be that leading municipalities are opting out of the PCP reporting and moving to GCoM and CDP instead, given the results of the 20 leading municipalities.

4.8.2 Community Milestone Trends Over Time

The trends of community milestone completion follow a similar pattern to corporate milestone achievements. Again, the number of milestones 1, 2, and 3 completions grew over the last decade, with 73 milestone 1 approvals, 60 milestone 2 approvals, and 57 milestone 3 approvals happening in the last five years. While a slightly smaller number of municipalities completed community milestone 1 than corporate milestone 1, more municipalities achieved community milestones 2 and 3 than corporate milestones 2 and 3. Furthermore, the number of municipalities to reach community milestones 1, 2, or 3 reduced in 2022, as was the case with the corporate milestones.

Community milestone 4 and 5 approvals followed a slightly different trend than the corporate milestone approvals. Instead of indicating a decline in the number of milestones achieved from 2014 to 2022, community milestones 4 and 5 achievements seemed to peak between 2017 and 2019, portraying an advancing pattern of climate action implementation, monitoring, and reporting before a stark drop in the milestones achieved starting in 2020. This timeline coincides with the beginning of the COVID-19 pandemic. It would be interesting to explore further if there is a connection between the two events. Based on the progression of municipalities through the community milestone process, several municipalities should be getting ready to begin milestones 4 and 5 and start implementing, monitoring, and reporting on their climate action plans.

4.8.3 Holistic View of Milestone Trends Over Time

Even though municipalities are showing success in moving through the different stages, or milestones, of climate action, the largest number of milestone completions was for milestone 1. Understandably, the number of municipalities that have achieved the subsequent corporate and community milestones decreases as the milestone number increases. However, considering that a large proportion of Canadian municipalities have now completed an emissions inventory, agreed upon an emissions reduction target, and constructed a climate action plan, the total municipalities to enter the next phase of climate action is bound to rise in the coming years. With numerous municipalities entering the stage of implementing, monitoring, and reporting on their climate action, the continual support to enhance such practices will be of great importance to assist municipalities in reaching their local climate targets and ultimately driving national emissions reductions through Canada's municipalities.

Chapter 5.0 Discussion

Chapter 5 focuses on answering the research questions of this thesis through the review and synthesis of the empirical results compared to the existing knowledge in the field presented in the literature review. This comparison will place the findings from this thesis amongst the current literature and ultimately capture the significance of the empirical findings in the broader field of research.

5.1 Research Question 1: Measurement Practices

- What GHG emissions measurement practices are used to assess corporate and community wide GHG emissions?

The measurement of GHG emissions is commonly known as a GHG emissions inventory. The literature suggests that to conduct a proper inventory of GHG emissions, municipalities must have access to accurate, complete, and current data, and a detailed and standardized methodology for calculating emissions (Arioli et al., 2020; Mia et al., 2019). However, several studies specify that the inventory practices between municipalities are dissimilar, due to a lack of data availability and the use of inconsistent methodologies or protocols that prompt the use of various measurement practices (Arioli et al., 2020; Creutzig et al., 2019; Lombardi et al., 2017; Marlowe & Clarke, 2022; Martire et al., 2018). In Canada, many municipalities make use of resources supplied by the PCP program, including the PCP and GPC protocols, which contain detailed information and instructions for completing an emissions inventory (FCM & ICLEI, 2014a; Robinson & Gore, 2015; WRI et al., 2021).

This streamlined and somewhat standardized approach to GHG measurement points to the potential for somewhat different empirical findings in Canadian municipalities. As indicated in Table 18, and discussed in the following sections, this expectation seems to hold true, as several details in the empirical results differ from what was found in the literature.

Table 18: Measurement Discussion Summary

Variables	Empirical	Literature	Comments
Protocols & Methodology	Most municipalities use either the PCP or GPC protocol to calculate their GHG inventories. However, a smaller portion of the municipalities reference the use of other protocols or methodologies.	There is a noticeable amount of variation between inventory protocols and methodologies used in municipalities. However, in Canada many municipalities are members of the PCP program and use the PCP and GPC protocols.	**Validate**
Reporting Levels	In the corporate sample, almost all municipalities use the equivalent of BASIC level reporting. However, in the community sample over 26% of the municipalities include some aspect of BASIC+ level reporting.	BASIC level reporting is more widely used than BASIC+ level reporting due to the complexity differences. Some leading municipalities are beginning to incorporate BASIC+ level aspects of reporting into their inventory processes.	**Validate / Extend –** While the literature points to some leading municipalities incorporating BASIC+ level aspects of reporting in their inventory processes, the empirical results indicate a trend toward more widespread use of BASIC+ reporting.
Corporate & Community Inventory	There were slightly more corporate than community inventories conducted in the sample. The difference, however, was minimal.	Two types of inventories exist: corporate and community. Municipalities generally conduct a corporate inventory before attempting a community inventory, due to the complexity level and control over emission sources.	**Partially Validate –** The literature suggests that corporate inventories are completed first, given their reduced level of complexity. While the results indicate a pattern that suggests this, there is only a minor difference in the number of corporate and community inventories in the sample, showing that municipalities are completing both types of

			inventories at similar rates.
Scope of Emissions	All corporate inventories included scope 1 and 2 emissions, with a small number of municipalities including scope 3 emissions. However, over 40% of community inventories included scope 3 emissions.	Scope 1 and 2 emissions are generally the primary focus of municipalities. Some leading municipalities are including scope 3 emissions in their inventories.	**Validate / Extend –** Scope 3 emissions were included in many community inventories.
Emissions Sources by Sector	Most corporate inventories included all main sectors. However, water and wastewater, and solid waste were included noticeably less than the other sectors. Most community inventories included all main sectors. A much smaller number of municipalities included Industrial Processes and Product Use (IPPU) or Agriculture, Forestry, and Other Land Use (AFOLU) in their community inventories.	The main corporate sectors include buildings, fleet, streetlights, water and wastewater, and solid waste. The main community sectors include stationary energy including electricity and buildings, transportation, and waste. IPPU and AFOLU may be included in some community inventories. However, it is likely that some municipalities may not have access to the relevant data to do so, and others may not have these sources of emissions within their boundaries.	**Partially Validate –** Water and wastewater, and solid waste are included much less than the other three main corporate sectors.
Consumption-based & Production-based Inventories	No municipalities used consumption-based inventory methodology for corporate inventories. One municipality used consumption-based methodology for their community inventory. However, all municipalities used production-based inventory methodology for both corporate and community inventories.	Most municipalities select production-based inventory methods over consumption-based methods.	**Validate**
Transparency	The level of detail provided by each municipality varied. However, in general, most municipalities provided details on the	There is a lack of transparency when it comes to the inclusion of data sources, emissions intensity coefficients, assumptions, and	**Not Found**

	transparency variables, including data sources, emissions coefficients, omissions, and assumptions.	omissions, in the inventory process.	
Carbon Sinks & Storage	A very small number of corporate municipalities included carbon sinks and storage in their inventory process. However, almost 10% of community inventories included carbon sinks and storage in some capacity.	While there are advantages to measuring carbon sinks and storage, most municipalities still focus on measuring carbon flows, rather than stocks.	**Validate / Extend –** The empirical results indicate that a growing number of municipalities are including some form of carbon sinks and storage in their community inventory processes.

5.1.1 Measurement Discussion

Protocols and Methodology

The literature shows that municipalities often utilize various methodologies to measure GHG emissions (Arioli et al., 2020; Ibrahim et al., 2012). For example, municipalities can use one of the widely accepted protocols, such as the GPC (WRI et al., 2021), a methodology explicitly tailored to that region (Arioli et al., 2020; Dahal & Niemelä, 2017), or an adapted, updated, upgraded, or alternative methodology, such as a protocol or framework being developed in the research community (Martire et al., 2018; Wiedmann et al., 2021). Municipalities may also choose to work with some combination of the above options. A lack of mandatory standardization of such protocols prompts the mixed use of various methodologies to measure GHG emissions (Arioli et al., 2020). However, many Canadian municipalities participate in the PCP program and thus conceivably use the PCP and GPC protocols.

The empirical results validate the literature. While some municipalities opted to use a methodology other than the PCP or GPC (15% of the corporate sample and 9% of the community sample), most used the PCP or GPC protocol. These results partially display the

variability in methodologies used and concurrently demonstrate the trend in Canadian municipalities to operationalize the methodology provided through the PCP program. Of course, all the data comes through the PCP program, and the 205 municipalities are about 30-40% of all municipalities that size, but the assumption is that the other 60-70% are not yet engaged in climate action.

Reporting Levels

In the GPC protocol, municipalities can choose two different levels of reporting, BASIC and BASIC+ (WRI et al., 2021). Linton et al. (2022) posit that leading municipalities are beginning to incorporate BASIC+ level reporting in their inventory processes. This finding is validated and extended in the empirical results. Roughly 26% of municipalities opted to include some aspect of BASIC+ level reporting in their community inventories, signifying that the ambition level of municipalities to cover more of their embodied emissions in their inventories is growing. This trend could be a result of the GPC recently emerging internationally as the accepted standard for community-based emissions inventory protocols. Additionally, these results may indicate that municipalities may be getting more familiar and comfortable with BASIC level inventory processes, allowing them to look for ways to expand their impact and improve their practices. While this trend is not as visible in the corporate inventories, that is likely a result of the BASIC and BASIC+ reporting levels being a product of the GPC, a community inventory methodology.

Corporate and Community Inventories

The literature introduces two types of GHG emissions inventories: corporate and community. As the more complicated and complete inventory process, covering all emissions within a municipality's boundaries, a community inventory is often attempted after a corporate inventory is achieved (Clarke & Ordonez-Ponce, 2017; FCM & ICLEI, 2014a, 2021a; Linton et al., 2022; Robinson & Gore, 2005). On the other hand, corporate inventories, measuring emissions that municipalities have direct control over (Clarke & Ordonez-Ponce, 2017; FCM & ICLEI, 2014a; Linton et al., 2022), involve less complicated processes. Thus, it would be unsurprising to see more corporate inventories completed than community inventories.

The difference in the number of municipalities that included corporate versus community inventories was trivial (190 vs. 188). Thus, the empirical results validate the findings in the literature. However, the results are not overwhelming. It would seem as though municipalities are becoming more advanced in their climate action journeys, moving past the measurement of emissions that can be directly controlled through corporate actions and delving into the emissions resulting from the larger community. Also, some municipalities only had a community inventory, indicating that they skipped the separate corporate one.

Scope of Emissions

The inclusion of scope 1, 2, and 3 emissions heavily relies on the level of reporting (Chen et al., 2019; WRI et al., 2021). Consequently, the trend in the scope of emissions naturally follows the same pattern found in the reporting level section. Once again, the finding by Linton et al. (2022) that some leading municipalities include BASIC+ and scope 3 emissions is

validated and extended, as roughly 41% of municipalities included scope 3 emissions in their community inventory. The literature also suggests that scope 1 and 2 emissions are the primary objective for municipalities, given the enhanced clarity in measuring and addressing these emissions (Chen et al., 2019; Linton et al., 2022; WRI et al., 2021). This notion is also validated in the empirical results, as virtually all municipalities measured scope 1 and 2 emissions in their corporate and community inventories. These patterns signify that municipalities may be increasing efforts toward measuring a broader scope of emissions. This trend could be explained by higher ambition amongst municipalities to cover more of the emissions within their boundaries, or because of increased familiarity with inventory methods or protocols, like the GPC, equipping municipalities with the tools and experience to expand their inventory efforts.

Emissions Sources by Sector

Municipalities generally focus on priority sectors of emissions when measuring and addressing their emissions. These sectors include electricity, buildings, transportation, and waste (Linton et al., 2022). The GPC, which focuses on community emissions, segments the sectors by buildings, transportation, waste, IPPU, and AFOLU (WRI et al., 2021). Concurrently, the PCP protocol, which focuses on corporate emissions, segments the sectors by buildings, fleet, streetlights, wastewater and sewage, and waste (FCM & ICLEI, 2014a). Since most PCP members follow the PCP and GPC protocols, it is probable that these sectors will be evident throughout the inventories collected in this thesis.

The empirical findings validate the literature on emissions sources by sector. For example, the main sectors of buildings, transportation, and waste, in community inventories, and

buildings, fleet, streetlights, wastewater and sewage, and waste, in corporate inventories, were evident in most inventories. In corporate inventories, wastewater, sewage, and waste were included the least. However, this was because the municipality was not responsible for waste collection and water services, or they had elected to record this information in the community inventory only. In the community inventories, IPPU and AFOLU were only included in 11% and 19% of inventories, respectively, which makes sense, given their classification as BASIC+ level reporting variables.

Ultimately, the sectors included in most inventories closely mirror the options in the PCP protocol, GPC, and the identified priority sectors in general. That said, a small number of corporate inventories (roughly 9%) included other sectors. These inventories were likely from the municipalities utilizing some different methodology to conduct their inventory.

Consumption-based and Production-based Inventories

With entirely different premises for emissions calculations, the results from consumption-based and production-based inventories can be quite diverse (Baltar de Souza Leão et al., 2020; Harris et al., 2020; Meng et al., 2017; Sudmant et al., 2018). The literature has demonstrated that this usually results in a higher emissions total in consumption-based versus production-based inventories (Baltar de Souza Leão et al., 2020; Harris et al., 2020; Meng et al., 2017; Sudmant et al., 2018). Most mainstream methodologies, including the PCP and GPC protocols, provide production-based instructions for GHG emissions measurement, with little or no information on consumption-based methods (Andrade et al., 2018; Harris et al., 2020; Sudmant et al., 2018; WRI et al., 2021). Further, the data required to conduct a consumption-based inventory remains

challenging to obtain (Chen et al., 2019). With these obstacles in mind, the literature suggests that production-based inventories are the dominant inventory method.

The empirical results overwhelmingly validate the literature, with no municipalities using consumption-based methods in the corporate sample and one municipality using these methods in the community sample. Most municipalities are bound to use the methods provided to them to conduct their inventories. However, the few municipalities that discuss or use consumption-based inventories consider the technique as supplemental to production-based inventories. These climate action leaders are looking for ways to enhance their measurement practices and gather additional data on their emissions profile. While this is novel and likely will depict a more accurate view of the total scope 3 emissions in a community, until consumption-based methods are better defined and standardized, production-based inventories will continue to be the norm.

Transparency

Municipalities need to demonstrate transparency when sharing details on their inventory processes. The literature emphasises the need for municipalities to supply information on data sources and assumptions made when creating the inventory, emissions coefficients used to calculate the inventory, and any deliberate omissions from the inventory (Baltar de Souza Leão et al., 2020; FCM & ICLEI, 2014a; Mia et al., 2019; WRI et al., 2021). However, Baltar de Souza Leão et al. (2020) and Mia et al. (2019) suggest that data sources, emissions coefficients, omissions, and assumptions are often not included in the inventory documentation from municipalities.

As part of the PCP milestone process, municipalities need to meet specific guidelines to achieve milestone recognition. Municipalities must provide information on data sources, emissions coefficients, omissions, and assumptions to achieve milestone one. As such, over 70% of municipalities offer detailed information on most of these variables for both corporate and community inventories. Additionally, a smaller proportion of municipalities provide at least some details on these variables. The variable with the least amount of information supplied is related to the omissions in community inventories. This result is likely due to the breadth of potential emissions sources that municipalities could include.

Due to the processes in place for PCP milestone completion, the findings in the literature are mainly not found in the empirical results. However, this is not to say that the level of provided detail is universal across municipalities. A significant amount of variability was evident in the breadth of information offered. Unfortunately, a more granular view of this occurrence was out of scope for this thesis.

Carbon Sinks and Storage

Even though many studies in the literature point to the potential benefits of measuring and implementing carbon capture and storage methods (Griscom et al., 2017; IEA, 2021; Keith et al., 2021), the coinciding methodology for measuring emissions reductions tied to these sources is more scarce. Some leading municipalities are incorporating nature-based solutions and solutions around carbon sinks into their climate action plans (Linton et al., 2022), but the PCP and GPC protocols don't include instructions for measuring the impact of such solutions (FCM

& ICLEI, 2014a; WRI et al., 2021). Consequently, it is unlikely that carbon sinks and storage will be extensively measured in the current inventories of Canadian municipalities.

Although most municipalities include no measures of carbon capture and storage practices in their inventories, a few included these methods in their corporate inventories, and almost 10% of municipalities included them in their community inventories. This information validates the literature in that it is still not common practice to include carbon stocks in the inventory process. However, the empirical results also extend the literature findings, indicating that a growing number of municipalities are attempting to incorporate these aspects into their inventories even without PCP guidance. Nevertheless, these processes are still in their infancy and will require some experimentation and guidance before they are used more abundantly.

5.2 Research Question 2: Emissions Reduction Targets

- How do current municipal GHG reduction targets compare to federal commitments?

Table 19 summarizes the empirical results and literature related to the emissions reduction targets in municipalities.

Table 19: Target Discussion Summary

Target Variables	Empirical	Literature	Comments
Interim & Final Targets	Many municipalities have set final targets related to one of the three Canadian targets (6%, 80%, Net Zero). Many municipalities have set interim targets that match or exceed the 30% or 40-45% Canadian target by	National targets have strengthened over the years, with targets in Canada being updated three distinct times. Municipalities are encouraged to create targets that are comparable to the	**Validate**

	2030. Less than half of the municipalities include an interim target.	national interim and federal targets. However, municipalities in the PCP program are only required to provide a final target.	
Target Years	Municipalities used 25 different final target years and 8 different interim target years.	Municipalities use several different baseline and target years.	**Validate**

5.2.1 Target Discussion

There are three distinct moments when Canada set or updated its emissions reduction targets. These moments happened after the ratification of the Kyoto Protocol, after the signing of the Paris Agreement, and after the release of recent IPPC information showcasing the drastic reductions needed to limit global warming to 1.5°C above pre-industrial levels (Doucet, 2004; Government of Canada, 2021; IPCC, 2018; Rogelj et al., 2016). Targets started at 6% emissions reductions below 1990 levels between 2008 and 2012, moved to 30% emissions reductions by 2030 and 80% reductions by 2050, and finally now stand at 40-45% emissions reductions by 2030 and net-zero emissions by 2050 (Doucet, 2004; Government of Canada, 2021; IPCC, 2018; Rogelj et al., 2016). Although municipalities are encouraged to set comparable targets, they are not required to set interim targets, and the literature has also demonstrated that municipalities use different target years (FCM & ICLEI Canada, n.d.; Kramers et al., 2013). Both practices indicate variability in targets between Canadian municipalities.

First, there is an evident trend in the empirical results for municipalities to set final targets that coincide with one of the three national targets mentioned. Several municipalities have final emissions reductions close to 6%, 80%, or net-zero. Concurrently, most municipalities,

including interim targets, have targets above 30% or 40%. This indicates that while municipalities generally follow federal targets, there seems to be a lag in the time it takes for municipalities to update their targets to match national marks. This is likely either a product of the inherent delay in the processes to update the climate action plan and corresponding target or an indication that municipalities do not believe the current national targets are achievable for their community yet. It is also interesting to note that many municipalities have targets that fall somewhere in between the federal targets mentioned. This shows that some municipalities are not referencing the national targets when creating their own or are simply working with a goal that they find attainable, regardless of its national relevance. Additionally, many municipalities still have interim targets that fall below 30% and final targets that fall between 6% and 79%, indicating that an enhanced level of ambition will be needed if Canada is to meet its emissions reduction goals. Finally, a smaller group of municipalities have set emissions reduction targets that are more aggressive than the national targets and, as such, are leading the way in terms of local climate mitigation in Canada.

The two findings in the literature of a lack of pressure for interim targets and the use of different target years (FCM & ICLEI Canada, n.d.; Kramers et al., 2013) were both validated in the empirical results. Only roughly 43% of municipalities included an interim target, while 25 distinct final target years and eight interim target years were utilized. The lack of an interim target year may place the emissions reduction goal too far in the future, reducing the urgency for climate action results. However, this may need to become a mandatory practice for municipalities to engage in the process of setting closer targets. Ultimately, this process would help ensure that municipalities are moving in the right direction and provide more feedback

loops for assessing progress and pivoting to implement the actions producing results. Meanwhile, the problem of diverse target years is likely a product of municipalities in different stages of their climate action journey, with some measuring their baseline emissions decades ago and others just getting started today. The national targets provide an ambitious goal for municipalities to strive towards. However, it is also necessary that the country achieve these targets. Thus, there could be more value in simply adopting the national targets and focusing on implementation, rather than battling with the process of identifying and setting new custom targets. While this may be precisely what was done in some municipalities, a significant number of municipalities still fall short of the current national targets.

5.3 Research Question 3: Monitoring Systems

- What systems are used to monitor progress towards reaching goals set in climate action plans?

Monitoring allows municipalities to evaluate and analyze progress, identify areas for improvement, and drive positive plan adjustments (C40, 2020; Clarke, 2011; Guyadeen et al., 2019; Linton et al., 2021; Reckien et al., 2018; Robinson & Gore, 2015; Seasons, 2003; Sun et al., 2020). It is evidently a valuable process in climate action planning, but the literature shows a general lack and poor quality of local climate action monitoring systems in municipalities (Boehnke et al., 2019; Guyadeen et al., 2019; Rivas et al., 2022).

Klostermann et al. (2018) provide a framework for evaluating monitoring systems in climate adaptation planning focusing on 1) the system of interest, 2) indicators used, 3)

organizations responsible for monitoring, and 4) monitoring procedures. Table 20 summarizes the empirical results and literature on the topic of monitoring systems using the Klostermann et al. (2018) framework.

Table 20: Monitoring Discussion Summary

Variables	Empirical	Literature	Comments
System of Interest	Most municipalities included details on all system of interest variables. Those that were missing would most definitely be present in earlier planning documents.	Municipalities can include several details that describe the system of interest, including the sectors of focus, specific functions of emission-producing activities within the sectors, the geographic area, and the timeframe of evaluation.	**Validate**
Indicators	While almost all municipalities in the corporate sample included an updated inventory, only about half of the municipalities in the community sample did. Most municipalities used all three types of indicators to evaluate actions. The least used indicator was outcome indicators in the community sample.	Updating emissions inventories can be difficult for municipalities given the challenge of accessing relevant and accurate data. Indicators that evaluate actions can be grouped into three categories: process-based, output, and outcome.	**Validate –** In the community sample, where monitoring is a more difficult task, fewer municipalities had updated inventories. Similarly, fewer municipalities included outcome indicators to measure the impact of actions.
Monitoring Responsibility	All three groups were identified at some point as being responsible for monitoring both corporate and community plans. Staff members were by far identified as the most often responsible for monitoring, followed by council members and community-wide entities. Community-wide entities were more often responsible for monitoring community plans.	Staff can be involved in the monitoring of both types of plans and can be a part of the oversight committee. Council members can respond to frequent reports or directly embed themselves in the oversight committee. Community-wide entities are more often used in monitoring community plans.	**Validate**

Stakeholder Engagement & Peer Review	Stakeholder engagement was used in more than half of the corporate and community monitoring systems. Peer review was only mentioned by a small number of municipalities.	The number and type of stakeholder involved in the monitoring process may vary by municipality, but it is an important part of climate action planning and implementation. Peer review can be a valuable tool in supporting the climate action monitoring process.	**Partially Validate –** Peer review was scarcely mentioned. Stakeholder engagement was only evident in roughly half the cases.
Monitoring and Evaluation Procedures	Most monitoring procedures were described in close to 50% of the municipalities. Reporting procedures were evident in roughly 80% of municipalities while plan revision was mentioned in closer to 30% of municipalities. The review of the monitoring system was hardly mentioned at all.	Monitoring procedures should be clear and transparent, allowing external parties the opportunity to understand how municipalities are monitoring their climate action plan. However, studies have shown that there is inconsistency in the amount of detail provided by Canadian municipalities. Municipalities review and revise their plans on a variety of different timescales, using several different methods, with some failing to set procedures for monitoring their plans at all.	**Validate –** There was an obvious variation in the amount of information provided that detailed the monitoring and evaluation procedures.

5.3.1 Monitoring Discussion

System of Interest

Klostermann et al. (2018) introduce the system of interest as a critical variable in evaluating climate action monitoring systems. It is vital to understand what details are meant to be monitored (Klostermann et al., 2018). However, perhaps these details are more diverse in climate adaptation monitoring, given the complexity and variety of adaptation situations presented to municipalities. It is still important for municipalities to disclose information on the identified boundaries of the monitoring system and the aspects of the system to be evaluated, but

a common framework of specific sectors to address and activities to undertake exists, and an agreed-upon goal of emissions reductions guides the narrative. Furthermore, all municipalities being reviewed have already gone through calculating an emissions inventory, setting emissions reduction targets, and creating a climate action plan that clearly defines the system of interest. As such, it is not surprising that the empirical results validate the literature and showcase most municipalities appropriately defining the system of interest.

Indicators

In climate mitigation, the golden standard for indicators is GHG emissions reductions, measured through a GHG inventory (Damsø et al., 2017). However, various indicators that measure project-based results and processes are also helpful for municipalities (Boswell et al., 2012; Damsø et al., 2017; ICLEI Canada, 2020; Kramers et al., 2013). These indicators allow municipalities to take a closer look at the processes underway, the status of projects, and the results attached to specific initiatives (Damsø et al., 2017; ICLEI Canada, 2020; Neves & Leal, 2010). Klostermann et al. (2018) argue that these indicators can be grouped into process-based, output, and outcome indicators.

Although the emissions inventory or measurement of emissions reductions is the primary indicator for depicting climate mitigation success, the literature points to difficulties municipalities face in securing accurate data, which leads to a reduced number of municipalities updating their inventories (Boehnke et al., 2019; Delponte et al., 2017; Rivas et al., 2022). This finding is validated in the empirical results, specifically in the community sample, as only 57% of municipalities included updated inventories. This result is easy to explain, given the

heightened complexity of collecting and working with data for the community, compared to corporate emissions only.

The measurement of project-based results is considered an important process in the PCP program, as it allows municipalities to measure the impact and progress of specific initiatives or actions (FCM & ICLEI, 2014b; ICLEI Canada, 2020). Although this finding is validated in the empirical results of the corporate and community samples, with municipalities in both samples including project-based results, corporate project-based results are included at a much higher rate than community project-based results. The enhanced complexity of measuring the results of community-based projects, with various community partners involved, is a likely explanation for the lower number of community project-based results. Furthermore, given that municipalities have direct control over their corporate operations and data collection processes, it is not surprising that municipalities include results from corporate projects more than their community projects.

All three indicators outlined in the literature were extensively used by municipalities in the empirical results, validating the literature that indicators can be grouped into these categories. With that said, outcome indicators were used significantly less in the community sample. Since these indicators focus on quantifying the impacts of completed actions and include emissions reductions, it is not surprising to see the same trend that was apparent in the emissions inventories of the community sample, also shown here. Logically, it is understandable that it is easier to gather information on the processes in place and the status of implementation or details of actions completed than to quantify measurable impacts such as GHG reductions, energy

efficiency improvements, or cost savings. However, outcome indicators are essential as they measure if the actions put in place are having the impact they are meant to have (Klostermann et al., 2018).

Monitoring Responsibility

The literature emphasizes the need to embed municipal staff in the climate action monitoring and oversight processes in corporate and community planning (Zhou, Clarke, & FCM, 2022). It is also important to incorporate consistent reports to council from the oversight committee of the plan. However, community plans are best managed and monitored by a multi-stakeholder partnership or community-wide entity, which includes staff, council, and many other community partners (Samuel & Clarke, 2022; Sun et al., 2020; Zhou, Clarke, & FCM, 2022).

The findings from the literature are validated in the empirical results at a base level. Generally, municipal staff were highlighted the most of the three groups for being responsible for monitoring climate action (over 70% in both samples). Conversely, council members and community-wide entities were mentioned as responsible for monitoring in a much smaller number of municipalities. Further, a much larger percentage of municipalities in the community sample referenced a community-wide entity as responsible for monitoring compared to the corporate sample (25% vs. 12%). Further study could see if the size of municipality influenced the monitoring responsibility.

It is a good sign that staff are often embedded in monitoring processes, as it reinforces better monitoring procedures (Rivas et al., 2022). However, including council members or

community-wide entities as responsible parties for monitoring is relatively uncommon. The literature suggests that council members should be involved in the monitoring and oversight process for corporate and community plans, as they have final decision-making power for corporate actions and direct influence over community actions (Clarke, 2012; Zhou, Clarke, & FCM, 2022). The literature also suggests that community-wide entities are the best organization for overseeing and monitoring community plans (Sun et al., 2020; Zhou, Clarke, & FCM, 2022). Therefore, many municipalities could benefit from including these parties in their monitoring processes.

Although the empirical results offer a general understanding of the parties responsible for monitoring, there was limited or no information on these details in many cases. As a result, it is certainly possible that additional municipalities rely on staff, council, and community-wide entities to monitor their climate action plans. However, this cannot be deduced without further research.

Stakeholder Engagement and Peer Review

Stakeholder engagement is portrayed in the literature as an essential step in climate action planning (FCM & ICLEI, 2014b). Incorporating a broad number of stakeholders into the monitoring process enhances the level of transparency and accountability and the impact of monitoring (C40, 2020; Delponte et al., 2017; Rivas et al., 2022). As such, the PCP program encourages and requires municipalities to report information on their stakeholder engagement processes (FCM & ICLEI, 2014b).

The literature also introduces the concept of peer review or external consultation as a valuable tactic in monitoring climate action and provides examples of how municipalities incorporate peer review into their processes (Damsø et al., 2017; Delponte et al., 2017; Rivas et al., 2022). For example, Damsø et al. (2017) profile the city of Copenhagen and describe the consistent review process they have built with external parties. Thus, it is suggested that this could be a valuable piece of a municipalities monitoring system.

The empirical results demonstrate that over half of municipalities include details on stakeholder engagement concerning their monitoring systems. This result validates the literature in that it showcases the use of stakeholder engagement in the monitoring systems of municipalities. However, because a relatively large number of municipalities do not include information on these processes, some may overlook the importance of these processes. Furthermore, it was more common for municipalities to describe the stakeholder engagement process as a planning tool when creating the plan instead of during the monitoring and review of plan implementation. As such, several municipalities might stand to improve their transparency, accountability, monitoring, and overall climate action performance by introducing stakeholder engagement processes throughout the entire planning and implementation process (Damsø et al., 2017; Delponte et al., 2017; Rivas et al., 2022). To accomplish this, municipalities might introduce feedback loop processes to keep relevant stakeholders engaged with the progress and successes of initiatives, or, in community planning specifically, appoint stakeholders to own the monitoring of specific projects while setting up communication processes to share their results with those responsible for overseeing the plan.

On the other hand, peer review was scarcely found in the empirical results, showing up in roughly 4% of the cases analyzed. As a result, this study shows that municipalities are not yet using peer review in their monitoring processes. However, the reasoning behind the lack of peer review remains unknown. Informal forms of review exist within city networks and programs, such as the PCP or GCoM. However, more formal procedures seem to be underutilized in Canadian municipalities.

Monitoring and Evaluation Procedures

The literature reinforces that municipalities should disclose information on climate action monitoring procedures (Brown et al., 2018; C40, 2020; Klostermann et al., 2018). Yet, some studies indicate the lack of such information in Canadian municipal planning processes (Guyadeen et al., 2019). Furthermore, while some municipalities have procedures in place to regularly monitor and update their plan on a quarterly or annual basis (Damsø et al., 2017; Linton et al., 2021), numerous other municipalities still struggle to incorporate review and revision processes into their monitoring systems (Boehnke et al., 2019; Rivas et al., 2022).

The findings from the literature are echoed and validated in the empirical results. Several municipalities included detailed information on monitoring procedures. However, most individual variables were only evident in roughly 50% of the sample, except for reporting procedures, which were included in over 80% of case municipalities. This result validates the finding that some leading municipalities share information on monitoring procedures, but this is not a universal practice. Additionally, fewer municipalities included details on how their plan was to be revised, and almost no municipalities indicated how their monitoring system would be

updated. Across the entire sample, the noticeable result was that most municipalities could provide additional details that they had omitted. This result is consistent with the need for an improved understanding and disclosure of monitoring procedures amongst municipalities discussed in the literature. Some leading municipalities are already doing this and are generating and sharing detailed reports with information related to all monitoring variables presented in this thesis, which others may learn from. However, municipalities, in general, could further learn from each other if more information on the processes in use was available, and the PCP program could revise their milestone 4 and 5 reporting guidance to request or encourage specific details.

5.4 Research Question 4: Reporting Procedures

- What reporting procedures are being used to disclose GHG emissions and/or climate action results?

It is imperative that climate action reporting is timely, accurate, and comparable (Gibassier & Schaltegger, 2015). However, the literature emphasizes inconsistencies in the timing of reporting and resistance to verifying data (Baltar de Souza Leão et al., 2020; Bertoldi et al., 2018; Hsu et al., 2019; Mia et al., 2019), among other issues already discussed in other sections of this thesis. Furthermore, the literature discusses the recent advancement of standardized climate action disclosure through platforms like CDP and GCoM (Balouktsi & Lützkendorf, 2020; Bertoldi et al., 2018; Linton et al., 2021; Mia et al., 2018, 2019), and puts forth reporting channels that municipalities may utilize to share climate action information (Depoers et al., 2016; Kolk et al., 2008; Lodhia, 2014; Mia et al., 2018).

Table 21 summarizes the empirical results and literature on reporting procedures and offers a brief synopsis of whether the findings from the literature were validated in the empirical results.

Table 21: Reporting Discussion Summary

Reporting Variables	Empirical	Literature	Comments
Reporting Quality Features	More than half the municipalities provided information on report timing, with most subscribing to the use of annual reporting. There was very little mention of validating report contents.	There is a lack of consistency, reliability, transparency, and thus comparability in the reporting of climate action. This translates to inconsistent timing of reporting, and a lack of reporting verification.	**Partially Validate –** There was a consistent response of annual reporting, that was more consistent than what the literature suggests.
Standardization	24 municipalities report to CDP and 14 are part of CDP but have not provided any data. 19 municipalities report to GCoM and 22 are a part of GCoM but have not provided any data. More than 60% of municipalities use some form of standardized reporting.	Municipalities are increasingly using standardized platforms such as CDP and GCoM to disclose climate relation information. However, the process is voluntary, causing variation in the amount of data shared through such platforms.	**Validate**
Reporting Channels	Close to 60% or more municipalities indicate that they use own and third-party channels to share climate action information. A much smaller proportion of municipalities mention the use of social media.	Municipalities can share climate action information through own channels, third-party channels, and on social media, although social media seems to be much less utilized.	**Validate**

5.4.1 Reporting Discussion

Reporting Quality Features

Contrary to the findings in the literature on variability in the timing of climate action reporting (Baltar de Souza Leão et al., 2020; Bertoldi et al., 2018; Hsu et al., 2019; Mia et al., 2019), the empirical results suggest that over 60% of municipalities share details on their reporting timeline, and the majority of those municipalities report on an annual basis. This result indicates that Canadian municipalities may be increasing their climate reporting efforts, perhaps because of their affiliation with standardized reporting platforms. For example, most BC municipalities participate in the Climate Action Revenue Incentive Program (CARIP), which imposes annual reporting. Regular reporting ensures a constant flow of communication between the municipalities and external stakeholders, increasing accountability and enticing further stakeholder engagement, all necessary in the continual strategic process of climate action.

The use of validation and data verification processes, conversely, was sparsely found in the empirical results. This detail validates the findings in the literature, indicating that report validation and verification use is limited amongst municipalities. Perhaps the trend in increased standardized platforms for reporting will influence this trend moving forward.

Standardization

Standardization of climate action reporting is an emerging and relatively recent topic in the literature, as platforms like CDP and GCoM continue to gather traction in the public sector (CDP, 2022; Linton et al., 2022; Mia et al., 2018, 2019). However, the use of these platforms is still relatively limited, given their recent introduction (Linton et al., 2022; Mia et al., 2018).

The empirical results demonstrate the rise of these types of standardized reporting platforms, with 24 municipalities reporting information to CDP, 19 reporting to GCoM, and another 14 and 22, respectively, being a part of these platforms without yet sharing data. Additionally, more than 60% of municipalities used some form of standardized reporting, with a large group of BC municipalities reporting through the CARIP program. Such empirical results validate the findings from the literature, demonstrating that standardized reporting is increasing in Canadian municipalities, led by platforms such as CDP and GCoM.

The PCP program can also be considered a mechanism for standardized reporting. Although municipalities are not limited to a reporting format, the general contents of reports are dictated by the milestone requirements. Further, although milestone submission reports are not public, the information contained in such reports is generally also shared publicly, even if the milestone reports don't explicitly indicate where the information is shared.

Reporting Channels

The literature explores different reporting channels, including own channels, such as a municipality's website or annual reports; third-party channels, such as CDP or GCoM; and social media channels, such as Facebook, Twitter, or Instagram (Mia et al., 2018). Studies show the importance of reporting through own and third-party channels and identify social media as an emerging, underutilized channel (Kolk et al., 2008; Lodhia, 2014; Mia et al., 2018).

The findings from the literature are validated in the empirical results, as close to 60% or more municipalities utilize their own and third-party channels to disseminate their climate action information, and a much smaller number of municipalities use social media. While social media remains a less formal approach to communication, it holds value in its ability to generate two-way, expedited conversations with stakeholders (Mia et al., 2018). Therefore, municipalities could benefit from increasing the use of this channel. Furthermore, when municipalities share consistent information across several reporting channels, it enhances the credibility of the messaging, reduces the cost of disclosing, and broadens communication reach (Depoers et al., 2016). Thus, extra value can also be derived through expanding reporting channels.

5.5 Research Question 5: Practices Related to Significant Emissions Reductions

- What measurement, monitoring, and reporting practices are evident in Canadian cities that are also achieving significant GHG emissions reductions?

Table 22 summarizes the empirical results and literature related to the measurement, monitoring, and reporting practices in municipalities demonstrating significant emissions reductions.

Table 22: Practices Related to Significant Emissions Reductions Discussion Summary

Variables	Empirical	Literature	Comments
Significant Emissions Reductions Practices	All variables identified in the literature were validated in the results. Additional variables were also uncovered in the results that were not discussed in the literature. They included the involvement of council members and community-wide entities, the increased use of reporting	Disclosure of GHG information, regular stakeholder engagement, recurring review of the plan, use of process-based, output, and outcome indicators, involvement of staff, and early adoption and deployment of a climate action plan are all linked	**Validate / Extend –** The literature outlines several variables associated with successful climate action implementation or GHG reductions. The empirical results extend these findings by adding to the list of variables that could be connected to successful emissions reductions in

	channels, and the inclusion of various monitoring procedure details.	to positive climate action results.	municipalities. Involvement of council members and community-wide entities, use of various reporting channels, and the inclusion of various monitoring procedure details were all identified in the empirical results as variables connected to municipalities with high emissions reductions.

5.5.1 Practices Related to Significant Emissions Reductions Discussion

Several measurement, monitoring, and reporting practices were identified in the literature as essential in successfully reducing emissions and accelerating climate action progress (Damsø et al., 2017; Mia et al., 2019; Rivas et al., 2022). These practices included the disclosure of GHG information through various channels, including CDP (Mia et al., 2019), the use of persistent stakeholder engagement, ongoing review of the plan, and deployment of process-based, output, and outcome indicators (Damsø et al., 2017; Rivas et al., 2022), and the rigorous involvement of staff in the planning process, and early development and implementation of a climate action plan (Rivas et al., 2022).

Every variable discussed was noticeably more evident in the practices of municipalities generating the most considerable corporate and community-based emissions reductions. This empirical result validates the literature and solidifies these variables as topics to be further explored in future studies to understand the significance of the relationship between those variables and emissions reductions. However, even without further evidence to prove the

relationship, municipalities can look to these examples as best practice findings to be implemented in their communities.

The empirical results also extend the literature findings by showcasing a few other evident variables in municipalities with greater emissions reductions. For example, the involvement of council members and community-wide entities, the use of a more diverse range of reporting channels, and the inclusion of details surrounding monitoring procedures were all more evident in the high emissions reductions sub-group of municipalities. The involvement of council members and community-wide entities could lead to higher emissions reductions because an extra layer of accountability and resources is added through the inclusion of council members, and a wider spread of responsibility for action and a broader reach is achieved through the inclusion of a community-wide entity. The use of a wide assortment of reporting channels also adds to the accountability a municipality may experience, as they are connecting with a larger, more diverse audience. As such, this may explain the increased emissions reductions. Finally, the inclusion of monitoring procedure details suggests that municipalities have allocated appropriate resources and effort to achieving their emissions reduction goals, and that they may be more advanced in their climate action implementation, leading to higher emission reductions. Future studies could explore the impact of these variables on emissions reductions by isolating each variable and using quantitative techniques to measure this relationship. However, as with the previously found variables in the literature, these additional variables can also be considered best practices in climate action measurement, monitoring, and reporting.

As the variables that were only marginally more evident or less evident in high emissions reducers were not particularly studied in this thesis, it could be another avenue for uncovering insights. Furthermore, a larger number of municipalities that meet a different threshold of emissions reductions could also be explored. What this section does provide is a snapshot understanding of the utilized practices in the municipalities demonstrating successful climate action progress.

5.6 Research Question 6: Change in Practices Over Time

- How has GHG measurement, monitoring, and reporting changed over time?

Table 23 summarizes the empirical results and literature related to the change in measurement, monitoring, and reporting practices over time.

Table 23: Change in Practices Over Time Discussion Summary

Target Variables	Empirical	Literature	Comments
Milestone 1, 2, 3, 4, and 5 achievements, completions, or approvals	A summary of corporate and community milestone achievements demonstrates the trends in Canadian climate action over the last decade.	Through the PCP milestone framework, a summary of where municipalities are in their climate action process can be created.	**Validate**

5.6.1 Change in Practices Over Time Discussion

This research question is associated with very few pieces of literature, as the change in measurement, monitoring, and reporting practices over time is a topic that has yet to be studied. Robinson and Gore (2015) use portions of the milestone framework to attempt to view the state of climate action at one moment in time. While their objective is ultimately to identify additional

actions that the milestone framework misses, they also acknowledge the capability of the PCP milestone framework in tracking climate action progress (Robinson & Gore, 2015). Thus, viewing when municipalities achieved specific milestones makes it possible to understand the progression of climate action and the practices involved over time.

Since each milestone is connected to a stage in the climate action progress, the empirical results can determine how many municipalities were measuring their emissions, setting targets, creating a climate action plan, implementing the plan, and monitoring and reporting the results, and at what point in time they were doing so. The empirical results validate this notion and provide a picture of the last decade of climate action. Generally, there has been a rise in milestone 1, 2, and 3 completions over the previous five years, with a slight downward trend in milestones 4 and 5 completions in the last ten years. With this information, it is also possible to predict that the coming years will likely see a surge in milestone 4 and 5 completions or at least the number of municipalities working towards these milestones. Thus, resources and insights to help municipalities through the implementation, monitoring, and reporting stages may become even more crucial moving forward.

Chapter 6.0 Conclusion

6.1 Objectives of Study

This study aimed to determine the current and historical state of GHG emissions measurement, target setting, monitoring, and reporting and develop insights into the best practices in the local climate action planning of Canadian municipalities. After identifying key variables in the literature on climate action planning, an evaluation framework was generated and utilized to compare the practices from the literature with those evident in Canadian municipal climate action processes. Through this comparison, the study strived to discover where the empirical results matched the findings in the literature and where approaches differed.

6.2 Theoretical Impact and Contribution of Research

This study made several contributions to theory and the literature on local climate action planning and deep decarbonization. First, it validated several findings from the literature on key aspects of the strategic management processes involved in climate action planning and further extended others. The exploration of Canadian municipalities generated insights tied to an understudied market that further contextualizes theoretical findings from pre-existing literature. Finally, by studying the local climate action measurement, monitoring, reporting, and target-setting practices of many Canadian municipalities, this study was able to contribute findings on the most common and best practices.

In the measurement section, the empirical results extended the findings from the literature for the reporting levels used, inclusion of scope 3 emissions, and use of carbon sinks and storage. For all three variables, a larger number of municipalities were found to incorporate BASIC+

level reporting, scope 3 emissions, and carbon sinks and storage, particularly in their community inventory processes, than what was expressed in the literature. Additionally, while most variables from the literature for monitoring and reporting were simply validated in the empirical results, the thesis section on practices related to significant emissions reductions extended the findings from the literature. All findings from the literature depicting the practices related to emissions reductions and successful climate action were validated. However, the involvement of council members and community-wide entities, the use of various reporting channels, and the inclusion of various monitoring procedure details were all uncovered as variables tied to higher emissions reductions, extending the literature on the impactful practices involved in successful climate mitigation.

The evaluation framework, derived from relevant literature, offers a viable approach to examine the central aspects of climate action planning. While some sections of the framework represent a synopsis of the relevant literature, others repurpose existing frameworks and guidelines from scholars and leading climate practitioners. Specifically, the measurement variables were well understood and explored in the literature. However, the framework created through this thesis brings the literature variables together under one structure. Monitoring, on the other hand, is less understood in the literature. Still, an existing framework for evaluating climate action adaptation found in the literature proved useful for assessing mitigation practices. Concurrently, reporting variables were also less explored in the literature, but a small number of studies identified important reporting variables, which this study was able to integrate into the evaluation framework. Also, the target-setting framework was built around the evident aspects of target setting in the literature and used to compare against the apparent federal targets. Finally,

the framework for exploring the change in practices over time was derived directly from the PCP milestone framework. A net new methodology for reviewing the measurement, target setting, monitoring, and reporting practices in local climate action planning remains. This framework can be repurposed, expanded, or inspected by future scholars and related studies.

6.3 Practical Implications

This study created a baseline understanding of the measurement, target setting, monitoring, and reporting practices in Canadian municipalities. By reviewing the results, practitioners, local staff, government representatives, and scholars can garner a general understanding of the practices used in Canadian local climate action planning. This knowledge and the best practice examples can help steer decision-making processes for the first three groups. Meanwhile, the academic community can use these results as a baseline for measuring the impact of future initiatives or studies, or for triangulating future studies.

The literature review from this study, and the evaluation framework that summarizes the key variables or findings from the literature, were used to help craft a survey instrument for an extensive research partnership led by Dr. Amelia Clarke. The Municipal Net-Zero Action Research Partnership (N-ZAP) comprises several academic, partitioner, and municipal contacts, aiming to advance measurement, monitoring, and climate action planning in Canadian municipalities. Working Group 1 of this partnership focuses on developing and administering a survey to a broad list of Canadian municipalities to capture the country's current state of measurement, monitoring, and planning. Ultimately, the findings from this study's literature review helped shape the content of the survey and will be used to triangulate survey results. The

result from the survey will be summarized in a publicly available database for any group or individual to review and utilize.

Finally, this study's data collection process was designed so that practitioners at FCM or ICLEI Canada could access and analyze the collected data, develop additional insights, and craft storylines from an organized and digestible dataset. Thus, the master spreadsheet created through this project will be a beneficial tool for practitioners to use and build on moving forward. Concurrently, students and scholars, including members of the N-ZAP, can explore future topics of study based on information explored in this thesis or other additional information captured at the time of data collection. A wealth of data is now accessible and summarized for future use, and both groups can thus benefit from this information.

6.4 Limitations and Future Research

The breadth of this study was vast, as the thesis aimed to develop a broad understanding of current and historical climate action planning practices in Canadian municipalities. In response, a large sample of over 200 municipalities, representing a significant portion of the Canadian population, was chosen as the topic of study. This decision allowed a comprehensive cross-case analysis to uncover common themes and patterns amongst Canadian municipalities. While it also covered an abundance of sub-topics within the main research questions, future studies could build on this work by narrowing the scope of municipalities or topics and providing a deeper analysis of chosen variables. For example, where this thesis aimed to supply a general overview of the current and historical state of measurement, target setting, monitoring, and

reporting, another study might dig deeper into the intricacies of these practices or deepen the understanding between specific variables in select municipalities.

Another limitation of this study is that it focuses only on Canadian municipalities participating in the PCP program. This decision was instrumental to the success of this thesis, as the opportunity to work directly with ICLEI Canada provided a wealth of data that would not have been available otherwise. Additionally, the PCP program has an extensive reach, and most municipalities working in the space of climate action and mitigation participate in the program in some capacity. Nevertheless, the findings are unique to the Canadian landscape and, more broadly, the countries of the global north. Thus, future studies could aim to replicate the processes introduced in this thesis for municipalities either within Canada but outside of the PCP program or in different countries.

A third limitation is in the methodology selected for this thesis. A qualitative, exploratory cross-case study approach was the optimal choice to answer the research questions posed, as it provided the tools and processes to adequately analyze and describe the current state of climate action planning in Canadian municipalities. Yet, future studies may expand on the findings and develop new insights by incorporating quantitative or mixed methods into their study. This research path would allow scholars to investigate the relationship between some of the variables identified in this thesis and results, such as GHG emissions reductions.

In summary, this qualitative and exploratory cross-case study achieved its goal. In addition to uncovering and summarizing the practices in Canadian municipalities that represent

the current historical state of measurement, target setting, monitoring, and reporting, this thesis also generated tangible insights into best practices in the field. The findings help validate and extend the current literature on various climate action planning and deep decarbonization practices and equip practitioners, municipal staff, and government officials with useable information for improving processes. Further, the collected dataset provides ICLEI Canada and FCM with an organized database to explore and generate storylines from and allows scholars to work with a clean, organized, and sizeable data archive. In totality, this study adds to the crescendo of information around deep decarbonization, local climate action, and the practices required to empower municipalities to be the leading players in the race to net zero.

References

Andrade, J. C. S., Dameno, A., Pérez, J., de Andrés Almeida, J. M., & Lumbreras, J. (2018). Implementing City-Level Carbon Accounting: A Comparison Between Madrid and London. *Journal of Cleaner Production*, *172*, 795-804. https://doi.org/10.1016/j.jclepro.2017.10.163

Arioli, M. S., D'Agosto, M. d. A., Amaral, F. G., & Cybis, H. B. B. (2020). The Evolution of City-Scale GHG Emissions Inventory Methods: A Systematic Review. *Environmental Impact Assessment Review*, *80*, 106316. https://doi.org/10.1016/j.eiar.2019.106316

Balouktsi, M., & Lützkendorf, T. (2020). On the Definition and Prioritization of Strategies and Actions to Minimize Greenhouse Gas Emissions in Cities: An Actor-Oriented Approach. *IOP Conference Series: Earth and Environmental Science*, *410*(1), 012004. https://doi.org/10.1088/1755-1315/410/1/012004

Baltar de Souza Leão, E., de Andrade Silva, A. M., Prado, A. F. R., Nascimento, L. F., & Andrade, J. C. S. (2022). Assessing Urban Emissions Through Different Methodologies: an Analysis of Brazilian Cities. *Mitigation and Adaptation Strategies for Global Change*, *27*(3), 19. https://doi.org/10.1007/s11027-022-09994-5

Baltar de Souza Leão, E., Nascimento, L. F. M. d., Andrade, J. C. S. d., & Puppim de Oliveira, J. A. (2020). Carbon Accounting Approaches and Reporting Gaps in Urban Emissions: An Analysis of the Greenhouse Gas Inventories and Climate Action Plans in Brazilian Cities. *Journal of Cleaner Production*, *245*, 118930. https://doi.org/10.1016/j.jclepro.2019.118930

Bernstein, S., & Hoffmann, M. (2019). Climate Politics, Metaphors and the Fractal Carbon Trap. *Nature Climate Change*, *9*(12), 919-925. https://doi.org/10.1038/s41558-019-0618-2

Bertoldi, P., Kona, A., Rivas, S., & Dallemand, J. F. (2018). Towards a Global Comprehensive and Transparent Framework for Cities and Local Governments Enabling an Effective Contribution to the Paris Climate Agreement. *Current Opinion in Environmental Sustainability*, *30*, 67-74. https://doi.org/10.1016/j.cosust.2018.03.009

Boehnke, R. F., Hoppe, T., Brezet, H., & Blok, K. (2019). Good Practices in Local Climate Mitigation Action by Small and Medium-Sized Cities; Exploring Meaning, Implementation and Linkage to Actual Lowering of Carbon Emissions in Thirteen Municipalities in the Netherlands. *Journal of Cleaner Production*, *207*, 630-644. https://doi.org/10.1016/j.jclepro.2018.09.264

Boswell, M. R., Greve, A. I., & Seale, T. L. (2012). *Local Climate Action Planning*. Island Press.

Brown, C., Shaker, R. R., & Das, R. (2018). A Review of Approaches for Monitoring and Evaluation of Urban Climate Resilience Initiatives. *Environment Development and Sustainability*, *20*(1), 23-40. https://doi.org/10.1007/s10668-016-9891-7

Bui, B., & de Villiers, C. (2017). Carbon Emissions Management Control Systems: Field Study Evidence. *Journal of Cleaner Production*, *166*, 1283-1294. https://doi.org/10.1016/j.jclepro.2017.08.150

Burch, S. (2018). Pursuing Deep Decarbonization in Canada: Advice from Canadian Scholars. https://www.cigionline.org/sites/default/files/documents/PB%20no.126.pdf

C40. (2020). *Climate Action Planning Framework*. https://cdn.locomotive.works/sites/5ab410c8a2f42204838f797e/pages/5ae2f92374c4837e195d0e00/files/20200324_C40_Climate_Action_Planning_Framework.pdf?1620380307

Carbon Neutral Cities Alliance. (2015). *Framework for Long-Term Deep Carbon Reduction Planning*. CNCA. https://carbonneutralcities.org/wp-content/uploads/2018/04/CNCA-Framework-for-Long-Term-Deep-Carbon-Reduction-Planning.pdf

CDP. (2022). *Cities A List 2021*. Retrieved February 17 from https://www.cdp.net/en/cities/cities-scores

Chen, G., Shan, Y., Hu, Y., Tong, K., Wiedmann, T., Ramaswami, A., Guan, D., Shi, L., & Wang, Y. (2019). Review on City-Level Carbon Accounting. *Environmental Science & Technology*, *53*(10), 5545-5558. https://doi.org/10.1021/acs.est.8b07071

Clarke, A. (2011). Key Structural Features for Collaborative Strategy Implementation: A Study of Sustainable Development/Local Agenda 21 Collaborations. *Management & Avenir*, *50*(10), 153-171. https://doi.org/10.3917/mav.050.0153

Clarke, A. (2012). *Passing Go: Moving Beyond the Plan*. Federation of Canadian Municipalities. https://data.fcm.ca/documents/tools/GMF/SS_PassingGo_EN.pdf

Clarke, A., & Ordonez-Ponce, E. (2017). City scale: Cross-Sector Partnerships for Implementing Local Climate Mitigation Plans. Special Blog Issue: Climate Change and Public Administration. *Public Administration Review*. http://faculty.washington.edu/aseem/Public_Administration_Review_cliamte_change_symposium.pdf

Clean Air Partnership. (2021). *The State of Climate Action Implementation in Ontario Municipalities - 2021 Report*. https://www.cleanairpartnership.org/wp-content/uploads/2022/06/Final-Climate-Action-Atlas-Report-1.pdf

Cook, A. (2009). Emission Rights: From Costless Activity to Market Operations. *Accounting, Organizations and Society*, *34*(3), 456-468. https://doi.org/10.1016/j.aos.2007.12.001

Creswell, J. W. (2007). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches* (Second ed.). Sage Publications.

Creswell, J. W., & Creswell, J. D. (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications.

Creutzig, F., Lohrey, S., Bai, X., Baklanov, A., Dawson, R., Dhakal, S., Lamb, W. F., McPhearson, T., Minx, J., Munoz, E., & Walsh, B. (2019). Upscaling Urban Data Science for Global Climate Solutions. *Global Sustainability*, *2*, e2, Article e2. https://doi.org/10.1017/sus.2018.16

Dahal, K., & Niemelä, J. (2017). Cities' Greenhouse Gas Accounting Methods: A Study of Helsinki, Stockholm, and Copenhagen. *Climate*, *5*(2), 31. https://www.mdpi.com/2225-1154/5/2/31

Damsø, T., Kjær, T., & Christensen, T. B. (2017). Implementation of Local Climate Action Plans: Copenhagen – Towards a Carbon-Neutral Capital. *Journal of Cleaner Production*, *167*, 406-415. https://doi.org/10.1016/j.jclepro.2017.08.156

Darwazeh, D., Clarke, A., & Wilson, J. (2021). Framework for Establishing a Sustainable Medical Facility: A Case Study of Medical Tourism in Jordan. *World*, *2*(3), 351-373. https://www.mdpi.com/2673-4060/2/3/22

Deep Decarbonization Pathways Project. (2015). *Pathways to Deep Decarbonization 2015 Report*. DDPP. https://www.iddri.org/sites/default/files/import/publications/ddpp_2015synthetisreport.pdf

Deetjen, T. A., Conger, J. P., Leibowicz, B. D., & Webber, M. E. (2018). Review of Climate Action Plans in 29 Major U.S. Cities: Comparing Current Policies to Research

Recommendations. *Sustainable Cities and Society*, *41*, 711-727. https://doi.org/10.1016/j.scs.2018.06.023
Delponte, I., Pittaluga, I., & Schenone, C. (2017). Monitoring and Evaluation of Sustainable Energy Action Plan: Practice and Perspective. *Energy Policy*, *100*, 9-17. https://doi.org/10.1016/j.enpol.2016.10.003
Depoers, F., Jeanjean, T., & Jérôme, T. (2016). Voluntary Disclosure of Greenhouse Gas Emissions: Contrasting the Carbon Disclosure Project and Corporate Reports. *Journal of Business Ethics*, *134*(3), 445-461. https://doi.org/10.1007/s10551-014-2432-0
Doucet, J. A. (2004). *The Kyoto Conundrum : Why Abandoning the Protocol's Targets in Favour of a More Sustainable Plan May Be Best for Canada and the World*. C.D. Howe Institute.
Eang, M., Clarke, A., & Ordonez-Ponce, E. (2023). The Roles of Multinational Enterprises in Implementing the United Nations Sustainable Development Goals at the Local Level. *BRQ Business Research Quarterly*, *26*(1), 79-97. https://doi.org/10.1177/23409444221140912
Engels, A. (2009). The European Emissions Trading Scheme: An Exploratory Study of How Companies Learn to Account for Carbon. *Accounting, Organizations and Society*, *34*(3), 488-498. https://doi.org/10.1016/j.aos.2008.08.005
Erickson, P., & Morgenstern, T. (2016). Fixing Greenhouse Gas Accounting at the City Scale. *Carbon Management*, *7*(5-6), 313-316. https://doi.org/10.1080/17583004.2016.1238743
Fawzy, S., Osman, A. I., Doran, J., & Rooney, D. W. (2020). Strategies for Mitigation of Climate Change: a Review. *Environmental Chemistry Letters*, *18*(6), 2069-2094. https://doi.org/10.1007/s10311-020-01059-w
FCM & ICLEI. (2014a). *PCP Protocol*. https://assets-global.website-files.com/6022ab403a6b2126c03ebf95/60e7367b103b1954f90e9f62_PCP-Protocol-Canada-Supplement-2021.pdf
FCM & ICLEI. (2014b). *Reaching Milestone 5: Monitoring and Reporting Guidelines*. https://assets-global.website-files.com/6022ab403a6b2126c03ebf95/604a4b0204de02cf82ece188_monitoring-reporting-and-verification_guidelines-av-pcp.pdf
FCM & ICLEI. (2020). *Partners for Climate Protection: National Measures Report 2019*. https://assets-global.website-files.com/6022ab403a6b2126c03ebf95/6025482e6b48231af815b356_pcp-national-measures-report-2019.pdf
FCM & ICLEI. (2021a). *Partners for Climate Protection Program: 2020-2021 Annual Report*. https://assets-global.website-files.com/6022ab403a6b2126c03ebf95/6101a410331718830ce72b58_partners-for-climate-protection-annual-report-2020-to-2021.pdf
FCM & ICLEI. (2021b). *Program: The PCP Milestone Framework*. https://www.pcp-ppc.ca/program
FCM & ICLEI Canada. (n.d.). PCP Milestone 2: Setting Emissions Reduction Targets. https://www.pcp-ppc.ca/resources/instructions-pcp-milestone-2-setting-emissions-reductions-targets
GCoM & ARUP. (2021). *Further and Faster Together: The Global Covenant of Mayors Impact Report*. https://www.globalcovenantofmayors.org/impact2021/
Gibassier, D., & Schaltegger, S. (2015). Carbon Management Accounting and Reporting in Practice: A Case Study on Converging Emergent Approaches. *Sustainability Accounting,*

Management and Policy Journal, *6*(3), 340-365. https://doi.org/10.1108/SAMPJ-02-2015-0014

Government of Canada. (2021). *Canada's 2021 Nationally Determined Contribution Under the Paris Agreement*. https://cuspnetwork.ca/wp-content/uploads/2021/07/Canada%27s_Enhanced_NDC_Submission_EN.pdf

Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., Schlesinger, W. H., Shoch, D., Siikamäki, J. V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R. T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M. R., Herrero, M., Kiesecker, J., Landis, E., Laestadius, L., Leavitt, S. M., Minnemeyer, S., Polasky, S., Potapov, P., Putz, F. E., Sanderman, J., Silvius, M., Wollenberg, E., & Fargione, J. (2017). Natural Climate Solutions. *Proceedings of the National Academy of Sciences*, *114*(44), 11645-11650. https://doi.org/10.1073/pnas.1710465114

Gurney, K. R., Liang, J., Roest, G., Song, Y., Mueller, K., & Lauvaux, T. (2021). Under-Reporting of Greenhouse Gas Emissions in U.S. Cities. *Nature Communications*, *12*(1), 553. https://doi.org/10.1038/s41467-020-20871-0

Guterres, A. (2019). Secretary-General's Remarks at C40 World Mayors Summit. [https://www.un.org/sg/en/content/sg/statement/2019-10-11/secretary-generals-remarks-c40-world-mayors-summit]. C40 World Mayors Summit, Copenhagen.

Guyadeen, D., Thistlethwaite, J., & Henstra, D. (2019). Evaluating the Quality of Municipal Climate Change Plans in Canada. *Climatic Change*, *152*(1), 121-143. https://doi.org/10.1007/s10584-018-2312-1

Harris, S., Weinzettel, J., Bigano, A., & Källmén, A. (2020). Low Carbon Cities in 2050? GHG Emissions of European Cities Using Production-Based and Consumption-Based Emission Accounting Methods. *Journal of Cleaner Production*, *248*, 119206. https://doi.org/10.1016/j.jclepro.2019.119206

Höhne, N., Gidden, M. J., den Elzen, M., Hans, F., Fyson, C., Geiges, A., Jeffery, M. L., Gonzales-Zuñiga, S., Mooldijk, S., Hare, W., & Rogelj, J. (2021). Wave of Net Zero Emission Targets Opens Window to Meeting The Paris Agreement. *Nature Climate Change*, *11*(10), 820-822. https://doi.org/10.1038/s41558-021-01142-2

Hsu, A., Höhne, N., Kuramochi, T., Roelfsema, M., Weinfurter, A., Xie, Y., Lütkehermöller, K., Chan, S., Corfee-Morlot, J., & Drost, P. (2019). A Research Roadmap for Quantifying Non-State and Subnational Climate Mitigation Action. *Nature Climate Change*, *9*(1), 11-17. https://doi.org/10.1038/s41558-018-0338-z

Hsu, A., Höhne, N., Kuramochi, T., Vilariño, V., & Sovacool, B. K. (2020). Beyond States: Harnessing Sub-National Actors for the Deep Decarbonisation of Cities, Regions, and Businesses. *Energy Research & Social Science*, *70*, 101738. https://doi.org/10.1016/j.erss.2020.101738

Hunger, J. D., & Wheelen, T. L. (2011). *Essentials of Strategic Management* (Fifth ed.). Pearson Education, Inc.

Ibrahim, N., Sugar, L., Hoornweg, D., & Kennedy, C. (2012). Greenhouse Gas Emissions from Cities: Comparison of International Inventory Frameworks. *Local Environment*, *17*(2), 223-241. https://doi.org/10.1080/13549839.2012.660909

ICLEI Canada. (2020). *Guidebook on Quantifying Greenhouse Gas Reductions at the Project Level*. https://fcm.ca/sites/default/files/documents/programs/pcp/guide-quantifying-ghg-reductions-project-level.pdf

IEA. (2021). *Net Zero by 2050*. IEA. https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

IFRS. (2022). *Who We Are*. International Financial Reporting Standards Foundation. Retrieved August 29, 2022 from https://www.ifrs.org/about-us/who-we-are/

IPCC. (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change. https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

IPCC. (2018). *Global Warming of 1.5°C [IPCC Special Report]*. Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SR15_Full_Report_LR.pdf

IPCC. (2021). *Climate Change 2021: The Physical Science Basis: Summary for Policymakers. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

Kammerer, M., & Namhata, C. (2018). What Drives the Adoption of Climate Change Mitigation Policy? A Dynamic Network Approach to Policy Diffusion. *Policy Sciences*, *51*(4), 477-513. https://doi.org/10.1007/s11077-018-9332-6

Kaselofsky, J., März, S., & Schüle, R. (2014). Bottom-up Monitoring of Municipal Energy and Climate Policy: More than an Alternative to Top-down Approaches? *Progress in Industrial Ecology, an International Journal*, *8*(4), 279-294. https://doi.org/10.1504/PIE.2014.066804

Keith, H., Vardon, M., Obst, C., Young, V., Houghton, R. A., & Mackey, B. (2021). Evaluating Nature-Based Solutions for Climate Mitigation and Conservation Requires Comprehensive Carbon Accounting. *Science of The Total Environment*, *769*, 144341. https://doi.org/10.1016/j.scitotenv.2020.144341

Kennedy, S., & Sgouridis, S. (2011). Rigorous Classification and Carbon Accounting Principles for Low and Zero Carbon Cities. *Energy Policy*, *39*(9), 5259-5268. https://doi.org/10.1016/j.enpol.2011.05.038

Klostermann, J., van de Sandt, K., Harley, M., Hildén, M., Leiter, T., van Minnen, J., Pieterse, N., & van Bree, L. (2018). Towards a Framework to Assess, Compare and Develop Monitoring and Evaluation of Climate Change Adaptation in Europe. *Mitigation and Adaptation Strategies for Global Change*, *23*(2), 187-209. https://doi.org/10.1007/s11027-015-9678-4

Kolk, A., Levy, D., & Pinkse, J. (2008). Corporate Responses in an Emerging Climate Regime: The Institutionalization and Commensuration of Carbon Disclosure. *European Accounting Review 17*(4), 719-745. https://doi.org/10.1080/09638180802489121

Kramers, A., Wangel, J., Johansson, S., Höjer, M., Finnveden, G., & Brandt, N. (2013). Towards a Comprehensive System of Methodological Considerations for Cities' Climate Targets. *Energy Policy*, *62*, 1276-1287. https://doi.org/10.1016/j.enpol.2013.06.093

Lambert, V. A., & Lambert, C. E. (2012). Qualitative Descriptive Research: An Acceptable Design. *Pacific Rim International Journal of Nursing Research*, *16*(4), 255-256. https://he02.tci-thaijo.org/index.php/PRIJNR/article/view/5805

Lara-Morales, O., & Clarke, A. (2023). Sustainable Tourism Value Chain Analysis as a Tool to Evaluate Tourism's Contribution to the Sustainable Development Goals and Local

Indigenous Communities. *Journal of Ecotourism,*, 1-19. https://doi.org/10.1080/14724049.2022.2147189
Linton, S., Clarke, A., & Tozer, L. (2021). Strategies and Governance for Implementing Deep Decarbonization Plans at the Local Level. *Sustainability*, *13*(1). https://doi.org/10.3390/su13010154
Linton, S., Clarke, A., & Tozer, L. (2022). Technical Pathways to Deep Decarbonization in Cities: Eight Best Practice Case Studies of Transformational Climate Mitigation. *Energy Research & Social Science*, *86*, 102422. https://doi.org/10.1016/j.erss.2021.102422
Lodhia, S. (2014). Factors Influencing the use of the World Wide Web for Sustainability Communication: an Australian Mining Perspective. *Journal of Cleaner Production*, *84*, 142-154. https://doi.org/10.1016/j.jclepro.2014.08.085
Lombardi, M., Laiola, E., Tricase, C., & Rana, R. (2017). Assessing the Urban Carbon Footprint: An Overview. *Environmental Impact Assessment Review*, *66*, 43-52. https://doi.org/10.1016/j.eiar.2017.06.005
Lovell, H., & MacKenzie, D. (2012). Accounting for Carbon: The Role of Accounting Professional Organisations in Governing Climate Change. In *The New Carbon Economy* (pp. 107-133). https://doi.org/10.1002/9781118315835.ch6
MacDonald, A., Clarke, A., & Huang, L. (2019). Multi-stakeholder Partnerships for Sustainability: Designing Decision-Making Processes for Partnership Capacity. *Journal of Business Ethics,*, *160*(2), 409-426. https://doi.org/10.1007/s10551-018-3885-3
MacDonald, A., Clarke, A., Ordonez-Ponce, E., Chai, Z., & Andreasen, J. (2020). Sustainability Managers: The Job Roles and Competencies of Building Sustainable Cities and Communities. *Public Performance & Management Review*, *43*(6), 1413-1444. https://doi.org/10.1080/15309576.2020.1803091
Mahmoudian, F., Lu, J., Yu, D., Nazari, J. A., & Herremans, I. M. (2021). Inter-and Intra-Organizational Stakeholder Arrangements in Carbon Management Accounting. *The British Accounting Review*, *53*(1), 100933. https://doi.org/10.1016/j.bar.2020.100933
Manabe, S. (2019). Role of Greenhouse Gas in Climate Change. *Tellus A: Dynamic Meteorology and Oceanography*, *71*(1), 1620078. https://doi.org/10.1080/16000870.2019.1620078
Marlowe, J., & Clarke, A. (2022). Carbon Accounting: A Systematic Literature Review and Directions for Future Research. *Green Finance*, *4*(1), 71-87. http://www.aimspress.com/article/doi/10.3934/GF.2022004
Martire, S., Mirabella, N., & Sala, S. (2018). Widening the Perspective in Greenhouse Gas Emissions Accounting: The Way Forward for Supporting Climate and Energy Policies at Municipal Level. *Journal of Cleaner Production*, *176*, 842-851. https://doi.org/10.1016/j.jclepro.2017.12.055
Meng, J., Mi, Z., Yang, H., Shan, Y., Guan, D., & Liu, J. (2017). The Consumption-Based Black Carbon Emissions of China's Megacities. *Journal of Cleaner Production*, *161*, 1275-1282. https://doi.org/10.1016/j.jclepro.2017.02.185
Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative Research: A Guide to Design and Implementation* (Fourth Edition ed.). John Wiley & Sons.
Mi, Z., Guan, D., Liu, Z., Liu, J., Viguié, V., Fromer, N., & Wang, Y. (2019). Cities: The Core of Climate Change Mitigation. *Journal of Cleaner Production*, *207*, 582-589. https://doi.org/10.1016/j.jclepro.2018.10.034

Mia, P., Hazelton, J., & Guthrie, J. (2018). Measuring for Climate Actions: A Disclosure Study of Ten Megacities. *Meditari Accountancy Research*. https://doi.org/10.1108/MEDAR-08-2017-0192

Mia, P., Hazelton, J., & Guthrie, J. (2019). Greenhouse Gas Emissions Disclosure by Cities: The Expectation Gap. *Sustainability Accounting, Management and Policy Journal*, *10*(4), 685-709. https://doi.org/10.1108/SAMPJ-11-2017-0138

Neves, A. R., & Leal, V. (2010). Energy Sustainability Indicators for Local Energy Planning: Review of Current Practices and Derivation of a New Framework. *Renewable and Sustainable Energy Reviews*, *14*(9), 2723-2735. https://doi.org/10.1016/j.rser.2010.07.067

O'Brien, K. (2018). Is the 1.5°C Target Possible? Exploring the Three Spheres of Transformation. *Current Opinion in Environmental Sustainability*, *31*, 153-160. https://doi.org/10.1016/j.cosust.2018.04.010

Oakley, K. L., Thomas, L. P., & Fancy, S. G. (2003). Guidelines for Long-Term Monitoring Protocols. *Wildlife Society Bulletin*, 1000-1003. http://www.jstor.org/stable/3784444

Ordonez-Ponce, E., Clarke, A., & MacDonald, A. (2021). Business Contributions to the Sustainable Development Goals Through Community Sustainability Partnerships. *Sustainability Accounting, Management and Policy Journal*, *12*(6), 1239-1267. https://doi.org/10.1108/SAMPJ-03-2020-0068

Perugini, L., Pellis, G., Grassi, G., Ciais, P., Dolman, H., House, J. I., Peters, G. P., Smith, P., Günther, D., & Peylin, P. (2021). Emerging Reporting and Verification Needs Under the Paris Agreement: How Can the Research Community Effectively Contribute? *Environmental Science & Policy 122*, 116-126. https://doi.org/10.1016/j.envsci.2021.04.012

Reckien, D., Salvia, M., Heidrich, O., Church, J. M., Pietrapertosa, F., De Gregorio-Hurtado, S., D'Alonzo, V., Foley, A., Simoes, S. G., Krkoška Lorencová, E., Orru, H., Orru, K., Wejs, A., Flacke, J., Olazabal, M., Geneletti, D., Feliu, E., Vasilie, S., Nador, C., Krook-Riekkola, A., Matosović, M., Fokaides, P. A., Ioannou, B. I., Flamos, A., Spyridaki, N.-A., Balzan, M. V., Fülöp, O., Paspaldzhiev, I., Grafakos, S., & Dawson, R. (2018). How Are Cities Planning to Respond to Climate Change? Assessment of Local Climate Plans from 885 Cities in the EU-28. *Journal of Cleaner Production*, *191*, 207-219. https://doi.org/10.1016/j.jclepro.2018.03.220

Rivas, S., Urraca, R., Palermo, V., & Bertoldi, P. (2022). Covenant of Mayors 2020: Drivers and Barriers for Monitoring Climate Action Plans. *Journal of Cleaner Production*, *332*, 130029. https://doi.org/10.1016/j.jclepro.2021.130029

Robinson, P., & Gore, C. (2015). Municipal Climate Reporting: Gaps in Monitoring and Implications for Governance and Action. *Environment and Planning C: Government and Policy*, *33*(5), 1058-1075. https://doi.org/10.1177/0263774X15605940

Robinson, P. J., & Gore, C. D. (2005). Barriers to Canadian Municipal Response to Climate Change. *Canadian Journal of Urban Research*, 102-120. http://www.jstor.org/stable/44320899

Rogelj, J., den Elzen, M., Höhne, N., Fransen, T., Fekete, H., Winkler, H., Schaeffer, R., Sha, F., Riahi, K., & Meinshausen, M. (2016). Paris Agreement Climate Proposals Need a Boost to Keep Warming Well Below 2 °C. *Nature*, *534*(7609), 631-639. https://doi.org/10.1038/nature18307

Rogelj, J., Luderer, G., Pietzcker, R. C., Kriegler, E., Schaeffer, M., Krey, V., & Riahi, K. (2015). Energy System Transformations for Limiting End-of-Century Warming to Below 1.5 °C. *Nature Climate Change*, *5*(6), 519-527. https://doi.org/10.1038/nclimate2572

Romero-Lankao, P., Bulkeley, H., Pelling, M., Burch, S., Gordon, D. J., Gupta, J., Johnson, C., Kurian, P., Lecavalier, E., Simon, D., Tozer, L., Ziervogel, G., & Munshi, D. (2018). Urban Transformative Potential in a Changing Climate. *Nature Climate Change*, *8*(9), 754-756. https://doi.org/10.1038/s41558-018-0264-0

Samuel, N., & Clarke, A. (2022). Partnerships and the Sustainable Development Goals. In E. Murphy, A. Banerjee, & P. P. Walsh (Eds.), *Partnerships and the Sustainable Development Goals* (pp. 13-26). Springer International Publishing. https://doi.org/10.1007/978-3-031-07461-5_2

Schepelmann, P., Goossens, Y., & Makipaa, A. (2009). *Towards Sustainable Development: Alternatives to GDP for Measuring Progress*. Wuppertal Spezial. http://hdl.handle.net/10419/59282

Seasons, M. (2003). Monitoring and Evaluation in Municipal Planning: Considering the Realities. *Journal of the American Planning Association*, *69*(4), 430-440. https://doi.org/10.1080/01944360308976329

Seto, K. C., Davis, S. J., Mitchell, R. B., Stokes, E. C., Unruh, G., & Ürge-Vorsatz, D. (2016). Carbon Lock-In: Types, Causes, and Policy Implications. *Annual Review of Environment and Resources*, *41*(1), 425-452. https://doi.org/10.1146/annurev-environ-110615-085934

Spash, C. L. (2016). This Changes Nothing: The Paris Agreement to Ignore Reality. *Globalizations*, *13*(6), 928-933. https://doi.org/10.1080/14747731.2016.1161119

Sperling, J. B., & Ramaswami, A. (2018). Cities and "Budget-Based" Management of the Energy-Water-Climate Nexus: Case Studies in Transportation Policy, Infrastructure Systems, and Urban Utility Risk Management. *Environmental Progress & Sustainable Energy*, *37*(1), 91-107. https://doi.org/10.1002/ep.12765

Sudmant, A., Gouldson, A., Millward-Hopkins, J., Scott, K., & Barrett, J. (2018). Producer Cities and Consumer Cities: Using Production- and Consumption-Based Carbon Accounts to Guide Climate Action in China, the UK, and the US. *Journal of Cleaner Production*, *176*, 654-662. https://doi.org/10.1016/j.jclepro.2017.12.139

Sun, X., Clarke, A., & MacDonald, A. (2020). Implementing Community Sustainability Plans Through Partnership: Examining the Relationship Between Partnership Structural Features and Climate Change Mitigation Outcomes. *Sustainability*, *12*(15), 6172. https://doi.org/10.3390/su12156172

TCFD. (2022). *About*. Task Force on Climate-Related Financial Disclosures. Retrieved August 29, 2022 from https://www.fsb-tcfd.org/about/#history

Tozer, L. (2013). Community Energy Plans in Canadian Cities: Success and Barriers in Implementation. *Local Environment*, *18*(1), 20-35. https://doi.org/10.1080/13549839.2012.716406

Tozer, L. (2019). Deep Decarbonization in Practice: Solutions and Challenges for Low-Carbon Building Retrofits. *Canadian Journal of Urban Research*, *28*(2), 32-45. https://www.jstor.org/stable/26868639

Tozer, L., & Klenk, N. (2018). Urban Configurations of Carbon Neutrality: Insights from the Carbon Neutral Cities Alliance. *Environment and Planning C: Politics and Space*, *37*(3), 539-557. https://doi.org/10.1177/2399654418784949

UN DESA - Population Division. (2018). *The World's Cities in 2018 - Data Booklet*. United Nations Department of Economic and Social Affairs. https://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2018_data_booklet.pdf

UN Habitat. (2015). *Guiding Principles for City Climate Action Planning*. United Nations Habitat. https://ecoplan.ca/Downloads/Guiding%20Principles%20for%20City%20Climate%20Action%20Planning_Habitat.pdf

Wiedmann, T., Chen, G., Owen, A., Lenzen, M., Doust, M., Barrett, J., & Steele, K. (2021). Three-Scope Carbon Emission Inventories of Global Cities. *Journal of Industrial Ecology*, *25*(3), 735-750. https://doi.org/10.1111/jiec.13063

Wong, K., Clarke, A., & Ordonez-Ponce, E. (2020). Cross-Sector Partnerships for Implementing Community Climate Action Plans: Implementation Structures, Partner Outcomes and Plan Outcomes. In G. v. Schnurbein (Ed.), *Transitioning to Strong Partnerships for the Sustainable Development Goals*. MDPI. https://doi.org/10.3390/books978-3-03897-883-1-9

WRI, C40, & ICLEI. (2021). *Global Protocol for Community-Scale Greenhouse Gas Inventories: An Accounting and Reporting Standard for Cities*. https://ghgprotocol.org/sites/default/files/standards/GPC_Full_MASTER_RW_v7.pdf

Wright, L. A., Coello, J., Kemp, S., & Williams, I. (2011). Carbon Footprinting for Climate Change Management in Cities. *Carbon Management*, *2*(1), 49-60. https://doi.org/10.4155/cmt.10.41

Yin, R. K. (2018). *Case Study Research and Applications* (Sixth ed.). Sage.

Zhou, Y., Clarke, A., & Cairns, S. (2020). Building Sustainable Communities Through Market-Based Instruments. In *Environmental Policy* (pp. 233-247). https://doi.org/https://doi.org/10.1002/9781119402619.ch14

Zhou, Y., Clarke, A., & Cairns, S. (2022). Toward Achieving Local Sustainable Development: Market-Based Instruments (MBIs) for Localizing UN Sustainable Development Goals. *Urban Science*, *6*(1), 24. https://www.mdpi.com/2413-8851/6/1/24

Zhou, Y., Clarke, A., & FCM. (2022). *Factsheet: Governance Components for Deep Decarbonization*. Federation of Canadian Municipalities https://fcm.ca/en/resources/mcip/factsheet-governance-components-deep-decarbonization

Appendices

Appendix 1: All Municipalities Included in the Study

Municipality	Province	Estimated Population	Corporate Inventory	Community Inventory
City of Calgary	AB	1,239,220	Yes	Yes
City of Edmonton	AB	980,000	Yes	Yes
City of Lethbridge	AB	99,769	Yes	Yes
City of Grande Prairie	AB	69,088	Yes	Yes
City of St. Albert	AB	66,082	Yes	Yes
City of Spruce Grove	AB	34,066	Yes	Yes
City of Leduc	AB	33,032	Yes	Yes
Town of Cochrane	AB	32,199	Yes	Yes
County of Parkland	AB	32,097	Yes	Yes
Town of Okotoks	AB	28,881	Yes	Yes
Town of Canmore	AB	19,880	Yes	Yes
Town of Stony Plain	AB	17,993	Yes	Yes
Greater Vancouver Regional District	BC	2,642,825	Yes	Yes
City of Vancouver	BC	631,486	Yes	Yes
City of Surrey	BC	517,887	Yes	Yes
Capital Regional District	BC	383,360	Yes	Yes
City of Burnaby	BC	249,125	No	Yes
City of Richmond	BC	209,937	No	Yes
Regional District of Nanaimo	BC	170,367	Yes	Yes
City of Kelowna	BC	144,576	Yes	Yes
City of Abbotsford	BC	141,397	Yes	Yes
City of Coquitlam	BC	139,284	Yes	Yes
Township of Langley	BC	117,285	Yes	Yes
District of Saanich	BC	114,148	No	Yes
City of Delta	BC	108,455	Yes	Yes
City of Nanaimo	BC	99,863	Yes	Yes
City of Kamloops	BC	90,280	Yes	Yes
Cowichan Valley Regional District	BC	89,013	Yes	Yes
District of North Vancouver	BC	85,935	No	Yes
City of Victoria	BC	85,792	No	Yes

District of Okanagan-Similkameen	BC	83,022	Yes	Yes
City of Maple Ridge	BC	82,256	Yes	Yes
City of Prince George	BC	74,003	Yes	Yes
City of New Westminster	BC	70,996	Yes	Yes
Comox Valley Regional District	BC	66,527	Yes	Yes
Region of East Kootenay	BC	65,896	Yes	Yes
Peace River Regional District	BC	62,942	No	Yes
Regional District of Central Kootenay	BC	59,517	Yes	Yes
City of Port Coquitlam	BC	58,612	Yes	Yes
City of North Vancouver	BC	52,898	Yes	Yes
District of West Vancouver	BC	44,122	Yes	No
District of Mission	BC	38,833	Yes	Yes
City of Penticton	BC	36,885	Yes	Yes
City of Port Moody	BC	33,551	Yes	Yes
City of Campbell River	BC	32,588	Yes	Yes
Regional District of Sunshine Coast	BC	32,170	Yes	Yes
District of North Cowichan	BC	31,990	Yes	Yes
Regional District of Kootenay Boundary	BC	31,447	Yes	Yes
Qathet Regional District	BC	20,070	Yes	No
City of Cranbrook	BC	20,047	Yes	Yes
District of Squamish	BC	19,512	Yes	Yes
City of Pitt Meadows	BC	19,146	Yes	Yes
City of Salmon Arm	BC	17,706	Yes	Yes
Township of Esquimalt	BC	17,655	Yes	Yes
District of Central Saanich	BC	16,814	Yes	Yes
Regional Municipality of Whistler	BC	13,982	Yes	Yes
City of Powell River	BC	13,943	Yes	Yes
District of Sooke	BC	13,001	Yes	Yes
City of Dawson Creek	BC	12,323	Yes	Yes
City of Terrace	BC	11,643	Yes	Yes
District of Summerland	BC	11,615	Yes	Yes
City of Williams Lake	BC	10,947	Yes	Yes
District of Sechelt	BC	10,847	Yes	Yes
City of Nelson	BC	10,572	Yes	Yes
Town of View Royal	BC	10,408	Yes	Yes
City of Quesnel	BC	10,007	Yes	Yes
City of Winnipeg	MB	705,245	Yes	Yes

City of Brandon	MB	48,859	Yes	Yes
Rural Municipality of Hanover	MB	17,216	Yes	Yes
Rural Municipality of Springfield	MB	16,142	Yes	Yes
City of Winkler	MB	13,745	Yes	Yes
City of Portage La Prairie	MB	13,270	Yes	Yes
City of Thompson	MB	13,035	Yes	Yes
Rural Municipality of St Andrews	MB	11,913	Yes	Yes
Rural Municipality of St. Clements	MB	11,586	Yes	Yes
City of Selkirk	MB	10,278	Yes	Yes
City of Moncton	NB	85,198	Yes	Yes
City of Saint John	NB	70,063	Yes	Yes
City of Fredericton	NB	58,220	Yes	Yes
Ville de Dieppe	NB	28,114	Yes	Yes
Town of Riverview	NB	20,584	Yes	Yes
Town of Quispamsis	NB	18,245	Yes	Yes
City of Miramichi	NB	17,537	Yes	Yes
City of Edmundston	NB	16,580	Yes	Yes
Town of Tracadie-Sheila	NB	16,000	Yes	Yes
City of Bathurst	NB	12,157	Yes	Yes
Town of Rothesay	NB	11,659	Yes	Yes
City of St John's	NL	109,633	Yes	Yes
Town of Conception Bay South	NL	26,199	Yes	Yes
City of Mount Pearl	NL	22,957	Yes	Yes
Town of Paradise	NL	21,389	Yes	No
City of Corner Brook	NL	19,806	Yes	Yes
Halifax Regional Municipality	NS	403,131	Yes	Yes
Colchester County	NS	36,091	Yes	Yes
Cumberland County	NS	30,005	No	Yes
Town of Lunenburg	NS	24,863	Yes	Yes
West Hants Regional Municipality	NS	15,368	Yes	Yes
Eastern Shelburne County	NS	13,966	No	Yes
Village of Chester	NS	10,310	No	Yes
City of Yellowknife	NWT	19,569	Yes	Yes
City of Toronto	ON	2,794,356	Yes	Yes
Region of Peel	ON	1,381,739	No	Yes
York Region	ON	1,173,103	Yes	No
City of Ottawa	ON	1,017,449	Yes	Yes

City of Mississauga	ON	717,961	Yes	Yes
Regional Municipality of Durham	ON	696,992	No	Yes
City of Brampton	ON	656,480	Yes	No
Region of Waterloo	ON	623,930	Yes	Yes
Regional Municipality of Halton	ON	548,435	Yes	Yes
City of Hamilton	ON	536,917	Yes	Yes
Regional Municipality of Niagara	ON	477,941	Yes	Yes
City of London	ON	401,000	Yes	Yes
City of Markham	ON	339,000	Yes	Yes
County of Simcoe	ON	307,050	Yes	No
City of Vaughan	ON	288,301	Yes	Yes
City of Kitchener	ON	233,222	Yes	Yes
City of Windsor	ON	217,188	Yes	Yes
City of Richmond Hill	ON	195,022	Yes	Yes
Town of Oakville	ON	193,832	Yes	Yes
City of Burlington	ON	183,314	Yes	Yes
City of Greater Sudbury	ON	161,531	Yes	Yes
City of Oshawa	ON	159,458	Yes	Yes
City of Barrie	ON	147,829	Yes	Yes
City of Cambridge	ON	138,479	Yes	Yes
City of St. Catharines	ON	133,113	Yes	Yes
City of Guelph	ON	131,794	No	Yes
Town of Whitby	ON	128,377	Yes	No
City of Kingston	ON	123,363	Yes	Yes
City of Waterloo	ON	121,436	Yes	Yes
Town of Ajax	ON	119,677	Yes	Yes
City of Thunder Bay	ON	107,909	Yes	Yes
City of Pickering	ON	99,186	Yes	Yes
City of Brantford	ON	98,500	Yes	Yes
Municipality of Clarington	ON	92,013	Yes	No
Northumberland County	ON	88,035	Yes	No
Town of Newmarket	ON	84,224	Yes	Yes
City of Peterborough	ON	81,032	Yes	Yes
City of Kawartha Lakes	ON	75,423	Yes	Yes
City of Sault Ste. Marie	ON	73,368	Yes	Yes
Lanark County	ON	68,698	Yes	Yes
Town of Caledon	ON	66,502	Yes	Yes

Town of Aurora	ON	61,845	No	Yes
Town of Halton Hills	ON	61,161	Yes	Yes
Dufferin County	ON	61,000	Yes	Yes
District of Muskoka	ON	60,599	Yes	Yes
County of Huron	ON	59,297	Yes	No
County of Peterborough	ON	55,800	Yes	Yes
City of Cornwall	ON	46,589	Yes	No
City of Timmins	ON	45,000	Yes	Yes
Town of East Gwillimbury	ON	34,637	No	Yes
City of Orillia	ON	33,411	Yes	No
City of Stratford	ON	31,465	Yes	Yes
Town of Orangeville	ON	28,900	Yes	Yes
King Township	ON	26,697	Yes	No
Town of Collingwood	ON	21,793	Yes	Yes
Township of Scugog	ON	21,581	Yes	Yes
Township of Uxbridge	ON	21,556	Yes	Yes
County of Haliburton	ON	20,571	Yes	Yes
Town of Cobourg	ON	19,440	Yes	Yes
Town of Georgian Bay	ON	19,012	Yes	Yes
Selwyn Township	ON	17,060	Yes	Yes
Loyalist Township	ON	17,000	Yes	Yes
Town of Port Hope	ON	16,969	Yes	Yes
Town of Midland	ON	16,864	Yes	Yes
Town of West Lincoln	ON	14,500	Yes	Yes
Town of Severn	ON	13,477	Yes	Yes
Regional Municipality of North Perth	ON	13,130	Yes	Yes
Town of Brock	ON	12,567	Yes	Yes
Township of Perth East	ON	12,261	No	Yes
Tiny Township	ON	11,787	Yes	Yes
Township of Hamilton	ON	10,942	Yes	Yes
Municipality of South Huron	ON	10,096	Yes	No
Town of Penetanguishene	ON	10,077	Yes	Yes
Tay Township	ON	10,033	Yes	Yes
Town of Cavan Monaghan	ON	10,016	Yes	Yes
City of Charlottetown	PE	38,809	Yes	Yes
Town of Stratford	PE	10,927	Yes	Yes
Ville de Montréal	QC	1,762,949	Yes	Yes

Ville de Québec	QC	550,326	Yes	Yes
Ville de Laval	QC	438,366	Yes	Yes
Ville de Gatineau	QC	291,042	Yes	Yes
Ville de Sherbrooke	QC	170,816	Yes	Yes
MRC de Vaudreuil-Soulanges	QC	164,529	Yes	Yes
Ville de Saguenay	QC	146,593	Yes	No
Ville de Montreal, Saint-Laurent	QC	98,828	Yes	Yes
MRC de Marguerite-d'Youville	QC	80,313	Yes	Yes
Ville de Sainte-Julie	QC	30,045	Yes	Yes
Arrondissement d'Outremont	QC	23,954	Yes	Yes
MRC de Nicolet-Yamaska	QC	23,848	Yes	Yes
Ville de Beloeil	QC	22,448	Yes	Yes
Ville de Joliette	QC	21,384	Yes	Yes
Ville de Varennes	QC	21,257	Yes	Yes
Ville de Candiac	QC	21,047	Yes	Yes
Ville de Rivière-du-Loup	QC	20,118	Yes	Yes
Ville de Beaconsfield	QC	19,977	Yes	Yes
MRC de la Côte-de-Gaspé	QC	17,547	Yes	Yes
MRC de Pontiac	QC	14,764	Yes	Yes
Ville de Saint-Amable	QC	13,322	Yes	Yes
Ville de Prévost	QC	13,290	Yes	Yes
MRC de Vals-de-Monts	QC	11,582	Yes	Yes
Ville de Bromont	QC	11,357	Yes	Yes
City of Saskatoon	SK	246,376	Yes	Yes
City of Regina	SK	226,404	Yes	Yes
City of Warman	SK	11,020	Yes	No
City of Whitehorse	YT	25,085	Yes	No

Appendix 2: Municipalities Included in the Monitoring and Reporting Samples

Municipality	Province	Estimated Population	Corporate Monitoring & Reporting	Community Monitoring & Reporting
City of Calgary	AB	1,239,220	Yes	Yes
City of Edmonton	AB	980,000	Yes	No
City of St. Albert	AB	66,082	Yes	Yes

City of Spruce Grove	AB	34,066	Yes	Yes
City of Leduc	AB	33,032	Yes	Yes
Town of Stony Plain	AB	17,993	Yes	Yes
Greater Vancouver Regional District	BC	2,642,825	Yes	Yes
City of Vancouver	BC	631,486	Yes	Yes
City of Surrey	BC	517,887	No	Yes
Capital Regional District	BC	383,360	Yes	Yes
City of Burnaby	BC	249,125	No	Yes
City of Richmond	BC	209,937	Yes	Yes
Regional District of Nanaimo	BC	170,367	Yes	Yes
City of Kelowna	BC	144,576	No	Yes
City of Abbotsford	BC	141,397	No	Yes
City of Coquitlam	BC	139,284	Yes	Yes
Township of Langley	BC	117,285	Yes	Yes
District of Saanich	BC	114,148	Yes	Yes
City of Delta	BC	108,455	Yes	Yes
City of Kamloops	BC	90,280	Yes	Yes
Cowichan Valley Regional District	BC	89,013	Yes	No
City of Victoria	BC	85,792	Yes	Yes
District of Okanagan-Similkameen	BC	83,022	Yes	Yes
City of Maple Ridge	BC	82,256	Yes	Yes
City of Prince George	BC	74,003	Yes	Yes
City of New Westminster	BC	70,996	Yes	Yes
Comox Valley Regional District	BC	66,527	Yes	No
Region of East Kootenay	BC	65,896	Yes	No
Regional District of Central Kootenay	BC	59,517	Yes	Yes
City of Port Coquitlam	BC	58,612	Yes	Yes
City of North Vancouver	BC	52,898	Yes	Yes
City of Penticton	BC	36,885	Yes	Yes
City of Port Moody	BC	33,551	Yes	Yes
City of Campbell River	BC	32,588	Yes	Yes
Regional District of Kootenay Boundary	BC	31,447	Yes	Yes
District of Squamish	BC	19,512	No	Yes
District of Central Saanich	BC	16,814	Yes	Yes
Regional Municipality of Whistler	BC	13,982	Yes	Yes
City of Powell River	BC	13,943	Yes	Yes
City of Dawson Creek	BC	12,323	Yes	Yes

City of Terrace	BC	11,643	Yes	Yes
City of Nelson	BC	10,572	Yes	Yes
City of Quesnel	BC	10,007	Yes	Yes
City of Winnipeg	MB	705,245	Yes	No
City of Brandon	MB	48,859	Yes	Yes
City of Fredericton	NB	58,220	Yes	Yes
Ville de Dieppe	NB	28,114	Yes	Yes
Town of Tracadie-Sheila	NB	16,000	Yes	Yes
City of Bathurst	NB	12,157	Yes	Yes
Town of Conception Bay South	NL	26,199	Yes	Yes
Halifax Regional Municipality	NS	403,131	Yes	No
City of Yellowknife	NWT	19,569	Yes	Yes
City of Toronto	ON	2,794,356	Yes	Yes
City of Ottawa	ON	1,017,449	Yes	Yes
City of Mississauga	ON	717,961	Yes	No
Region of Waterloo	ON	623,930	Yes	Yes
City of Hamilton	ON	536,917	Yes	No
City of Kitchener	ON	233,222	Yes	No
City of Richmond Hill	ON	195,022	Yes	Yes
Town of Oakville	ON	193,832	Yes	No
City of Burlington	ON	183,314	Yes	Yes
City of Greater Sudbury	ON	161,531	Yes	Yes
City of Oshawa	ON	159,458	Yes	No
City of Cambridge	ON	138,479	Yes	No
City of Guelph	ON	131,794	No	Yes
City of Kingston	ON	123,363	Yes	Yes
Town of Ajax	ON	119,677	No	Yes
City of Thunder Bay	ON	107,909	Yes	Yes
City of Pickering	ON	99,186	Yes	Yes
Municipality of Clarington	ON	92,013	Yes	No
Town of Caledon	ON	66,502	Yes	Yes
County of Peterborough	ON	55,800	Yes	Yes
Township of Uxbridge	ON	21,556	Yes	No
Selwyn Township	ON	17,060	Yes	Yes
Ville de Montreal, Saint-Laurent	QC	98,828	Yes	Yes
MRC de Nicolet-Yamaska	QC	23,848	Yes	Yes
Ville de Rivière-du-Loup	QC	20,118	Yes	Yes

MRC de Vals-de-Monts	QC	11,582	Yes	Yes
City of Regina	SK	226,404	Yes	Yes
City of Whitehorse	YT	25,085	Yes	No

Appendix 3: Municipalities Included in the Target Sample

Municipality	Province	Estimated Population
City of Calgary	AB	1,239,220
City of Edmonton	AB	980,000
City of Grande Prairie	AB	69,088
City of St. Albert	AB	66,082
City of Spruce Grove	AB	34,066
City of Leduc	AB	33,032
Town of Cochrane	AB	32,199
Parkland County	AB	32,097
Town of Okotoks	AB	28,881
Town of Canmore	AB	19,880
Town of Stony Plain	AB	17,993
Greater Vancouver Regional District	BC	2,642,825
City of Vancouver	BC	631,486
City of Surrey	BC	517,887
Capital Regional District	BC	383,360
City of Burnaby	BC	249,125
City of Richmond	BC	209,937
Regional District of Nanaimo	BC	170,367
City of Kelowna	BC	144,576
City of Abbotsford	BC	141,397
City of Coquitlam	BC	139,284
Township of Langley	BC	117,285
District of Saanich	BC	114,148
City of Delta	BC	108,455
City of Kamloops	BC	90,280
Cowichan Valley Regional District	BC	89,013
District of North Vancouver	BC	85,935
City of Victoria	BC	85,792

District of Okanagan-Similkameen	BC	83,022
City of Maple Ridge	BC	82,256
City of Prince George	BC	74,003
City of New Westminster	BC	70,996
Comox Valley Regional District	BC	66,527
Region of East Kootenay	BC	65,896
Peace River Regional District	BC	62,942
Regional District of Central Kootenay	BC	59,517
City of Port Coquitlam	BC	58,612
City of North Vancouver	BC	52,898
District of West Vancouver	BC	44,122
District of Mission	BC	38,833
City of Penticton	BC	36,885
City of Port Moody	BC	33,551
City of Campbell River	BC	32,588
Regional District of Sunshine Coast	BC	32,170
District of North Cowichan	BC	31,990
Regional District of Kootenay Boundary	BC	31,447
City of Cranbrook	BC	20,047
District of Squamish	BC	19,512
City of Pitt Meadows	BC	19,146
City of Salmon Arm	BC	17,706
Township of Esquimalt	BC	17,655
District of Central Saanich	BC	16,814
Regional Municipality of Whistler	BC	13,982
City of Powell River	BC	13,943
District of Sooke	BC	13,001
City of Dawson Creek	BC	12,323
City of Terrace	BC	11,643
District of Summerland	BC	11,615
City of Williams Lake	BC	10,947
District of Sechelt	BC	10,847
City of Nelson	BC	10,572
City of Quesnel	BC	10,007
City of Winnipeg	MB	705,245
City of Brandon	MB	48,859
Rural Municipality of Hanover	MB	17,216

Rural Municipality of Springfield	MB	16,142
City of Winkler	MB	13,745
City of Portage La Prairie	MB	13,270
City of Thompson	MB	13,035
Rural Municipality of St Andrews	MB	11,913
Rural Municipality of St. Clements	MB	11,586
City of Moncton	NB	85,198
City of Saint John	NB	70,063
City of Fredericton	NB	58,220
Ville de Dieppe	NB	28,114
Town of Riverview	NB	20,584
Town of Quispamsis	NB	18,245
City of Miramichi	NB	17,537
City of Edmundston	NB	16,580
Town of Tracadie-Sheila	NB	16,000
City of Bathurst	NB	12,157
Town of Rothesay	NB	11,659
City of St John's	NL	109,633
Town of Conception Bay South	NL	26,199
City of Corner Brook	NL	19,806
Halifax Regional Municipality	NS	403,131
Colchester County	NS	36,091
West Hants Regional Municipality	NS	15,368
City of Yellowknife	NWT	19,569
City of Toronto	ON	2,794,356
Region of Peel	ON	1,381,739
City of Ottawa	ON	1,017,449
City of Mississauga	ON	717,961
Regional Municipality of Durham	ON	696,992
City of Brampton	ON	656,480
Region of Waterloo	ON	623,930
City of Hamilton	ON	536,917
Regional Municipality of Niagara	ON	477,941
City of London	ON	401,000
City of Markham	ON	339,000
City of Vaughan	ON	288,301
City of Windsor	ON	217,188

City of Richmond Hill	ON	195,022
Town of Oakville	ON	193,832
City of Burlington	ON	183,314
City of Greater Sudbury	ON	161,531
City of Oshawa	ON	159,458
City of Barrie	ON	147,829
City of Guelph	ON	131,794
City of Kingston	ON	123,363
Town of Ajax	ON	119,677
City of Thunder Bay	ON	107,909
City of Brantford	ON	98,500
Town of Newmarket	ON	84,224
City of Peterborough	ON	81,032
City of Kawartha Lakes	ON	75,423
City of Sault Ste. Marie	ON	73,368
Town of Caledon	ON	66,502
Town of Aurora	ON	61,845
Town of Halton Hills	ON	61,161
Dufferin County	ON	61,000
County of Peterborough	ON	55,800
City of Timmins	ON	45,000
Town of East Gwillimbury	ON	34,637
City of Stratford	ON	31,465
Township of Scugog	ON	21,581
Township of Uxbridge	ON	21,556
Town of Cobourg	ON	19,440
Town of Georgian Bay	ON	19,012
Selwyn Township	ON	17,060
Loyalist Township	ON	17,000
Town of Midland	ON	16,864
Town of West Lincoln	ON	14,500
Town of Severn	ON	13,477
Town of Brock	ON	12,567
Tiny Township	ON	11,787
Town of Penetanguishene	ON	10,077
Tay Township	ON	10,033
City of Charlottetown	PE	38,809

Town of Stratford	PE	10,927
MRC de Vaudreuil-Soulanges	QC	164,529
Ville de Montréal	QC	1,762,949
Ville de Laval	QC	438,366
Ville de Sherbrooke	QC	170,816
Ville de Montreal, Saint-Laurent	QC	98,828
MRC de Marguerite-d'Youville	QC	80,313
Ville de Sainte-Julie	QC	30,045
MRC de Nicolet-Yamaska	QC	23,848
Ville de Varennes	QC	21,257
Ville de Candiac	QC	21,047
Ville de Rivière-du-Loup	QC	20,118
Ville de Beaconsfield	QC	19,977
MRC de la Côte-de-Gaspé	QC	17,547
MRC de Pontiac	QC	14,764
Ville de Saint-Amable	QC	13,322
Ville de Prévost	QC	13,290
MRC de Vals-de-Monts	QC	11,582
City of Saskatoon	SK	246,376
City of Regina	SK	226,404
City of Whitehorse	YT	25,085

Appendix 4: Municipalities Included in the High Emissions Reduction Sample in Order from Highest Reductions to Lowest

CORPORATE SAMPLE			**COMMUNITY SAMPLE**		
Municipality	**Province**	**Population**	**Municipality**	**Province**	**Population**
Ville de Rivière-du-Loup	QC	20118	City of Oshawa	ON	159,458
Ville de Saint-Amable	QC	13322	Cobourg	ON	19440
Town of Stratford	PE	10,927	City of Toronto	ON	2,794,356
London	ON	401000	Windsor	ON	217,188
MRC de Marguerite-d'Youville	QC	80,313	Corner Brook	NL	19806
City of Toronto	ON	2,794,356	Miramichi	NB	17537
Cobourg	ON	19440	City of Greater Sudbury	ON	161,531

City of Markham	ON	339,000	City of Burlington	ON	183,314
City of Burlington	ON	183,314	Burnaby	BC	249,125
City of Charlottetown	PE	38,809	City of Thunder Bay	ON	107,909
MRC de Nicolet-Yamaska	QC	23848	Stratford	ON	31465
City of Ottawa	ON	1,017,449	Edmundston	NB	16,580
City of Kitchener	ON	233,222	Loyalist Township	ON	17000
City of Richmond Hill	ON	195,022	City of Hamilton	ON	536,917
Fredericton	NB	58,220	District of Summerland	BC	11615
City of Oshawa	ON	159,458	London	ON	401000
Windsor	ON	217,188	City of Markham	ON	339,000
City of Vancouver	BC	631,486	Canmore	AB	19880
Edmundston	NB	16,580	District of Saanich	BC	125107
City of Spruce Grove	AB	34,066	Esquimalt	BC	17,655