

Deep Decarbonization in Cities: Pathways, Strategies, Governance Mechanisms and
Actors for Transformative Climate Action

by

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Author's 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

As the urgency for climate action heightens, local governments and stakeholders are developing short-term strategies and long-term pathways towards deep decarbonization at the local level. Urban areas are the largest place-based source of greenhouse gas emissions, accounting for 71%-76% of global emissions, and are projected to house 60% of the global population by 2030. Local governments have direct and indirect control of over 52% of emissions that occur within their municipalities. This study aims to qualitatively explore eight cases of best practice cities that are leading the way towards decarbonization. The eight cases are: Bridgewater (Nova Scotia, Canada), Park City (Utah, USA), Guelph (Ontario, Canada), Lahti (Finland), Vancouver (British Columbia, Canada), Oslo (Norway), Toronto (Ontario, Canada) and New York City (New York, USA). Cases were chosen based on the ambitiousness of climate action targets. Each Canadian case was paired with an international case similar in population size. The study was conducted to qualitatively explore the emerging best practice initiatives as well as highlight any patterns among the cities, depending on the population size and/or the national context. The method of qualitative investigation involved interviewing key municipal staff or plan managers on the pathways that are being implemented, the governance structures, the key actors and the tools being used for plan development and implementation. The results of this study fill theoretical gaps in the literature around the pathways that cities of different sizes are developing and the results help to provide understanding and insight on the key variables in deep decarbonization planning and implementation variables. Through identifying the key variables in the urban climate action literature, this study aimed to explore which of these were being addressed in climate action plans, and if cities were going beyond what the literature prescribed. The key research questions related to which sectors were the focus of emissions reduction pathways, what strategies were developed for plan development and implementation, how the plans were organized and governed, what key actors were involved. This study made contributions to the literature on decarbonization frameworks in six key areas by extending the literature to include new initiatives that leading cities are developing. The areas that this study contributes to are: decarbonizing the energy sector in small cities, increasing capacity of local carbon sinks, developing green economy targets and

workforce development, formalizing communication structures, bottom up vertical integration tactics, and creating funding mechanisms. The findings from this study can be useful for practitioners working towards local deep decarbonization as well as transnational city networks such as C40, CNCA and ICLEI as it highlights emerging best practices.

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Chapter 1. Introduction

1.1 Introduction and Problem Statement

In 2018, the IPCC released a special report on the status of climate change (IPCC, 2018). This report states that in order to limit global warming to 1.5 degrees Celsius and stabilize the climate, decarbonization of the planet by the year 2050 is essential (IPCC, 2018). This massive transformation that must occur within the next few decades will place decarbonization as the ultimate goal of the 21st century (IPCC, 2018).

Governments at all levels are committing to decreasing their greenhouse gas (GHG) emissions as a result of the increasing urgency of climate action. Many are committing to an “80 by 50” target, which represents a reduction of GHG emissions of 80% by the year 2050 (Carbon Neutral Cities Alliance, 2015). This is the target set out by the 2015 Paris Agreement (Kammerer & Namhata, 2018). Some governments and organizations are committing to an even more ambitious target of net carbon neutrality by the year 2050, which is in line with the more recent 2018 IPCC special report findings (CDP, 2019).

In order to reach global GHG reduction targets, cities and urban areas will be at the forefront of deep decarbonization practices (Carbon Neutral Cities Alliance, 2015). Urbanization is occurring at accelerating rates all over the world. In 2018, roughly 55.3 percent of the global population lived in urban settlements and that number is projected to increase to 60 percent by the year 2030 (United Nations-Department of Economic and Social Affairs-Population Division, 2018). Cities are the largest place-based source of GHG emissions, accounting for 71%-76% of global emissions (IPCC, 2014). Local governments have control directly and indirectly over 52% of emissions that occur within their cities and/or municipalities (FCM & ICLEI, 2018; Robinson & Gore, 2005; Tozer, 2013). An increasing number of cities have pledged to the 80 by 50 target and have created extensive plans in order to reach their goals (Carbon Neutral Cities Alliance, 2015; FCM & ICLEI, 2018). It is at the local scale that the application of technological and social innovation occurs most effectively and has the greatest impact in increasing sustainability at a broader scale (Dale, Ling, & Newman, 2010) (Dale et al., 2010).

There are four priority areas for cutting GHG emissions in cities; energy systems, buildings, waste and transportation (Carbon Neutral Cities Alliance, 2015; Deep Decarbonization Pathways Project, 2015; IPCC, 2018). By tackling these main sources of emissions, along with other actions including increasing carbon offsetting, carbon capture and storage and the capacity of carbon sinks in cities, deep decarbonization is technically feasible (Deep Decarbonization Pathways Project, 2015). Not only is the shift to deep decarbonization feasible, the plans have the added benefit of continuing to support and foster economic growth and account for increasing urban populations (Deep Decarbonization Pathways Project, 2015; IPCC, 2018).

Cities face many challenges as they work to implement their strategies for decarbonizing urban systems (Carbon Neutral Cities Alliance, 2015). The main barriers to the implementation and achievement of emissions targets are social and political in nature (Burch, 2018). Many cities are failing to achieve meaningful GHG emissions reductions in spite of the governance frameworks in place designed specifically for this purpose (Luque-Ayala, Marvin, & Bulkeley, 2018).

A rethinking of institutional structures, operational plans and budgets, including the way cities work with the community and business sectors will be required (Carbon Neutral Cities Alliance, 2015). Previous extractive models of low carbon transitions, where focus is placed on reducing emissions (point source pollution) should be replaced by embedded models of decarbonization (Luque-Ayala et al., 2018). An embedded model is one where a low carbon mentality is rooted in and across political rationalities and technical pathways (Luque-Ayala et al., 2018).

This thesis will examine and document the current practices of eight leading cities that have made the ambitious pledge to reduce their GHG emissions to meet a minimum of 80% reduction by 2050. Currently, there are gaps in knowledge regarding the different pathways to deep decarbonization at the local level. Van der Heijden (2019) highlighted a need for further research in governance structures and mechanisms for climate action. Decarbonization research thus far has focused on large high profile cities through transnational city networks such as C40

and the Carbon Neutral Cities Alliance. There are gaps in knowledge about planning and implementation processes regarding small towns and cities of varying sizes.

Through examining the current deep decarbonization literature and the result of eight leading case studies, this study aims to fill in the knowledge gaps for the pathways, strategies, governance and actors that local governments of varying sizes are using to implement deep decarbonization plans.

1.2 Research Questions

In order to study the pathways to deep decarbonization currently in practice in progressive pioneering cities, the following research questions have been developed. Addressing these questions will allow for greater insight into the decision-making and implementation processes of deep decarbonization strategies and gain a better understanding of how cities are forging pathways to deep decarbonization.

1. What are the GHG reduction pathways and strategies that are being developed for the implementation of deep decarbonization plans?
2. What planning and implementation strategies are outlined in the local deep decarbonization plans and/or are being utilized in order to implement the plans?
3. What forms of governance are being utilized in the planning and implementation of local deep decarbonization plans?
4. Who are the actors involved in local deep decarbonization strategies?
 - 4.1 What kind of roles do the actors undertake?

1.3 Contribution to Research

The objective of this study is to use the case study method to qualitatively explore deep decarbonization strategies, the key actors involved in the planning and implementation processes, the governance structures and mechanisms being used and other relevant tools and mechanisms for deep decarbonization in cities.

The purpose of this study is to determine which governance structures cities are using for the implementation of deep decarbonization and carbon neutrality plans. The study will provide insights into effective designs for achieving aggressive GHG reductions in cities; it will contribute to literature on climate policy, urban studies, and sustainability management.

To answer these research questions, an extensive literature review was conducted, and data was collected from eight cities as case studies, four Canadian and four international. Data collection was conducted in partnership with ICLEI Canada – Local Governments for Sustainability – an association of local governments whose mission is, "to build and serve a worldwide movement of local and regional governments that are committed to achieving tangible improvements in environmental sustainability" (ICLEI - Canada, n.d, p 1). The data collected was deductively coded and then inductively coded based on findings in the literature review. Cross-case comparisons were made, and the findings were determined.

1.4 Thesis Outline

This thesis is composed of six chapters. The Introduction (Chapter 1) is followed by a literature review (Chapter 2) that provides a comprehensive overview of the previous research and the current knowledge on deep decarbonization in cities. The literature review also frames the research questions and demonstrates the gap in current knowledge. The methodology chapter (Chapter 3) outlines the research design as well as the data analysis process. The results chapter (Chapter 4) presents the empirical findings. The discussion (Chapter 5) details the implications of the findings and provides answers to the research questions. Lastly, the conclusion (Chapter 6) summarizes the overall thesis as well as outlines the contributions of the research, its limitations and potential future research directions.

Chapter 2: Literature Review

The following literature review summarizes the up to date knowledge deep decarbonization pathways and strategies at the local level. The chapter begins with an introduction to climate change, deep decarbonization, climate action planning at the local level, and then discusses the existing literature regarding the four research questions on the technical pathways, institutionalization strategies, governance and actors for local deep decarbonization.

2. Climate Change

Over the past three decades, concern over climate change defined as “long term changes in temperature and precipitation patterns” (Bernauer, 2013 p. 422) has moved from the purview of natural scientists and environmental activists to the top of the international and national agendas and policies (Bernauer, 2013; Smith et al., 2009). It is now undeniable that the continuous burning of fossil fuels and other human activity is changing the climate at an unprecedented rate leaving cities all over the world vulnerable to massive repercussions (IPCC, 2018). Climate change is a very complex problem, with many social, political and technological factors and barriers (Bernauer, 2013; Burch, 2018; IPCC, 2014, 2018; Rogelj et al., 2015). Yet, its urgency and imminence makes it the greatest issue of the 21st century (IPCC 2018).

2.1.1 GHG Mitigation

GHG mitigation refers to the efforts to reduce or prevent emissions (IPCC, 2014). The only way to limit global warming is to reduce GHG emissions and simultaneously increase carbon offsetting, the capacity of carbon sinks, and the rate of carbon capture and storage (CCaS) in large emitting industries and/or facilities (IPCC, 2018). The IPCC Special Report on Climate Change published in 2018 states that in order to limit global warming to 1.5 degrees Celsius, GHG emissions must be reduced by 45% by 2030 (compared to 2010 levels) and be effectively (net) zero by 2050 (IPCC, 2018). The need for emission reductions has been established and recognized globally and there are many strategies for GHG mitigation including transitioning away from the use of fossil fuels and moving towards renewable sources of energy and new technologies, making older equipment more energy efficient, and changing management practices and consumer behaviour (Day et al., 2018).

GHG mitigation from human sources can be viewed as a collective action problem in which individual actors make independent decisions and actions, whose outcomes jointly affect everyone (Ostrom, 2010). The costs of GHG mitigation are borne locally, but the benefits are distributed globally (Brozynski & Leibowicz, 2018). Without an appropriate policy framework at the global scale, individual actors have insufficient incentives to curb their own emissions (Brozynski & Leibowicz, 2018).

2.1.2 Paris Agreement

The need for emission reductions has been established and recognized globally. There have been multiple attempts at international accords to limit GHG emissions and climate change, such as the Kyoto Protocol and the Paris Agreement, though many of these have not been overly successful (Kammerer & Namhata, 2018). The 2015 Paris Agreement was first international treaty in the history of climate change politics where 197 countries agreed to act cohesively (Kammerer & Namhata, 2018). The agreement recognizes the need to limit global warming to well below 2 degrees above preindustrial averages (Kammerer & Namhata, 2018). There is concern as to whether this accord will be effective as it is based on the voluntary pledges of each nation, without any provisions for legally binding emission targets (Spash, 2016). Many climate scientists argue that the current national pledges are barely sufficient to contain a temperature rise at 2°C (Robiou du Pont et al., 2017). Additionally, as mentioned previously, the IPCC released a special report in 2018 urging more ambitious global climate action to limit global warming to 1.5°C (IPCC 2018).

2.2 Deep Decarbonization

In order to reach the GHG reduction levels needed to limit global warming to 1.5 degrees Celsius, rapid and far-reaching transitions must occur (IPCC, 2018). Considering this reality, deep decarbonization has emerged at the forefront of climate policies. Deep decarbonization is a polycentric approach to tackling climate change where mitigation activities are undertaken by many actors at many levels (Brozynski & Leibowicz, 2018; Ostrom, 2010). In essence, decarbonization is the transformation to integrate ‘zero carbon’ into urban systems while also considering broader sustainability goals such as climate adaptation, social equity and institutional transitions (Bernstein and Hoffmann 2018; Tozer 2019). Deep decarbonization is a useful framework because it goes beyond GHG mitigation. It has the ability to capture the

social and political dynamics that are essential for effective climate change mitigation initiative design and implementation (Tozer, 2019).

Local deep decarbonization refers to deep GHG mitigation and specifically targets urban transformation (Carbon Neutral Cities Alliance, 2015). Decarbonization is a complete transformation of the systems and technologies that rely on fossil fuels. This requires a rethinking of institutional structures, operational plans and budgets, as well as changing to the way governments work with the community and business sectors (Carbon Neutral Cities Alliance, 2015; Sachs, Schmidt-Traub, & Williams, 2015).

Achieving deep decarbonization is a daunting task. Until recently, leading nations, cities and organizations have pursued this in relative isolation from each other (Carbon Neutral Cities Alliance, 2015; Tozer & Klenk, 2019). Now, networks and alliances such as the Deep Decarbonization Pathways Project (DDPP) and the Carbon Neutral Cities Alliance (CNCA) have emerged in order to streamline the decarbonization process, share resources, and disseminate information (Carbon Neutral Cities Alliance, 2015; Deep Decarbonization Pathways Project, 2015; O'Brien, 2018). Various roadmaps and pathways to achieving rapid decarbonization have been developed, acknowledging the need for transformations in all sectors, including energy, agriculture, construction, transport, manufacturing, and finance (O'Brien, 2018).

Deep decarbonization planning is emerging as a sophisticated, data-driven, adaptive, performance management approach and is increasingly being integrated with other planning processes (Carbon Neutral Cities Alliance, 2015). In both the short and long term, decarbonization will affect most aspects of economic activity in every economy in the world (Association, 2018). It will lead to a transformation in how goods and services are produced and consumed at a scale similar to that of the industrial revolution (Association, 2018).

For the purpose of this thesis, "deep decarbonization" targets in cities includes the 80 by 50 reduction target and/or targets that are more ambitious, such as carbon neutrality by 2050 or earlier.

2.2.1 Incremental and Transformative Change

In order to reach deep decarbonization targets, a transformative change will have to occur in most systems and societies (Carbon Neutral Cities Alliance, 2015; Deep Decarbonization Pathways Project, 2015; IPCC, 2018; O'Brien, 2018). Incremental change refers to a small adjustment made toward a targeted result (Kates, Travis, & Wilbanks, 2012). Historically, this has been the predominant approach towards GHG mitigation and climate action (Sachs et al., 2015). Making an incremental change does not have a significant impact on the existing structures of carbon lock-in and therefore is not sufficient for deep decarbonization (Kates et al., 2012; Sachs et al., 2015). While improving energy efficiency in technology for example decreases combustion engine GHG emissions, it will not eliminate them (Lawson & Ahmad, 2018). This example of incremental change helps countries, cities and organizations decrease their carbon footprints while at the same time reinforces a carbon-lock in/ carbon trap (Lawson & Ahmad, 2018; Sachs, 2015).

Deep decarbonization requires a full transformation so that systems, societies and technologies are no longer reliant on fossil fuels (Sachs, 2015). Natural gas and fuel-efficient vehicles will not be enough to reach global emissions targets (Lawson & Ahmad, 2018; Sachs, 2015). Zero-carbon electricity and electric vehicles charged on the zero-carbon electricity grid are examples of the more profound transformation that offers the only path to a safe climate (Sachs et al., 2015).

A transformative approach is a way to fundamentally redesign a large-scale carbon-emitting sector or system so that it can eventually operate with no or little carbon emissions (Carbon Neutral Cities Alliance, 2015). The transformative approach has developed important insights with respect to the large-scale societal transitions needed to respond to climate change (Rosenbloom & Meadowcroft, 2014). It is technically more complex and rigorous enough to support private and public sector investments that will achieve deep emissions reductions and related co-benefits (Patterson et al., 2015; Walker, Holling, Carpenter, & Kinzig, 2004). Transformations are dynamic, political, and involve multiple dimensions of change (Patterson et al., 2015). They provide an opportunity to create a fundamentally new system when ecological, economic, or social conditions make the existing system unsupportable (Walker et al., 2004).

System transformation for decarbonization requires the alignment of stakeholders around an ambitious carbon emissions goal and a vision for what the redesigned system will look like (Carbon Neutral Cities Alliance, 2015). Policy decisions must be made at multiple levels of government and enormous financial investments by governments and the private sector will be essential to a system transformation (Carbon Neutral Cities Alliance, 2015). In addition, behaviour changes at the individual level are vital and inevitable for deep decarbonization to be accomplished (Carbon Neutral Cities Alliance, 2015).

Rapid and deep decarbonization requires transformation of sociotechnical systems, which are the interlinked mix of technologies, infrastructures, organizations, markets, regulations, and user practices that together deliver societal functions (Geels, Sovacool, Schwanen, & Sorrell, 2017). Climate strategies must address the multidimensional nature of the deep decarbonization challenge (Deep Decarbonization Pathways Project, 2015). Co-evolutionary interactions between technology and society are vital to solving this challenge (Geels et al., 2017; Rosenbloom & Meadowcroft, 2014).

2.2.2 Co-benefits of Decarbonization

Decarbonization avoids the grave cost of climate change inaction and has the positive contribution of providing many co-benefits (Day et al., 2018; Ürge-Vorsatz, Herrero, Dubash, & Lecocq, 2014). GHG mitigation can result in consequences in areas other than climate and thus can serve diverse policy purposes and social priorities (Day et al., 2018). Co-benefits have become a key area of climate change and energy discourses and are tied to a greater purpose of sustainable development (Eberhard & Madlener, 2003). The definition of co-benefits varies internationally. Co-benefits may be secondary benefits of climate action, secondary climate benefits from other policy actions, or the combination of climate and non climate benefits (Floater et al., 2016). There is evidence that mitigation measures have a range of positive human health, ecosystem functioning, macroeconomic, social, and/or equity side effects that in some cases outweigh the importance of climate change mitigation benefits (Ürge-Vorsatz et al., 2014). From green jobs and growth, to active, happier lives and cleaner air and water, climate action strategies can have an immediate and tangible impact on lives (Day et al., 2018).

The ability to demonstrate the co-benefits of climate action is a critical first step to unlocking its potential (Day et al., 2018; Gonzales-Zuñiga et al., 2018). Ideally, the co-benefits should be regularly considered in decision making related to climate or energy investment or policy (Day et al., 2018; Eberhard & Madlener, 2003; Ürge-Vorsatz et al., 2014). Co-benefit considerations are rarely accounted for in decision making, partially because traditional decision making frameworks (such as cost-benefit analysis) are lacking a multidisciplinary outlook (Ürge-Vorsatz et al., 2014). In order to reap the co-benefits of decarbonization, policies and decisions must be taken with consideration of the full range of costs and benefits (Ürge-Vorsatz et al., 2014).

2.3 Local Climate Action Planning

The concept of addressing large, transboundary issues such as climate change at the local level was first raised in a chapter of the 1987 Brundtland Report (Fuhr, Hickmann, & Kern, 2018). This chapter was dedicated to the environmental challenges of urban areas and the importance of local governments in attaining sustainable development (Fuhr et al., 2018). The 1992 Rio Earth Summit and Agenda 21 re-emphasized the role played by cities in response to climate change. Climate action at the local level has continued to gain momentum with initiatives at the international level such as the New Urban Agenda (2016) and the Sustainable Development Goals (2015) (Fuhr et al., 2018).

As urban areas account for 71%-76% of global GHG emissions (IPCC, 2014) and local governments have direct and indirect control of over 52% of emissions (FCM & ICLEI, 2018; Robinson & Gore, 2005; Tozer, 2013), it is apparent that urban areas will be at the forefront of climate action. Local governments have pledged to a target of reducing community-wide GHG emissions by 80% by the year 2050 and they have created extensive plans in order to reach their goals (Carbon Neutral Cities Alliance, 2015; FCM & ICLEI, 2018). It is at the local scale that the application of technological and social innovation occurs most effectively and has the greatest impact in increasing sustainability at a broader scale (Dale et al., 2010). Climate action planning in cities has evolved to become a complex performance management approach that is increasingly being tied to other local government planning and budgetary processes (Carbon Neutral Cities Alliance, 2015). The key characteristics of climate action planning in cities are: political continuity, deep technical analysis, stakeholder engagement, planning for infrastructure turnover and planning

and measurement systems established (Carbon Neutral Cities Alliance, 2015). Guyadeen, Thistlethwaite & Henstra (2019) conducted a study on the quality of municipal climate change plans in Canada. They found that most plans (in the Canadian context) include some combination of the eight main characteristics: fact based, goals, policies, implementation and inter-organizational coordination, monitoring and evaluation, participation, and plan organization and presentation (Guyadeen, Thistlethwaite, & Henstra, 2019). They also found that many Canadian municipalities, while acknowledging the importance of stakeholder participation and engagement, did not adequately consider this element in the planning process (Guyadeen et al., 2019).

There is a significant level of uncertainty that cities must address when planning for decarbonization (Carbon Neutral Cities Alliance, 2015). Many local governments are dependant on the decisions of higher levels of government, therefore changes in federal policy can impact climate action at the local level (Carbon Neutral Cities Alliance, 2015). Predicting impacts of climate change as well as the impact of GHG reduction strategies can be very difficult, making it hard for planners to calculate projections with certainty (Carbon Neutral Cities Alliance, 2015). Funding to support climate action in cities is also uncertain due to the reliance on many sources of funding from multiple levels of government (Carbon Neutral Cities Alliance, 2015).

2.3.1 Corporate and Community Plans

There are two types of local climate action plans led by municipal governments - corporate and community. Corporate plans reflect the control that local governments have around land use, transportation planning, waste management, and greening of public infrastructure and the amount of emissions for these sectors (FCM & ICLEI, 2018; Robinson & Gore, 2005). Local governments can also influence emissions from energy and other economic development (Clarke & Ordonez-Ponce, 2017). Through their direct influence over their areas, corporate climate action plans are created, where the “corporation” is the local government itself and the corporate plan focuses on actions within their control and influence (Clarke & Ordonez-Ponce, 2017). Community climate action plans, in comparison, consider all GHGs emitted within the local geographic boundaries of the community (FCM & ICLEI, 2015). Emissions from industry, home heating, burning fuel in private vehicles, etc. are all considered in community plans (FCM & ICLEI, 2015). Local governments have less jurisdiction over the community-wide GHG emissions, making it imperative that

community plans include large multi-stakeholder partnerships to be successful (Clarke & Ordonez-Ponce, 2017).

2.3.2 The Planning Process

Decarbonization is a long term and ongoing process that requires extensive planning.

Many networks and organizations have created their own effective processes. For example, the Partners for Climate Protection Program uses a five-milestone framework for their climate action planning and implementation (FCM & ICLEI, 2018). GHG mitigation and decarbonization begins with taking an inventory of current emissions and creating a forecast of future emissions (FCM & ICLEI, 2018). Without a reliable inventory, it is difficult for city planners to identify where efforts should be directed (Brozynski & Leibowicz, 2018). The second milestone is to set emission reduction targets (FCM & ICLEI, 2018). Next an action plan for the community (based on the targets) is developed (FCM & ICLEI, 2018). The fourth milestone is to implement the action plan while the fifth and final milestone is to continuously monitor and report on the progress of the climate action plan implementation (FCM & ICLEI, 2018). While the process for corporate and community climate action plans is similar, corporate plans are solely developed and adopted by the local government whereas, community plans are developed by the local government in collaboration with many local actors such as businesses, NGOs and citizen organizations (Clarke & Crane, 2018; Clarke & Ordonez-Ponce, 2017).

2.4 Pathways for Deep Decarbonization in Cities & Communities

Road maps and pathways for deep decarbonization are important for describing, planning and tracking the technological, managerial, institutional and behavioural changes consistent with the targets and goals that have been set out (Carbon Neutral Cities Alliance, 2015; Deep Decarbonization Pathways Project, 2015; O'Brien, 2018). Pathways include strategies and actions for all relevant sectors, both in the short and long term (Carbon Neutral Cities Alliance, 2015). Pathways provide a common method by which governments, business, civil society and researchers can communicate, compare and debate differing concrete visions for deep decarbonization (O'Brien, 2018). Pathways are increasingly being used to communicate stories about large-scale transformations (O'Brien, 2018). They also aid in the design and implementation of short-term

policy packages that are consistent with long-term global decarbonization (Deep Decarbonization Pathways Project, 2015).

Brozynski and Leibowicz (2018) propose that decarbonization pathways consist of two sequential stages. The first is to decarbonize the power sector and then shift focus to the transportation sector (Brozynski & Leibowicz, 2018). Together these two sectors account for the largest share of global GHG emissions (IPCC, 2018).

The Aspen Institute (2019) has outlined the five elements of achieving deep decarbonization. The first is to maximize energy efficiency in order to reduce the energy needs that must be met. The second is to decarbonize the electricity supply by switching to renewable and zero emission sources of energy. The third element is to transfer clean electricity into other sectors such as transportation and buildings. Fourth, use zero-carbon fuels for the remaining areas that cannot be effectively electrified. And last is to use carbon capture and carbon dioxide removal for areas where fossil fuels are still needed as well as for achieving negative emissions (Ballentine, Connaughton, & Grossman, 2019). Along with the technical pathways that address GHG emissions by sector, cities must institutionalize deep decarbonization by taking actions that ensure the commitment, and involvement of stakeholders to reinforce deep decarbonization (Carbon Neutral Cities Alliance, 2015).

2.4.1 Scope of Emissions

There are three scopes of accounting for GHG emissions within a city (Bhatia, Ranganathan, & WBCSD, 2004). Scope 1 refers to direct GHG emissions from a geographical unit (e.g., Emissions from vehicles in that area, buildings). Scope 2 is the emissions from the use of electricity and Scope 3 is all the other emissions released indirectly by the city & its citizens (e.g., the emissions associated with imported goods, air travel etc) (Bhatia et al., 2004). This thesis is focused on Scope 1 and 2.

2.4.2 Four Priority Sectors in Cities

There are many different sources of emissions in cities. Four priority areas in cities have been identified as the sectors with the largest GHG potential; energy, buildings, waste and transportation (Carbon Neutral Cities Alliance, 2015; Deep Decarbonization Pathways Project, 2015; IPCC, 2018; USDN, 2018). The focus is placed on these sectors because they represent the vast majority of city-wide emissions and local governments have a degree of control and/or jurisdiction over them (Carbon Neutral Cities Alliance, 2015; Deep Decarbonization Pathways Project, 2015). By tackling these main sources of emission (among other actions) deep decarbonization is technically feasible (Deep Decarbonization Pathways Project, 2015).

2.4.2.1 Energy

Energy systems are comprised of three aspects: generation, distribution, and use (Carbon Neutral Cities Alliance, 2015). Generation, which occurs in generators or power plants, refers to the transformation of primary energy sources to usable energy (Carbon Neutral Cities Alliance, 2015). Distribution refers to the delivery network for usable energy from where it is generated to where it is used (Carbon Neutral Cities Alliance, 2015). Use refers to the amount of energy consumed and the total demand of energy (Carbon Neutral Cities Alliance, 2015). Decarbonization of the entire energy sector is needed to address ambitious climate goals in cities (Ballentine et al., 2019; Brozynski & Leibowicz, 2018; C40 & ARUP, 2016; De Chalendar, Glynn, & Benson, 2019; Rogelj et al., 2015).

Many cities are dependant on the decisions of higher levels of government and utility companies when it comes to their energy (C40 & ARUP, 2016; Koben et al., 2017). Due to city-specific geography and history, access to renewable and clean energy varies (Carbon Neutral Cities Alliance, 2015). Despite these differences, cities tend to have similar energy supply system conditions, visions for what a redesigned energy system will look like, and common barriers to system change (Carbon Neutral Cities Alliance, 2015). The balance between pushing for increased energy efficiency and a decrease in the carbon content of the energy supply is also a common occurrence in most cities today (Carbon Neutral Cities Alliance, 2015).

Morvaj et al., created an energy optimization model for decarbonizing urban energy systems and concluded that it is only possible to have a carbon neutral district when clean and renewable energy sources account for 100% of the grid (Morvaj, Evins, & Carmeliet, 2017). Since a large number of cities do not have full control over their energy supply, these cities can focus on deploying building-scale and district clean energy solutions, and industrial efficiency to decarbonize their energy sector (C40 & ARUP, 2016).

2.4.2.2 Buildings

Buildings emit a large amount of GHGs through their energy, making them a substantial target for low carbon action (Broto & Bulkeley, 2013; Edwards & Bulkeley, 2017; Lovell, 2007; Tozer, 2019). The sector encompasses the energy consumption by residential, commercial, industrial, and public facilities, including streetscapes (Carbon Neutral Cities Alliance, 2015). This sector is related to the “use” category of the Energy sector.

There are many factors to consider when evaluating the emissions of buildings because the type, age, uses, construction methods and materials, height, size, age, energy-use intensity and type of energy use of building stock vary between and within cities (Carbon Neutral Cities Alliance, 2015). Buildings have long life spans, and as such; reductions from net-zero techniques in new constructions will not be enough to reach current GHG reduction goals (Billimoria, Guccione, Hennen, & Louis-Prescott, 2018). Retrofits of existing buildings are critical in successful decarbonization (Hoicka & Das, 2020).

Local decarbonization plans for the building sector have two subsets; existing (old) buildings and new developments (C40 & ARUP, 2016; Carbon Neutral Cities Alliance, 2015).

2.4.2.2.1 Existing Buildings

For existing buildings, retrofits are necessary to improve energy efficiency and convert heating and cooling systems from natural gas and fuel oil to electric or other zero carbon sources (Billimoria et al., 2018; Salon et al., 2010). There is a growing consensus that building electrification is the most viable and predictable path to zero-emission buildings in many

locations (Koben et al., 2017). Greenhouse gas savings from building retrofits can be realized more quickly than GHG reductions from other sectors and deliver net cost savings. They are cost effective when compared to other climate mitigation measures (Lucon et al., 2014) and can provide social and economic benefits, such as improved health and comfort, and lower energy costs (Hoicka & Das, 2020; Lucon et al., 2014).

There is a role for local governments to strengthen the market for building retrofits. They can use different strategies to approach different building owners supported by the identification selling points that go beyond a business case based on lower energy bill (CNCA, 2016). New strategies are also needed to secure financing for retrofits in the existing building stock and they should be based on a combined effort from public and private stakeholders (CNCA, 2016). Programs like Property Assessed Clean Energy (PACE) have shown some promise in its way of disconnecting the debt of the building owner undertaking the retrofit and attaching it to the building itself. Green Bonds are emerging as a ‘new city tool’ in this sector (CNCA, 2016). To get the investment vehicles moving and market liquidity flowing, retrofit investments can be up-scaled and include cash-flows from both private markets and investments projects from public offices (CNCA, 2016).

2.4.2.2.2 New Buildings

Efficiency and building standards can be implemented by cities for all new developments, making all new buildings low or zero carbon emitters (Billimoria et al., 2018). A zero-emissions, or “net-zero”, building standard is one that requires new buildings to be designed and equipped so that all energy use (for heating, cooling, lighting, appliances, vehicle charging, etc.) is efficient and comes only from renewable energy sources (Shank, 2018). By increasing the standards for existing and new buildings as well as encouraging data reporting from all buildings, cities can substantially decrease the GHG emissions from the building sector (C40 & ARUP, 2016; Salon et al., 2010).

Responsibility for building regulation in Canada rests with the provinces and territories (Canadian Home Builders’ Association, n.d.). There are processes in place that work to minimize variations in codes and standards and promote consistency and uniformity (Canadian

Home Builders' Association, n.d.). With the exception of Vancouver, city building codes are based on the national model, and are adopted in each of the provinces and territories with little or no change (Canadian Home Builders' Association, n.d.).

Local governments can play a role in regulating and educating for improved building performance. Through local policies and programs, municipal governments can influence both the technical efficiency of buildings and the energy-use behaviours of their inhabitants (Salon et al., 2010). They are also able to act as regulator, convener, facilitator, as well as a strategic partner along with higher levels of governments for policy design and implementation (Becque et al., 2019; Salon et al., 2010). Local governments can lead by example as an owner/investor of a substantial portfolio of buildings (Becque et al., 2019).

In recent years, researchers and policy makers have acknowledged that in order to truly decarbonize the built environment, fossil fuel GHG emissions must be eliminated from both building operations and the embodied carbon of building materials and construction (Shank, 2018).

2.4.2.3 Waste

Waste disposal places a heavy load on urban infrastructure and requires land and energy consumption for the construction and operation of waste disposal infrastructure (UNECE, 2011; Zaman & Lehmann, 2013). Solid waste is a product at the end of its lifecycle and the continual production of it consumes resources and energy (UNECE, 2011). Waste landfills are among the most significant emitters of methane and, when burned, waste is also responsible for carbon emissions (Koben et al., 2017). Financially, there is a large lost opportunity cost of materials that could be composted or recycled going to landfills (Sandulescu, 2004; Zaman & Lehmann, 2013). Although this sector is considered small, it still responsible for a significant amount of GHG emissions in cities and for this reason, it is considered to be of the priority sectors for decarbonization (Carbon Neutral Cities Alliance, 2015).

GHG emissions from the waste sector can be reduced or eliminated by reducing the amount of waste produced and by redirecting waste going to landfills (Sandulescu, 2004; Zaman & Lehmann,

2011, 2013). Non-recyclable materials can be converted into usable energy – heat, electricity or fuel through a variety of waste to energy (W2E) processes (Moya, Aldás, Jaramillo, Játiva, & Kaparaju, 2017). GHGs that are released from landfills can be captured with landfill gas capture systems (Carbon Neutral Cities Alliance, 2015).

Communities can commit to zero waste, meaning that no material goes to landfill or high-temperature destruction (Carbon Neutral Cities Alliance, 2015; Koben et al., 2017). Instead, local governments can design their solid waste systems to prevent waste, reduce and reuse materials, recycle and compost, and recover energy in ways that do not release carbon emissions (Carbon Neutral Cities Alliance, 2015; Zaman & Lehmann, 2011).

Zero waste commitments are a part of a broader sustainable consumption approach, which has adapted the “reduce, reuse, recycle” model to include “refuse, rethink, redesign” (Ewall, n.d.; Zero Waste International Alliance, 2018). This model involves not only improvements in waste management, through actions like improving the design and packaging of products to minimize waste, it also encourages systems where waste is not generated in the first place (Zero Waste International Alliance, 2018). “Refuse, rethink, redesign” involves influencing upstream purchasing decisions through consuming less, consuming smartly and influencing producers to produce less non-recyclable, non-compostable goods and packaging and with longer life cycles (Zero Waste International Alliance, 2018)

Behaviour changes from producers and consumers can decrease the amount of solid waste produced and thereby the emissions associated with the production and distribution of manufactured goods. (Enterprises pour L’Environment & World Resources Institute, 2013; Tucker & Speirs, 2003). The local government can implement policy education and advocacy programs in order to influence behaviour changes to reduce and eliminate waste (Zaman & Lehmann, 2011).

C40’s Deadline 2020 shows that the greatest emissions savings in the waste sector are associated with programmes that reduce waste sent to landfill (C40 & ARUP, 2016). These programmes include improving city collection of recyclables and food waste, alongside incentivising source segregation in households and businesses alike (C40 & ARUP, 2016). The

United Nations Economic Commission for Europe found that active city infrastructure for recycling, waste-to-compost and waste-to-energy is most effective in reducing related GHG emissions (UNECE, 2011).

2.4.2.4 Transportation

The transportation sector refers to the transport of passengers and goods (Transport Decarbonisation Alliance, 2017). Globally, the transport sector contributes about one quarter of all energy related CO₂ emissions and is 96% oil dependent (Transport Decarbonisation Alliance, 2017). In most cities, transportation is the top carbon-emitting system because the dominant mode of mobility is fossil-fuel vehicles (Carbon Neutral Cities Alliance, 2015). GHG emissions from transportation in cities refers to the Scope 1 emissions, meaning that only the emissions occurring within the geographical area of the city are counted (Bhatia et al., 2004). Scope 3 emissions from the transportation sector would include transit between cities and air travel (Bhatia et al., 2004). Transportation is the fastest growing sector in terms of emissions, as it stands, the growth in demand for mobility of goods and people is projected to cause a doubling of GHG emissions from transportation by the year 2050 (Lah, 2017). It will not be possible to achieve the ambition of the Paris Agreement, without effective action on transport. Transport has gained the reputation of being the most challenging sector to decarbonise (Lah, 2017; Transport Decarbonisation Alliance, 2017).

There are many associated challenges in decarbonizing transportation systems, mainly due to the socio-technical and institutional path dependencies that lead to carbon lock-in (Driscoll, 2014). Because of path dependencies, breaking carbon lock-in, particularly in the transportation sector is often difficult for policy makers trying to introduce aggressive low carbon goals (Echeverri, 2018). Decarbonization strategies are often challenged by interest groups that consider it a priority to provide fossil-fuel based automotive mobility for political goals and economic growth (Driscoll, 2014; Echeverri, 2018; Transport Decarbonisation Alliance, 2017).

The high energy density fuels derived from oil have given current transport modes unrivalled mileage capacities and are considered inexpensive (Lah, 2017). This limits incentives to develop and implement alternatives to fossil fuel dependant modes of transportation (Lah, 2017; Transport Decarbonisation Alliance, 2017). In addition, transport is the sector for which

the cost of CO₂ reductions is often regarded as the highest (Sovacool, Noel, Kester, & De Rubens, 2018; Transport Decarbonisation Alliance, 2017). Alternative technologies have not yet been developed to scale for all sub-modes of transport, especially for long distance freight, internal shipping and aviation (Transport Decarbonisation Alliance, 2017). Huge behavioural changes from people, governments and businesses that result in substantive modal shifts towards less carbon intensive modes of transport are likely required for transport decarbonization to be successful (Transport Decarbonisation Alliance, 2017). Electrifying the transport industry has become a common theme in decarbonization literature (Koben et al., 2017). In order for electrification to be successful, the sources of energy must be renewable and low carbon (Koben et al., 2017; Lawson & Ahmad, 2018). It must also increase capacity to supply the growing demand. So far, the global energy sector has not demonstrated its capacity to supply the required, affordable alternative energies in due quantities and current commitments are not adequate to enable full decarbonisation of motorized transport (Transport Decarbonisation Alliance, 2017). Lastly, many players within the sector are still pursuing agendas that are inconsistent with the Paris Agreement and climate action objectives (Transport Decarbonisation Alliance, 2017).

When it comes to planning for decarbonization in cities, the main considerations are: the fossil fuel intensity of transportation; long travel distances; the state of public transport infrastructure; congestion, population density; and electrification of transport (Sovacool et al., 2018). Local governments do not have full control over the transport sector (Ahmad, 2019; Lawson & Ahmad, 2018; Yedla, Shrestha, & Anandarajah, 2005). Businesses within the transport industry (supply side) and higher levels of government have a large stake in this sector (Ahmad, 2019).

Overall strategies for emissions reduction comprise mainly demand reduction (mode shift), efficiency improvements, and switching to low-carbon fuels or electrification (fuel shift) (C40 & ARUP, 2016; Lawson & Ahmad, 2018). Efficiency can be improved by making design changes such as using lighter materials and more efficient motors (Lawson & Ahmad, 2018). These efficiency improvements can take advantage of existing infrastructure (e.g., roads, fuelling stations, and ports) and as a result of this, most reductions in the sector are from increased efficiency (Ahmad, 2019; Lawson & Ahmad, 2018). Transportation mode shift can be influenced though the

promotion and increase in the use of zero emissions modes of transportation (e.g., walking, biking, public transit) (C40 & ARUP, 2016; Carbon Neutral Cities Alliance, 2015; UNECE, 2011).

Transportation fuel shift includes switching to zero emission vehicles and fuels including ethanol, natural gas, biofuels, hydrogen, and electricity (Lawson & Ahmad, 2018). Many of the current petroleum substitutes have direct or indirect emissions (Lawson & Ahmad, 2018). The carbon benefits of alternative fuels will depend on whether they can be derived from non-emitting sources and alternate production methods would have to be developed at scale to achieve deep reductions (Lawson & Ahmad, 2018). Electricity can potentially be used to fuel any class of road vehicle and, when coupled with decarbonization of the power sector, has the potential to deliver deep sector reductions (Lawson & Ahmad, 2018).

The transportation sector in cities is very complex and is tied in with many other city functions such as land use, zoning, planning and development (Driscoll, 2014). In order to decarbonize transportation in cities, both for the corporate and collective plans, cities will have to integrate policies for all of the sectors that are related and influence transportation such as zoning, public transit, and parking subsidies (Ahmad, 2019; Driscoll, 2014).

Local governments, while not having complete control over the transportation sector, play an important role in it (Carbon Neutral Cities Alliance, 2015). They are responsible for: operating transit services; designing and planning transportation modal networks; providing long range forecast analysis of fleets; facilities; and right of way infrastructure; regulating commercial vehicles and parking; partnering with regional transit operators and agencies; building and maintaining city-owned public rights-of-way and infrastructure, including streets, sidewalks, and public spaces; guiding development on private property through land use and urban design policies and guidelines; managing how streets are used through rules, regulations, and pricing and educating and empowering citizens to make sustainable transportation choices (Carbon Neutral Cities Alliance, 2015).

Local governments can create policies that align with their climate action goals as well as make significant investments in infrastructure and support the policies that provide residents with low carbon transportation options (C40 & ARUP, 2016; Carbon Neutral Cities Alliance, 2015; Lah,

2017; Transport Decarbonisation Alliance, 2017). Decision making on transport policy and infrastructure investments can be as complex as the sector itself (Lah, 2017). Single measures rarely achieve effective impacts, therefore an integrated policy approach that combines various measures to provide a basis for political coalitions and political continuity that enables the take-up of policies and ensures stability is required to meet decarbonization targets (Lah, 2015, 2017).

The scope for local policies that affect vehicle emissions is limited outside of fleet-based operations (Salon et al., 2010). There are, however, creative ways that cities could impact the vehicle choices of their residents such as providing prime parking spots for fuel-efficient vehicles and raising road prices for larger vehicles. Local governments could also mount social marketing campaigns in support of climate-friendly vehicles (Salon et al., 2010).

Literature on decarbonization shows that many policy and planning decisions have synergistic effects, meaning that their impacts are larger if implemented together (Brozynski & Leibowicz, 2018). It is, therefore, generally best to implement and evaluate integrated programs rather than individual strategies, especially in the transportation sector (Brozynski & Leibowicz, 2018; Lah, 2017).

2.4.2.5 Synergies Between Sectors

Much like the co-benefits of climate action, there are co-benefits and synergies on decarbonizing certain sectors. All these systems are connected and integrated with each other and must be considered in decarbonization decision-making (Ürge-Vorsatz et al., 2014). One of the most powerful synergies can emerge from mitigation activities in the power and transportation sectors. Decarbonization activities in each sector mutually enhance one another (Brozynski & Leibowicz, 2018). For example by using a vehicle to grid system (V2G), electric vehicles could contribute to decarbonization of the power sector by providing mobile storage to help integrate intermittent electricity sources like wind and solar (Lawson & Ahmad, 2018). The use of electricity as a transportation fuel causes larger marginal GHG emissions reductions as the power sector decarbonizes upstream (Lawson & Ahmad, 2018). This is one reason why most energy-economy

models choose to decarbonize electricity generation before investing significantly to convert transportation fleets to electric vehicles (Löffler et al., 2017).

2.4.3 Carbon Offsetting and Carbon Sinks in Cities

Most deep decarbonization plans involve actions on how to reduce and eliminate GHG emissions from the four priority sectors (among other areas) (Carbon Neutral Cities Alliance, 2015). When carbon emission reductions have reached a threshold, cities can use carbon offsetting to further reduce their GHG footprint (Barreto, Gonzalez, Mate, & Zuk, 2018). As defined by the GHG Protocol, an offset is “a specific activity or set of activities intended to reduce GHG emissions, increase the storage of carbon, or enhance GHG removals from the atmosphere” (World Resource Institute & World Business Council, 2004 p. 60).

Cities have naturally occurring carbon sinks within their geographical boundaries, and they can increase the capacity of the carbon sinks in order to offset some of their emissions (Davies, Edmondson, Heinemeyer, Leake, & Gaston, 2011). Carbon sinks are a natural carbon storage system, meaning that they can absorb carbon dioxide from the atmosphere (Davies et al., 2011). The largest carbon sinks are forests, oceans and soil (IPCC, 2014). By enhancing and developing green systems in urban landscapes and infrastructures such as increasing vegetation in urban areas and maintaining soil health, cities can increase the capacity of urban carbon sinks and offset GHG emissions (Davies et al., 2011).

Cities can also purchase carbon offsets to further reduce their GHG emissions (Carbon Neutral Cities Alliance, 2015). An offset is a form of trade that represents the rights to a greenhouse gas reduction, which a local government or organization purchases and then retires so that it cannot be used (Barreto et al., 2018). Purchasing an offset is a form of funding for projects that reduce GHG emissions (Barreto et al., 2018). The projects might include restoring forests, updating power plants and factories, or increasing the energy efficiency of buildings and transportation. Carbon offsets allow the purchaser to aid in global GHG reductions when they have reduced their own emissions to the furthest extent (Barreto et al., 2018; Carbon Neutral Cities Alliance, 2015).

Table 1 summarizes the key variables highlighted in the literature for the pathways to deep decarbonization. The key variables refer to priority sectors for GHG reductions at the local level. This thesis uses the variables to frame the research in the data collection and the discussion sections.

Table 1: Key Variables for Technical Pathways

Variable	Finding/ Contribution	Source
Energy	Energy is the priority sector for decarbonization and can be done by removing fossil fuels entirely from electricity grid. Local governments have limited control over this sector, but they can utilize building scale and district energy solutions.	(Ballentine et al., 2019; C40 & ARUP, 2016; Morvaj et al., 2017)
Buildings	New and existing buildings need different approaches. Existing buildings can be decarbonized through retrofits and new buildings can be constructed to be net zero. Local governments can implement low carbon or zero carbon building performance/energy standards and regulations if they have the power, or they can offer incentives and education.	(Becque et al., 2019; Billimoria et al., 2018; Carbon Neutral Cities Alliance, 2015; Salon et al., 2010)
Transportation	Transportation decarbonization includes mode shift and fuel shift. Local governments have limited influence over this sector other than local government owned fleets. Local governments can offer incentives, use market based instruments (MBIs) as well as investment in public transit and they can develop active transport infrastructure to reduce emissions associated with transportation.	(Ahmad, 2019; Lawson & Ahmad, 2018; Carbon Neutral Cities Alliance, 2015)
Waste	Emissions from the waste sector can be mitigated through decreasing the amount of waste sent to landfills. This can be done through increased recycling and diversion measures. No- recyclable waste can be converted to energy by incineration or biogas production. Gas capture systems can be installed to capture emissions as landfill waste breaks down.	(C40 & ARUP, 2016; Moya et al., 2017; Sandulescu, 2004; UNECE, 2011; Zaman & Lehmann, 2011, 2013)
Carbon Sinks and Offsets	Preserving and increasing natural carbon sinks, such as forests, vegetation, and soils and other carbon sinks in cities acts as a carbon sink. Local Governments can also purchase carbon offsets to balance their emissions.	(Barreto et al., 2018; Carbon Neutral Cities Alliance, 2015; Davies et al., 2011).

2.5 Institutionalization Strategies and Tools

Decarbonization is a complete transformation of the systems and technologies that rely on fossil fuels and requires a rethinking of institutional structures. Cities must not only develop technical pathways to decarbonize the main emitting sectors, but they must also develop strategies implement actions that will embed it in institutional frameworks and steer the local economy to a low carbon one (Carbon Neutral Cities Alliance, 2015). As the C40 Climate Action Framework puts it, cities must have in place goals and targets that will help to embed climate action as an integrated agenda within local government priorities. Local governments can leverage resources from across their institutions to deliver actions with shared benefits (C40, 2020).

Institutionalizing strategies are those that can help to transform institutional structures and embed sustainability in those structures and they include the use of tools available to local governments to encourage and support climate actions (Government of British Columbia, n.d.). They include: building technical capacity and stimulating innovation; engaging stakeholders and the community; influencing other levels of government; funding climate action plans; stimulating innovation in government; sustaining long-term endeavours; using financial incentives/ investment tools; and implementing regulation/policy tools (Carbon Neutral Cities Alliance, 2015; Government of British Columbia, n.d.). Local governments have a variety of modes of governance available to them when it comes to developing and delivering climate action plans (Kern & Alber, 2009).

2.5.1 Engagement

Widespread public engagement helps to strengthen and sustain local political will for long-term systems transformation (Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015). Local governments must build effective relationships with the many stakeholder groups and must communicate effectively with community. Engagement involves getting input from a wide variety of stakeholders, maintaining constant and meaningful communication, promoting education campaigns, being transparent, as well as highlighting and celebrating stakeholders actions (Carbon Neutral Cities Alliance, 2015). Meaningful stakeholder and community engagement includes the involvement of key stakeholders in the implementation of plan and actions (Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015). Inclusive stakeholder

engagement can generate a sense of ownership, encourage cross-sectoral collaboration, spark complementary action, increase awareness, and build capacity (UN Habitat, 2015).

Advocacy tools also are important as engagement mechanisms, where the local government works with other actors such as governments, utilities, and other sectors to encourage them to apply their regulatory and investment tools to support zero emissions outcomes and tools that connect with all stakeholders in the climate action plan (City of Edmonton, 2018; Vancouver City Council, 2019; Carbon Neutral Cities Alliance, 2015; Clarke & Crane, 2018; Kirchner et al., 2019). Participation in regional, national, and international networks of cities that promote climate action can help cities in their decarbonization processes (C40, 2020; Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015). These transnational networks facilitate learning, peer-to-peer sharing, and provide access to tools and resources. Network membership also offers solidarity, encourages more ambitious action, and confers recognition upon local achievements (UN Habitat, 2015).

2.5.2 Technical Capacity

Local governments must develop the technical capacity for high levels of analysis, modeling potential impacts, designing, and planning climate action planning and implementation (Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015). Engaging outside specialists to furnish specific inputs while building local capacity can be helpful (UN Habitat, 2015). Assembling expertise from external consultants and/or developing partnerships with useful organizations helps local governments that do not have the resources to build their internal capacity (Carbon Neutral Cities Alliance, 2015).

2.5.3 Funding

A crucial role of a local government is to fund or find funding for their climate action plans. Carbon reduction strategies require funding, whether it is to support local government operations or to incentivize consumer and business behaviours and investments (Carbon Neutral Cities Alliance, 2015). Local governments can apply traditional methods of funding public programs to their climate action plans and also invent new funding mechanisms in order to raise the money required for plan implementation (Carbon Neutral Cities Alliance, 2015).

Traditional funding mechanisms include using tax revenue/local government budgets and, partner and sponsor funds. Innovative funding sources include carbon tax/cap and trade systems green bonds, insurance and financing pricing (Carbon Neutral Cities Alliance, 2015).

2.5.4 Green Economy

Aylett (2014) found that there is a lack of functional synergies between mitigation efforts and local development priorities, particularly related to economic goals. His study found that 82% or more of cities (globally) reported that mitigation efforts contributed little or nothing to the city's economic development (Aylett, 2014). Combined with findings that the private sector lacked significant engagement in climate planning and implementation. Aylett suggested that cities have yet to align environmental and economic objectives (Aylett, 2014).

More recently, economic development tied with sustainability and the notion of a “green economy” has emerged at the center of climate action planning (C40, n.d.). A green economy is defined as “one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive” (Fedrigo-Fazio et al. 2012 p.3). Cities can use strategies to achieve green economies such as supporting clean technology development, developing circular economies, integrating sustainability into the city's economic plan and other climate action initiatives (C40, n.d.). Cities can accelerate innovation and the green economy by developing and increasing measures to support start-ups and help to create a wider innovation ecosystem within the city. To do this, they can explore co-design initiatives, improve procurement policies and foster public/private partnerships to engage businesses (C40, n.d.). Local governments can also support market transformation and help open up new areas of economic activity. Approaches may include public/private provision of climate friendly infrastructure, and the development of broader green economic development strategies (UN Habitat, 2015).

2.5.5 Long Term Plans

Climate action is not a brief process; a portion of strategies and critical outcomes can span multiple political lifetimes (Carbon Neutral Cities Alliance, 2015). Buy-in from subsequent

leaders depends in part upon long-term measured results, and in part a sense of ownership from various leaders and stakeholders. For decarbonization to be successful, planning must be done for both the short and long term, and sustainability themes must be embedded into institutional frameworks (C40, 2020; Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015).

2.5.6 Behaviour Influencing Financial Tools

Behaviour influencing financial tools refer to the tools that local governments can use to encourage citizens to chose low carbon optional and lower community-wide GHG emissions (City of Edmonton, 2018; Vancouver City Council, 2019). Local government can use market based instruments (MBIs) to put a price on carbon emitting activities, or alternatively, provide financial incentives to encourage residents and businesses to choose zero emissions options (City of Edmonton, 2018; Görlach, 2013; Vancouver City Council, 2019). Market-based instruments are indirect regulatory instruments, which influence actors' behaviours by changing their economic incentive structure, examples of these are; environmental taxes, emissions trading systems and removing perverse incentives (Görlach, 2013).

Local governments can also influence behaviour by investing directly in equipment and infrastructure that lead to a reduction carbon emissions, for example bike lanes and improving public transit infrastructure (Carbon Neutral Cities Alliance, 2015; City of Edmonton, 2018; Vancouver City Council, 2019).

2.5.7 Regulatory and Policy Tools

Regulatory and policy tools occur at all levels of government. At the local level, the local government uses its authority under its charter to establish the rules that guide resident and business decisions that support zero emissions outcomes (Vancouver City Council, 2019). These tools can be used to directly or indirectly reduce GHG emissions. They can set limits on emissions or emission intensities, create price signals to incorporate externality costs and influence purchasing decisions (Deep Decarbonization Pathways Project, 2015). Policy can directly require the development, improvement and/or adoption of efficient and low-carbon technologies, or it can provide incentives for investment in them, or consumer adoption of them

(Deep Decarbonization Pathways Project, 2015). Policy tools must be flexible, transparent and collaborative in order to yield legitimate social acceptability and deepened trust among parties (Kirchner, Schmidt, & Wehrle, 2019; Mundaca, Ürge-Vorsatz, & Wilson, 2019).

Most of the decarbonization literature has focused on technology policy and the need to address market failures (Mundaca et al., 2019). As decarbonization pathways require both technical and social change, policies must address both dimensions (Bager & Mundaca, 2017; Eyre, 1997; Fredriks, Stenner, & Hobman, 2015; Mundaca et al., 2019). The climate policy implementation process must be coordinated, and policy evaluation is crucial (Mundaca et al., 2019). In addition to the implementation of climate policies such as carbon pricing and other demand-side policies, various papers underline the need for comprehensive and integrated policy mixes (Kirchner et al., 2019; Mundaca et al., 2019).

Climate policy instruments that can be used in decarbonization strategies are classified as non-market-based and market-based instruments (Görlach, 2013). Non-market-based instruments impose certain obligations or install non-monetary incentives to change behaviour. These policy instruments include command and control regulations, reporting requirements, active green technology support, removal of green-tech financial barriers and information and voluntary approaches (Görlach, 2013).

Not all policy tools are accessible to local governments and actors because of the limited jurisdiction of municipal government (Carbon Neutral Cities Alliance, 2015). Local governments can lead by example by setting policies and regulations for corporate-owned assets and local government operations, which they have direct control over. Through self regulation, local governments can model the actions and behaviour for their residents (Carbon Neutral Cities Alliance, 2015). For policy development in sectors where cities do not have direct control, they can coordinate with and advocate to higher levels of government (Carbon Neutral Cities Alliance, 2015; Kirchner et al., 2019).

Table 2 summarizes the key variables deducted from the literature for institutionalization strategies for deep decarbonization planning at the local level.

Table 2: Key Variables for Institutionalization Strategies

Variable	Findings	Source
Engagement	Local governments must build effective relationships with the many stakeholder groups through valuing stakeholder input, communication, and education. Meaningful engagement includes having partners participate in plan development and implementation. Local governments can use advocacy tools to encourage stakeholders, higher levels of governments and other local governments to participate and collaborate in the climate action plan.	(C40, 2020; Carbon Neutral Cities Alliance, 2015; City of Edmonton, 2018; Day et al., 2018; UN Habitat, 2015; Vancouver City Council, 2019)
Long Term Endeavours	Local governments must ensure that climate action planning is long term and results are monitored over long periods of time.	(Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015)
Building Technical Capacity	Local governments need to develop technical capacity and make decisions based on data through increasing internal technical capacity, outsourcing or through partnerships.	(Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015)
Funding	Local governments can apply traditional methods of funding public programs to their climate action plans as well as new innovative funding mechanisms.	(Carbon Neutral Cities Alliance, 2015)
Green Economy and Innovation	Local governments can help develop a green economy by supporting clean technology development, developing circular economies, integrating sustainability into the city's economic plan and other climate action initiatives.	(Aylett, 2014; C40, n.d.; Fedrigo-Fazio et al., 2012; UN Habitat, 2015)

Regulatory/ Policy Tools	Using local regulations to support low carbon initiatives and coordination with higher levels of government to implement policies for climate action.	(Carbon Neutral Cities Alliance, 2015; City of Edmonton, 2018; Deep Decarbonization Pathways Project, 2015; Görlach, 2013; Mundaca et al., 2019; Vancouver City Council, 2019)
Behaviour Influencing Financial Tools	Investing directly in equipment and infrastructure that are low carbon, providing financial incentives, or using MBIs in order to influence the behaviour of residents to choose low carbon options.	(City of Edmonton, 2018) (Vancouver City Council, 2019)

2.6 Governance

Governance refers to the structures, processes, rules and traditions that determine how people in societies make decisions, share power, exercise responsibility and ensure accountability (Cundill & Fabricius, 2010; Folke, Hahn, Olsson, & Norberg, 2005; Lebel, Anderies, Campbell, Folke, & Hatfield-Dodds, 2006). This includes several possible modes of policy and decision making as well as multiple possible actors such as; government, industry, research, civil society (Patterson et al., 2017). Governance also describes the system of governing through which a range of public and private actors deliver core services (Fröhlich & Knieling, 2013). It can be seen as a of blurring of boundaries between state and society (Fröhlich & Knieling, 2013).

2.6.1 Local Climate Change Governance

As the effects of climate change become more pronounced, there is a need for governance structures that can adapt and be resilient to the uncertainty that is a result of climate change (Fröhlich & Knieling, 2013). While there is no specific one size fits all panacea for climate change governance, it is evident that frameworks that involve collaboration and partnerships across different sectors and levels are more effective in climate action (Fröhlich & Knieling, 2013).

Within the local context, governance of climate is multi-faceted. “While the legal and regulatory frameworks for climate change response may be established by formal institutions, climate change governance may also take place through interventions designed and

implemented by non-state actors, including businesses, non-governmental organisations and communities. Informal institutions and their associated social practices, norms, and path-dependencies also structure the scope and nature of action on climate change in cities” (Prieur-Richard et al., 2018 p. 3). While urban climate governance is/can be fluid (Robinson & Gore, 2015), defined roles, responsibilities and oversight must be included. In order for proper oversight, local governments must clearly locate the authority of climate planning in a way that commands attention across local government departments and is in close touch with the elected leadership (Carbon Neutral Cities Alliance, 2015).

A governance structure or framework refers to how power and decision-making is distributed within an organization, the governance framework is an important factor in the success of the organization meeting its goals (Keping, 2017). Governance frameworks vary; some structures are better suited for different industries, organizations, or problems than others (Keping, 2017). A governance structure should reflect the unique needs of the organization (Keping, 2017). A defined structure includes organizational design, a reporting structure, committee structures and charters, it must control and support function interdependencies (Baret, Hida, Hatfield, Sandford, & Vazirani, 2013). Oversight responsibilities define the roles and responsibilities of actors as well as accountability matrices (Baret et al., 2013). A robust governance operating model helps execute governance responsibilities at all levels (Baret et al., 2013). Building sustainable and resilient cities and communities also depends on strong leadership and clear and open communication (Callaghan & Colton, 2008). Nguyen, Davidson and Gleeson (2018) conducted a study that suggests that a local government's governance structure influences the way it undertakes climate actions and the potential efficacy of those actions (Nguyen, Davidson, & Gleeson, 2018). Emerging frameworks for urban climate governance also address the importance of a multi-actor approach and vertical and horizontal coordination (Fröhlich & Knieling, 2013).

Van der Heijden (2019) did an extensive review of 260 studies on urban climate governance from the last decade. The review highlights gaps in the urban climate governance literature, one of them being that previous studies focus on the global north and small n (number of samples) studies (Van der Heijden, 2019).

A second gap identifies the enabling factors of urban climate governance (Van der Heijden, 2019). The enabling factors that have been highlighted in the literature so far are; a supportive political and legal context (Cadman, Maguire, & Sampford, 2015; Castan Broto, 2017; Johnson et al., 2015; Pierre, 2011; Schroeder & Bulkeley, 2009).; autonomy (Bulkeley & Betsill, 2013; Hein & Pelliter, 2006; Johnson, 2018).; access to funding for climate action (Bulkeley & Betsill, 2013; Clarke, 2017; Hughes, 2017; Hughes, Chu, & Mason, 2018; Sanchez-Rodriguez, 2009).; vertical coordination (Clarke, 2017; Hughes et al., 2018; Johnson et al., 2015; Knieling, 2016; Luque-Ayala et al., 2018).; horizontal coordination (Coaffee & Lee, 2016; Knieling, 2016).; capacity building and learning networks (Acuto & Rayner, 2016; Castan Broto, 2017; Jordan & Turnpenny, 2015; Rosenweig et al., 2018).; collaboration with and participation of stakeholders (Castan Broto, 2017; Chu, Anguelovski, & Carmin, 2016; Coaffee & Lee, 2016; Haus & Klausen, 2011; Kwon, Jang, & Feiock, 2014).; and the presence of a local climate champion (Castan Broto, 2017; Haus & Klausen, 2011; Hughes et al., 2018; Sanchez-Rodriguez, 2009). The consensus in the urban climate governance literature is that these factors work in conjunction, helping to create trajectories and pathways that can lead to effective urban climate governance but are not sufficient alone (Van der Heijden, 2019). The challenge in understanding outcomes in urban climate governance is that there is no single indicator that best captures the outcomes (Chan, Falkner, Goldberg, & van Asselt, 2018; Sennet, Burdett, & Sassen, 2018) nor is there a single measurement for these outcomes (van der Heijden, 2019).

2.6.2 Structures within the Local Governments

Two approaches exist for the creation and implementation of climate action plans: first, a unit, which is in charge of climate change policy, can be established within each climate-relevant department (Kern & Alber, 2009)- The agencies that contribute most heavily to designing and implementing climate change plans are those responsible for environmental planning, land-use planning, solid waste management, water, and transportation (Aylett, 2014). This approach means having climate related capacities built in to each of their (and more) local government divisions (Kern & Alber, 2009).

The second approach relies on a form of climate policy steering group, or an overarching unit with appropriate competences for mainstreaming climate change policy within local

government planning (Kern & Alber, 2009). Given the limited availability of staff in many municipalities, this second approach appears to be more promising (Kern & Alber, 2009). A centralized sustainability or climate change agency must to be combined with various task forces, which coordinate the activities around specific issues and across all relevant policy areas within the local government administration (Kern & Alber, 2009). Centralized sustainability teams can help to ensure all key departments and agencies can provide input into the plan and create a sense of co-ownership over the final product (UN Habitat, 2015). An overarching sustainability team can help to support other departments and agencies to integrate climate action objectives into their own plans and help pave the way for innovative and constructive partnerships during implementation (UN Habitat, 2015). It is critical that environmental agencies have the competencies to implement comprehensive concepts or they risk coordination and implementation problems (Kern & Alber, 2009)

Aylett (2014) found that in 63% of cities he studied, climate action was being led by either a small team or a single individual within the city. The study revealed that the individuals or small teams did not necessarily work in isolation, that globally, there was a general dominance of integrative and collaborative mitigation planning processes over more isolated and siloed approaches (Aylett, 2014).

Building internal networks between departments are the most effective strategies for encouraging inter-departmental engagement with climate change (Aylett 2014). Though the study found that most cities were not adopting tried and true measures to support innovation (Aylett 2014). Kern & Alber (2009) found that in most cases they studied, climate related issues were not taken into account when relevant decisions were taken outside the environmental departments. Meaning that expertise on climate and environmental related issues was/is concentrated within those departments and they were not involved in decision-making.

2.6.3 Oversight, Monitoring and Reporting

Monitoring and evaluation is a crucial part of climate action planning and implementation (Guyadeen et al., 2019). In order to do so, local governments must clearly locate the authority of climate planning in a way that commands the attention of the departments and is also in

close touch with the elected leadership (Carbon Neutral Cities Alliance, 2015). Keeping decision makers well informed through continual monitoring and reporting is crucial to the continual implementation and success of climate action planning.

Climate actions plans should include a monitoring and evaluation framework, along with key performance indicators for measuring progress that lead to updates for the actions (C40, 2020; Carbon Neutral Cities Alliance, 2015; Guyadeen et al., 2019; Robinson & Gore, 2015; UN Habitat, 2015). Effective monitoring includes the tracking of process, as well as outcomes (UN Habitat, 2015). A climate action plan is a living document. Regularly monitoring progress and updating plans can help local governments to reflect the latest climate science, technological developments, financial situations and development capacities (UN Habitat, 2015). It also enables the on-going engagement with stakeholders and communities, ensuring that climate action planning continues to meet the wider development goals of the local government (UN Habitat, 2015).

Robinson and Gore (2015) conducted a study of Canadian municipalities implementing climate action plans; they found that municipalities in Canada are implementing more emission-reducing activities than previous monitoring revealed. These results suggest that monitoring protocols do not capture the breadth of action being undertaken, and highlight a need to find new ways to track mitigation actions that is not captured through milestone reporting (Robinson & Gore, 2015)

2.6.4 Vertical Integration

Vertical integration has been highlighted as one of the key attributes of urban climate governance (Gleeson, Darbas, & Lawson, 2004; Hammer, Kamal-Chaoui, Robert, & Plouin, 2011) Vertical integration implies whether the climate action strategies are integrated with the different activities at the national or sub-national levels for conveying meaningful outcomes (Gleeson et al., 2004; Hammer et al., 2011). While integration and coordination are key, it has been found that municipal governments are not necessarily awaiting higher order institutions or organizations to direct their activities or to provide them with incentives for action (Robinson & Gore, 2015). Hammer et al. (2011) indicate that strong integration of plans at all levels

contributes to creating consistency and coherence in the formulation of policies and regulations, better facilitating the implementation of plans. This has drawn attention to the multi-level governance systems and networks in which cities are integrated. The relationship between the different arenas of authority and the integration of cities in national and international networks are considered critical in shaping the global capacity to govern climate change (UN-Habitat, 2011).

In order to pursue mitigation actions effectively and efficiently, cities need the support from other levels of government (Corfee-Morlot et al., 2009). Working in a multi-level governance framework where the involvement of regional, and national levels as well as relevant stakeholders is important for avoiding policy gaps between local action plans and national frameworks (Corfee-Morlot et al., 2009).

2.6.4.1 Multi level Governance

Ideas of multi-level governance acknowledge that local governments are not the only urban actors who can lead and deliver climate action (Betsill & Bulkeley, 2006; Bulkeley & Betsill, 2013). A variety of state and non-state actors play key roles in climate change governance. Actors at the national level provide crucial support to local governments and may be leading action at the local level (Betsill & Bulkeley, 2006; Bulkeley & Betsill, 2005; Corfee-Morlot et al., 2009). Supra-national levels and international organizations also play a crucial role in informing regulation and enabling innovation (Monni & Raes, 2008).

This form of governance redistributes the political authority of climate action vertically upward to transnational networks, downward to communities and horizontally to non state actors (Betsill & Bulkeley, 2006). This is an example of a governance structure that goes beyond state actors, where the roles of governmental and nongovernmental actors are recognized at all levels.

2.6.5 Coordination and Collaboration

Coordination and collaboration have also been identified as a key attribute to urban climate governance. The idea of using collaborative strategies to tackle issues such as these has gained

momentum as demand for climate action increases (Clarke, 2011, 2014). Local governments are often more successful in delivering climate action when they coordinate with other actors from the private sector and civil society (C40, 2015; MacDonald, Clarke, & Huang, 2018). Nurturing partnerships with actors from both state and non-state sectors may afford cities the opportunity to employ their powers most effectively and ultimately catalyze climate action (C40, 2015).

In recent years, the role of the local government sector has shifted from making policies and providing services to also managing the networks built with different sectors (Clarke, 2012; Mazzara, Sangiorgi, & Siboni, 2010). Inter-organizational collaboration serves as a necessity in solving the sustainable development issues for plan implementation (Clarke, 2012; Mazzara, Sangiorgi, & Siboni, 2010). Numerous cross-sector partners and voluntary actions are needed to implement a local sustainability plan (Clarke & Erfan, 2007; Sun, Clarke, & MacDonald, 2020). Partnerships and resources play pivotal roles in achieving these sustainability goals at the local level during the collaboration of governments with other sectors (Clarke & Erfan, 2007).

The C40 report “Powering Climate Action” (2015) concluded that, on average, cities that take a collaborative approach to governance of their climate action plans deliver twice as many actions as those that implement through an approach not based on partnerships (C40, 2015). The report also studied the relationship between the relative power (over jurisdictions) that a local government has, and the outcomes of climate action plans (C40, 2015). It was found that when it comes to delivering action, the ability of cities to partner is more important than the type or degree of power they have (C40, 2015).

Much of the current literature concludes that cross sector partnerships and collaborative governance structures are very important in the implementation of climate action plans and result in more actions taken with more favourable outcomes (C40, 2015).

2.6.5.1 Collaborative Governance

As large societal issues become more complex, there has been an increase in collaborative problem solving (Selin & Chevez, 1995). In this approach collaboration entails collective

decision making and collective responsibility for actions between stakeholders (Ansell & Gash, 2008; Clarke & Fuller, 2010; Clarke, 2011; Selin & Chevez, 1995). Instead of collaboration being a fixed, organized state, it can be seen as an ongoing process (Selin & Chevez, 1995). With the widely applicable and useful nature of collaboration processes, they have become effectively used in different sectors globally in at least the past two decades (Selsky & Parker, 2005).

There are many definitions of collaborative governance (it can also be referred to as network governance or new public management) (Ansell & Gash, 2008). The core idea behind collaborative governance is non-government stakeholders working with governments and/or across sectors for collective action and collaborative planning (Gray & Stites, 2013). Collaborative governance involves a collective decision-making process that is formal, consensus-oriented, deliberative, and aims to make or implement public policy or manage public programs or assets (Ansell & Gash, 2008). It also has the intention of developing a more comprehensive understanding of the issue or problem under consideration than government could achieve on its own (Creswell, 1998; Gray & Stites, 2013; Kramer & Gray, 1990; Wondolleck & Yaffee, 2000). In collaborative governance structures, government agencies retain the formal authority for any decision making related to their jurisdiction, while non-government actors are expected to assume serious deliberative roles and play key roles in implementing any decision taken (Ansell & Gash, 2008).

Ansell and Gash (2008) have identified six essential criteria for collaborative governance (Ansell & Gash, 2008, p.544):

1. The forum [partnership] is initiated by public agencies or institutions;
2. Participants in the forum include non-state actors;
3. Participants engage directly in decision making and are not merely “consulted” by public agencies;
4. The forum is formally organized and meets collectively;
5. The forum aims to make decision by consensus (even if consensus is not achieved in practice); and
6. The focus of collaboration is on public policy or public management.

2.6.6 Modes of Urban Climate Governance

There are different modes of governance that have emerged from the study of the dynamics of urban climate governance. These modes are distinct in terms of their governing capacities and range from soft forms of governing to traditional forms of state intervention (Bulkeley & Kern, 2006). The modes of governance that local governments reflect the strategies that the local governments are using as well as the level of power and autonomy that the local government has when it comes to implementing climate action plans (Kern & Alber, 2009).

First, self-governing is defined as the capacity of local government to govern its own activities, such as the improvement of energy efficiency in government offices and other municipally owned buildings. Self-governing relies on reorganization, institutional innovation and strategic investments (Kern & Alber, 2009). This can also be called an “in house” approach to governing climate action, through management of local government owned assets (UN Habitat, 2015).

Governing through enabling refers to the role of local government in coordinating and facilitating partnerships with private actors and encouraging community engagement. Tools such as incentives, provision of information, demonstration, projects to encourage and support action are most important for this mode of governing (Kern & Alber, 2009; UN Habitat, 2015).

Governing by provision refers to the delivery of services and resources. This is accomplished through infrastructure and financial means (Kern & Alber, 2009). This can include public provision (government led development of climate friendly infrastructure systems and provision) and public/private provision (development of climate friendly infrastructure systems and provision with private sector engagement) (UN Habitat, 2015).

Governing by authority can be characterized as the use of traditional forms of authority such as regulation and the use of sanctions to support climate outcomes (Kern & Alber, 2009; UN Habitat, 2015).

The UN Habitat “Guiding Principles for City Climate Action Planning” framework adds corporate/community led actions as a mode or approach to urban climate governance. This

refers to direct actions undertaken by community and corporate actors that are congruent with the goals of the municipality but are outside of the influence of the local government (UN Habitat, 2015).

Although these modes of governing may overlap and individual measures are often based on a combination of several modes, the differentiation between modes of governance provides a tool for the analysis of urban climate governance and the variety of measures preferred by municipalities (Kern & Alber, 2009).

Table 3 summarizes the key variables highlighted in urban climate governance literature. These variables refer to the structure of governance for local climate action planning and the mechanisms of integration with climate action at higher levels of governments.

Table 3: Key Variables for Urban Climate Governance

Decision-Making Structure	The structure should have defined organizational design and reporting structure. Municipal climate governance structures can have centralized sustainability departments and/or embedded sustainability capacity in relevant departments.	(Baret et al., 2013; Kern & Alber, 2009) (Callaghan & Colton, 2008)
Oversight, Monitoring & Reporting	Roles, responsibilities and accountability must be clearly specified by a defined oversight body. Local governments should clearly declare an oversight authority and keep decision makers informed through continual monitoring and reporting. New standardized frameworks for monitoring and reporting must be developed to accurately capture climate action progress.	(Baret et al., 2013; C40, 2020; Carbon Neutral Cities Alliance, 2015; Guyadeen et al., 2019; Robinson & Gore, 2015; UN Habitat, 2015)
Leadership	Strong leadership to provide direction must be present.	(Callaghan & Colton, 2008)
Communication	Clear, open and continuous communication throughout governance structure is vital.	(Callaghan & Colton, 2008)
Vertical integration and Multi Level Governance	Integration with national and other sub national planning is a key enabler. Cities can leverage multi-	(Betsill & Bulkeley, 2006; Bulkeley & Betsill, 2005; Corfee-Morlot et al., 2009; Gleeson et al., 2004;

	level governance for vertical integration.	Hammer et al., 2011)
Coordination and Collaborative Governance	Internal coordination with external actors is a key attribute of governance. Cities can use a collaborative governance framework.	(Ansell & Gash, 2008; Clarke & Fuller, 2010; Clarke, 2011, 2014; Selin & Chevez, 1995)
Modes of Urban Climate Governance	Local governments can use a combination of approaches for climate action implementation (self regulating, enabling, provisioning, authority and corporate-community led).	(Kern & Alber, 2009; UN Habitat, 2015)

2.7 Key Actors in Local Deep Decarbonization

As previously mentioned, collaboration is a key success factor in climate action planning (C40, 2015). A multitude of actors can be involved in the processes “while the legal and regulatory frameworks for climate change response may be established by formal institutions, climate change governance may also take place through interventions designed and implemented by non-state actors, including businesses, non-governmental organisations and communities. Informal institutions and their associated social practices, norms, and path-dependencies also structure the scope and nature of action on climate change in cities” (Priour-Richard et al., 2018 p. 3).

Local governments often lead climate action planning, but in order to be effective, multiple agencies will be inclusively engaged (UN Habitat, 2015). Strong climate action plans tend to be developed by cross-departmental teams that are empowered to coordinate with a centralized sustainability team that helps to ensure all key departments provide input and to create a sense of co-ownership over the final product (UN Habitat, 2015).

Castan Broto and Bulkeley (2013) conducted a global study that showed that in 66% of urban climate change efforts, local governments hold the main leading role. They also found that other private and civil society actors may also have key roles (Castan Broto & Bulkeley, 2013).

As (usually) leaders of the climate action process, local governments play the key roles. Local governments can affect GHG emissions as a regulator, facilitator, convener, program deliverer, funder, and educator as well as a strategic partner along with higher levels of governments for policy design and implementation (Becque et al., 2019; FCM & EnviroEconomics, 2009; Salon et al., 2010). The various roles that a local government will play reflect the level of autonomy and power that it has. Powers may be defined in terms of: the city's direct ownership or operation of assets and functions; its ability to create and enforce laws, regulations, policy; its ability to control budgets; or its ability to set a vision for future planning (C40, 2020). In sectors where the local government has more power, it can act as a direct service provider, regulator, and purchasers of goods and services. In sectors where the local government has lower levels of autonomy, it can act as an influencer, enabler, facilitator, a provider of information to residents and provider of funding for initiatives (UN Habitat, 2015).

Deep Decarbonization plans will be enacted through the conscription of diverse public, private and individual authorities with a shared vision (Tozer, 2018) as municipal governments directly control only a small portion of the assets that drive deep emissions reductions (Carbon Neutral Cities Alliance, 2015; Clarke & Ordonez-Ponce, 2017; Kirchner et al., 2019). Businesses, civic leadership organizations and community groups can play a key role in the planning and implementation of local deep decarbonization (Clarke & Crane, 2018; Clarke, 2011, 2014; Clarke & Ordonez-Ponce, 2017). Each of the priority sectors for GHG reduction in cities (mentioned in section 2.4.2 of the literature review) have key actors that can be engaged in decarbonization (Carbon Neutral Cities Alliance, 2015). For example, building owners, developers, and energy equipment manufacturers can play a role in the decarbonization of the building sector (Carbon Neutral Cities Alliance, 2015).

Effective decarbonization is not possible without the support of key actors that can weaken or strengthen political will and take bold actions towards decarbonization (Carbon Neutral Cities Alliance, 2015). Partnerships with a variety of stakeholders can ensure a wide range of support and community buy-in for the deep decarbonization plan (Carbon Neutral Cities Alliance, 2015; Clarke & Ordonez-Ponce, 2017). They can also aid in capacity building for local climate action through knowledge and resource sharing (Clarke & Crane, 2018; Le Pennec & Raufflet,

2018). Support from key private sector and non-governmental stakeholders can be vital. ‘Bottom-up’ leadership from proactive civil society groups can also galvanize city-scale climate action (UN Habitat, 2015). Key roles that a multitude of actors can play in climate action planning can be categorized as enabling roles, coordinating roles and facilitating roles (Yan, Lin, & Clarke, 2018). Enabling roles include; service provider, capacity builder, and consultant. Coordinating roles include broker and mediator. Lastly, facilitating roles are those of initiator, convener, advocate, leader, and innovator and strategic partner (Yan et al., 2018).

Civil society and private sector groups can play an important role in helping design and implement local responses to climate change. Civil society groups are already acting as valuable partners in urban responses to climate change (Aylett, 2014). NGO’s have been found to play crucial roles in facilitating social change. The role of businesses, from local businesses to multinational corporations, in climate action planning have also been increasingly studied (Aylett, 2014). The private sector can play a big role in climate action planning, though, Aylett’s study in 2014 found that in many cases the private sector has a neutral role in climate action planning and implementations, meaning that there is still untapped potential in this sector (Aylett, 2014).

Another key relationship exists between cities and academic and research institutions. Aylett (2014) found that in many cases local governments and academic institutions have managed to create meaningful relationships around the issue of climate policy. The study suggests that researchers are meaningfully engaging with local governments and that universities play an important role as they provide significant sources of information and support to the cities they work with (Aylett, 2014).

Lastly, Aylett (2014) found that having support from local government networks (transnational networks) is a key enabler for local climate action. These networks provide key resources such as; access to technical expertise, opportunities to learn directly from practitioners from other cities, and opportunities to network and form personal connections with practitioners from other cities (Aylett, 2014).

In climate action plans themselves, the roles of actors should be defined, and actions should have a named organisation as action lead (C40, 2020).

Table 4 summarizes the variables deduced from the literature for the key actors and roles in local climate action planning and implementation.

Table 4: Key Variables for Actors & Stakeholders

Variable	Findings	Sources
Actors	<p>Input and collaboration between different actors in diverse sectors result in better decarbonization outcomes.</p> <p>Local governments are usually the leaders. Multiple departments within local government should be involved. Businesses, NGOs, community groups, civic leadership organizations, academic institutions and transnational city networks can all play a role in climate action planning and implementation.</p>	<p>(Carbon Neutral Cities Alliance, 2015; Clarke & Fuller, 2010; Clarke, 2011; Clarke & Ordonez-Ponce, 2017; UN Habitat, 2015)</p>
Roles	<p>Roles vary between the different actors involved in climate action planning.</p> <p>Local governments can be the regulators depending on the level of autonomy.</p> <p>Other actors can play enabling, coordinating, facilitating and regulating roles in climate action planning and implementation.</p>	<p>(Aylett, 2014; FCM & EnviroEconomics, 2009; UN Habitat, 2015; Yan et al., 2018)</p>

2.8 Summary of Literature Review

Through examining the literature, it was found that governance for climate action and deep decarbonization in cities can have various structures though there is uncertainty as to the outcomes of climate action for the given structures (Van der Heijden, 2019).

Most of the climate change governance literature shows that collaboration processes and partnerships across sectors and levels of government are powerful mechanisms for addressing deep decarbonization in cities. Collaboration with higher levels of government is also needed

for many climate action tools and policies that may be out of a city's jurisdiction (Carbon Neutral Cities Alliance, 2015). As a result of the many integrated systems within cities, multiple actors and many different levels are necessary for meaningful climate action (Ansell & Gash, 2008; Clarke & Crane, 2018; Clarke & Fuller, 2010). The integrated systems within cities present an opportunity for synergistic effects across multiple sectors (Brozynski & Leibowicz, 2018) and provide numerous co-benefits for the residents living in the cities (Day et al., 2018).

There is a gap in knowledge about climate governance in small cases and much of the urban climate governance research focuses on single cases, or studies with small sample sizes (n) (less than 5 cases) (Van der Heijden, 2019). This thesis will address these gaps by studying cases of varying sizes, including small communities and by studying and comparing eight cases, which falls in the medium n group (Van der Heijden, 2019). While there is very current and growing literature on deep decarbonization, it is still an understudied area, and much is still to be learned about local decarbonization pathways, strategies, governance and actors. Most current literature is in practitioner (grey literature) guidance documents.

This thesis will address the research questions outlined in the introductory chapter by studying eight case studies. Documents, reports, and interviews will be analyzed for data related to the key findings and variables outlined in the literature review.

Table 6 outlines the components of research that were deducted from the literature review.

Table 5: Components of Research

Technical Pathways	Institutionalization Strategies	Governance	Actors
Energy	Stakeholder Engagement	Decision-Making Structure	Types of Actors
Existing Buildings	Long Term Endeavours	Oversight	Types of Roles
New Buildings	Oversight, Monitoring and Reporting	Leadership	
Mode Shift	Building Technical Capacity	Communication	
Fuel Shift	Funding	Vertical Integration	
Waste	Green Economy	Collaboration	
Carbon Sinks/ Offsets	Policy & Regulatory Tools Behaviour Influencing Financial Tools	Governance Mode	

Chapter 3: Methods

3.1 Introduction to Methodology

The following chapter discusses the approach that was taken for this research study. In order to explore the pathways to deep decarbonization of local governments and cities, a qualitative case study approach was taken. Due to the nature of the research questions, appropriate descriptive case study methods were used in gathering and analyzing data for each case (Creswell, 2014).

This research was undertaken to observe and understand the processes and mechanisms involved in the development of pathways to deep decarbonization in cities. More specifically, the research aims to develop insights on the transitions to low carbon cities in Canada and around the world.

This chapter begins by outlining the research design, the selection criteria for the cases as well as the data collection and analysis process. This is followed by a discussion of the limitations, reliability, and validity of this study.

3.2 Research Design

In order to answer the research questions highlighted in Chapter 1, a qualitative case study approach was taken. This research is inherently qualitative and takes a naturalistic approach (Lambert & Lambert, 2012). This type of study takes a descriptive role rather than a critical one by outlining the current status of a variable or a phenomenon (Lambert & Lambert, 2012). This approach is useful when researchers want to know, regarding events, who was involved, what was involved, and where did things take place (Lambert & Lambert, 2012). In descriptive research there is no initial hypothesis but positions can be developed after the data has been collected and analyzed (Creswell, 1998). The lack of hypotheses for this study allows for the discovery of what naturally occurs in this setting (Fraenkel, Wallen, & Hyun, 2012). Through this approach, this study aims to explore the existing circumstances of cities with the best practices in terms of a transition to a low carbon or carbon neutral future. This study did not aim to critique the data collected from the cases but rather intended to document and analyze.

Case study is a form of qualitative and descriptive research. This approach is typically used for evaluative purposes where a detailed analysis of a case (such as programs, activities or processes)

is desired (Creswell, 2014). A case study approach bridges the gap between theory and practice. Moreover, it allows researchers to gain an in-depth understanding of the specific social phenomenon, by focusing on the underlining process and the context of the situation (Merriam, 1998; Yin, 2011, 2014). For this study, eight case studies were conducted to gain insight on some of the best practices in Canada and around the world in deep decarbonization strategies.

3.3 Case Study Selection

The following section presents the criteria from which the case study locations were selected, followed by the rationale for choosing each criterion. When conducting case study research, there should be a set of operational criteria used in the selection process of the cases (Yin, 2014). Since this study involves multiple cases, the criteria should fit for each of the cases (Yin, 2014).

The criteria are as follows:

1. The case must have adopted an ambitious climate action plan with targets of reducing GHG emissions by 80% or more by the year 2050.
2. The case must have reported to the Carbon Disclosure Protocol's Cities 2018/2019 Database.
3. The case must have a written document(s) that outline the climate action strategies. This document must include GHG emissions targets, actions that will result in decreasing GHG emissions, an implementation schedule of the actions and a measurement system.
4. The case must have completed at least one citywide GHG emission inventory.
5. The climate action plan must be in the implementation stage.
6. The case must have reported a decrease [or no change] in overall GHG emissions in the 2019 CDP database.
7. Reports must be available in English and/or French.
8. Four (4) of the cases must be cities located in Canada and four (4) cases must be cities located outside of Canada.
9. Cases of varying population size will be selected two small cities (population of 1- 50,000), two medium cities (population of 50,000-500,000), two large cities (500,000-1 Million) and two very large cities (1 million +) one Canadian municipality of each size will be selected and one corresponding international municipality within the same population range.

10. Representatives of the local government must be willing to participate in the study and be available for an interview if sufficient information is not available through publically available documents.

The CDP Cities 2019 database was used in order to narrow the search for potential case cities. The CDP provides a global platform for cities to annually report and disclose environmental information (CDP, 2019). In 2019 the CDP partnered with ICLEI Local Governments for Sustainability, C40 and Global Covenant of Mayors in order to streamline the city climate reporting process and to present a unified platform of reporting (CDP, 2019). The CDP Cities 2019 database that was used for this thesis is an open access database which includes all data points for cities who reported publicly in 2019 (CDP, 2019). Over 625 cities reported to the CDP in 2019 (CDP, 2019).

Cities were filtered by their responses to several key questions in the Cities 2019 Questionnaire (see Appendix 1). Two hundred and thirteen cities worldwide had reported a complete citywide GHG inventory, specific GHG emissions targets and a climate change mitigation or energy access plan for reducing GHG emissions. Of the 213 cities, 132 of them also reported a decrease or no change in GHG emissions between inventories (Appendix 2). The 132 cities were then narrowed further, by the ambitiousness of their GHG reduction targets. Cities that had reported a GHG emissions reduction target of at least 80% by the year 2050 were put on a short list (Appendix 3). The researcher then conducted Internet searches of the remaining cities on the short list and made case study selections based on the ambitiousness of the targets, the quality of the climate action plans and the amount of publications and news articles about the city's climate action plans.

After determining potential case cities, it became apparent that small cities (urban areas with populations under 50,000) were not well represented. Due to the gap identified in the literature review, that local climate governance studies focus on large cities, therefore overlooking climate action in smaller urban areas (Van der Heijden, 2019) and given the Canadian context where there are many more small municipalities than large cities (World Population Review, 2019), the researcher opted to include cases of exemplary climate action in small communities. For the

Canadian example, the only small municipality to report to the CDP was the town of Bridgewater, NS. The town of Bridgewater meets most of the case study selection criteria (except for a city-wide GHG inventory). It is also a member of the Canadian PCP program (FCM & ICLEI, 2015). Bridgewater is also known for its innovation in the field of municipal climate action (FCM, 2018).

In order to select a comparison case of similar population size to the Town of Bridgewater, the researcher went back to the list of 132 CDP cities that had reported having a climate action plan, specific GHG reduction targets, a city-wide GHG inventory and, decreased or the same emissions since the previous report (Appendix 2). This list was filtered by population size. It was found that the cities of Emeryville, CA and Park City, UT were of similar population size to the town of Bridgewater (Appendix 4). The researcher then conducted an Internet search for the climate action plans and GHG reduction targets of both cities. It was found that the city of Emeryville has committed to a 80% reduction by the year 2050 (City of Emeryville, 2016) and Park City, UT has made an ambitious target of reducing 100% of its community wide GHG emissions by the year 2030 (Park City, 2019). Having a more ambitious GHG reduction target and a closer population to that of Bridgewater, Park City, Utah was selected as a small urban area case study. Appendix 5 shows the final list of selected cases with their populations, GHG reduction targets and target years.

The final list of selected case studies is:

Small city (0-50,000 population) – Bridgewater, NS and Park City, USA

Medium city (50,000-500,000 population) – Guelph ON, and Lahti, Finland

Large city (500,000-1,000,000 population) – Vancouver BC and Oslo, Norway

Very large city (1,000,000 + population) – Toronto, ON and New York City, USA

3.4 Data Collection

The data collection for a case study is extensive and draws from multiple sources such as interviews, archival records or documents and audio-visual materials (Bowen, 2009). Of the types of evidence that are typically gathered in case study research (Yin, 2014), two types that were applicable were collected, namely archival records, documents, and information from informant

interviews. Archival records were studied through content analysis methods and interviews were conducted with key players in local governments with deep decarbonization plans in order to gain an understanding of the current landscape of each case as well as answer the research questions highlighted in the Introduction.

3.4.1 Document Content Analysis

Background data both from publicly available sources and internal archival sources were used to develop the background for each case study. Case study selection criterion two specifies that there must be some form of written document outlining the city's climate action plan. Those reports were collected and analyzed for information pertaining to the research questions. Other documents such as peer reviewed and newspaper articles, third party reports and studies were also collected as they are also valid sources of data for document analysis (Bowen, 2009).

3.4.2 Interviews

Interviews were conducted with key actors from five of the case cities. The object of the interviews was to gather information pertaining to the research questions that was not available or clearly specified in public documents. Project managers from all of the cities were contacted via email, five of which responded and consented to being interviewed. For the remaining three cities, it was determined that there was sufficient information in publically available documents and databases for the researcher to conduct the study without an interview.

The key actors, such as the deep decarbonization project managers, were identified during the document analysis phase. They were initially contacted by email, the recruitment emails contained a recruitment letter (appendix 6) and an information letter (appendix 7). Once a willingness to participate in the research study was established, the participants were sent an interview guide prior to the interview (appendix 8). The participant and the researcher agreed upon dates and times and the interviews were then completed using Skype software or the telephone. Interview guides were developed specifically for each case study. Once finished, the interviews were transcribed immediately in order to be analyzed.

3.5 Data Analysis

Upon completion of the data collection, data from the interviews as well as the content analysis was deductively and then inductively coded in order to aid in the understanding of each city's climate action strategy. The deductive codes were built from the key words identified in the literature review. Data from the document analysis and interviews were deductively coded for pathways, institutionalization strategies, governance structures, actors, and then inductively coded for other emerging mechanisms. From these results, tables were created for each case and a cross case comparison was done. The data was analyzed for emerging patterns and theories that can contribute to the findings of the study.

3.6 Limitations, Reliability & Validity

Case studies as a method are criticized for lack of rigor (Creswell, 1998; Maxwell, 1992). One of the challenges with case studies is ensuring construct, external and internal validity (Flyvbjerg, 2006). To ensure internal validity, multiple data sources were collected, and triangulation of data sources was used to establish the validity of the research and to protect against researcher bias (Creswell, 2014). The coherence of findings in the data analysis phase was assured by cross-checking the results (Yin, 2011) and cross-case pattern matching was also used in the data analysis phase (Marshall & Rossman, 1989). To ensure external validity, replication of the research design was used in all of the case studies (Parkhe, 1993), the scope and boundaries were also defined in the research design phase, in order to achieve reasonable generalizations for the research (Marshall & Rossman, 1989). To ensure construct validity regarding the design of the study, a detailed literature review was conducted (Yin, 2011).

In order to establish reliability, the researcher has ensured the repeatability of the research through detailed documentation of the research process. The researcher also used a case study protocol as well as developed a case study database (Yin, 2014). The protocol includes how data was collected, which includes research tools such as interview questions (Yin, 2014). The database contains the transcripts, documents, and other archival information used (Yin, 2014).

The limitations of the research design were highlighted in the case study selection process. The case study cities were selected based on criteria and data in the CDP Cities 2019 database. It

was found that small cities and non-English speaking cities were not as well represented as larger, English speaking cities. Most cities who reported to the CDP in 2019 are located in the Global North and are in developed countries, meaning that cities in the Global South and developing countries were not as well represented. Lastly, it was found that several of the cities that reported to the CDP in 2019 did not report their full GHG emissions targets for the year 2050. In many cases, cities do in fact have more ambitious GHG reduction targets but only reported their more immediate GHG reduction targets (CDP, 2019). Despite these limitations, the CDP Cities 2019 database was the best option for selecting case studies because it is the largest public database for local climate action and GHG emissions data (CDP, 2019).

Chapter 4 Results

This chapter presents the empirical results from archival data, documents, and interviews of the eight cities that were chosen as case studies. Each case study begins with background information on the community, the history of climate action and their current climate action goals. A section on the findings of the plan structure, the pathways, the governance structure, the actors and the tools used are presented for each case study. The findings from the data collection process are presented in tables and are summarized from the information. The end of the Results chapter presents cross-case tables that collectively summarize findings across the case studies for cross case comparison purposes.

4.1 Sections

Technical Pathways: Examines the specific targets and strategies for each sector involved in the climate action plans.

Institutionalization Strategies: Reviews the strategies, actions and tools that institutionalize deep decarbonization into local government planning and policy making.

Governance: Describes the decision-making, communication and oversight structures of the climate action plan. This section also examines the extent of collaboration within the governance structure as well as the level of vertical integration of climate policy with other levels of government.

Actors: Investigates who the internal and external organizations or departments are as well as their roles in the planning and implementation phases of the climate action plans.

Cross Case Comparison Tables: The variables from each section were categorized and inductively coded for key words. The tables are meant to highlight any patterns that may emerge across the case studies.

4.2 Bridgewater, Nova Scotia, Canada

The Town of Bridgewater is located in Lunenburg County, Nova Scotia, Canada, at the navigable limit of the LaHave River. Bridgewater has a growing population, with 8,532 residents as of 2016, making it the largest town in the South Shore region. Bridgewater's population has grown by more than 25% in the past 20 years, making Bridgewater one of the fastest growing areas in the province.¹

Bridgewater has a diverse economy with manufacturing and construction the largest employment sectors. Bridgewater is the major service centre for the region, and as a result, the retail sector comprises a large component of the town's employment base. Over the past three decades there has been an increase in the presence of government services in the town, particularly in the health care and education sectors.²

4.2.1 Sustainability & Climate Action

Bridgewater has recently gained regional and national exposure for its *Energize Bridgewater* program. This work originated with an Integrated Community Sustainability Plan (ICSP) and Bridgewater has successfully embedded a sustainability lens in major city projects. In 2015, Bridgewater completed its Municipal Climate Change Action Plan (MCCAP) and produced an updated Energy Management Plan for the period of 2015-2019. Recently, the Town piloted the Property Assessed Clean Energy (PACE) program, and created the Community Energy Investment Plan (CEIP), which won a Globe Series award in the Small Municipal Trailblazer category³. The CEIP provides fully costed pathways towards a low carbon economy through energy efficiency and renewable energy. Through community engagement and technical analysis the CEIP envisions how Bridgewater can reduce GHG emissions by 80% by 2050.⁴

¹ CDP, "2019 Full Cities Dataset. [Dataset],"

² CDP, "2019 Full Cities Dataset. [Dataset],"

³ Interview with Junior Planner, February 5, 2020

⁴ CDP, "2019 Full Cities Dataset. [Dataset],"

The resulting investment plan requires nearly \$500 million in energy efficient buildings, new community-scale energy systems, and clean & active transportation systems to be added in the town over 32 years (2018-2050). The Community Energy Investment Plan was officially launched in Bridgewater in the fall of 2018 with acclaim from the provincial Minister of Energy, and is being profiled as an example for its framing of climate action in terms of local economic development.⁵

Bridgewater is also a member of the FCM/ICLEI Partners for Climate Protection program. In 2019, Bridgewater won the national Smart Cities Challenge in the \$5 million category. Its proposed approach to combatting energy poverty through energy transition, using data and connected technologies, allowed it to secure the win. Bridgewater is now implementing its programs under the *Energize Bridgewater* brand.⁶

4.2.2 Technical Pathways: Bridgewater

The Bridgewater CEIP actions are organized into three strategies: energy efficient buildings, community scale energy systems and clean & active transportation systems. The CEIP also outlines actions the Town of Bridgewater will take as a capacity builder, enabler and investor.⁷

Table 6: Technical Pathways: Bridgewater

Variable	Findings
Decarbonization of Electricity/ Energy	Energy Shift Pathway: <ul style="list-style-type: none"> - New community-scale energy systems: to account for 40% of the needed energy shift. By 2050: <ul style="list-style-type: none"> - Install a 20 MW run-of-river hydro power system and 12 MW of large-scale wind turbines. - Supply the downtown commercial buildings with district heating and cooling, generated through sustainably-harvested local wood heat, geothermal heat exchange or a heat exchanger in the river. - Install 12 MW of ground-mounted solar PV systems (in 2021) – locally owned.

⁵ Bridgewater CEIP pg. 11

⁶ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁷ Bridgewater CEIP

	<ul style="list-style-type: none"> - Install 5kW battery banks in 50% of homes. - Total Investment: \$157 million. - Total Savings: \$336 million. - GHG Emissions Reduced: 1396 KT⁸.
Existing Buildings	<p>By 2050:</p> <ul style="list-style-type: none"> - All residential, and commercial facilities and industrial facilities operate 50% more efficiently. - 60% of all residential buildings and 85% of all commercial buildings have heat pumps installed. - 80% of all buildings have solar PV systems, and 50% of buildings have solar hot water systems installed. - Total Investment: \$151 million. - Total Savings: \$569 million. - GHG Emissions Reduced: 1952 KT⁹.
New Buildings	<p>By 2030:</p> <ul style="list-style-type: none"> - All newly constructed buildings meet the highest energy performance standard - Net zero and passive house performance standard. - Total Investment: \$1.7 million. - Total Savings: \$15 million. - GHG Emissions Reduced: 45 KT¹⁰.
Transportation Mode Shifting	<p>By 2050:</p> <ul style="list-style-type: none"> - Investments in walking and cycling infrastructure allow 50% of short distance trips to be done by foot or by bike. - Total Investment: \$4 million. - Total Savings: \$10 million. - GHG Emissions Reduced: 41 KT¹¹.
Transportation Fuel Shifting	<p>By 2050:</p> <ul style="list-style-type: none"> - Bridgewater public transportation system to be fully electric. - All vehicles in Bridgewater are electric, allowing vehicle batteries to add to the community's total energy storage. - It is anticipated that most vehicles in Bridgewater operate autonomously, allowing households to own 50% fewer vehicles, however, increased access results in higher overall transportation energy consumption. - Total Investment: \$60 million. - Total Savings: \$194 million. - GHG Emissions Reduced: 46 KT¹².
Waste Reduction, Diversion & Capture	<ul style="list-style-type: none"> - Current plan does not have a waste reduction target or strategy. - Current waste diversion rate is 50%. - Waste management is controlled by municipal joint services board¹³.
Carbon Sinks, Storage & Offsets	<ul style="list-style-type: none"> - Current plan does not include a strategy or target for carbon sinks or storage¹⁴.

⁸ Bridgewater CEIP page 25, 29

⁹ Bridgewater CEIP pg. 28

¹⁰ Bridgewater CEIP pg. 28

¹¹ Bridgewater CEIP pg. 25

¹² Bridgewater CEIP pg. 25

¹³ Interview with Junior Planner, February 5, 2020

¹⁴ Interview with Junior Planner, February 5, 2020

4.2.3 Institutional Strategies: Bridgewater

Table 7: Institutional Strategies: Bridgewater

Variable		Findings
Engagement	Plan Development	<ul style="list-style-type: none"> - The CEIP involved extensive community engagement over an 18-month period.¹⁵ - BCEI Advisory Committee included local stakeholders (energy utilities, businesses and residents) who provided valuable project advice and connections to stakeholders in the community¹⁶ - Community crowdsourcing and consultation involved community meetings, workshops, focus groups, online polls, surveys, public events and individual correspondence and meetings with specific stakeholders.¹⁷ - Dedicated focus groups were held with low-income and vulnerable residents.¹⁸
	Plan Implementation	<ul style="list-style-type: none"> - Bridgewater Energy Partnership educated the community on energy issues through meetings and workshops. - The Energize Bridgewater Website acts as Bridgewater's communication portal.¹⁹
	Advocacy	<ul style="list-style-type: none"> - Bridgewater is working with other governments and sectors, encouraging them to support zero emissions outcomes and participate/collaborate in the climate action plan.²⁰ - The town challenges local businesses to adopt actions outlined in the CEIP.²¹ - The Energy Partnership is a learning and action program for local business and organizations that encourages innovative energy solutions.²²
Long Term Endeavors	<ul style="list-style-type: none"> - The CEIP provides a costed pathway to achieve its 80x50 reduction target.²³ - GHG mitigation targets and sustainability goals are embedded in other local government plans such as the Downtown and Waterfront Master Plan. 	
Building Technical Capacity	<ul style="list-style-type: none"> - Sustainability Solutions Group (SSG), a consulting firm was hired for technical analysis - to determine current trends in consumption and GHG emissions. Scenarios were then created to analyze GHG trajectories, including a BAU scenario and an 80x50 scenario. The 80x50 scenario was determined technically feasible.²⁴ - The aim of the technical analysis was to provide an investment roadmap using a detailed energy and emissions model.²⁵ - Partnerships with Nova Scotia Community College (NSCC) and other educational institutions were created for capacity building.²⁶ - Bridgewater partnered with the Clean Net Zero Project to pilot a Net Zero Retrofit project. They used a multi-sectoral collaboration between 	

¹⁵ Bridgewater CEIP pg. 13

¹⁶ Interview with Junior Planner, February 5, 2020

¹⁷ Town of Bridgewater, "Smart Cities Application," 2018.

¹⁸ Town of Bridgewater, "Smart Cities Application," 2018.

¹⁹ Bridgewater CEIP pg. 19

²⁰ Bridgewater CEIP pg. 39

²¹ Bridgewater CEIP pg. 39

²² Energize Bridgewater, "Partnership – Energize Bridgewater," 2019, <http://www.energizebridgewater.ca/partnership/>.

²³ CDP, "2019 Full Cities Dataset. [Dataset]," 2019.

²⁴ Bridgewater CEIP pg. 13

²⁵ Town of Bridgewater, "Smart Cities Application."

²⁶ Bridgewater CEIP pg. 43

	<p>municipalities, technical experts, and lending institutions. The project will map out a pathway that will reduce the barriers facing homeowners who want to make the leap to net zero energy.²⁷</p>
Funding	<ul style="list-style-type: none"> - The investment required would be undertaken by a mix of public and private sector entities and not solely the local government.²⁸ - The local government will invest nearly \$400 million in infrastructure: energy efficient buildings, new community-scale energy systems, and clean & active transportation systems over 32 years.²⁹ - Bridgewater receives funding from various programs and grants from different levels of government.³⁰ - Smart Cities award winner – the town won \$5 million over 5 years to fund the energy poverty reduction program. - Province partially funds public transit system.³¹ - All of the 20 Actions in the CEIP have a positive NPV, meaning they are viewed as investment opportunities.³² - “Right now we’re investigating different opportunities that are available for municipalities to raise funds for different kinds of projects. There are a few barriers that exist for that, so we’re only allowed to borrow from the municipal finance corporation as a municipality and so it’s hard to create funds that aren’t for core services for green projects. So we have to look at external organizations that build -co-ops and that kind of thing. That can then act to fund different projects.”³³
Green Economy	<ul style="list-style-type: none"> - The CEIP is framed as an economic development strategy for the town. - The CEIP will create clean energy jobs and other employment related to building retrofits and transportation. - The goal to have a sustainable local economy where goods are produced and consumed locally using environmentally responsible practices. - The town is aiming to have more sustainable purchasing practices.³⁴
Regulatory / Policy Tools	<ul style="list-style-type: none"> - The town council adopted the Energy Poverty Reduction Program, which is a large policy document and the first point of implementation of the CEIP.³⁵ - The town is undertaking a review of its Municipal Planning Strategy this year and will likely include policies identified in the CEIP.³⁶
Financial / Investment Tools	<ul style="list-style-type: none"> - The Bridgewater PACE program and Clean Energy Financing programs for home renovations and clean energy to expand the limit on per household loans.³⁷ - The LaHave Credit Union (a partner organization) has low interest loans for residents to do a number of energy efficiency projects.³⁸ - Through the Smart Cities Program, Bridgewater is developing a local clean energy investment system.³⁹

²⁷ Bridgewater CEIP pg. 46

²⁸ Bridgewater CEIP pg. 27

²⁹ Bridgewater CEIP pg. 19 & 22

³⁰ Interview with Junior Planner, February 5, 2020

³¹ Interview with Junior Planner, February 5, 2020

³² Bridgewater CEIP pg. 13

³³ Interview with Junior Planner, February 5, 2020

³⁴ <https://www.bridgewater.ca/town-services/planning/31-town-services/sustainability/459-green-self-supportive-local-economy>

³⁵ Interview with Junior Planner, February 5, 2020

³⁶ Interview with Junior Planner, February 5, 2020

³⁷ Interview with Junior Planner, February 5, 2020

³⁸ Interview with Junior Planner, February 5, 2020

³⁹ Town of Bridgewater, “Smart Cities Application.”

4.2.4 Governance: Bridgewater

Table 8: Institutional Strategies: Bridgewater

Variable	Findings
Decision-Making Structure	<ul style="list-style-type: none"> - Decision making and responsibilities take shape in a hierarchy⁴⁰ - The CAO for the Town of Bridgewater is responsible for implementing and administering the town's climate change mitigation and adaptation actions. - Implementation actions are distributed among all departments.⁴¹ - The CAO's office provides support services including reporting, recording and facilitating all matters of significance to town council. The CAO acts as a liaison between all actors. In addition, the CAO's office provides support on communication matters.⁴² - Bridgewater is in the process of creating an Energize Bridgewater Advisory Committee, which will be a forum for the town to engage and support the energy poverty reduction program and the CEIP.⁴³ - Community Development Department is responsible for planning and implementation and has sustainability embedded in its functions. It is supported by the Engineering Department.
Oversight, Monitoring & Reporting	<ul style="list-style-type: none"> - CAO office ensures that policies adopted by town council are implemented and followed.⁴⁴ - The Town Council is the overseeing body. - Annual work plan and review and indicator report track effectiveness of actions. - GHG Inventory takes place every 2 years. - CEIP updates to reflect changing conditions—every 5 years.⁴⁵ - Partners participate in ongoing program evaluation and improvement, with key service delivery partners actively participating in the evaluation process. Evaluation will lead to periodic adjustments to the processes, policies, and procedures of the service. Evaluation processes will be led and supported by staff and will involve client feedback on a regular basis.⁴⁶
Leadership	<ul style="list-style-type: none"> - Energize Bridgewater – a community-wide initiative with over 50 partners⁴⁷ and the Town of Bridgewater
Communication	<ul style="list-style-type: none"> - CAO office facilitates communication and acts as a liaison between town council and all departments as well as committees and boards.⁴⁸ - Regular meetings are held between city departments.⁴⁹ - Town of Bridgewater Website
Vertical Integration	<ul style="list-style-type: none"> - The Provincial government made it mandatory for all municipalities to develop Municipal Climate Change Action Plans (MCCAP). Bridgewater's plan exceeds the provincial standards and is used as a best practice example for other municipalities across Canada.⁵⁰

⁴⁰ Interview with Junior Planner, February 5, 2020

⁴¹ CDP, "2019 Full Cities Dataset. [Dataset]," 2019.

⁴² CDP, "2019 Full Cities Dataset. [Dataset]," 2019.

⁴³ Interview with Junior Planner, February 5, 2020

⁴⁴ Interview with Junior Planner, February 5, 2020

⁴⁵ Bridgewater CEIP pg. 49

⁴⁶ Bridgewater Energy Poverty Reduction Program pg. 17

⁴⁷ Interview with Junior Planner, February 5, 2020

⁴⁸ CDP, "2019 Full Cities Dataset. [Dataset]," 2019.

⁴⁹ Interview with Junior Planner, February 5, 2020

⁵⁰ Municipal Climate Change Action Plan Guidebook – Nova Scotia

Collaboration	<ul style="list-style-type: none"> - Collaboration is practiced through the Energize Bridgewater entity, which includes over 50 partners from various sectors. Energize Bridgewater is led by the local government and takes a collaborative approach towards community-wide decision-making through the Advisory Committee⁵¹ - The town led in the development of the Energy Partnership, Living Energy Laboratory, Community Energy Center, Community Sustainability Network and the Energize Bridgewater Advisory Committee.⁵² - All of these groups help choose and lead actions that benefit the community and help to shape initiatives and policies.⁵³
Governance Mode	<ul style="list-style-type: none"> - Self regulating through ambitious corporate emissions reduction plan and provisioning. - Enabling through programs like Energize Bridgewater and stakeholder engagement activities, incentives and educational programs. - Provisioning through the provision of public infrastructure and investments in infrastructure.

4.2.5 Actors: Bridgewater

Table 9: Actors: Bridgewater

Variable	Findings
External Actors	<ul style="list-style-type: none"> - Energize Bridgewater - an organization led by the town but composed of various community actors with over 50 partners with an Advisory Committee who helped to shape the plan. This organization is involved with many of the community actions.⁵⁴ - The external partners played a role in shaping the plan.⁵⁵ - Partnerships with academic institutions (NSCC) help to build capacity and play an enabling role. - Partners have made specific commitments that are outlined in the strategy.⁵⁶ <p>Roles:</p> <ul style="list-style-type: none"> - Higher levels of government play enabling roles through funding. - External partners take on enabling and facilitating roles through plan development (consulting) and implementation.,
Internal Actors	<ul style="list-style-type: none"> - CAO office plays a coordinator role. - All city departments are responsible for implementation actions. - “The Community Development Department, which is responsible for planning and development as well as recreation which led to the Climate Action Plan process with support from the Engineering Department. Those are the primary actors.”⁵⁷ - “The town’s priority is to build its capacity to implement the CEIP and to empower community partners to exercise leadership as well. This priority includes investing in staff, identifying funding, engaging the community, facilitating community processes and ensuring that its own practices reflect community’s values and objectives.”⁵⁸

⁵¹ Energize Bridgewater, “The Bridgewater Energy Partnership” (Bridgewater, 2016).

⁵² Energize Bridgewater, “The Bridgewater Energy Partnership” (Bridgewater, 2016).

⁵³ Energize Bridgewater, “Partnership – Energize Bridgewater,” 2019, <http://www.energizebridgewater.ca/partnership/>.

⁵⁴ Interview with Junior Planner, February 5, 2020

⁵⁵ Town of Bridgewater, “Smart Cities Application.”

⁵⁶ Town of Bridgewater, “Energy Poverty Reduction Program ” (Bridgewater, 2019). Pg. 41

⁵⁷ Interview with Junior Planner, February 5, 2020

⁵⁸ Bridgewater CEIP pg. 43

	<p>Roles</p> <ul style="list-style-type: none"> - Leading, decision making, facilitating, enabling, coordinating, and funding/investing.
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4.3 Park City, Utah, USA

Park City, which currently has one of the fastest growing and most diverse economies in the United States is located in Summit County Utah, USA, approximately 30 miles from Salt Lake City. Park City is home to world-class ski resorts and was the mountain host for the 2002 Winter Olympics in Salt Lake City. Park City also hosts the country’s largest independent film festival, the Sundance Film Festival.⁵⁹ The town has population of roughly 8,500 residents and receives an average of 3 million tourists annually. Non-residents own approximately seventy percent of the housing stock in Park City as holiday residences. Park City enjoys a strong economy that is diversifying from its historic dependence on winter sports. It brings in a yearly average of \$529,800,000 to Utah’s economy. Park City has many upscale luxury lodging and hotels, retailers, clubs, bars and restaurants and has nearby reservoirs, hot springs, forests and hiking and 450 miles of biking trails. Park City has historically been the driving economic engine of Summit County.⁶⁰

4.3.1 Sustainability & Climate Action

As part of the Energy Critical Priority, Park City has set North America's most ambitious climate goals: to have 100% renewable electricity by 2022 for municipal operations and to be carbon neutral for community-wide emissions by 2030.⁶¹ The community-wide goals were originally targeted for 2032 but were brought forward to 2030 to align with the IPCC's 1.5-degree special report and Salt Lake City/Park City’s Olympic bid for 2030.⁶²

Park City played a leading role in the passing of the Community Renewable Energy Act in the State of Utah. This piece of legislation sets the legal framework for the State Public Service

⁵⁹ www.parkcity.org

⁶⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁶¹ www.parkcity.org/departments/sustainability

⁶² CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

Commission to regulate the procurement and pricing of large-scale renewables for communities that want 100% renewable energy. This bill was based on Park City's ambitious goals, and Park City staff and elected officials were major players in crafting and lobbying for the bill's passage.⁶³

Park City has six main objectives in terms of climate action: community leadership, transportation and land use, energy use, energy supply, waste reduction and diversion and carbon offsets. By implementing actions for these objectives, Park City is aiming to be a carbon neutral community by 2030.⁶⁴

Emissions by Sector (2016)⁶⁵

Transportation 37.1%

Electricity 36.3%

Stationary Fuels 23.4%

Solid waste 3%

4.3.2 Technical Pathways: Park City

Park City has yet to create a formal action plan that is publically available. The city has outlined the strategies it is implementing on its website. The focus of the Park City sustainability strategy is renewable energy and greening city operations.

Table 10: Technical Pathways: Park City

Variable	Findings
Decarbonization of Electricity/ Energy	<ul style="list-style-type: none"> - 100% renewable energy by 2030 - Partnership with Rocky Mountain Power (utility company) to build a solar energy plant roughly 50 miles west of Park City. - Local renewable energy will be installed to reach the 100% target by 2030

⁶³ CDP, "2019 Full Cities Dataset. [Dataset]," 2019.

⁶⁴ CDP, "2019 Full Cities Dataset. [Dataset]," 2019.

⁶⁵ <https://www.parkcity.org/home/showdocument?id=48660>

	through a public/private partnership with Rocky Mountain Power ⁶⁶
Existing Buildings	<ul style="list-style-type: none"> - No specific target⁶⁷ but they are advocating for people to increase efficiency through: - Summit Community Power Works (SCPW) Challenge, - C-PACE program - for commercial building only - Conservation kits – for residents (targeted to lower income), - Energy detective kits for residents, - Streamlined permit process for solar panels.⁶⁸ - Utah State law says that cities cannot change efficiency regulations for buildings, but Park City is working on a financial incentive program for residents to retrofit homes and a stretch code to improve energy efficiency.⁶⁹
New Buildings	<ul style="list-style-type: none"> - Net-zero energy performance standard for local government-owned buildings and facilities.⁷⁰ - All new municipal buildings and affordable housing that the town builds will be heated using electricity instead of natural gas.⁷¹ - The town has a voluntary a stretch code for new buildings, but does not have the jurisdiction over construction/efficiency regulations to implement actual codes/policies.⁷²
Transportation Mode Shifting	<ul style="list-style-type: none"> - Free public transit that connects residential and commercial areas. - Summit Bike Share Program - Paid parking in the city to dis-incentivise drivers. - MyStop app for real time bus schedules. - Reduce vehicle miles on entry corridors by 25 percent by 2030.⁷³ - Promote a walkable and bikable Park City map highlighting trails, routes and key components in the city like grocery stores, schools etc.⁷⁴
Transportation Fuel Shifting	<ul style="list-style-type: none"> - By 2026: public transit will be 100% electric. - Installing 100 EV charging stations by the end of 2020, which will be supplied by 100% renewable energy by 2022. - EV charging will be free.⁷⁵
Waste Reduction, Diversion & Capture	<ul style="list-style-type: none"> - Plastic bag ban.⁷⁶ - Recycling program, in partnership with Recycle Utah to reduce food waste and C+D recycling.⁷⁷
Carbon Sinks, Storage & Offsets	<ul style="list-style-type: none"> - Regeneration is one of the main strategies to get Park City to its net zero goal. - Focus is placed on local carbon sinks. - Exact amount of carbon storage that will be needed to meet the goals is not calculated but will be “quite a bit.”⁷⁸ - Approximately 70% of Park City's total land area is covered by open space designated under easements. This land is being actively tracked and managed to increase carbon sequestration, in cooperation with universities to determine the

⁶⁶ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁶⁷ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁶⁸ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁶⁹ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁷⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁷¹ Park City, <https://www.parkcity.org/departments/sustainability/electrification>

⁷² Interview with Environmental Sustainability Project Manager. February 20, 2020

⁷³ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁷⁴ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁷⁵ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁷⁶ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁷⁷ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁷⁸ Interview with Environmental Sustainability Project Manager. February 20, 2020

	<p>best methodologies for increasing sequestration rates in soils and increasing vegetation and tree growth.⁷⁹</p> <ul style="list-style-type: none"> - Regenerative agriculture actions. - The community funds open space bonds to protect land and soil for recreation and carbon sinks.⁸⁰
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4.3.3 Institutionalization Strategies: Park City

Table 11: Institutionalization Strategies: Park City

Variable		Findings
Engagement	Plan Development	<ul style="list-style-type: none"> - Three phase visioning process for the town’s general plan. - Stakeholder meetings for plan creation.⁸¹
	Plan Implementation	<ul style="list-style-type: none"> - Using the public library as a climate change center for community engagement and public education on climate change.⁸² - Monthly science talks and events to educate the residents on climate change and the impact that it will have on Park City. - Fun challenges for residents – “my sustainable year” and other monthly challenges targeted to specific behaviours such as transportation or waste management.⁸³
	Advocacy	<ul style="list-style-type: none"> - Park City played a leading role in the Community Renewable Energy Act advocating to the Utah State Government⁸⁴ - Park City has partnered with and is a member of several transnational city networks; GCoM, ICLEI, and The Climate Reality Project – 100% Committed Initiative and Mountain Towns 2030
Long Term Endeavors		<ul style="list-style-type: none"> - The local government has made a commitment to have net zero local government emissions by 2022 and community-wide by 2030.⁸⁵
Building Technical Capacity		<ul style="list-style-type: none"> - Working on a monthly reporting system to city managers on energy usage. - Data analysis through the Wattsmart communities planning process.⁸⁶
Funding		<ul style="list-style-type: none"> - Funding comes from various grants from the State and Federal governments. - Funding is allocated by Park City Council. - Rocky Mountain Power supplies funding for renewable energy projects.⁸⁷ - Currently developing partnerships and funding opportunities with local NGOs. - Park City Climate Fund, established by the Park City Community Foundation in October 2019, to provide seed capital to innovative projects that help address climate change.⁸⁸ - Open Space Bonds – the community has voted to fund 4 open space bonds protecting 8,000 acres of open space.⁸⁹
Green Economy		<ul style="list-style-type: none"> - Changing town procurement to reflect the target to be net zero by 2022 (for corporate emissions).

⁷⁹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁸⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁸¹ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁸² Interview with Environmental Sustainability Project Manager. February 20, 2020

⁸³ <https://www.parkcitymag.com/health-and-wellness/2019/01/building-sustainable-lifestyles-as-a-community>

⁸⁴ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁸⁵ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁸⁶ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁸⁷ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁸⁸ “Park City Community Foundation Announces First Park City Climate Fund Grantees - Park City Community Foundation,” accessed March 2, 2020, <https://parkcitycf.org/park-city-community-foundation-announces-first-park-city-climate-fund-grantees/>.

⁸⁹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

	<ul style="list-style-type: none"> - City-wide plastic bag ban to limit consumption of plastics.
Regulatory/ Policy Tools	<ul style="list-style-type: none"> - Net zero performance standard for municipal buildings and affordable housing.⁹⁰ - “We’re working on a stretch code and it should lead into being able to track the energy efficient buildings and renovations that are going up and that will lead into a bench marking program.”⁹¹ - Park City was the first town in Utah to have a community-wide ban on plastic bags.⁹²
Financial/ Investment Tools	<ul style="list-style-type: none"> - C-PACE retrofit program for local commercial buildings.⁹³ - Waiving building permit fees and other fees associated with energy efficient construction (the stretch code).⁹⁴ - Received funding for a retrofit for residents program but it is not underway yet. - “Another program that we’ve been working with Summit Community Power Work/Utah Clean Energy is community solar. So basically a bulk buy. If a resident wants rooftop solar they get it at 30% off of what they would if they were not a part of the community solar program.”⁹⁵ - Investments in renewable energy infrastructure. - Free public transit⁹⁶ - Free EV charging⁹⁷

4.3.4 Governance: Park City

Table 12: Governance: Park City

Variable	Findings
Decision- Making Structure	<ul style="list-style-type: none"> - “Hierarchy” in terms of how decisions are made and roles and responsibilities are outlined. Park City has a council-manager government structure.⁹⁸ - Climate Action is lead by a 2-person sustainability team who work under the city manager.⁹⁹ - Other relevant town departments are involved in climate actions as implementation partners.
Oversight, Monitoring & Reporting	<ul style="list-style-type: none"> - Municipal carbon footprint is calculated annually, and they are working on a new system to calculate it monthly. - Energy reports are submitted to city managers.¹⁰⁰
Leadership	<ul style="list-style-type: none"> - Park City Sustainability Department - Park City Council¹⁰¹
Communication	<ul style="list-style-type: none"> - Small team makes communication easier.¹⁰² - Email, meetings, reports to council - Website - Community events - Engaged in lobbying at the state level

⁹⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁹¹ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁹² Park City, <https://www.parkcity.org/departments/sustainability/policy-rulemaking>

⁹³ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁹⁴ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁹⁵ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁹⁶ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁹⁷ Interview with Environmental Sustainability Project Manager. February 20, 2020

⁹⁸ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁹⁹ Interview with Environmental Sustainability Project Manager. February 20, 2020

¹⁰⁰ Interview with Environmental Sustainability Project Manager. February 20, 2020

¹⁰¹ Interview with Environmental Sustainability Project Manager. February 20, 2020

¹⁰² Interview with Environmental Sustainability Project Manager. February 20, 2020

Vertical Integration	<ul style="list-style-type: none"> - Park City has taken a bottom up approach to vertical integration, through their work on the Community Renewable Energy Act. This bill will support other municipalities in Utah who want to integrate more renewable energy.
Collaboration	<ul style="list-style-type: none"> - The Park City Government partners with local businesses, NGOs and local stakeholders for engagement and implementation of actions. - Many of the partnerships are to increase Park City’s capacity/expertise for sustainability as well as for funding.
Governance Mode	<ul style="list-style-type: none"> - Self-governing through the corporate emissions planning and public procurement.¹⁰³ - Enabling through community-wide engagement and education and events. - Provisioning through investments in public infrastructure and provisioning of services such as EV charging and free public transit. - Authority through some regulations regarding vehicle idling and a plastic bag ban.¹⁰⁴

4.3.5 Actors: Park City

Table 13: Actors: Park City

Variable	Findings
External Actors	<ul style="list-style-type: none"> - Partnership with Rocky Mountain Power is the most significant since RMP will be building the renewable energy facilities and supplying the renewable energy. - Other partnerships include local NGOs and local small businesses.
	<p>Roles</p> <ul style="list-style-type: none"> - Partners (businesses and NGOs) help to implement actions, determine their own contribution, and play a consulting role¹⁰⁵ (enabling and facilitating roles). - RMP (utility) is a service provider, and strategic partner (enabling and facilitating).
Internal Actors	<ul style="list-style-type: none"> - Sustainability team (2 person team) - Other city departments help with implementation actions. - City Manager and City Council oversee the plan and progress.¹⁰⁶
	<p>Roles</p> <ul style="list-style-type: none"> - The town acts as a regulator, enabler, facilitator, coordinator and provides funds.

4.4 Guelph, Ontario, Canada

Guelph is a city in southwestern Ontario, Canada, with a population of approximately 132,000.

Guelph is consistently rated as one of Canada's best places to live because of its relatively low crime rates, clean environment and generally high standard of living. Guelph has been noted as having one of the lowest unemployment rates in the country, in large part due to the great

¹⁰³ <https://www.parkcity.org/departments/sustainability/policy-rulemaking>

¹⁰⁴ <https://www.parkcity.org/departments/sustainability/policy-rulemaking>

¹⁰⁵ Interview with Environmental Sustainability Project Manager. February 20, 2020

¹⁰⁶ Interview with Environmental Sustainability Project Manager. February 20, 2020

number of manufacturing facilities. The five key sectors of the local economy are: agri-food, innovation firms, environmental management, technology, and tourism operators.¹⁰⁷

4.4.1 Sustainability & Climate Action

Guelph has a strong history of climate action, being the first city in Canada to have a Community Energy Plan in 2007. The CEP was renamed the Community Energy Initiative (CEI) in 2010 and with it the city saw a wave of climate action initiatives that resulted in a decrease in community-wide emissions. The plan was made into policy, Guelph City Council allocated resources to it, including full-time staff. This added momentum and profile to the CEI and created the impression that the city had things well in hand. Direct community involvement seemed unnecessary, and gradually faded away. Over several years task forces and committees related to the CEI disappeared and were not renewed, resulting in a gradual decline in implementation and progress of the CEI.¹⁰⁸

In 2018 Our Energy Guelph (OEG), a community stakeholder group and now not-for-profit enterprise, presented an update of the CEI to Guelph City Council. The update was approved by City Council and OEG was recognized as the official implementer of the plan. The current CEI is a community lead, municipally resourced plan.¹⁰⁹ Along with the short-term targets of the CEI, Our Energy Guelph has developed a long-term deep decarbonization pathway with a target to have net zero emissions by 2050.¹¹⁰

4.4.2 Technical Pathways: Guelph

Actions in the Community Energy Initiative are separated into technical actions, organizational actions and enabling activities. The technical actions are those that will result in direct or indirect GHG reductions in the buildings, energy, transportation and/or waste sector. The

¹⁰⁷ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹⁰⁸ <https://www.ourenergYGuelph.ca/community-energy-initiative-cei-update-2018/a-brief-history-of-the-cei/from-cep-to-cei>

¹⁰⁹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹¹⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

organizational actions are those that help the community organization is built to co-lead the implementation with the City of Guelph. The enabling activities are to be implemented to encourage community-wide action.¹¹¹

Table 14: Technical Pathways: Guelph

Variable	Findings
Decarbonization of Electricity/ Energy	<ul style="list-style-type: none"> - 100% renewable energy by 2050 - Investment in district heating systems by launching a district energy team. - 67 MW of energy storage installed by 2050 to reduce the curtailment of the ground-mounted PV. - 50 MW of wind energy installed by 2050 outside of city limits. - 100 kilowatts of run of river hydro electricity generation added. - 16 MW seasonal storage district energy system installed in the downtown area. - 20 megawatts (MW) of commercial scale ground mounted solar PV installed per year between 2018 and 2050. - Guelph’s target is to add building scale renewable energy and heat pumps.¹¹² - The city has partnered with local utilities to develop rooftop solar PV programs and energy efficiency projects.¹¹³
Existing Buildings	<ul style="list-style-type: none"> - By 2050 retrofit 98% of pre 2017 buildings (residential, commercial, institutional) to have 50% energy savings¹¹⁴ through building code improvements.¹¹⁵ - OEG is launching an energy efficiency retrofit (residential and ICI) team.¹¹⁶ - OEG is pushing for a Property Accessed Clean Energy (PACE) program
New Buildings	<ul style="list-style-type: none"> - 100% of new homes net zero by 2030 and 100% of non residential buildings achieve passive house levels by 2030.¹¹⁷ - OEG is launching a building code team that has representatives from diverse stakeholders and a task of developing (voluntary) codes that will support the targets of the CEI.¹¹⁸
Transportation Mode Shifting	<ul style="list-style-type: none"> - Public transit will be expanded to high density areas. - Cycling and walking mode will be increased. - Double number of rideshare trips by 2050. - Car free downtown by 2040.¹¹⁹ - OEG is looking into developing a light rail system. Guelph is one of two municipalities in Canada that owns its own rail way, meaning that Guelph could have a light rail system for a small fraction of the cost of other cities.¹²⁰
Transportation Fuel Shifting	<ul style="list-style-type: none"> - Transit and municipal fleets fully electric by 2050¹²¹ - The city purchased 35 electric busses and is currently building a facility to charge and maintain the busses. Thirty more busses will be purchased in the future.¹²²

¹¹¹ <https://www.ourenergyguelph.ca/community-energy-initiative-cei-update-2018/recommended-actions>

¹¹² “Appendix: Actions in the Low Carbon Pathway — Our Energy Guelph,” accessed February 10, 2020, <https://www.ourenergyguelph.ca/pathway-to-net-zero-carbon/appendix-actions-in-the-low-carbon-pathway>.

¹¹³ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹¹⁴ “Appendix: Actions in the Low Carbon Pathway — Our Energy Guelph.”

¹¹⁵ SSG, “A Low Carbon Pathways for the City of Guelph,” 2019.

¹¹⁶ “Launch Building Code Team — Our Energy Guelph,” accessed February 10, 2020,

¹¹⁷ “Appendix: Actions in the Low Carbon Pathway — Our Energy Guelph.”

¹¹⁸ “Launch Building Code Team — Our Energy Guelph,” accessed February 10, 2020,

¹¹⁹ “Appendix: Actions in the Low Carbon Pathway — Our Energy Guelph.”

¹²⁰ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹²¹ “Appendix: Actions in the Low Carbon Pathway — Our Energy Guelph.”

¹²² Interview with Our Energy Guelph Executive Director. February 19, 2020

	<ul style="list-style-type: none"> - Target is to have 100% of new passenger vehicles be electric by 2050 and - 95% commercial vehicles electric by 2035. - OEG is launching an electric transit team.¹²³
Waste Reduction, Diversion & Capture	<ul style="list-style-type: none"> - 70% waste diversion by 2021 - The city is currently updating The City of Guelph Solid Waste Management Master Plan.¹²⁴ The updated plan will incorporate strategies for waste minimization and diversion from landfill¹²⁵
Carbon Sinks, Storage & Offsets	<ul style="list-style-type: none"> - 8% of emissions will have to be offset by the year 2050 (to reach net zero target) - Purchase green electricity, CCAS, or other offsetting methods¹²⁶ -

4.4.3 Institutionalization Strategies: Guelph

Table 15: Institutionalization Strategies: Guelph

Variable		Findings
Engagement	Plan Development	<ul style="list-style-type: none"> - Our Energy Guelph (OEG) is a community group composed of many stakeholders. This group is responsible for the plan creation as well as implementation. They engaged stakeholders through surveys and in person responses.¹²⁷
	Plan Implementation	<ul style="list-style-type: none"> - My World My Choice – university students mentor middle school and high school students on sustainability. - Local Action on Climate Change - encouraging young people to become advocates and to work constructively with governments to deliver change. - Planet Protector Academy - a multi media program targeted at grades 2-4. - Random Acts of Green App – where residents can sign up and log their low carbon habits and receive rewards such as discounts at local shops.¹²⁸ - OEG Webpage and social media communication. - CEI update to council results in communication to community; council meetings publicly presented and activities related to CEI result in communication and outreach to the community. - OEG is largely responsible for plan implementation, the community group engages stakeholders at all levels for implementation of actions.
	Advocacy	<ul style="list-style-type: none"> - “Advocacy is our story” – as a community group that advocates federal and provincial governments for climate action and to local business and stakeholders¹²⁹ - OEG collaborates and partners with local business and community groups - Programs for businesses:

¹²³ “Appendix: Actions in the Low Carbon Pathway — Our Energy Guelph.”

¹²⁴ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹²⁵ City of Guelph Solid Waste Master Plan Update

¹²⁶ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹²⁷ “Community Energy Initiative Update ” (Guelph, 2018).

¹²⁸ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹²⁹ Interview with Our Energy Guelph Executive Director. February 19, 2020

		<ul style="list-style-type: none"> - Guelph Energy Managers (GEMs) - energy and environment managers from Guelph’s largest employers that meet on a quarterly basis at one of the member’s facilities and do a round table on what they are doing around energy and environment. - GEMs Plus - partnering with Green Economy Canada and creating a green economy hub. - GEMs Elite - for small to medium businesses that do not have expertise or capacity in house to make climate actions. GEMs elite would offer a consulting service on the cost recovery basis for those small and medium sized enterprises to do energy auditing as well as create and implement an action plan.¹³⁰ - OEG is looking to formalize partnerships with the business community for both ongoing and one-off arrangements. Through partnerships the businesses will benefit by; having access to a platform to acquire and share knowledge about successful initiatives to reduce energy costs, reduce consumption, and emissions; establish new customer relationships and opportunities to sell products and services, develop opportunities for co-branding and gaining “green” credibility with customers and the general public, improve employee job satisfaction, engagement, and retention by improving sustainability and corporate citizenship.¹³¹
Long Term Endeavors		<ul style="list-style-type: none"> - OEG created a pathway to net zero by 2050, which was approved and adopted by city council.¹³² - OEG has developed a short term plan (Community Energy Initiative) and pathway to Net Zero Carbon. - The city has other plans that have sustainability themes embedded into them
Building Technical Capacity		<ul style="list-style-type: none"> - OEG and The City of Guelph Climate Change Office hired Sustainability Solutions Group (SSG) to prepare the pathway. SSG used a sophisticated computer model called City Insight, that accounted for factors like employment, vehicle movements, building codes, and industry.¹³³ - SSG modeled BAU and other more ambitious scenarios to determine pathway. - OEG works with local businesses through the GEMs programs to stimulate innovation, encourage businesses to green their operations and help them to gain knowledge and capacity. - OEG and the city government work together to combine resources and knowledge, helping to build capacity on both sides.
Funding		<ul style="list-style-type: none"> - OEG receives operational funding from the City of Guelph (for salaries and a modest amount for implementation/ other actions). - OEG is looking into a community-funding model “local climate bank” for the majority of capital (explained in financial tools section).¹³⁴ - 9% internal rate of return on the \$3.2 billion project (\$1.7 billion net present value). - Guelph City Council has allocated funds for certain actions. - Other orders of government also provide funding through various programs (e.g. the Ontario Climate Challenge Fund, which reinvests the proceeds of the Ontario Cap and Trade system) - Institutional investors, crowd-funding, cooperatives are also used.¹³⁵
Green Economy		<ul style="list-style-type: none"> - OEG works with local businesses through the GEMs programs helping and encouraging

¹³⁰ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹³¹ <https://www.ourenergylguelph.ca/community-energy-initiative-cei-update-2018/a-catalyst-for-building-a-liveable-city/business-relationships>

¹³² Interview with Our Energy Guelph Executive Director. February 19, 2020

¹³³ SSG, “A Low Carbon Pathways for the City of Guelph,” 2019.

¹³⁴ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹³⁵ <https://www.ourenergylguelph.ca/community-energy-initiative-cei-update-2018/a-catalyst-for-building-a-liveable-city/financial-resources-and-business-model>

	innovation and “greening” of business practices.
Regulatory/ Policy Tools	<ul style="list-style-type: none"> - OEG makes policy change recommendations to city council to achieve the CEI targets. - City council has committed to the targets and will be shaping local policies in accordance with the targets set out by the CEI and the decarbonization pathway.¹³⁶
Financial/ Investment Tools	<ul style="list-style-type: none"> - OEG is in the process of developing a community investment fund or a “local climate bank” that will provide capital for the plan. “ An investment fund that can take deposits from individual investors that are RSP eligible – so people can invest part of their retirement savings in local climate initiatives that create local jobs, make their local air cleaner...”¹³⁷ - OEG is looking into a PACE program for commercial and residential retrofits -very low investment risk – the property tax default rate (Guelph has one of the lowest in the country).¹³⁸ - OEG wants to play “the role of the convener” on projects (which have a projected worth of 3-5% of the total project value). - The city is investing in electric busses and EV charging infrastructure.¹³⁹

4.4.4 Governance: Guelph

Table 16: Governance: Guelph

Variable	Findings
Decision- Making Structure	<ul style="list-style-type: none"> - The CEI has a collaborative governance structure where the city and OEG work together to develop and implement the plan. - OEG has a Board of Directors – 15 members (including 2 youth reps who share a vote and other stakeholders who represent various sectors). - Executive Director – oversees action implementation and reports to Board of Directors. - Sub teams for each of the priority actions report to Executive Director and Board of Directors. - OEG and the City of Guelph work together – city council has adopted the plan and will shape policy and strategies to reflect the plan.¹⁴⁰
Oversight, Monitoring & Reporting	<ul style="list-style-type: none"> - OEG board of directors oversees activities. - OEG reports to the Guelph City Council quarterly.¹⁴¹ - Guelph City Council receives quarterly updates on OEG's work.¹⁴² - Three of the updates are qualitative progress reports and the fourth involves metrics and calculations (quantitative)¹⁴³ - Annual GHG inventory and progress report towards the established targets.¹⁴⁴ - Plan updated every 5 years¹⁴⁵
Leadership	<ul style="list-style-type: none"> - OEG is taking the lead on Guelph’s sustainability plan.¹⁴⁶
Communication	<ul style="list-style-type: none"> - OEG Board meets every month and a half - Sub committees for sectors communicate internally and report to Board of Directors.

¹³⁶ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹³⁷ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹³⁸ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹³⁹ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹⁴⁰ “Community Energy Initiative Update .”

¹⁴¹ Our Energy Guelph, “Our Relationship with the City of Guelph .”

¹⁴² Our Energy Guelph, “Our Relationship with the City of Guelph .” 2019, <https://www.ourenergylguelph.ca/about-us/our-relationship-with-the-city-of-guelph>.

¹⁴³ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹⁴⁴ <https://www.ourenergylguelph.ca/community-energy-initiative-cei-update-2018/a-catalyst-for-building-a-liveable-city/progress-reporting>

¹⁴⁵ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹⁴⁶ Our Energy Guelph, “Our Relationship with the City of Guelph .”

	<ul style="list-style-type: none"> - Email, Google Drive organized by the actions in the plan - Doodle polls used for quick decision making.¹⁴⁷
Vertical Integration	<ul style="list-style-type: none"> - In Ontario, municipalities are creatures of the province, they must follow the province’s decision making and policies. The Ontario Provincial government has recently repealed policies such as the provincial cap and trade system and the green energy act, cancelling a large number of renewable energy projects and energy-conservation demand programs. This has created a policy gap between the targets of municipalities like Guelph and the provincial agenda.¹⁴⁸
Collaboration	<ul style="list-style-type: none"> - There is extensive collaboration between many diverse community groups, businesses and city government for the Community Energy Initiative and the 2050 Pathway¹⁴⁹ - OEG has created teams for sectors/actions composed of diverse stakeholders with expertise in the field.
Governance Mode	<ul style="list-style-type: none"> - Self Regulating – through targets to reduce corporate emissions and sustainable procurement. - Enabling – OEG has many stakeholder engagement and education initiatives to engage and involve residents with climate action planning and implementation. - Provisioning – The City of Guelph governs through provisioning of public infrastructure. - Community led actions- OEG is an example of community led governance actions.

4.4.5 Actors: Guelph

Table 17: Actors: Guelph

Variable	Findings
External Actors	<ul style="list-style-type: none"> - Local businesses and community groups <p>Roles</p> <ul style="list-style-type: none"> - Implementation partners and enabling roles
Internal Roles	<ul style="list-style-type: none"> - Our Energy Guelph and the City of Guelph work together for the CEIP. - OEG plays a leading role.¹⁵⁰ - Municipal government plays a resourcing and supporting role.¹⁵¹ The city has approved the plan, provides funding and city council has committed to shape local policies to help implement the pathway¹⁵² <p>Roles</p> <ul style="list-style-type: none"> - OEG plays a leading role, decision making, implementation, enabling, coordinating and facilitating. One of their main roles is that of the convenor (grouped into facilitating roles). - City of Guelph provides resources and plays financing, regulating, enabling and facilitating roles.

¹⁴⁷ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹⁴⁸ https://www.toronto.ca/ext/digital_comm/inquiry/inquiry_site/cd/gg/add_pdf/77/Governance/Electronic_Documents/Other_CDN_Jurisdictions/Powers_of_Canadian_Cities.pdf

¹⁴⁹ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹⁵⁰ Interview with Our Energy Guelph Executive Director. February 19, 2020

¹⁵¹ Our Energy Guelph, “Our Relationship with the City of Guelph .”

¹⁵² Interview with Our Energy Guelph Executive Director. February 19, 2020

4.5 Lahti, Finland

The City of Lahti is located in southern Finland, roughly 100 kms from Helsinki, which is Finland's capital and economic hub. The city has a population of 120 000 inhabitants and roughly 200,000 in the surrounding region. Lahti is known for its winter sports, environmental expertise and for being a renowned center for design.¹⁵³ The last 50 years have proven to be a remarkable growth period for the City. After the Second World War, Lahti was the fastest growing city in Finland due to the rapid industrialization and urbanization of the area in the 1960s and 1970s. Lahti's economy suffered in the 1990s due to the collapse of their trade with the Soviet Union and the economic recession. Since then, the economy has diversified and now the city is pioneering in a circular economy.¹⁵⁴

4.5.1 Sustainability & Climate Action

In 2015 Lahti won the WWF Earth Hour City Challenge and more recently Lahti was announced as the 2021 European Green Capital for its climate change mitigation and adaptation efforts.¹⁵⁵ The Sustainable Energy and Climate Change Action Plan (SEACAP) outlines 93 adaptation and mitigation actions for the local government and partners by 2030. It is a continuation of the Sustainable Energy Action Plan (SEAP) that spanned from 2015 to 2020.¹⁵⁶ Many of the original targets from the SEAP were increased because progress on the plan was moving faster than anticipated. For example, the original target to reduce GHG emissions by 70% by the year 2030 was updated to an 80% reduction by 2025, along with enough carbon offsets to be carbon neutral. By the year 2050 Lahti aims to be carbon negative,

¹⁵³ <https://www.smartlahti.fi/smart-city-long-intro/>

¹⁵⁴ CDP, "2019 Full Cities Dataset. [Dataset]," 2019.

¹⁵⁵ <https://www.smartlahti.fi/smart-city-long-intro/>

¹⁵⁶ CDP, "2019 Full Cities Dataset. [Dataset]," 2019.

meaning it will offset and/or capture more emissions than it produces. Since the baseline year of 1990, GHG emissions in Lahti have decreased by roughly 40%.¹⁵⁷

Lahti’s Direction Project includes the City Master Plan, a Sustainable Urban Mobility Plan, and the Environmental Program and a Service Program. Environmental and climate impact assessments have been conducted for the city’s latest master plan and will be incorporated in all aspects of city planning.¹⁵⁸

4.5.2 Technical Pathways: Lahti

In the SEACAP, actions are categorized by the effectiveness of emissions reductions (large, rather large, relatively small, small and difficult to estimate emissions reduction potential) as well as by sector (buildings, transportation, heating/cooling, land use planning, circular economy).¹⁵⁹

Table 18: Technical Pathways: Lahti

Variable	Findings
Decarbonization of Electricity/ Energy	<p>Biogas:</p> <ul style="list-style-type: none"> - Replacing coal with biogas in 2020 using bio waste from the region and sewage/sludge from the water department making Lahti “almost” fossil fuel free.¹⁶⁰ - After the gasification process, the remaining mass is composted and used as soil.¹⁶¹ - The plant will reduce emissions by roughly 160000 metric tonnes of CO2 every year.¹⁶² This will represent a 40% decrease in emissions. - A storage tank will be built to account for energy consumption peaks.¹⁶³ <p>Other:</p> <ul style="list-style-type: none"> - Gas to energy infrastructure from two landfills in Lahti has been built - Private solar power projects not affiliated with the city have been built.¹⁶⁴
Existing Buildings	<ul style="list-style-type: none"> - Lahti signed a new Energy Efficiency Agreement for 2017-2025, targeting 7% energy

¹⁵⁷ <https://www.smartlahti.fi/smart-city-long-intro/>

¹⁵⁸ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹⁵⁹ City of Lahti SEACAP 2030

¹⁶⁰ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁶¹ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁶² CDP Full Cities Database – Lahti, 2019

¹⁶³ “European Green Capital 2021 Application - 11. Energy Performance,” accessed February 25, 2020, <http://lahdenvuosi.fi/european-green-capital-2021-application/11.-energy-performance>.

¹⁶⁴ Interview with Sustainable Development Coordinator, February 27, 2020

	<p>savings by 2025¹⁶⁵</p> <ul style="list-style-type: none"> - Over 80% of the buildings have district heating, which is produced from the biogas plant.¹⁶⁶ - The district heating company, which is partially owned by the city, offers discounts to residents to connect to the heating network. - National government also offers support for efficiency upgrades.¹⁶⁷ - Public-private partnership for residential retrofit program is in the pilot phase. The Canemure Project is finding cost-effective ways to retrofit existing residential houses.¹⁶⁸
New Buildings	<ul style="list-style-type: none"> - New municipal building code (2018) requires all new buildings to be low energy. All schools and office buildings must use less than 90 kWh/m²/year.¹⁶⁹ This policy is 10% more efficient than the national regulation.¹⁷⁰ - For all non municipal buildings national efficiency regulations are used.¹⁷¹
Transportation Mode Shifting	<ul style="list-style-type: none"> - By 2030 50% of journeys in Lahti will be made by walking or cycling.¹⁷² - The local government has created a Sustainable Urban Mobility Plan for the year 2030. - Modern bike lanes and smart lighting systems are in place. - There is a focus on sustainable urban planning to reduce traffic.¹⁷³ - CITICap – a personal cap and trade system for mobility for the residents of Lahti is in the pilot stage and it is first of its kind in the world. It aims to reduce 25% of transport emissions for each participant.¹⁷⁴ The carbon footprint for mobility will be calculated for users, and users can receive benefits, such as discounts on bus fare, bike repair etc, in exchange for smart mobility choices.¹⁷⁵ - Lahti provides bikes and e-bikes for city personnel for short trips during the work day.¹⁷⁶
Transportation Fuel Shifting	<ul style="list-style-type: none"> - By 2030 public transit will be 100% electric and or biogas¹⁷⁷ - Today 87% of the city’s buses are low emission buses.¹⁷⁸ - New procurement will start in 2019-2020 for an electric [regional] fleet¹⁷⁹ - The local government will be using renewable bio diesel in city-owned cars - Lahti is installing EV charging throughout the city and in partner organizations¹⁸⁰
Waste Reduction, Diversion & Capture	<ul style="list-style-type: none"> - Waste free city by 2050¹⁸¹ - 96% of household waste is re-used (50% recycled, 46% for energy production) - Local biogas production plant uses sewage and agricultural waste for energy production. - Landfill gas capture & solar energy project is in closed landfill. - The city is incorporating circular economy strategies into its master plan¹⁸²

¹⁶⁵ “European Green Capital 2021 Application - 11. Energy Performance.”

¹⁶⁶ “European Green Capital 2021 Application - 1. Climate Change: Mitigation.”

¹⁶⁷ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁶⁸ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹⁶⁹ “European Green Capital 2021 Application - 11. Energy Performance.”

¹⁷⁰ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁷¹ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁷² “European Green Capital 2021 Application - 3. Sustainable Urban Mobility,” 2018, <http://lahdenvuosi.fi/european-green-capital-2021-application/3.-sustainable-urban-mobility>.

¹⁷³ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹⁷⁴ “European Green Capital 2021 Application - 1. Climate Change: Mitigation.”

¹⁷⁵ Smart & Clean Lahti, “CitiCAP LAHTI- Citizens’ Cap and Trade Co-Created ,” 2018, <https://www.smartlahti.fi/citicap/>.

¹⁷⁶ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹⁷⁷ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹⁷⁸ “European Green Capital 2021 Application - 3. Sustainable Urban Mobility.”

¹⁷⁹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹⁸⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹⁸¹ <https://www.lahti.fi/en/decision-making/strategy-and-economy/environmental-programme>

¹⁸² CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

Carbon Sinks, Storage & Offsets	<ul style="list-style-type: none"> - The local government has created a carbon sink and offset plan. It was passed by City Council January 2020¹⁸³ - Lahti had its carbon storages and sinks mapped in GIS in 2018-2019.¹⁸⁴ The results were that the Lahti will need to add capacity to these sinks in order to meet their carbon neutral target by 2025.¹⁸⁵ - Following the LULCF – EU regulation about land use and emissions – they are looking into using harvested wood products in construction as a form of carbon sink.¹⁸⁶ - Nature conservation actions will be made in order to protect and increase carbon sinks. A compensation programme will be established before 2021.¹⁸⁷
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4.5.3 Institutionalization Strategies: Lahti

Table 19: Institutionalization Strategies: Lahti

Variable		Findings
Engagement	Plan Development	<ul style="list-style-type: none"> - Porukka App – an application designed for continuous stakeholder engagement and communication – used by the City of Lahti to gather ideas and feedback from residents in a manner that is cost, energy and time efficient.¹⁸⁸ - Through the app the local government received 43,700 comments on SEACAP development. The app uses polls, surveys and other tactics like gamification to get younger people interested.¹⁸⁹
	Plan Implementation	<ul style="list-style-type: none"> - The local government employs professional environmental educators that work with schools and kindergartens. - There are partnerships with two local universities for research and education. - An Environmental Grandparents Program has been developed for children to learn about sustainability and nature. - Sustainable development coordinators visit the schools.¹⁹⁰
	Advocacy	<ul style="list-style-type: none"> - Lahti was involved in the planning of a national climate change medium-term policy plan (KAISU) in 2015-16.¹⁹¹ - Climate Partnership Network is a program started by the city in cooperation with Lahti University of Applied Sciences. Local businesses volunteer to have their emissions calculated by students, they then assess and address the company and suggest how the business could reduce emissions. Monitoring takes place after two years and successful companies receive a diploma from the Mayor.¹⁹²

¹⁸³ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁸⁴ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

¹⁸⁵ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁸⁶ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁸⁷ City of Lahti, “Application Form for the European Green Capital Award ,” 2018.

¹⁸⁸ <https://www.slideshare.net/marikakakko3/porukkaapplication-engages-lahti-city-residents>

¹⁸⁹ “Porukkaapplication Engages Lahti City Residents ,” Observatory of Public Sector Innovation, accessed February 3, 2020, https://www.oecd.org/governance/observatory-public-sector-innovation/innovations/page/porukkaapplicationengageslahticityresidents.htm#tab_lessons.

¹⁹⁰ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁹¹ “European Green Capital 2021 Application - 1. Climate Change: Mitigation.”

¹⁹² “European Green Capital 2021 Application - 1. Climate Change: Mitigation.”

	<ul style="list-style-type: none"> - The local government has launched a new co-creation platform where the clean tech solutions from the region will be showcased and targeted towards companies.¹⁹³ - The Lahti Business Region has hosted an annual investment event for Cleantech companies and investors, Cleantech Venture Day, since 2006.¹⁹⁴
Long Term Endeavors	<ul style="list-style-type: none"> - The local government has developed a pathway to be carbon neutral by 2025 and has a target to be carbon negative by 2050.¹⁹⁵ - Sustainability targets are embedded in other local government plans such as the Sustainable Urban Mobility Plan and other land use planning.
Building Technical Capacity	<ul style="list-style-type: none"> - Technical scenario modeling and analysis was done internally by the sustainable development office for the target and plan development. - Lahti partners with the technical universities in the area to increase technical capacity and innovation for decarbonization – Student projects are based off of the targets and become integrated into the SEACAP (like the CitiCap).¹⁹⁶
Funding	<ul style="list-style-type: none"> - Funding for projects comes from various sources such as the EU, the National Government, partner organizations (City Group) and the City of Lahti¹⁹⁷ - Funding / financing is secured for individual actions in the SEACAP and comes from various sources) - The Sustainable Development Department is in charge of finding funds for projects (outside of the city budget).¹⁹⁸
Green Economy	<ul style="list-style-type: none"> - The City of Lahti has an ambitious Procurement Policy (2014-2020) that states that all municipal units should realize their role in creating new markets for innovative and sustainable products, and services.¹⁹⁹ - The city uses the Finnish Road Map to a Circular Economy 2016-2025 as a guidebook. - There is heavy focus on the circular economy in City Master Plan so that changing procurement policies can be more sustainable. - The city has many circular economy actions such as – developing a circular economy map for the city, borrowing programs for residents, improving construction standards and waste recovery programs.
Regulatory/ Policy Tools	<ul style="list-style-type: none"> - Implementing policies at the municipal level (for city employees and city owned assets). - Compensating flight emissions and other employee travel emissions, starting January 2020. - Requiring energy efficiency regulations for municipal buildings. - Incorporating targets from the climate action plan in the city master plan, published in April 2020. Setting, for the most part policies and regulations established at the national level. Finland has aggressive GHG mitigation targets.²⁰⁰
Financial/ Investment Tools	<ul style="list-style-type: none"> - The local government is utilizing financial tools offered by the national government rather than creating their own.²⁰¹ - The local government and City Group companies made large investments in infrastructure such as; the new bio energy plant, solar energy projects, landfill gas capture, active transit infrastructure (such as bike lanes, smart lighting system) and electric busses and charging stations.²⁰²

¹⁹³ “European Green Capital 2021 Application - 12. Governance.”

¹⁹⁴ <http://lahdenvuosi.fi/european-green-capital-2020-application/10.-green-growth-and-eco-innovation>

¹⁹⁵ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁹⁶ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁹⁷ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁹⁸ Interview with Sustainable Development Coordinator, February 27, 2020

¹⁹⁹ <http://lahdenvuosi.fi/european-green-capital-2020-application/10.-green-growth-and-eco-innovation>

²⁰⁰ Interview with Sustainable Development Coordinator, February 27, 2020

²⁰¹ Interview with Sustainable Development Coordinator, February 27, 2020

²⁰² CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

	- The largest infrastructure investment is 180 million Euros on an environmentally friendly bioenergy plant. ²⁰³
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4.5.4 Governance: Lahti

Table 20: Governance: Lahti

Variable	Findings
Decision -Making Structure	<ul style="list-style-type: none"> - Long-term environmental objectives are governed through the Lahti Environmental Program. It aligns the major transition targets of the City: a carbon-free, zero-waste and sustainable city by 2050.²⁰⁴ - Lahti City Group – Companies, including energy, district heating, waste management and water treatment that are owned entirely or partially by the City of Lahti. The local government can promote or enforce its decarbonization actions/initiatives on these companies as an owner or part owner.²⁰⁵ - Lahti Sustainable Development Department takes charge on plan creation and follow up.²⁰⁶ - Plan creation and coordination is done through the Sustainable Development Department. This department is also in charge of recruiting other departments for actions directly related to the SEACAP - Other departments do have sustainability embedded in what they do and have their own plans that use a climate lens (for example transportation and the sustainable urban mobility plan) in all of their projects.
Oversight, Monitoring & Reporting	<ul style="list-style-type: none"> - The City Board (City Council) oversees progress on the SEACAP and the Environmental Program.²⁰⁷ - Biannual follow up with EU Covenant of Mayors - Environmental Balance Sheet, and every 2nd year in the EUCoM (EU covenant of mayors) SEAP report and City Strategy Follow-Up.(“European Green Capital 2021 Application - 1. Climate Change: Mitigation,” 2017) - GHG inventory every 4 years²⁰⁸ - Progress on the carbon sinks and offsetting plan will be done annually²⁰⁹
Leadership	<ul style="list-style-type: none"> - The SEACAP is lead by the Sustainable Development agency and the City Council of Lahti

²⁰³ Lahden Kaupunki, “The Age of Coal Is over in Lahti,” *Clean & Smart Lahti*, February 4, 2019.

²⁰⁴ “European Green Capital 2021 Application - 12. Governance,” 2018, <http://lahdenvuosi.fi/european-green-capital-2021-application/12.-governance>.

²⁰⁵ Interview with Sustainable Development Coordinator, February 27, 2020

²⁰⁶ Interview with Sustainable Development Coordinator, February 27, 2020

²⁰⁷ Interview with Sustainable Development Coordinator, February 27, 2020

²⁰⁸ The Covenant of Mayors for Climate and Energy Reporting Guidelines pg. 7

²⁰⁹ Interview with Sustainable Development Coordinator, February 27, 2020

Communication	<ul style="list-style-type: none"> - Sustainable Development Department facilitates communication with other local government departments, City Group companies and other actors.²¹⁰ - Internal website, email, formalized meetings and informal meetings
Vertical Integration	<ul style="list-style-type: none"> - The National government is updating the National Energy and Climate Change Strategy for the nation wide target to be carbon neutral by 2030. - The national government (Ministry of Environment) implemented a “municipal climate change solutions program”, where local governments are responsible for land use, zoning, transport planning, ownership and steering of energy companies, and choice of heating systems for buildings. The national government promoted climate work of municipalities and finances local climate solutions.²¹¹
Collaboration	<ul style="list-style-type: none"> - Partnerships with Lahti City Group companies play the biggest role in GHG mitigation (shift to renewables).²¹² - Public/ private partnerships are formed for the implementation of actions. - The Sustainable Development Department coordinates with other city departments for implementation of actions and projects.
Governance Mode	<ul style="list-style-type: none"> - Self Governing – Lahti self governs through the corporate emissions reduction strategy and public procurement policies. - Enabling – through stakeholder and resident engagement programs. - Provisioning – The local government provides renewable energy and investments in public infrastructure.

4.5.5 Actors: Lahti

Table 21: Actors: Lahti

Variable	Findings
External Actors	<ul style="list-style-type: none"> - Universities in Lahti have enabling roles and are implementation partners through their research projects. - Local businesses through the Climate Partnership are implementation partners.²¹³ - Local NGOs and community groups are implementation partners - National government provides regulating and funding <p>Roles:</p> <ul style="list-style-type: none"> - Enabling, capacity building, implementation partners
Internal Actors	<ul style="list-style-type: none"> - City of Lahti Sustainability Department plays a leading role and is responsible for plan creation, implementation and monitoring roles. The Sustainability Department also coordinated between departments (agencies) and facilitated communication. - All other City departments are implementation partners, and help with decision making. - Lahti City Group Companies are decision making and implementation partners²¹⁴ <p>Roles:</p> <ul style="list-style-type: none"> - Decision making, coordinating, enabling, facilitating, funding.

²¹⁰ Interview with Sustainable Development Coordinator, February 27, 2020

²¹¹ Ministry of the Environment, Municipal Climate Change Solutions Programme (2018-2023).

²¹² “European Green Capital 2021 Application - 1. Climate Change: Mitigation.”

²¹³ Interview with Sustainable Development Coordinator, February 27, 2020

²¹⁴ Interview with Sustainable Development Coordinator, February 27, 2020

4.6 Vancouver, British Columbia, Canada

The City of Vancouver is located on the west coast of Canada and has a population of 631,486 people²¹⁵, the City of Vancouver is the eighth largest Canadian city and Metro Vancouver is the third largest region in Canada. Vancouver has the most diverse economy in Canada²¹⁶ as well as the second lowest unemployment rate in Canada.²¹⁷ Vancouver has one of North America's fastest growing low carbon economies and is becoming a model for sustainable green growth.²¹⁸ This case is focused on the City of Vancouver (Vancouver), and not the region (Metro Vancouver).

4.6.1 Sustainability & Climate Action

In 2010, Vancouver ranked second on the EIU Greenest City Index, thanks to bold decisions, such as protecting local watersheds, maintaining public access to long stretches of the waterfront, and rejecting freeways through the city.²¹⁹ Vancouver was one of the first cities in the world to recognize the threat posed by climate change, with the Clouds of Change Task Force recommending in 1990 that the local government begin reducing CO2 emissions. Today, Vancouver has the Greenest City Action Plan (GCAP), adopted in 2011 as a comprehensive climate action plan to support the city's transformation to a low-carbon, thriving economy. The GCAP outlines Vancouver's goals and targets with respect to climate change. There are 10 goal areas and 17 targets supporting actions that are managed by different departments in the city and are monitored and reported on by the Sustainability Department.²²⁰ The Renewable City Action Plan approved by City Council in 2017 commits the City of Vancouver to derive 100%

²¹⁵ Canadian Census, 2016

²¹⁶ Conference Board of Canada, 2019

²¹⁷ Statistics Canada, 2018

²¹⁸ Vancouver economic.com

²¹⁹ CDP, "2019 Full Cities Dataset. [Dataset]," 2019.

²²⁰ City of Vancouver Greenest City Action Plan

of its community-wide energy from renewable sources before 2050.²²¹ Vancouver also became one of the first cities in Canada to declare a climate emergency. The Climate Emergency Response (2019) sets out the Six Big Moves and a suite of 53 accelerated actions to keep Vancouver's emissions on an IPCC-compliant trajectory by rapidly decreasing community-wide emissions by 50% before 2030 in order to achieve carbon neutrality by 2050.²²² The City has developed other strategies that reinforce actions from the GCAP and RCAP and Climate Emergency. The city intends to radically cut carbon emissions from new buildings over the next decade with the Zero Emissions Building Plan. Vancouver has also created a Zero Waste Plan where the city aims to be a zero waste community by 2040.²²³

Emissions by sector (2016)

Buildings – 55%

Transportation - 41%

Solid waste - 4%

4.6.2 Technical Pathways: Vancouver

The GCAP is organized by the 10 goals it sets out to achieve - Climate and Renewables, Green Buildings, Green Transportation, Zero Waste, Access to Nature, Clean Water, Local Food, Clean Air 50, Green Economy and Lighter Footprint. For each of the goals, targets and actions are described.

The RCAP actions are organized by sector; buildings, transportation, waste, and cross-sectoral actions. The cross-sectoral actions highlight that the city will “lead by example” by developing actions such as; developing building standards for the city, retrofitting city buildings,

²²¹ City of Vancouver, Renewable City Action Plan

²²² <https://council.vancouver.ca/20190424/documents/cfsc1.pdf>

²²³ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

construction projects, looking into how the City can use its purchasing power to support suppliers in adopting renewable energy and energy efficiency; supporting a Corporate carbon pricing policy; reporting on fuel burning vehicles and equipment used in city operations and examining how to transition to renewable energy sources ²²⁴

The Climate Emergency Response includes a suite of actions that are “next steps” or entirely new actions from those in the GCAP. It includes the Six Big Moves and 53 accelerated actions that are organized into 15 categories (city- wide planning, zero emissions areas, land use incentives for green buildings, financial incentives for zero emissions buildings (ZEB) and equipment, ZEB standards, neighborhood energy, active transport and transit infrastructure, transportation demand management, goods movement and fleets, electric charging network, EV incentives, solid waste, food and beverage, city leadership and intergovernmental relations and community engagement).The document also outlines how each action reduces carbon pollution and identifies the department that lead each action.

Table 22: Technical Pathways: Vancouver

Variable	Findings
Decarbonization of Electricity/ Energy	<ul style="list-style-type: none"> - 100% renewable by 2050.Vancouver’s electricity grid is already roughly 97% renewable.²²⁵ - The city’s Renewable City Action Plan outlines the pathway to Vancouver achieving 100% renewable energy for buildings, transportation and waste.²²⁶ - There is a focus on electrification of heating systems, moving away from natural gas/ fossil fuel space and water heating in new buildings²²⁷ and high-density neighborhoods through neighborhood renewable energy systems.²²⁸ - “We operate a neighbourhood district energy system that collects heat from a sewer and powers the neighbourhood and that footprint that it serves is growing over time”²²⁹

²²⁴ City of Vancouver, Renewable City Action Plan pg. 21

²²⁵ City of Vancouver, “Zero Emissions Building Plan,” 2016.

²²⁶ City of Vancouver, Renewable City Action Plan

²²⁷ City of Vancouver, Zero Emissions Building Plan Pg. 5

²²⁸ City of Vancouver Greenest City Action Plan pg. 19

²²⁹ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

Existing Buildings	<ul style="list-style-type: none"> - Reduce energy use and GHG emissions in existing buildings by 20% (compared to 2007 levels)²³⁰ - Zero emissions for all new and replacement heating and hot water systems by 2025. This will reduce Vancouver’s carbon pollution by 552,000 tonnes/year in 2030 (46% of the targeted reductions).²³¹ - By 2050 transition all new and existing buildings to 100% renewable energy.²³² - As part of the GCAP 2020 Vancouver introduced Canada’s first energy bylaw for existing buildings. The energy retrofit requirements come into effect when residents apply for a building permit to renovate any part of a building, including residential suites.²³³ - The city is focusing on supporting voluntary actions (in high opportunity sectors) and leveraging incentives for energy retrofits. -
New Buildings	<ul style="list-style-type: none"> - Zero Emissions Building Plan (2016) and Vancouver Building Bylaw - Target: By 2030, all new buildings have net zero GHG emissions. - Policy requirements in place to reduce emissions by 60% in new buildings. - Embodied emissions in new buildings and construction projects will be reduced by 40% compared to a 2018 baseline. - All new City owned buildings will be built to Passive House standards. - Through rezoning processes, large new buildings are required to be built to a passive house standard (near zero emissions). - 78,000 tonnes/year of carbon pollution could be reduced by 2030.²³⁴ - The local government manages networks of building owners and stakeholders and provides tools and engagement activities at the ZEB Center of Excellence
Transportation Mode Shifting	<ul style="list-style-type: none"> - By 2030, 90% of people live within an easy walk/roll of their daily needs. - 153,000 tonnes/year of carbon pollution could be reduced by 2030 (13% of the targeted reductions).²³⁵ - By 2030, 66% of trips in Vancouver will be by active transportation and public transit. - 141,000 tonnes/year of carbon pollution could be reduced by 2030 (12% of the targeted reductions). This would be in addition to the 153,000 tonnes in Big Move #1.²³⁶ - In total, by 2030, 294,000 tonnes/year of carbon pollution, 25% of the targeted reductions could be reduced as a result of these actions. - Infrastructure investments in expanding and improving bike paths and pedestrian infrastructure are being undertaken. - Update parking bylaw to influence transportation demand. - E-Bike share program is underway. - The city is using financial tools such as parking process and tolls to incentivise mode shift.²³⁷
Transportation Fuel Shifting	<ul style="list-style-type: none"> - By 2030, 50% of the kilometres driven on Vancouver’s roads will be by zero emissions vehicles. The rapid transition to electric and other zero emissions vehicles would reduce Vancouver’s carbon pollution by 283,000 tonnes per year by 2030 - 24% of the targeted reductions.²³⁸

²³⁰ City of Vancouver, Greenest City 2020 Action Plan 2018-2019 Implementation Update pg. 11

²³¹ <https://council.vancouver.ca/20190424/documents/cfsc1.pdf> pg. 14

²³² City of Vancouver, Greenest City Action Plan, pg. 19

²³³ <https://vancouver.ca/green-vancouver/energy-resources-and-programs-for-multi-family-buildings.aspx>

²³⁴ Climate Emergency Response <https://council.vancouver.ca/20190424/documents/cfsc1.pdf> pg. 15

²³⁵ <https://council.vancouver.ca/20190424/documents/cfsc1.pdf> pg. 11

²³⁶ <https://council.vancouver.ca/20190424/documents/cfsc1.pdf> pg. 12

²³⁷ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²³⁸ <https://council.vancouver.ca/20190424/documents/cfsc1.pdf> pg. 13

	<ul style="list-style-type: none"> - Vancouver has created the EV ecosystem strategy. - The City has committed to reducing fleet emissions by 50% by 2030 and having 100% renewable energy usage by 2050.²³⁹ - The City provides parking incentives for EVs. - The City of Vancouver will have a role as a provider of and a market enabler for electric vehicle charging access as a community amenity over the next five years.²⁴⁰ - Regulations for multi-family buildings where every stall must be wired for EV charging are being implemented. Commercial buildings will have a similar requirement.²⁴¹
Waste Reduction, Diversion & Capture	<ul style="list-style-type: none"> - By 2040, divert all waste from landfills and incinerators. - Zero Waste 2040 Plan is a separate strategic plan to become a zero waste community by 2040 with 17 actions.²⁴² - System improvements and exploring gas to energy options²⁴³ for landfill gas capture are being made to meet the provincial government’s 75% landfill gas recovery requirement by 2016. The City continues to invest in the expansion of landfill gas collection infrastructure, improvements in predictive modeling of gas generation, and the maximization of gas capture.²⁴⁴
Carbon Sinks, Storage & Offsets	<ul style="list-style-type: none"> - By 2030, restoration work will be completed on enough forest and coastal ecosystems in Vancouver and the surrounding region to remove one million tonnes of carbon pollution annually by 2060.²⁴⁵ - Carbon offsets are not included directly in climate action plans.

4.6.3 Institutionalization Strategies: Vancouver

Table 23: Institutionalization Strategies: Vancouver

Variable		Findings
Engagement	Plan Development	<ul style="list-style-type: none"> - In the development of the Greenest City Action Plan (GCAP), there were two components to the public engagement process: the External Advisory Committees (EAC) and the broad based public process. - Over 60 municipal staff, more than 120 organizations, and thousands of individuals contributed to the creation of the GCAP.²⁴⁶ - Over the course of a year, in collaboration with over 300 internal and external advisors, staff identified these high-priority actions and opportunities for advocacy. - Over 46,000 people were included in this process, of which over 13,000 were considered engaged (in-person and social media feedback). The actions in this strategy have been further refined based on direct, written input from over 850 community members (written feedback).²⁴⁷

²³⁹ <https://vancouver.ca/green-vancouver/green-fleets.aspx>

²⁴⁰ <https://vancouver.ca/files/cov/EV-Ecosystem-Strategy.pdf> pg. 4

²⁴¹ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁴² <https://vancouver.ca/green-vancouver/zero-waste-vancouver.aspx>

²⁴³ <https://council.vancouver.ca/20180516/documents/pspc2a.pdf>

²⁴⁴ City of Vancouver, Greenest City Action Plan, pg. 10

²⁴⁵ <https://council.vancouver.ca/20190424/documents/cfsc1.pdf> pg. 16

²⁴⁶ City of Vancouver, Greenest City Action Plan Pg. 5

²⁴⁷ City of Vancouver, Greenest City Action Plan Pg. 6

	Plan Implementation	<ul style="list-style-type: none"> - The city calculates the number of people empowered to take action (through city programs) as an indicator of support for the plan. The number of people increased by 28500 between 2011 and 2018.²⁴⁸ - The Award of Excellence for Greenest City Leadership now recognizes outstanding achievements made by individuals and organizations that advance the City’s GCAP goals. - The Greenest City Curriculum is a suite of courses at community centers and libraries that support people in sustainable living actions. - The Green Events Program helps reduce the environmental impact of city-permitted events. - Two student-oriented programs, Greenest City Scholars (a partnership with UBC offering paid internships to graduate students working on City projects) and City Studio (an innovation hub where staff, experts, and university students from six universities and colleges co-create projects that support City programs) support students to take action to green the city.²⁴⁹ - The Zero Emissions Building Centre of Excellence is a local learning hub that hosts designer and builder dialogues, produces case studies, and delivers training to optimize solutions for best practice and industry scalability.²⁵⁰ - “Greenest City” social media campaigns for mass awareness/communication are promoted through daily posts, and stories. - Greenest city newsletter (monthly), events, speakers, website, the annual report to council is distributed to city libraries, community centers and is available online.²⁵¹
	Advocacy	<ul style="list-style-type: none"> - Advocacy actions to federal and provincial governments are outlined in the GACP for each proposed action²⁵² - Vancouver continues to advocate for the continuation and increase of BC’s provincial carbon tax.²⁵³ - Vancouver developed the Corporate Climate Leaders Program (delivered in partnership with Climate Smart) and the Business Energy Advisor Program (delivered in partnership with LiveSmart BC and CityGreen) which have been successful in supporting small and medium enterprises to assess and act on GHG reduction opportunities.²⁵⁴ - Vancouver is part of several transnational networks (such as CNCA and C40) that share knowledge and experiences on deep decarbonization.
Long Term Endeavors		<ul style="list-style-type: none"> - Vancouver has created a pathway to net zero emissions by 2050 along with the short term plans GCAP and RCAP. - Sustainability targets are embedded in City planning. Not only does the City have multiple climate action plans (GCAP, RCAP and Climate Emergency), separate city agencies have their own plans (ZEB, Zero Waste...)
Building Technical Capacity		<ul style="list-style-type: none"> - The local government has 1 FTE staff member dedicated to environmental related data management.²⁵⁵ - The City used data driven decision making and technical scenario modeling for planning.²⁵⁶

²⁴⁸ City of Vancouver, Greenest City 2020 Action Plan 2018-2019 Implementation Update. pg. 4

²⁴⁹ City of Vancouver, Greenest City Action Plan, pg. 64

²⁵⁰ <https://www.fastcompany.com/90421205/how-vancouver-is-pushing-for-all-its-new-buildings-to-be-zero-emissions>

²⁵¹ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁵² City of Vancouver, “Greenest City 2020 Action Plan.” Pg. 22

²⁵³ City of Vancouver, Greenest City Action Plan, pg. 11

²⁵⁴ City of Vancouver, Greenest City Action Plan, pg. 10

²⁵⁵ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

²⁵⁶ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

	<ul style="list-style-type: none"> - The governance structure of the plans allows for technical capacity to build in the responsible departments of the actions. - Student oriented programs (described above) City Studio and Greenest City Scholars are partnerships with local universities in which the City provides graduate students with office space and engages them on City projects.
Funding	<ul style="list-style-type: none"> - BC Carbon Tax – municipalities pay a carbon tax based on corporate emissions. Provided that the city fulfills certain requirements, they are refunded the carbon tax and it is to be used for climate action. This brings in 1-1.5 million dollars every year for the City of Vancouver, which they allocate to the climate targets.²⁵⁷ - The majority of funding comes from the city’s tax revenue – “this year, City Council quite boldly approved a 7% tax increase in Vancouver a large chunk of that was used to fund the climate emergency work. We had done some early budgeting of what it was going to take to hit the targets in that climate emergency and so they approved a significant tax increase and a big chunk of that was used specifically to fund retrofits.²⁵⁸ - Greenest City Fund - 2-million-dollar fund to finance local sustainability projects.²⁵⁹ - The City looks for other sources of funding from the federal and provincial governments.²⁶⁰ - As for the private sector, there are no co-funding partnerships²⁶¹
Green Economy	<ul style="list-style-type: none"> - Target to double the number of green jobs and businesses greening operations by 2020.²⁶² - GCAP outlines a list of green jobs related to each of the targets / sectors in the plan. Many of the goals in the GCAP contribute in some way to the green economy target. - Many of the green economy initiatives are led by the Vancouver Economic Commission (an independent economic development agency) which, has created a green jobs roadmap that the city is using. - Vancouver will launch a clean tech accelerator to support local entrepreneurs and develop programs for innovation. Vancouver will also develop an action plan to attract green investment capital. - The City partners with educational institutions to match business challenges to student projects in order to train the future workforce.²⁶³ - Vancouver will create a Green Business Platform – an online digital platform that engages and educates local businesses to reduce the environmental footprint of their operations. It will help to reach the 95% of businesses that may not have a green product or service, but can still be involved in the green economy by reducing their footprint.²⁶⁴ - Green and Digital Demonstration Program (GDDP) helps local green tech get to market. - The ZEB plan has created an opportunity for growth in the green job market.²⁶⁵ Vancouver and British Columbia’s zero emissions and net-zero energy ready building policies are stimulating a \$3.3 billion market for high-performance building products and technologies in Metro Vancouver. - The City worked with the local technical college to expand skills training for green building design and construction innovations. - “As part of the building by-law amendment, [the city] is supporting trades training, the transition of trades from gas furnaces to heat pumps in the next 18 months. [The city has] contributed funding to that training.”²⁶⁶ - “[The City] will approach industry associations to help offset training costs and procure case studies. There are different ways that we can help build capacity without directly granting to a private entity.”²⁶⁷

²⁵⁷ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁵⁸ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁵⁹ <https://vancouver.ca/people-programs/green-grants.aspx>

²⁶⁰ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁶¹ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁶² City of Vancouver, Greenest City 2020 Action Plan 2018-2019 Implementation Update pg. 39

²⁶³ City of Vancouver Greenest City Action Plan pg. 12

²⁶⁴ City of Vancouver Greenest City Action Plan pg. 58

²⁶⁵ City of Vancouver, Greenest City 2020 Action Plan 2018-2019 Implementation Update pg. 39

²⁶⁶ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁶⁷ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

Regulatory/ Policy Tools	<ul style="list-style-type: none"> - The city introduced Canada’s first energy bylaw for existing buildings. - There is a Zero Emissions Building Plan for all new construction. - Vancouver is the only city in Canada to have its own building code with a focus on GHG emissions intensity - The city has had step codes since 2008 so that Vancouver is nearly at full electrification of single family and town homes. - Rezoning process for big buildings – energy and efficiency requirements (passive house standard) as a condition of rezoning (used to be lead gold standard, but now the focus is placed on GHG emissions). - Regulation for EV charging in multifamily buildings – soon to be commercial buildings too.²⁶⁸ - Using a stretch code for buildings until 2030²⁶⁹
Financial/ Investment Tools	<ul style="list-style-type: none"> - Greenest City Grants²⁷⁰ are offered to residents for projects that take actions towards reaching the GCAP targets. The grants are supported by the Greenest City Fund for local projects/programs²⁷¹ - \$5 million program to advance building retrofits led by the city.²⁷² - Infrastructure investments such as bike lane networks, better sidewalks (pedestrian infrastructure) electric vehicle infrastructure and transit, rapid bus routes are underway. - The city is investing \$25 million in technology designed to capture landfill gas and put it to beneficial use.²⁷³ - They are exploring the creation of a Vancouver Climate Trust, which would have the objective of providing ongoing investments to reduce emissions from existing buildings.²⁷⁴ - The city provides incentives for heat pumps (the province offers an incentive and the city is essentially doubling that incentive. - The city offers some energy retrofit incentives (for windows and building envelopes). - No low interest loans, Vancouver more focused on providing financial incentives than financing.²⁷⁵

4.6.4 Governance: Vancouver

Table 24: Governance: Vancouver

Variable	Findings
Decision – Making Structure	<ul style="list-style-type: none"> - “Rather than centralizing implementation in one sustainability department, the GCAP, and Climate Emergency Plan embeds responsibility for meeting the defined targets within city departments where the specific expertise lies. This ensures longevity and demands innovating solutions from across the city.”²⁷⁶ - The City Manager and City Council are the main overseers. The Sustainably Department is in charge of monitoring and reporting (among other things).²⁷⁷ - Each of the 10 goals for the GCAP have both internal and external committees for the implementation of actions related to that goal.²⁷⁸ - There is internal expertise by sector (mobility, zero waste, zero emission buildings...) sustainability-oriented plans / strategies in each relevant city

²⁶⁸ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁶⁹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

²⁷⁰ <https://vancouver.ca/people-programs/green-grants.aspx>

²⁷¹ <https://vancouver.ca/people-programs/green-grants.aspx>

²⁷² City Council Report, <https://council.vancouver.ca/20190424/documents/cfsc3.pdf>

²⁷³ City of Vancouver, “Greenest City 2020 Action Plan.” Pg. 10

²⁷⁴ <https://council.vancouver.ca/20190424/documents/cfsc1.pdf> pg. 6

²⁷⁵ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁷⁶ City of Vancouver Greenest City Action Plan pg. 11

²⁷⁷ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁷⁸ City of Vancouver, Greenest City Action Plan, pg. 82

	<p>department.</p> <ul style="list-style-type: none"> - Within sectors/departments there is collaboration through working groups and committees with many stakeholders being represented. - The focus is on collaboration “not a top down plan.”²⁷⁹ - Vancouver has a sustainability team with 20 FTE staff dedicated to mitigation actions.²⁸⁰ - The Sustainability Department provides support to other departments that “own goals”. – The Sustainability Department also owns a few goals, such as green buildings. - “Occasionally the Sustainability Department provides support for other departments. For example research on best practices or community to school programs, have the opportunity to reach out to us in the Sustainability Department and request that support and we offer it for those goal owners. There are other goals, Green Buildings is probably the most notable that Sustainability owns and leads the work for Green Buildings. So we have our own Green Buildings focused staff and experts who develop the policy, and who implement those actions. A bit of both.” - The Sustainability Group does provide a role beyond just being a goal owner in that we run a few different social media platforms around Greenest City and we also do some engagement with the broader public and some businesses on a less goal specific engagement more a general climate or sustainability program.”²⁸¹
Oversight, Monitoring & Reporting	<ul style="list-style-type: none"> - City Council approved and oversees the progress on the GCAP and other plans such as ZEB plan and RCAP. - The Sustainability Department (monitoring and reporting specialist) prepares reports annually, which are reviewed by the Sustainability Director. Then it goes to the city manager and to city council. - The City Manager is the executive sponsor and there is a director from each of the goal areas responsible for delivery on each of their targets. - The City Manager provides ultimate decision making, but within each target or big move there will be accountability for the leaders of each big move²⁸² - Annual progress reports/updates on the GCAP are written and made public.²⁸³ - GCAP is updated every 5 years. - The city employs a Monitoring and Reporting Planner.²⁸⁴ - GHG inventories are calculated annually in the buildings, transportation and waste sectors.²⁸⁵ - The Sustainability Department is in charge of monitoring and reporting “tracking our GHG numbers and other sustainability metrics. There is a monitoring reporting specialist position that monitors and tracks the data for our annual reports and the Director of Sustainability then reviews and signs off on the reports”²⁸⁶
Leadership	<ul style="list-style-type: none"> - Lead by the Vancouver Sustainability Department - Each Goal and/or Big Move has a leader (the city department that owns it) and the City collectively plays a leadership role. - “The City will need to lead the way in its own operations as well, demonstrating what a green city looks like in City-run buildings, facilities and operations. Leadership from other levels of government and other public sector agencies will also be critical to our success.”²⁸⁷

²⁷⁹ Justin Baker, “Vancouver and the GCAP – What Is Sustainability?,” accessed February 11, 2020, <https://journeys.dartmouth.edu/envs3jbaker/envisioning-the-future/vancouver-and-the-gcap/>.

²⁸⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

²⁸¹ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁸² Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁸³ <https://vancouver.ca/news-calendar/greenest-citys-annual-update-highlights-achievements-and-opportunities.aspx>

²⁸⁴ City of Vancouver, Greenest City Action Plan pg. 82

²⁸⁵ City of Vancouver, Renewable City Action Plan pg. 13

²⁸⁶ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁸⁷ City of Vancouver, Greenest City Action Plan, pg. 3

Communication	<ul style="list-style-type: none"> - The City of Vancouver has a cross-department team to share information on progress and challenges regarding RCAP and GCAP implementation (meet quarterly).²⁸⁸ - The City has an internal website dedicated to green operations, it also provides an online course for city staff to learn about sustainability, there is also an internal newsletter called City Wire that discusses sustainability actions and topics.²⁸⁹ - Dissemination of information to the public is through GCAP and Climate Emergency Plan progress reports, website, education and engagement programs.
Vertical Integration	<ul style="list-style-type: none"> - City strategies are aligned with others at the regional (Metro Vancouver) and provincial levels. - City of Vancouver and Metro Vancouver share systems for waste management and transportation (among others). The two work closely together to integrate policy for the entire Vancouver region. - At the provincial level, British Columbia has many policies regarding GHG emissions, renewable energy targets, waste management etc. The province and the city work closely to integrate the policies. - The BC carbon tax is the best example of vertical integration. The city complies with the provincial (regulations) and in turn, receives a refund on its carbon tax, which provides funding for the climate action plan.²⁹⁰ - Vancouver is a charter city, which allows the City to customize legislation to its needs.²⁹¹
Collaboration	<ul style="list-style-type: none"> - Internal and external advisor groups for each of the (10) goals in the plan coordinate for the actions and provide expertise.²⁹² - Collaboration between multiple city departments and each action in the plans specifies the responsible department.²⁹³ - For internal collaboration, the city created the Climate Emergency Directors Forum, which is the place where the various directors are brought together to develop the Climate Emergency Response Plan and the Greenest City Plan. They also oversee the implementation of it.²⁹⁴ - There are 6 post-secondary institutions where students work on GCAP related projects.²⁹⁵ - Collaboration with external stakeholders is grouped by sectors/ goal areas.
Governance Mode	<ul style="list-style-type: none"> - Self regulating – corporate emissions reductions strategy. - Enabling – through stakeholder engagement programs, educational initiatives, and partnerships that the city facilitates. - Provisioning – through the provision of and investments in public infrastructure. - Authority – through the ZEB bylaws among other regulations that the city imposes.

4.6.5 Actors: Vancouver

Table 25: Actors: Vancouver

Variable	Findings
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²⁸⁸ City of Vancouver. Renewable City Action Plan

²⁸⁹ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁹⁰ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁹¹ https://www.toronto.ca/ext/digital_comm/inquiry/inquiry_site/cd/gg/add_pdf/77/Governance/Electronic_Documents/Other_CDN_Jurisdictions/Powers_of_Canadian_Cities.pdf

²⁹² City of Vancouver, Greenest City Action Plan, pg. 82

²⁹³ City of Vancouver, “Renewable City Action Plan.”

²⁹⁴ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁹⁵ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

External Actors	<ul style="list-style-type: none"> - External advisor groups for each of the GCAP goals – specialists in the field – playing advisory roles for the GCAP plan.²⁹⁶ - The City leverages many partnerships with external actors (such as local businesses, NGOs, community groups, educational institutions) for implementation and capacity building.²⁹⁷ <p>Roles:</p> <ul style="list-style-type: none"> - Enabling, implementation partners, capacity builders - Higher levels of government have funding roles and enabling roles
Internal Actors	<ul style="list-style-type: none"> - Internal advisor groups for specific actions from various departments within the City who have expertise in the field²⁹⁸ - For the 6 Big Moves the internal engagement included meetings and workshops with staff from Planning, Urban Design and Sustainability; Engineering; Development, Buildings and Licensing; Real Estate and Facilities Management; Social Policy; Park Board; Legal Services; Finance; and Intergovernmental Relations.²⁹⁹ <p>Roles:</p> <ul style="list-style-type: none"> - The internal actors within the local government play leadership, funding, coordinating, facilitating, enabling, decision making roles.

4.7 Oslo, Norway

Oslo is the capital and the largest city of Norway with a population of 683 794 inhabitants. The City is experiencing rapid growth, which is creating opportunities, but is also putting pressure on the city’s land area, infrastructure, environment and economy. Oslo has successfully transformed from an industrial city into a modern, green, knowledge hub.³⁰⁰

4.7.1 Sustainability & Climate Action

The City of Oslo has committed to take action against climate change and has set a goal of reducing GHG emissions by 95% by 2030 (without offset trading). Oslo has phased in several zero emission solutions, such as a large-scale roll-out of zero emission vehicles, a bus fleet on renewables and fossil-free district heating. Direct carbon emissions in Oslo are relatively low due to the use of predominantly clean hydropower for heating and power consumption and the

²⁹⁶ City of Vancouver, Greenest City Action Plan, pg. 81

²⁹⁷ Interview with Assistant Director of Sustainability, City of Vancouver. May 20, 2020

²⁹⁸ City of Vancouver, Greenest City Action Plan, pg. 81

²⁹⁹ <https://council.vancouver.ca/20190424/documents/cfsc1.pdf> pg. 21

³⁰⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

fact that approximately 70% of daily trips in Oslo are made by public transport, walking and cycling.³⁰¹

In 2016 the Climate and Energy Strategy for Oslo was enacted along with the first ever climate budget, that set a ceiling on the amount of GHGs Oslo could emit per year. This Climate Budget is integrated into the City’s fiscal budget, with a slogan to “Count emissions the way we count money”.³⁰² It represents a commitment for all municipal entities to issue regular reports on the status of execution of the climate measures for which they are responsible.³⁰³ Oslo’s Climate Budget has received global recognition as an innovating and effective tool for climate action in cities.³⁰⁴

Emissions by sector (2017)³⁰⁵

Transport – 54.5%

Waste/ energy – 25.2%

Heating - 5.8%

Maritime - 3.6%

Constriction & other mobile sources - 6.5%

Other sources - 4.4%

4.7.2 Technical Pathways: Oslo

Oslo categorizes the actions in the Climate Budget as “measures with quantified emissions reduction”, “non-quantified measures expected to provide emissions reductions” and “activities

³⁰¹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁰² CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁰³ Oslo Climate Budget 2020 pg. 3

³⁰⁴ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁰⁵ Green House Gas Emissions in Oslo - City of Oslo- Published 27.05.2019

that lay the foundations for future emissions reductions”.³⁰⁶ The first two categories are more focused on specific sectors in the City with GHG reduction targets. The activities that lay the foundations for future emissions reductions are actions that will help to reinforce work for the climate in the Oslo. These activities are included in the climate budget to clarify the wide range of instruments that are utilized to promote emissions reductions in Oslo, and to denote responsibility for the different activities.

Table 26: Technical Pathways: Oslo

Variable	Findings
Decarbonization of Electricity/ Energy	<ul style="list-style-type: none"> - Oslo’s electricity comes from 100% hydro power.³⁰⁷ - Existing gas engines for production of heat and electricity will be updated for energy use of landfill gas.³⁰⁸
Existing Buildings	<ul style="list-style-type: none"> - A national ban on fossil fuel heating came into effect Jan 1, 2020 for old and new buildings, residential and commercial.³⁰⁹ - The district heating provider will phase out fossil oil and gas in 2020 and replace it with bioenergy, and spillover heat from the waste incineration plant. - Buildings in Oslo use direct electricity for heating (emission factor equal zero due to all electricity being produced by hydropower).³¹⁰
New Buildings	<ul style="list-style-type: none"> - All new municipal buildings are net ZEB³¹¹ and must be connected to district heating networks. - Fossil fuel heating systems have been banned since the beginning of 2020. - In addition Oslo has a policy document – Climate and Environmental Requirements for the City of Oslo’s Construction Sites³¹² to work toward zero emissions construction sites. It was piloted in 2016 and since 2017, the municipality has required that its own construction projects be fossil fuel free, and has required that contractors connect buildings to the district heating network during the construction phase where possible. - The new procurement strategy that has applied since October 2017, specifies that the machinery used should employ zero-emission technology, as far as this is possible.³¹³
Transportation Mode Shifting	<ul style="list-style-type: none"> - Goal to reduce traffic by 33% by 2030 (compared to 2015 levels).³¹⁴ - Increase in public transport capacity to cope with population growth and reduced use of private cars. - Package of 100 initiatives to reduce delays on public transport. - Increase tolls around city center with the majority of toll income invested back into

³⁰⁶ Oslo Climate Budget 2020

³⁰⁷ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁰⁸ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁰⁹ <https://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=25032&LangID=E>

³¹⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³¹¹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³¹² <https://www.klimaoslo.no/wp-content/uploads/sites/88/2019/11/Climate-and-environmental-requirements.pdf>

³¹³ <https://www.klimaoslo.no/2019/04/10/moving-on-from-fossil-free-construction/>

³¹⁴ Oslo Platform for City Government Cooperation pg. 12

	<ul style="list-style-type: none"> public transport. - Reduce parking throughout the city. - Make parts of the city center car free zones. - Build more and better facilities for cyclists to increase the ratio of cyclists to 25% by 2025.³¹⁵ - Phase out street parking and create car free zones in the city center.
Transportation Fuel Shifting	<ul style="list-style-type: none"> - Oslo is known as the “EV capital of the world.” - National ban on petrol cars by 2025.³¹⁶ - Diesel ban by 2025³¹⁷ - 100% ZEV by 2030. - New regulations for taxis in Oslo, which lays down a requirement for the taxi industry to use zero-emissions vehicles by 2024.³¹⁸ - Fossil fuel free public transit by 2020. - Electrification of ferries and ships.³¹⁹ - Installation of adequate charging infrastructure for passenger cars. - Continued implementation of local and regional and national instruments to promote the use of zero-emission cars. - Implementation of national 20 percent biofuel blending requirement in 2020. - Time and emissions-based tolls into the city.³²⁰
Waste Reduction, Diversion & Capture	<ul style="list-style-type: none"> - Closed landfills are equipped with new capture systems for landfill gas combined with measures for new layers to cover the landfills and turn the area into parks. Existing gas engines for production of heat and electricity will be updated for energy use of the landfill gas.³²¹ - Household waste goes to incineration that provides heat for district energy. A full scale carbon capture system will be in place by 2020. This will result in 12-15% (400,000 tons CO₂/year) reduction of community wide emissions alone.³²² - A bio gas plant creating fuel for the transportation industry has been built. - The city has its own waste strategy that outlines actions for waste reduction³²³
Carbon Sinks, Storage & Offsets	<ul style="list-style-type: none"> - Carbon sinks / offsets are not considered in the plan. - The local government is incorporating actions that will increase the carbon sinks in Oslo, such as repurposing of parking spaces into “green lungs” and increasing the urban canopy. These are considered resiliency measures and not included in offsetting emissions.³²⁴

4.7.3 Institutionalization Strategies: Oslo

Table 27: Institutionalization Strategies: Oslo

Variable		Findings
Engagement	Plan Development	<ul style="list-style-type: none"> - The Climate and Energy Strategy was developed in dialogue with and involvement of 40 organisations from the City of Oslo, the business community and state-owned enterprises. This involvement process

³¹⁵ Oslo Climate Budget 2020 pg. 15

³¹⁶ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³¹⁷ <https://www.euractiv.com/section/climate-environment/interview/oslo-mayor-heres-how-we-plan-to-become-a-carbon-neutral-city/>

³¹⁸ Oslo Climate Budget 2020 pg. 15

³¹⁹ <https://www.euractiv.com/section/climate-environment/interview/oslo-mayor-heres-how-we-plan-to-become-a-carbon-neutral-city/>

³²⁰ <https://www.visitoslo.com/en/transport/by-car/toll-ring/>

³²¹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³²² <https://www.euractiv.com/section/climate-environment/interview/oslo-mayor-heres-how-we-plan-to-become-a-carbon-neutral-city/>

³²³ Oslo Climate and Energy Strategy pg. 22

³²⁴ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

		<p>was mainly undertaken in five sector groups: Transport, Energy, Buildings, Resource Utilisation and Cross-Sectoral Energy Issues.³²⁵</p> <ul style="list-style-type: none"> - Annual climate survey for residents of Oslo.³²⁶
	Plan Implementation	<ul style="list-style-type: none"> - The local government leads information campaigns about climate change and the actions outlined in the climate and energy strategy.³²⁷ - Climate communications targets children and adolescents through an education portal called “Climate School” for teachers and pupils in Oslo schools, with “climate pilots” who tour Oslo schools. Oslo works in cooperation with the Climate House regarding communication and information on the role of the city in relation to work for the climate. - The Climate House is a physical place where climate, teaching and active information for primary and lower-secondary schools is offered along with exhibitions and information for the city’s residents.³²⁸
	Advocacy	<ul style="list-style-type: none"> - Advocating to other cities to mainstream climate budgets Partnering with other cities and networks (like C40, CNCA, 100 Resilient Cities) to scale up climate solutions, share knowledge and tools at a global scale. - Businesses for Climate Network is a network created by the city where businesses commit to implementing climate measures (prioritize emissions reductions) must report progress 3 times per year.³²⁹ - Demand for greener construction machinery is causing this market to develop and expand; The City of Oslo is developing a 30-tonne battery- and hydrogen-powered digger in collaboration with NASTA, SINTEF, Skanska, Siemens and Bellona. By setting high standards, the city has pushed the industry to change, causing global ripples.³³⁰ - The city advocates to the national government for continuous climate action.
Long Term Endeavors		<ul style="list-style-type: none"> - Oslo has developed a pathway to a 95% GHG reduction by 2030. - Sustainability targets are embedded in City planning.
Building Technical Capacity		<ul style="list-style-type: none"> - The methods for estimating effects of measures in the climate budget for 2020 have been improved to take into account the estimated effects of current policy, using a BAU-baseline.³³¹ - Oslo utilizes data and resources from Statistics Norway for technical analysis.³³² - The City is leading pilot projects and studies in multiple sectors, notably in the transportation sector and the CCaS system at the Klemetsrud plant.
Funding		<ul style="list-style-type: none"> - Funding for the actions outlined in the climate budgets comes from the national government, City Council and through public/private partnerships. - Enova (a national government fund) and Oslo’s Climate and Energy Fund support the transition to fossil-fuel free heating.³³³ and encourages research and development, as well as innovations in renewable energy and energy saving technologies.
Green Economy		<ul style="list-style-type: none"> - The City of Oslo has been proactive in demonstrating that fossil-fuel free construction is a practical option. In addition to continuing to boost efforts to make the city’s own construction activities ever more climate-friendly, the city will intensify efforts to promote

³²⁵ https://www.c40knowledgehub.org/s/article/Oslo-Climate-and-Energy-Strategy?language=en_US.

³²⁶ Oslo Climate Budget 2020 pg. 10

³²⁷ Oslo Climate and Energy Strategy pg. 26

³²⁸ Oslo Climate Budget 2020 pg. 20

³²⁹ https://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2018/05/Oslo_Climate_Budget.pdf

³³⁰ <https://www.sustaineurope.com/oslo-european-green-capital-2019-20191023.html>

³³¹ Oslo Climate Budget pg. 10

³³² https://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2018/05/Oslo_Climate_Budget.pdf

³³³ Oslo Climate and Energy Strategy pg. 22

	<p>fossil-fuel free and zero-emission construction practices among developers in the public and private sectors.³³⁴</p> <ul style="list-style-type: none"> - The City of Oslo with help from C40, has established a Clean Construction Forum to reduce GHG emissions from construction sites and use of materials in buildings. One of the main purposes of the C40 Clean Construction Forum is to develop a declaration of demand for zero-emissions construction machinery and climate-friendly materials from interested C40 cities, and to promote cooperation and exchange of experience between cities to reduce emissions from this sector.³³⁵ - Oslo's economic plan includes the climate budget targets. - The city has increased city procurement guidelines to be more environmentally friendly.³³⁶ - The Climate and Energy Fund helps to encourage innovation in the green tech sector by providing funding for projects.³³⁷
Regulatory/ Policy Tools	<ul style="list-style-type: none"> - The Carbon Budget is a key regulatory and governance tool that ensures that all Oslo's agencies assume responsibility for climate initiatives.³³⁸ - Regulatory enforcement is a vital aspect to the success for the Climate Budget – through managing laws and regulations such as regulating taxis, low emissions zones, increasing traffic regulations.³³⁹ - The majority of regulations (for buildings and transportation) are set at the national level.
Financial/ Investment Tools	<ul style="list-style-type: none"> - Oslo provides subsidies through the Climate and Energy Fund that will facilitate the implementation of measures by private individuals and businesses in Oslo to help reduce GHG emissions and use energy more efficiently. These subsidies can complement those granted by the state.³⁴⁰ - National programs and subsidies make up for the national ban on fuel heating thereby encouraging home-owners and businesses to switch to electricity and district energy systems.³⁴¹ - Road user payment system – environmental differentiation of toll rates – most of the money collected from this is reinvested in public transportation projects. - The City is divesting from fossil fuels in the city pension fund.³⁴² - Oslo is making large infrastructure investments such as: active transit routes, carbon capture and storage systems, electric vehicles for fleet and transit.

4.7.4 Governance: Oslo

Table 28: Governance: Oslo

Variable	Findings
Decision – Making Structure	<ul style="list-style-type: none"> - The Climate Budget and the Energy Plan are the result of joint work by the Finance Department and the Environment and Transport Departments, working with the other municipal departments and 50 local agencies. - The local government has 32 FTE staff dedicated to mitigation actions³⁴³ and 3 FTE for environmental data management and communication.³⁴⁴

³³⁴ <https://www.klimaoslo.no/2019/06/20/emissions-free-construction-site/>

³³⁵ Oslo Climate Budget 2020 pg. 9

³³⁶ https://www.c40.org/blog_posts/from-outstanding-oslo-to-the-norwegian-normal-mark-watts-c40

³³⁷ Oslo Climate Budget 2020 pg. 11

³³⁸ https://www.c40knowledgehub.org/s/article/Oslo-Climate-and-Energy-Strategy?language=en_US.

³³⁹ https://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2018/05/Oslo_Climate_Budget.pdf

³⁴⁰ <https://energy-cities.eu/budget-climat-un-dialogue-avec-oslo/>

³⁴¹ <https://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=25032&LangID=E>

³⁴² Oslo Climate and Energy Strategy pg. 26

³⁴³ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁴⁴ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

	<ul style="list-style-type: none"> - The Agency for Climate, created by City Council in 2016, is a specialist entity within the City advising on, and actively encouraging the implementation of climate measures that helps to promote cross sector initiatives.³⁴⁵ - The climate budget is a governance tool that clearly outlines the measures that the City will implement, who is responsible for them, the timeline and the expected emissions reductions.³⁴⁶ The Climate Budget provides a sense of cross municipal ownership of climate action.
Oversight, Monitoring & Reporting	<ul style="list-style-type: none"> - The City Council has overall responsibility for monitoring and implementing the climate measures and associated initiatives in the Climate Budget.³⁴⁷ - All local government agencies are held accountable to their targets by Council. - The Climate Barometer is a monitoring and oversight tool that helps to keep all actors and actions on track. It uses normal business management processes, with quarterly and annual reporting on results and the status of climate efforts. - The Climate Barometer - 14 indicators that are updated quarterly on the progress of the Climate Budget. This identifies the need for increased action in specific sectors.³⁴⁸ - Annual review and update process. - Annual Climate Budgets. - Statistics for GHG emissions from each Norwegian municipality are calculated annually by the Norwegian Environment Agency in collaboration with Statistics Norway (SSB).³⁴⁹
Leadership	<ul style="list-style-type: none"> - Oslo Agency for Climate, created in 2016, acts as a specialist agency and coordinates the Climate Budget
Communication	<ul style="list-style-type: none"> - 3 FTE staff for environmental data management and communication.³⁵⁰ - On going monitoring process (climate barometer) feeds internal decision making. - Website - Annual climate budgets outline the targets and strategies for the year and are publicly available.
Vertical Integration	<ul style="list-style-type: none"> - Oslo's Climate and Energy strategy, along with the annual carbon budgets are integrated with national policies: For example the ban on fossil fuel heating, electric transportation incentives and bio-fuel requirements in vehicles - The national government and the Oslo municipal government work together on integrating policies. - Norway has a long-term target to be a "low carbon society" by 2050. Norway is regarded as a leader in GHG mitigation initiatives, despite being a large oil and gas producing country.³⁵¹
Collaboration	<ul style="list-style-type: none"> - Oslo Agency for Climate coordinates and facilitates collaboration between all the local government agencies and external actors for the Climate Budget and implementation action.³⁵² - The Climate Budget is a tool that ensures collaboration and spreads responsibility across departments, agencies and the public, businesses. - Businesses for Climate Network encourages communication between stakeholders. - Oslo works closely with the state and other public actors on climate initiatives by creating partnerships that focus on the development of regulations that authorize the municipality to implement measures and engage in joint financing of public transport projects.³⁵³

³⁴⁵ Oslo Climate Budget 2019 pg. 12

³⁴⁶ https://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2018/05/Oslo_Climate_Budget.pdf

³⁴⁷ https://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2018/05/Oslo_Climate_Budget.pdf

³⁴⁸ <https://www.fastcompany.com/90410124/how-oslo-manages-carbon-emissions-like-it-manages-money>

³⁴⁹ Oslo Climate Budget 2019 pg. 46

³⁵⁰ CDP, "2019 Full Cities Dataset. [Dataset]," 2019.

³⁵¹ <https://www.cnbc.com/2020/02/07/reuters-america-leading-european-oil-gas-producer-norway-rises-carbon-cutting-goal.html>

³⁵² https://www.c40knowledgehub.org/s/article/Oslo-Climate-and-Energy-Strategy?language=en_US

³⁵³ Oslo Climate and Energy Strategy pg. 26

Governance Mode	<ul style="list-style-type: none"> - Self Governing – The local government has made ambitious commitments for corporate emissions and initiatives such as the fossil free construction sites and procurement policy. - Enabling – the local government leads stakeholder engagement and education activities and provides transparent reporting on the progress. - Provisioning – the local government invests in and provides public infrastructure. - Authority – The local government uses its authority to enforce low carbon initiatives such as toll rings, building standards.
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4.7.5 Actors: Oslo

Table 29: Actors: Oslo

Variable	Findings
External Actors	<ul style="list-style-type: none"> - Businesses for Climate Network is made up of businesses that implement climate measures (prioritize emissions reductions) and they must report progress 3 times per year.³⁵⁴ - The City works closely with the construction industry for its pioneering projects in fossil-fuel free construction and eventual zero emissions construction sites. - The National Government is one of the main partners: the Norwegian government sets regulations and adds capacity and provides funding for many of Oslo’s projects. <p>Roles:</p> <ul style="list-style-type: none"> - Implementation partners, enabling, regulating/ policy making, funding,
Internal Actors	<ul style="list-style-type: none"> - The Agency for Climate was established in 2016 (for Oslo’s climate and energy strategy) as a driving force and specialist agency for climate initiatives. It includes internal actors and external stakeholders and its purpose is to promote cross sector initiatives. - All City agencies are involved in planning and/or implementation. - Vice Mayor of Finance (and Department of Finance are responsible for the climate budget process.³⁵⁵ <p>Roles:</p> <ul style="list-style-type: none"> - Regulating, funding, enabling, coordinating, facilitating, decision making, monitoring

4.8 Toronto, Ontario, Canada

Toronto is the largest city in Canada and the fourth largest in North America with a population of roughly 3 million people. Toronto is the provincial capital of Ontario and is located on the shore of Lake Ontario. Toronto is an international center of business, finance, arts and culture and it is recognized as one of the most multicultural cities in the world.³⁵⁶

³⁵⁴ https://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2018/05/Oslo_Climate_Budget.pdf

³⁵⁵ <https://www.fastcompany.com/90410124/how-oslo-manages-carbon-emissions-like-it-manages-money>

³⁵⁶ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

4.8.1 Sustainability & Climate Action

The City of Toronto has a target is to reduce emissions by 80% by the year 2050 (based off 1990 levels).³⁵⁷ TransformTO is Toronto’s long-term climate action strategy; it was unanimously approved by City Council in 2017.³⁵⁸ As of 2017, Toronto has had success in reducing citywide emissions by 44% while both the population and the GDP have been steadily increasing.³⁵⁹ Alongside the TransformTO strategy, various departments in the city have strategies that correspond with the GHG targets set out by the City. These strategies include: the long term waste management strategy, the zero emissions buildings framework, the electric vehicle strategy, the congestion management plan to name a few.³⁶⁰

The TransformTO plan takes a multi-solving approach to climate action, in which climate outcomes are tied with social equity, health and well-being.³⁶¹ In October of 2019, Toronto City Council declared a climate emergency and with that they are committed to looking for opportunities to accelerate the TransformTO actions.³⁶²

Emissions by sector in (2017)³⁶³

Buildings – 52%

Transportation – 38%

Waste – 10%

³⁵⁷ TransformTO: Report #2 - The Pathway to a Low Carbon Future

³⁵⁸ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁵⁹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁶⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁶¹ TransformTO: Report #2 - The Pathway to a Low Carbon Future

³⁶² Toronto City Council Consideration October 2, 2019 – Declaring a Climate Emergency and Accelerating Toronto’s Climate Action Plans

³⁶³ TransformTO: Report #2 - The Pathway to a Low Carbon Future

4.8.2 Technical Pathways: Toronto

TransformTO has both short term and long-term strategy reports. The plan outlines actions to be taken in the four target areas; Homes and Buildings, Energy, Transportation and Waste Diversion.³⁶⁴

Table 30: Technical Pathways: Toronto

Variable	Findings
Decarbonization of Electricity/ Energy	<ul style="list-style-type: none"> - 75% of community-wide energy use will be derived from renewable or low-carbon sources by 2050. - The City is the sole shareholder of the Toronto Hydro Corporation (THC) supporting the city’s renewable energy goal of installing 550 MW of renewable generation by 2020, including 166 MW of solar PV generation.³⁶⁵ - The City will work alongside Toronto Hydro and Enbridge Gas to support urban renewable energy development, to expand customer access to utility data, and to manage issues related to city-wide energy growth, such as reducing demand in high-growth, energy constrained areas.³⁶⁶
Existing Buildings	<ul style="list-style-type: none"> - Retrofit all City-owned buildings, including social housing, to the highest emission reduction technically feasible, on average achieving a 40% energy savings over 2016 building energy performance by 2040.³⁶⁷ - Retrofit 100% of existing buildings (to achieve an average of 40% efficiency increase compared to 2017 levels). - By 2050: 30% of all floor space will be connected to low carbon thermal energy (district energy). - The city created the Better Building Partnership (BBP), which connects the city with building owners, managers and builders, to ensure that buildings are energy efficient and have low environmental impact.³⁶⁸ - Toronto Green Will Initiative is a program of the BBP, a voluntary program targeting building portfolios initially, that will support building owners/operators in moving their buildings through the key stages towards achieving net-zero emissions.³⁶⁹ - Energy Retrofit Loan Program – all buildings in Toronto are eligible for financing at a rate equal to the city’s cost of borrowing³⁷⁰ “Launched in 2014, the Residential Energy Retrofit Programs have provided financing to support capital improvements (retrofits) for residential properties with energy efficiency and water conservation benefits. The Programs operate as two streams: the Home Energy Loan Program (HELP) for eligible houses; and the High-rise Retrofit Improvement Support Program (Hi-RIS) for multi-unit residential buildings. To date, almost \$14.9 million in financing has been committed to projects with over 202 properties participating in the program, which has resulted in an emissions reduction of over 4,000 tonnes of CO2 equivalents.”³⁷¹

³⁶⁴ TransformTO: Report #2 - The Pathway to a Low Carbon Future

³⁶⁵ 2018 Toronto Hydro Environmental Performance Report pg. 12

³⁶⁶ TransformTO: Report #2 - The Pathway to a Low Carbon Future pg. 31

³⁶⁷ TransformTO: Report #2 - The Pathway to a Low Carbon Future pg. 18

³⁶⁸ <https://www.toronto.ca/business-economy/business-operation-growth/green-your-business/better-buildings-partnership/>

³⁶⁹ <https://www.toronto.ca/business-economy/business-operation-growth/green-your-business/better-buildings-partnership/green-will-initiative/>

³⁷⁰ <https://www.toronto.ca/services-payments/water-environment/environmental-grants-incentives/energy-retrofit-loans/>

³⁷¹ <https://www.toronto.ca/legdocs/mmis/2019/ie/bgrd/backgroundfile-134697.pdf pg. 1>

New Buildings	<ul style="list-style-type: none"> - Target: 100% new buildings are designed and built to be (near) zero emissions by 2030. - The City updated the Toronto Green Standard for regulations on new developments in the city to match with Toronto’s Zero Emissions Buildings Framework.³⁷² The third version of the TGS was co-developed with the Atmospheric Fund. - The Zero Emissions Building Framework sets requirements for the total energy use intensity, thermal energy demand and GHG intensity of the five most common building archetypes in Toronto.³⁷³ - The ZEB framework also includes a Climate Change Resilience Checklist for New Development to encourage the construction of safe and resilient buildings that are able to withstand expected changes in climate.³⁷⁴ - Toronto Green Standard to include stepped performance targets to approach zero emissions for all new buildings by 2030. It has 4 tiers: “The four tiers of increasing performance were developed to reflect the need to update building performance targets every four years to reach the zero emissions target. It is a target that voluntary Tier 4 level requirements in the 2018 TGS will eventually become the required Tier 1 by TGS 2030. This reflects the ultimate goal of the TGS framework which is to achieve a future for Toronto where new developments are constructed to a ‘near-zero emissions level of performance.’³⁷⁵ - The City of Toronto is also targeting zero emissions for its own new facilities designed and built by 2026, starting with the Mount Dennis Childcare Centre, which will be designed to meet zero energy and emissions standards.
Transportation Mode Shifting	<ul style="list-style-type: none"> - 75% of trips under 5km will be done through active transportation by 2050 - City Council adopted the 10-year cycle network update - \$16 million per year in funding. - The City has developed a Congestion Management Plan (2016-2020) that aims to mitigate congestion in the growing city and reduce the impact of transportation on the environment and the GHG emissions associated with the sector.³⁷⁶ - Smart Commute Program – The City has partnered with Metrolinx to develop a program to encourage businesses to promote sustainable commuting. - City Council voted to make permanent a pilot project that discourages cars from driving on a 2.5-km section through the city’s financial core and prioritize streetcar traffic.
Transportation Fuel Shifting	<ul style="list-style-type: none"> - By 2050- 100% of all transit and personal vehicles use low or zero carbon energy sources. - Vehicles-for-Hire Bylaw Review: The Vehicle-for-Hire By-law provides regulations for taxicabs, limousines and private transportation companies. The City is exploring an emissions reduction incentive program and/or low-emission standards and targets for the entire vehicle-for-hire industry, in keeping with TransformTO’s transportation goals.³⁷⁷ - The City will work with the province to support the anticipated adoption of EVs by developing policies and programs to expand EV use in Toronto, particularly with respect to vehicle charging stations and parking. Also, the City will partner with Toronto Hydro to provide needed infrastructure and electrical grid resilience for EV use.

³⁷² <https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/toronto-green-standard-overview/>

³⁷³ Toronto Zero Emissions Building Framework Report pg. 7

³⁷⁴ ³⁷⁴ Toronto Zero Emissions Building Framework Report pg. 8

³⁷⁵ <https://urbantoronto.ca/news/2018/06/sustainable-design-understanding-toronto-green-standard>

³⁷⁶ Toronto Congestion Management Plan pg. 7

³⁷⁷ Toronto Electric Vehicle Strategy pg. 8

Waste Reduction, Diversion & Capture	<ul style="list-style-type: none"> - By 2050, 95% of waste will be diverted from all sectors. - 70% diversion rate by 2026.³⁷⁸ - The City developed a long-term waste management strategy and is in the implementation phase. The strategy is focused on waste reduction and diversion.³⁷⁹ - The City’s Solid Waste Management Services Division, in partnership with Enbridge Gas Distribution Inc., installed new equipment at the Dufferin Solid Waste Management Facility to make renewable natural gas – to be used in the waste collection vehicles for a closed loop system.³⁸⁰
Carbon Sinks, Storage & Offsets	<ul style="list-style-type: none"> - Carbon sinks were not included in the GHG modeling because the rate was too low (36.5 KTCO₂e/year.)³⁸¹ - The City has created a Forest Management Plan with a target to increase the urban tree canopy to cover 40% of the city³⁸²

4.8.3 Institutionalization Strategies: Toronto

Table 31: Institutionalization Strategies: Toronto

Variable		Findings
Engagement	Plan Development	<ul style="list-style-type: none"> - Over 2000 members of the public were engaged early in the process to contribute to the development of the targets and the plan with online surveys, panel discussions, community discussions and events, as well as youth engagement events.³⁸³ - A team of 20 staff from different local government divisions and agencies were convened (regularly) to design and implement the climate initiatives.³⁸⁴ - Toronto uses mass media to raise awareness for TransformTO and its goals.³⁸⁵ - In 2018, the City of Toronto commissioned a survey to capture residents’ perceptions on climate change and to better understand their willingness to take action in the community.³⁸⁶ - The City partnered with Indigenous Climate Action (ICA) to design, host, and report on the outcomes of a workshop with Indigenous communities on urban climate action.
	Plan Implementation	<ul style="list-style-type: none"> - The City engages businesses with the “Green Your Business” portal on the city’s website.³⁸⁷ - The City developed programs and partnerships to engage stakeholders in certain sectors, for example the Better Buildings Partnership which connects residents and building owners of Toronto with incentives and expertise for better building efficiency.³⁸⁸ - Live Green Toronto Outreach Program participated in over 400 events between 2017-2018.³⁸⁹

³⁷⁸ Toronto Long Term Waste Management Strategy pg. 2

³⁷⁹ Toronto Long Term Waste Management Strategy pg. iii

³⁸⁰ <https://www.toronto.ca/home/media-room/backgrounders-other-resources/backgrounder-waste-to-renewable-natural-gas-project/>

³⁸¹ TransformTO: Report #2 - The Pathway to a Low Carbon Future Attachment B – Modeling Toronto’s Low Carbon Future pg.128

³⁸² CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁸³ TransformTO Community Engagement Report pg. 5-8

³⁸⁴ TransformTO: Report #2 - The Pathway to a Low Carbon Future pg. 12

³⁸⁵ TransformTO: Implementation Update 2017 and 2018 pg. 44

³⁸⁶ TransformTO: Implementation Update 2017 and 2018 pg. 44

³⁸⁷ <https://www.toronto.ca/business-economy/business-operation-growth/green-your-business/>

³⁸⁸ <https://www.toronto.ca/business-economy/business-operation-growth/green-your-business/>

³⁸⁹ TransformTO: Implementation Update 2017 and 2018 pg. 44

	Advocacy	<ul style="list-style-type: none"> - City Council directed the City Manager to advocate to the Provincial and Federal Governments for co-delivery opportunities, and related policies and regulatory supports necessary to achieve the TransformTO long-term, low carbon goals.³⁹⁰ - Partnering with other cities and networks (like C40, CNCA, 100 Resilient Cities) to scale up climate solutions, share knowledge and tools at a global scale. - Toronto is a member of transnational city networks such as C40 and shares knowledge and advocates for other cities worldwide to commit to climate action. - Through its public engagement strategies, the City advocates to the residents of Toronto to support the actions in the TransformTO plan.
Long Term Endeavors		<ul style="list-style-type: none"> - Long term pathway to 80% reduction by 2050 along with the shorter term TransformTO plans - Sustainability targets are embedded in other City planning.
Building Technical Capacity		<ul style="list-style-type: none"> - SSG were hired as technical consultants for the modeling and scenario building.³⁹¹ - Used geospatial data to determine in which areas emissions were higher.³⁹² - The local government hired 30 more staff to help build capacity and accelerate the actions.³⁹³ - Green Market Acceleration Program – the City partners with local firms to develop and bring to market green technologies. Participants gain access to city owned infrastructure and assets for research and pilot projects for green technology, builds technical capacity for the city and the green economy.³⁹⁴
Funding		<ul style="list-style-type: none"> - City Council in February 2018 fully funded implementation of the TransformTO 2017-2020 short-term strategies.³⁹⁵ - “An estimated \$320-\$866 million of capital investment is required community-wide to implement the TransformTO Report #1 strategies. In this context and given the significant funding identified, "community-wide investment" means potential financial contributions from all orders of government (i.e. Federal, Provincial and City), plus the private sector and individual property owners.”³⁹⁶ - All building energy-efficiency retrofit related capital costs for City-owned facilities will be funded through recoverable debt, and building retrofit programs will be aligned with existing state of good repair capital projects. - Staff are monitoring and engaging with provincial and federal counterparts in pursuit of available funding that is aligned with the city's climate change priorities. It is unknown what level of financial support and timing of investment is to be expected by other levels of government, external parties, and the portion to be City funded.”³⁹⁷ - “Led by the Environment and Energy Division, a coordinated cross-corporate effort was made to leverage funds for over 50 GHG mitigation proposals seeking external funding. Funding has been accessed from various sources such as the Government of Canada, Natural Resources Canada, the Province of Ontario, the Federation of Canadian Municipalities, the Independent Electricity System Operator and C40 Cities. Funding secured by the city ranges from \$50,000 - \$135 million in support of new and enhanced capital projects, demonstrations, research and technical studies.”³⁹⁸ - Green Bond Program was established in 2018 by the City. It is a \$300 million dollar bond that will fund climate actions associated with the TransformTO Plan (mostly transit).³⁹⁹

³⁹⁰ TransformTO: Report #2 - The Pathway to a Low Carbon Future pg. 4

³⁹¹ TransformTO: Report #2 - The Pathway to a Low Carbon Future pg. 13

³⁹² TransformTO: Implementation Update 2017 and 2018 pg. 4

³⁹³ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

³⁹⁴ <https://www.toronto.ca/business-economy/doing-business-with-the-city/green-market-acceleration-program-gmap/>

³⁹⁵ TransformTO: Implementation Update 2017 and 2018 pg. 2

³⁹⁶ TransformTO: Report #2 - The Pathway to a Low Carbon Future pg. 9

³⁹⁷ TransformTO: Report #2 - The Pathway to a Low Carbon Future pg. 9

³⁹⁸ TransformTO: Implementation Update 2017 and 2018 pg. 50

³⁹⁹ https://www.toronto.ca/wp-content/uploads/2019/07/8e6e-DS_19_0300_EED_Green_Bond_Newsletter_full_final.pdf

Green Economy	<ul style="list-style-type: none"> - Green jobs are mentioned as a co-benefit of the overall strategy – but there is no specific target in the TransformTO plan. - The City has developed the Green Market Acceleration Program, which provides local firms and foreign investors with an opportunity to collaborate with the city to develop green technologies and bring them to market.⁴⁰⁰ - Workforce mobilization - Develop a high-performance building workforce strategy in consultation with local employers, employee groups, trade unions and training facilities, to create a highly skilled workforce to support high-performance new building construction, retrofits, and distributed renewable energy deployment. The workforce strategy should give special consideration to people who face barriers to employment and consider ways to implement the retrofits.⁴⁰¹ - In the climate emergency declaration, the city council committed to “engaging job-seekers, workers, unions, academic institutions, relevant sectors, and social service agencies in the creation of a low-carbon jobs strategy that supports a decent work agenda, career pathways for equity-seeking groups, and the expansion of green industry sectors across Toronto.”⁴⁰²
Regulatory/ Policy Tools	<ul style="list-style-type: none"> - The City has updated the Toronto Green Standard for new buildings to correspond with the Toronto Zero Emissions Buildings Framework. It is a set of environmental performance measures for sustainable development that includes a step code that will reach ZEBs by 2030. - The TransformTO plan is a policy document passed by City Council.
Financial/ Investment Tools	<ul style="list-style-type: none"> - The City provides many grants and financial incentives for residents to take on green projects. They include: retrofit and energy programs, tree planting, an eco-roof program, and waste reduction. - Neighbourhood Climate Action Grants – the City provides funding for resident led projects that help to engage citizens and reduce GHG emissions.⁴⁰³ - The city will endeavour to scale-up programs like Competitive Sustainable Energy Plan Financing loans and the Home Energy Loan Program (HELP), and explore new partnership opportunities to mobilize private capital for energy projects.⁴⁰⁴ - Better Building Partnership – all buildings in Toronto are eligible for low interest loans at the City’s borrowing rate. It offers financing up to 100% of the cost of the project with repayment terms up to 20 years. - Toronto Atmospheric Fund – created by Toronto City Council in 1991 to finance climate action initiatives is funded by endowments.⁴⁰⁵ - Cycling infrastructure (10-year cycle network update). - Purchasing Electric Vehicle fleet.

4.8.4 Governance: Toronto

Table 32: Governance: Toronto

Variable	Findings
Decision – Making Structure	<ul style="list-style-type: none"> - Environment and Energy Division is responsible for the coordination and the preparation of the TransformTO plan. - Relevant city departments (Transportation, Waste Management, Planning, Fleet Services), have their own strategies that align with the targets of TransformTO – each of

⁴⁰⁰ <https://www.toronto.ca/business-economy/doing-business-with-the-city/green-market-acceleration-program-gmap/>

⁴⁰¹ TransformTO: Report #2 - The Pathway to a Low Carbon Future pg. 31

⁴⁰² <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2019.MM10.3>

⁴⁰³ <https://www.toronto.ca/services-payments/water-environment/environmental-grants-incentives/neighbourhood-climate-action-grants/>

⁴⁰⁴ TransformTO: Report #1- Short Term Strategies – Highlights pg. 6

⁴⁰⁵ <https://taf.ca/about-us/>

	<p>these departments plays a leading role on their own actions.</p> <ul style="list-style-type: none"> - All City departments are required to use a “climate lens” and work in an integrated fashion.⁴⁰⁶ - In 2018 City Council supported the hiring of 30 positions to accelerate the plan.⁴⁰⁷
Oversight, Monitoring & Reporting	<ul style="list-style-type: none"> - City Council oversees the progress on the strategy - Chief Corporate Officer (prepares reports for council) - Every 4 years (each new term of city council) the Chief Corporate Officer prepares a report that identifies: <ul style="list-style-type: none"> - GHG inventory - Co benefits of actions - Public engagement levels - Amount of financial and other resources mobilized - Progress on the actions - Revisions and additions to the actions an implementation⁴⁰⁸ - Every second year a status update will be prepared for council to report on the key performance indicators for TransformTO⁴⁰⁹
Leadership	<ul style="list-style-type: none"> - The Environment and Energy Division play a leading role in the creating and implementation of TransformTO.
Communication	<ul style="list-style-type: none"> - TransformTO ebsite makes all information publicly available. - Public Reports examine the progress on the strategy and the next steps. - Information in internal communication systems not available
Vertical Integration	<ul style="list-style-type: none"> - City staff are currently assessing the implications of climate policy and regulation changes introduced by the Province of Ontario, including the cancelled Cap and Trade program (Bill 4, Cap and Trade Cancellation Act, 2018).⁴¹⁰ - In Ontario, municipalities are creatures of the province, they must follow the province’s decision making and policies. The Ontario Provincial government has recently repealed policies such as the provincial cap and trade system and the green energy act, cancelling a large number of renewable energy projects and energy-conservation demand programs. This has created a policy gap between the targets of Toronto and the provincial policies.⁴¹¹
Collaboration	<ul style="list-style-type: none"> - Partnerships have been developed with external actors working in separate sectors – each sector partnership has a different agreement “model” to work on various projects.⁴¹² - Partnerships are separated by sectors and/or specific actions.⁴¹³ - Environment and Energy Division collaborates with other city departments to develop targets and actions.
Governance Mode	<ul style="list-style-type: none"> - Self Governing – through the corporate emissions plans and actions - Enabling – through public engagement programs such as Live Green Toronto, the various programs and partnerships that the city has developed for climate action initiatives. - Provisioning – the City invests heavily in public infrastructure such as transit and active transportation systems. - Authority- through regulations that the city has imposed like the King Street car free zone and the Toronto Green Standard.

⁴⁰⁶ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴⁰⁷ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴⁰⁸ TransformTO: Report #2 - The Pathway to a Low Carbon Future pg. 4

⁴⁰⁹ TransformTO: Report #2 - The Pathway to a Low Carbon Future pg. 35

⁴¹⁰ <https://www.toronto.ca/city-government/council/2018-council-issue-notes/climate-change/>

⁴¹¹ https://www.toronto.ca/ext/digital_comm/inquiry/inquiry_site/cd/gg/add_pdf/77/Governance/Electronic_Documents/Other_CDN_Jurisdictions/Powers_of_Canadian_Cities.pdf

⁴¹² TransformTO: Implementation Update 2017 and 2018 pg. 51

⁴¹³ TransformTO: Implementation Update 2017 and 2018 pg. 51

4.8.5 Actors: Toronto

Table 33: Actors: Toronto

Variable	Findings
External Actors	<ul style="list-style-type: none"> - The City has developed partnerships with external actors in the private sector in order to implement individual actions (for example En Wave, a private energy provider).⁴¹⁴ - External actors help and support actions / build capacity, implement actions. - The Toronto Atmospheric Fund plays a big role with engagement and helps build capacity for the plan.⁴¹⁵ - The City works with academic institutions, community groups, NGOs – to help the City build capacity with an increasing the level of engagement. <p>Roles:</p> <ul style="list-style-type: none"> - Enabling, consulting, (some) funding, capacity building
Internal Actors	<ul style="list-style-type: none"> - Environment and Energy Division responsible for creation, coordination and implementation of TransformTO. This division plays enabling and coordinating roles. - Other City divisions are involved in the planning and implementation of actions. Certain divisions also have corresponding plans/strategies that work towards TransformTO goals. <p>Roles:</p> <ul style="list-style-type: none"> - Decision making, regulating, leading, enabling, coordinating, facilitating

4.9 New York City, USA

New York City is the largest city in the United States and has been described as the cultural capital of the world. It has a population of 8,622,700 people. New York City is a global power city and has a large impact on commerce, finance, media, fashion, art, technology and global affairs as the United Nations headquarters is located in the city.⁴¹⁶

4.9.1 Sustainability and Climate Action

In 2014 New York City committed to the 80x50 GHG reduction framework (compared to 2005 levels).⁴¹⁷ The OneNYC plan was introduced in 2015 and is labeled as “New York’s Green New Deal”. The OneNYC strategy covers city-wide planning and has targets of climate

⁴¹⁴ <https://www.globenewswire.com/news-release/2018/05/01/1494234/0/en/City-of-Toronto-and-Enwave-partner-to-develop-low-carbon-thermal-energy-networks.html>

⁴¹⁵ <https://taf.ca/programs/transformto/>

⁴¹⁶ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴¹⁷ New York City’s Roadmap to 80x50

mitigation, equity and strengthening democracy.⁴¹⁸ After the American federal government announced that it would pull out of the Paris Agreement in 2017 the City reinforced its commitment to climate action and has since scaled up its climate action target – to have net zero emissions by 2050. NYC has also introduced legislation for climate action through the Climate Mobilization Act in 2019.⁴¹⁹

Emissions per sector (2016)⁴²⁰

Buildings – 66%

Transportation 30%

Waste – 4%

4.9.2 Technical Pathways: New York City

OneNYC is New York’s strategic plan and “green new deal”. In it, are nine strategies to make New York City a safe, equitable, democratic and environmentally friendly city. Part 7 “a livable climate” outlines the goals, targets and actions for climate action in NYC. There are also separate chapters that specifically deal with transportation and modern infrastructure. These chapters have a climate-focused lens for new developments in these sectors.⁴²¹

New York City has also published a roadmap to 80x50. This document outlines the actions the city and partners will take to reach emissions targets in the four priority sectors (energy, buildings, transportation and waste).⁴²²

Table 34: Technical Pathways: New York City

⁴¹⁸ OneNYC 2050: A Livable Climate

⁴¹⁹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴²⁰ New York City’s Roadmap to 80x50

⁴²¹ OneNYC 2050: A Livable Climate

⁴²² New York City’s Roadmap to 80x50

Variable	Findings
Decarbonization of Electricity/ Energy	<ul style="list-style-type: none"> - 100% renewable energy by 2040 – 50% by 2030⁴²³ - New York State has committed to 100% renewable energy by 2040.⁴²⁴ - Expansion of the transmission network coming into the city (from regional grid) is needed in order to reach the target in cooperation with New York State, the New York Power Authority, and the New York Independent System Operator.⁴²⁵ - 500 MW of storage available by 2025. The local government will commit to permitting all small and medium installations within 12 months or less by 2020.⁴²⁶ - Increasing local renewable energy generation by scaling up solar PV installations in the city.⁴²⁷ - Install 100 MW of solar energy on all City-owned buildings.⁴²⁸ - Solar Partnership was formed by Sustainable CUNY of the City University of New York (CUNY), the city, and the NYC Economic Development Corporation (NYCEDC) to reduce market barriers for investing in solar, to attract solar energy companies to the city, and to increase solar energy production capacity.
Existing Buildings	<ul style="list-style-type: none"> - Retrofit every City-owned building to reduce energy consumption.⁴²⁹ - Reduce GHG emissions from buildings by 30% by 2025.⁴³⁰ - Enforce energy efficiency and intensity mandate for buildings over 25,000 square feet (Local Law 97) – they must reduce their GHG emissions 40% by 2030 increasing to an 80% reduction requirement by 2050 (2005 baseline). LL97 is the most ambitious climate legislation for buildings enacted by any city in the world.⁴³¹ - Advise residents and building decision makers on energy and efficiency projects through NYC Retrofit Accelerator a free program that is part of NYC Green Building Plan and the Community Retrofit NYC Program - Assist buildings in complying with the city’s benchmarking requirements and help improve data quality through the Benchmarking Help Center, run by the city.⁴³² - Pass laws requiring the development of solar PV arrays or green roofs on all buildings pursuing major roof renovations.⁴³³ -
New Buildings	<ul style="list-style-type: none"> - Net zero energy buildings by 2030 – local law 32 (2017) using stretch energy codes in 2019 and 2022. - Climate Mobilization Act (CMA) (2019) – strict regulations for new buildings.⁴³⁴ - Laws requiring the development of solar PV arrays or green roofs on all new buildings.⁴³⁵
Transportation Mode Shifting	<ul style="list-style-type: none"> - Target: 80% sustainable mode share (walking, biking or transit) by 2050 - Introducing congestion pricing in Manhattan moving towards funding better public transit⁴³⁶ - Citibike -a bike share program public/private partnership⁴³⁷

⁴²³ OneNYC 2050: A Livable Climate pg. 5

⁴²⁴ OneNYC 2050: A Livable Climate pg. 13

⁴²⁵ OneNYC 2050: A Livable Climate pg. 13

⁴²⁶ OneNYC 2050: A Livable Climate pg. 14

⁴²⁷ New York City’s Roadmap to 80x50 pg. 8

⁴²⁸ New York City’s Roadmap to 80x50 pg. 8

⁴²⁹ New York City’s Roadmap to 80x50 pg. 8

⁴³⁰ OneNYC 2050: 2019 update pg. 37

⁴³¹ <https://www.urbangreencouncil.org/content/projects/80x50-buildings-partnership>

⁴³² OneNYC 2050: 2019 update pg. 38

⁴³³ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴³⁴ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴³⁵ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴³⁶ OneNYC 2050: A Livable Climate pg. 47

⁴³⁷ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

	<ul style="list-style-type: none"> - Install/ enhance 50 miles of bike lanes / year (including 10 miles of protected lanes).⁴³⁸ - Improving and expanding transit (bus) routes to reach 500,000 more residents by 2027⁴³⁹ - Modernizing the city’s mass transit networks is a key initiative of the OneNYC plan. The city will work with the MTA to invest in fixing and expanding the city’s vast transit network.⁴⁴⁰ - The City will support shared mobility options (rideshare). - Introducing congestion pricing in high traffic areas – funds will go towards improving public transit. - Testing “people priority zones” that will restrict vehicle access – with the potential for expansion⁴⁴¹
Transportation Fuel Shifting	<ul style="list-style-type: none"> - Target for 20% of all motor vehicles for sale in NYC to be EVs (plug ins) by 2025 (2017 target).⁴⁴² - Carbon neutral City fleet by 2040.⁴⁴³ - City investing at least \$10 million in installing 50 fast charging hubs across the city by 2020.⁴⁴⁴ - “The City will also leverage funding allocated by the Volkswagen settlement to promote diesel-to-electric replacements of commercial vehicles.” - Dedicated curb space for zero emission vehicles - Expand clean truck program.⁴⁴⁵
Waste Reduction, Diversion & Capture	<ul style="list-style-type: none"> - Zero waste to landfills by 2030.⁴⁴⁶ - Renewable gas production from waste water facilities and organic waste by increasing organics processing capacity (1 million tons / year).⁴⁴⁷ - Comprehensive Solid Waste Management Plan. - Commercial waste zoning to reduce truck traffic associated with waste collection by more than 50%. - Mandatory city-wide organics collection.⁴⁴⁸ - City-wide bans on certain products like polystyrene foam and plastic bags.⁴⁴⁹
Carbon Sinks, Storage & Offsets	<ul style="list-style-type: none"> - Emissions will be reduced as much as possible and “irreducible emissions” — those that are not feasible to eliminate — will be offset with projects that create negative emissions outside New York City.⁴⁵⁰ - Purchase high grade Carbon Credits outside of city limits to meet targets.

4.9.3 Institutionalization Strategies: New York City

Table 35: Institutionalization Strategies: New York City

⁴³⁸ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴³⁹ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴⁴⁰ OneNYC 2050: Volume 8: Efficient Mobility pg. 11

⁴⁴¹ OneNYC 2050: A Livable Climate pg. 11

⁴⁴² CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴⁴³ <https://onenyc.cityofnewyork.us/strategies/onenyc-2050/#main-content>

⁴⁴⁴ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴⁴⁵ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴⁴⁶ New York City’s Roadmap to 80x50 pg. 101

⁴⁴⁷ OneNYC 2050: 2019 update pg. 171

⁴⁴⁸ OneNYC 2050: 2019 update pg. 19

⁴⁴⁹ OneNYC 2050: 2019 update pg. 40

⁴⁵⁰ OneNYC 2050: A Livable Climate pg. 11

Variable		Findings
Engagement	Plan Development	<ul style="list-style-type: none"> - For the plan development; 17 focus group meetings with more than 100 technical and policy experts including; academia, regional think tanks, national environmental organizations, local environmental justice advocates, utilities, industry leaders, and state agencies and authorities.⁴⁵¹
	Plan Implementation	<ul style="list-style-type: none"> - GreeNYC is the resident engagement program for the net-zero target. They are dedicated to educating, engaging and mobilizing New Yorkers to help New York City meet its ambitious sustainability goals.⁴⁵² The program includes a multitude of engagement activities and resources for New Yorkers to get involved with climate action in the city. - Mass social media marketing / education program for residents to learn and get involved in climate initiatives.⁴⁵³ - “Birdie” is the symbol or mascot for the plans in the city and is recognisable on social media.
	Advocacy	<ul style="list-style-type: none"> - NYC Carbon Challenge is a voluntary leadership initiative and public-private partnership between the Mayor's Office of Sustainability and leaders in the private, institutional, and non-profit sectors who have committed to reduce their greenhouse gas emissions by 30% or more over ten years.⁴⁵⁴ - The City will advocate and partner with the State of New York to reach renewable energy targets (NYISO & PSC). - Advocate to utilities and partner with them for increased capacity in renewables.⁴⁵⁵ - Advocating for strict GHG emissions regulation and fight federal attempts to divorce regulatory efforts from sound science. The City will support the state’s inclusion in the Transportation and Climate Initiative’s regional low carbon transportation proposal. - The city will actively participate in the New York Independent System Operator’s (NYISO) exploration of carbon pricing in the wholesale energy market and continue to advocate for aggressive federal regulation of GHG emissions. The City will also continue to advocate for New York State’s efforts to develop a comprehensive valuation of distributed energy resources to monetize external benefits from clean distributed energy deployment.⁴⁵⁶ - “Pursue a lawsuit to fight federal attempts to rollback essential regulations limiting GHG emissions, including those that govern new and existing power plants and light duty vehicles”⁴⁵⁷ - Partnering with other cities and networks (like C40, CNCA, 100 Resilient Cities) to scale up climate solutions, share knowledge and tools at a global scale.⁴⁵⁸ - The City will develop a global carbon neutrality protocol for cities in partnership with C40 and other leading cities. This protocol will create a shared definition of carbon neutrality, define the role of carbon sequestration and carbon offsets, and provide guidance on a path to

⁴⁵¹ New York City’s Roadmap to 80x50 pg. 29

⁴⁵² <https://www1.nyc.gov/site/greenyc/about/about.page>

⁴⁵³ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴⁵⁴ <https://www1.nyc.gov/site/sustainability/our-programs/carbon-challenge.page>

⁴⁵⁵ New York City’s Roadmap to 80x50 pg. 50

⁴⁵⁶ Aligning NYC with Paris Agreement Report pg. 14

⁴⁵⁷ OneNYC 2050: A Livable Climate pg. 30

⁴⁵⁸ OneNYC 2050: A Livable Climate pg. 31

		carbon neutrality. This global protocol will enable the city to develop future strategies to achieve carbon neutrality. ⁴⁵⁹
Long Term Endeavors		<ul style="list-style-type: none"> - New York City has developed a road map to an 80% reduction by 2050 and has also developed the OneNYC plan – New York’s Green New Deal.⁴⁶⁰ - Sustainability targets are embedded in other sections of the OneNYC plan.
Building Technical Capacity		<ul style="list-style-type: none"> - The local government engaged groups of technical advisors for plan creation.⁴⁶¹ - BAU and other technical scenario models based off of previous GHG inventories were developed. - Geospatial analysis was used to inform priority areas for action for renewable energy projects and for building retrofits.⁴⁶² - The local government has developed partnerships with private and other external actors, including NGOs/ Academic institutions to help build capacity within specific sectors (solar partnership, building performance lab, building energy exchange).
Funding		<ul style="list-style-type: none"> - Capital for each of the actions comes from one or several of the following entities: City agencies, state agencies, federal government, private sector.⁴⁶³ - The City has committed \$4 billion in city pension fund investments for projects in renewable energy, energy efficiency, and other climate change solutions.⁴⁶⁴ - Several green /sustainable bonds have been issued in different sectors (including a sustainable neighbourhood bond and several climate certified bonds from MTA for low carbon transportation).⁴⁶⁵ - “Fiscal support from the federal government has declined significantly since the 1980s.” - The City of New York has filed lawsuits against polluters – namely VW and the five largest oil companies who are responsible for climate change. The goal was to sue polluters into playing for the climate actions in the city. The case was rejected, but the city will continue to look for settlement funding in this manner. - The City has committed to divesting \$5 billion dollars from fossil fuels in the NYC pension fund, and reinvesting 4\$ billion into climate action initiatives.
Green Economy		<ul style="list-style-type: none"> - Mayor de Blasio and the Building Construction Trades Council (BCTC) announced an agreement to launch the first class of pre-apprenticeships available through the NYC Green Jobs Corps. This new partnership with the BCTC and its members under the NYC Green Jobs Corps is necessary to deliver on the Mayor’s commitment to train 3,000 workers with new skills needed for the emerging green economy over the next three years.⁴⁶⁶ - The City is developing a program to train 10,000 building operators in the latest energy-efficiency principles and practices by 2025. The program will help operators develop their skills and gain access to new work opportunities and, at the same time, help reduce the city’s emissions and better manage its energy demands with a focus on providing green operations and maintenance training opportunities to non-union workers. The City will collaborate with unions to develop and share best-in-class curricula specific to New York City’s built environment. The program will also support the development of energy benchmarking and monitoring tools to ensure that the progress of greenhouse gas emissions reduction goals and key performance indicator scan be tracked..⁴⁶⁷ - Building Energy Exchange (BEEx)– non profit created by the city that provides educational resources for the industry on energy efficiency technologies and strategies.⁴⁶⁸
Regulatory/ Policy Tools		<ul style="list-style-type: none"> - Climate Mobilization Act (2019) - Using legislation for climate action, the largest climate solution put forth by any city in the world, includes a slate of laws designed to dramatically

⁴⁵⁹ Aligning NYC with Paris Agreement Report pg. 14

⁴⁶⁰ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴⁶¹ New York City’s Roadmap to 80x50 pg. 24

⁴⁶² New York City’s Roadmap to 80x50 pg. 42

⁴⁶³ Aligning NYC with Paris Agreement Report pg. 61

⁴⁶⁴ OneNYC 2050: A Livable Climate pg. 33

⁴⁶⁵ <http://web.mta.info/mta/investor/new/green-bonds.htm>

⁴⁶⁶ CDP, “2019 Full Cities Dataset. [Dataset],” 2019.

⁴⁶⁷ One New York: The Plan for a Strong and Just City pg. 62

⁴⁶⁸ New York City’s Roadmap to 80x50 pg. 72

	<p>cut GHG emissions in the city.⁴⁶⁹</p> <ul style="list-style-type: none"> - Laws include green roofs, building energy efficiency grade, PACE program, buildings mandate, 80x50 target, long term energy plan and a climate action executive order.⁴⁷⁰
Financial/ Investment Tools	<ul style="list-style-type: none"> - PACE program⁴⁷¹ - Introducing congestion pricing to reduce traffic and generate funds for the improvement of public transit systems.⁴⁷² - Infrastructure investments - The City is investing over \$20 billion in infrastructure such as better public transit, bike lanes, safe pedestrian infrastructure, better buildings, - “The City and NYCEDC will also continue to invest in emerging technologies and private sector innovation for DERs, DG, energy storage, and other opportunities through its joint initiatives.”⁴⁷³ - Divesting \$5 billion from fossil fuels in the City pension fund by 2022.⁴⁷⁴ - Using City pension fund investments in climate change solutions - \$4 billion by 2021.⁴⁷⁵

4.9.4 Governance: New York City

Table 36: Governance: New York City

Variable	Findings
Decision – Making Structure	<ul style="list-style-type: none"> - City Council and city agencies are decision makers. - The NYC Mayor’s Office of Climate Policy and Programs leads New York City’s fight against climate change and manages OneNYC 2050. - The Office of Climate Policy and Programs (CPP) includes the Office of Sustainability, the Office of Recovery and Resiliency and the Office of Environmental Coordination. - The CPP works in partnership with other city departments/agencies to implement actions in the 80x50 pathway and the OneNYC plan.⁴⁷⁶ - Different City departments or agencies “own” their own actions.
Oversight, Monitoring & Reporting	<ul style="list-style-type: none"> - City Council is the legislative body of local government that oversees implementation of local laws. It is the oversight body that the Mayor’s office reports to on the progress. - The CPP and other departments report to the Mayor’s office. - Annual GHG Inventory (city-wide and municipal emissions) - Local Law 22.⁴⁷⁷ - Annual OneNYC progress reports. - OneNYC plan update every 4 years.⁴⁷⁸ - The NYC open data platform includes updates on the City’s progress toward OneNYC

⁴⁶⁹ <https://www1.nyc.gov/site/sustainability/legislation/legislation.page>

⁴⁷⁰ <https://www1.nyc.gov/site/sustainability/legislation/legislation.page>

⁴⁷¹ OneNYC 2050: A Livable Climate pg. 16

⁴⁷² OneNYC 2050: A Livable Climate pg. 47

⁴⁷³ New York City’s Roadmap to 80x50 pg. 50

⁴⁷⁴ OneNYC 2050: A Livable Climate pg. 30

⁴⁷⁵ OneNYC 2050: A Livable Climate pg. 5

⁴⁷⁶ Aligning NYC with Paris Agreement Report pg. 32

⁴⁷⁷ New York City’s Roadmap to 80x50 pg. 23

⁴⁷⁸ New York City’s Roadmap to 80x50 pg. 114

	targets. ⁴⁷⁹
Leadership	- Office of Climate Policy and Programs & Mayor’s Office of Sustainability
Communication	<ul style="list-style-type: none"> - DCAS facilitates communication between City agencies.⁴⁸⁰ - Information not available on internal communication systems within the city government. - Monitoring and reporting informs decision making. - OneNYC website and open data portal are available to the public for transparency and to keep NYC residents involved in the actions. - Reports are made public.
Vertical Integration	<ul style="list-style-type: none"> - The State of New York announced similar overall targets for GHG reduction in 2019 – 100% renewable energy by 2040 and overall GHG reduction of 85% by 2050. The State and the City work together closely and the City plays a large role in advocacy to the state for climate action.⁴⁸¹ - The federal government backed out of its Paris Agreement target and is relaxing policies on environmental protection. - The City advocates to higher levels of government in a bottom up approach.
Collaboration	<ul style="list-style-type: none"> - City-wide collaboration for the creation and implementation of OneNYC - Through Executive Order 26, the Department of City-wide Administrative Services has led all city agencies in the development of city building and vehicle-specific climate action plans that will serve as the basis for energy and GHG emissions reductions.⁴⁸² - The City utilizes public/private partnerships for individual actions or sectors (such as the Solar Partnership, The Building Energy Exchange Partnership with Motivate for the bike share program, Con Edison energy company) - Partnerships are developed surrounding a specific sector.
Governance Mode	<ul style="list-style-type: none"> - Self-Governing – through corporate emissions reductions and procurement policy changes. (Ending City purchases of unnecessary single-use plastic food-ware and phasing out the purchase of processed meat, cutting beef purchasing in half, committing to a carbon neutral city fleet by 2040, pursuing expanding mandatory organics collection citywide, and undertaking comprehensive projects to mitigate climate risk) - Enabling – the City developed a community engagement program, provides information and education for residents, incentives and projects that support action. The city also coordinated and facilitates partnerships for implementation of actions. - Provisioning – through infrastructure investments. - Authority – the City has put forward the largest climate solution/ most ambitious regulations of any city in the world, the Climate Mobilization Act along with the various local laws and mandates that the City has imposed.⁴⁸³

4.9.5 Actors: New York City

Table 37: Actors: New York City

Variable	Findings
External	<ul style="list-style-type: none"> - Private sector actors in all different sectors, including utilities (Con Edison)

⁴⁷⁹ <https://data.cityofnewyork.us/City-Government/OneNYC-Indicators/f34v-uffx>

⁴⁸⁰ Aligning NYC with Paris Agreement Report pg. 32

⁴⁸¹ <https://www.dec.ny.gov/energy/99223.html>

⁴⁸² Aligning NYC with Paris Agreement Report pg. 32

⁴⁸³ <https://www1.nyc.gov/site/sustainability/legislation/legislation.page>

	<ul style="list-style-type: none"> - Community non-profits, project developers, financing and funding entities, academic institutions and state and federal partners.⁴⁸⁴ <p>Roles</p> <ul style="list-style-type: none"> - The City has external partners for implementation actions. - The external actors play enabling roles (consulting and capacity building) and facilitating roles through innovating and advocating. Some private partners have funding (investing) roles.
Internal	<p>Actors</p> <ul style="list-style-type: none"> - Decisions, responsibilities and implementation roles are spread across City departments. - Mayors Office of Sustainability, Department of City-Wide Administrative Services, Department of Transportation, Department of Sanitation, NCY Pension Trustees, Law/CPP. <p>Roles</p> <ul style="list-style-type: none"> - The City government is the main decision maker and plays regulating, enabling, coordinating, facilitating and funding roles.

4.10 Cross Case Comparison

The following tables show a cross case comparison of all of the variables for each city described above in the results section. The variables were deductively and then inductively coded and are represented by the key words deducted from the literature review and inductively from the results. Appendix 6 contains table with all of the codes for each section.

Table 38: Technical Pathways Cross Comparison

	Energy	Existing Buildings	New Buildings	Mode Shift	Fuel Shift	Waste	Carbon Sinks & Storage
Bridgewater	44MW of renewables installed by 2050	Improve efficiency by 50%	Net Zero buildings by 2030	50% short trips walking or biking	100% EV by 2050	No target	No target
	Installing RE systems, building scale energy	PACE, enabling activities	Building performance standard	Infrastructure investments	Electric transit investment	Supporting actions	No actions

⁴⁸⁴ New York City's Roadmap to 80x50 pg. 43

Park City	100% renewable electricity by 2030	No target - supporting actions	Net zero municipal buildings	No target	100% electric transit by 2026,	No target	Capture remaining emissions
	Installing RE system	C-PACE, financial incentives, enabling activities	Voluntary stretch code for residential buildings	Infrastructure investments, Financial tools	Electric transit investment, EV charging infrastructure, financial incentives	Regulation, enabling activities	Increase local sink capacity
Guelph	100% renewable energy by 2050	Retrofit 98% of buildings by 2050	Net zero buildings by 2030	Increase cycling & walking trips, double rideshare trips	Electric transit and fleet by 2050, 100% EV passenger vehicles	70% diversion by 2021	Offset 8% of emissions by 2050
	RE systems, district heating, building scale energy	PACE, building code improvements, city-owned building retrofits	Developing building codes	Infrastructure investments, Regulations	EV charging infrastructure, electric transit investment	Enabling activities	Purchase offsets
Lahti	~100% renewable energy by 2020	7% efficiency increase by 2025	Low energy municipal buildings	50% short trips walking or biking by 2030,	100% electric/bio gas transit by 2030	100% diversion by 2050 (currently 96%),	Capture ~20% emissions by 2025
	RE systems, district energy	Pilot retrofit program	Building code for municipal buildings	Infrastructure investments, MBI	EV charging infrastructure, transit investment	Landfill gas capture, waste to energy systems, enabling activities	Increase local sink capacity
Vancouver	100% renewable energy by 2050 (Currently ~ 97%)	Reduce GHG emissions in buildings by 20%, reduce emissions by 552,000 tons CO2/year	Net zero buildings by 2030, reduce emissions by 78,000 tons CO2/year, reduce embedded emissions by 40%	66% short trips walk/bike/transit by 2030, reduce emissions by 294,000 tons CO2/year	50% EVs by 2030, reduce emissions by 283,000 CO2/year – Electric fleet and transit by 2050	100% diversion by 2040,	1,000,000 tons CO2/year by 2060
	District energy	Regulations, financial incentives, city-owned building retrofits	Building code	Infrastructure investment	EV charging infrastructure, regulations, EV incentives, electric transit	Landfill gas capture, W2E systems, enabling activities	Restore local sinks

					investment		
Oslo	Currently 100% renewable energy	Zero / low emissions heating in all buildings by 2020	Near zero emissions municipal buildings by 2020, reduce embedded emissions	Reduce traffic 33% by 2030, 25% trips by bike by 2025	EV transit by 2020, 100% EV by 2030,	100% diversion,	No target
		Regulation, financial incentives, city-owned building retrofits	Regulations	Infrastructure investments, regulations, MBIs	Transit investments, Ferry boat and ship electrification, financial incentives, regulations	Landfill gas capture, waste to energy, CCaS for incineration	Supporting actions – increase green spaces
Toronto	75% renewable electricity by 2050	Retrofit 100% buildings for 40% efficiency increase by 2050	Near zero buildings by 2030	75% short trips walk/bike	100% low/zero carbon vehicles by 2050	95% diversion by 2050	No target
	RE systems, building scale energy, district heating	Low interest loan, city-owned building retrofits	Voluntary buildings standard	Infrastructure investments, regulation (car free zone)	EV charging infrastructure, transit investment	Waste to energy, enabling activities	Supporting actions – green spaces
New York	100% renewable electricity by 2040	Retrofit 100% of local government owned buildings- 80% efficiency upgrade for large buildings by 2050	Net zero buildings by 2030	80% short trips walk/ bike/ transit	Carbon neutral fleet by 2040, 20% of vehicles for sale are electric by 2025	100% diversion by 2030	Offset remaining emissions
	Installing RE systems, building scale renewable energy, district heating	Regulation, PACE program, city-owned building retrofits	Stretch code	MBIs, infrastructure investments, regulation (restricted vehicle access zones)	Electric fleet and transit investments, EV charging infrastructure, EV incentives	Landfill gas capture, waste to energy, enabling activities	Purchase offsets

Table 39: Institutionalization Strategies Cross Comparison (Part 1)

	Engagement (Planning, Implementation & Advocacy)	Long Term Endeavours	Technical Capacity	Funding
Bridgewater	Community-wide & Technical experts	Short Term Strategy + Long Term Pathway - Sustainability embedded in other city planning	Technical scenario modeling, technical report with help from consultants, partnership with educational institution	Local government funds (tax revenue), higher governments, private sector
	Resident engagement program, Partner with educational institutions, meetings/ workshops/ events			
	Advocate to higher governments, local business challenge, partnerships, transnational city network			
Park City	Community-wide & Technical experts	Commitment to net zero	Technical scenario modeling, outside consultants	Local government funds (tax revenue), higher governments, public - private partnership, Open space bond
	Climate Change Center, meetings, events, workshops			
	Advocate to State and Federal Government, partnerships, Local business challenge			
Guelph	Community-wide & Technical expert	Short Term Strategy + Long Term Pathway – sustainability embedded on city planning	Technical scenario modeling, Technical report, – outside consultants – creating task forces for each sector of plan	Local government funds (tax revenue), higher governments, green investment strategy (under development)
	Resident engagement program, youth engagement programs, partnership with educational institutions, meetings, events, workshops			
	Local Business Network, Advocate to higher governments, partnerships, transnational city network			
Lahti	Community-wide & Technical experts	Short term strategy –Long term Pathway - sustainability embedded in other city planning	Technical scenario modeling, partner with educational institutions	Local government, higher governments, Public - Private Partnership
	Youth engagement programs, Mobile engagement application, Partnership with educational institutions, resident engagement program			
	Local Business Network, Advocate to higher governments, partnerships, transnational city networks			
Vancouver	Community-wide & Technical experts	Short Term Strategy + Long Term Pathway - sustainability embedded in other city planning	Technical scenario modeling, partnerships with educational institutions, building internal capacity, task forces for each sector of plan	Local government funds (tax revenue), higher governments, green fund, Provincial carbon tax
	Youth programs, resident engagement program, mass social media campaign, leadership award, partnerships with educational institutions			
	Local Business Network, Advocate to higher governments, partnerships, transnational city networks			
Oslo	Community-wide & Technical experts	Short Term Strategy + Long Term Pathway - sustainability embedded in other city	Technical scenario modeling, Building internal capacity for data management,	Local government funds (tax revenue), higher governments, green fund, public-private partnership
	Youth education program, climate change center, mass social media, annual survey, partner with educational institutions			

	Local Business Network, Advocate to higher governments, partnerships, transnational city networks for decarbonization	planning		
Toronto	Community-wide & Technical experts	Short Term Strategy + Long Term Pathway - sustainability embedded in other city planning	Technical scenario modeling, technical report, geo-spatial analysis, building internal capacity and hired consultants	Local government funds (tax revenue), higher government, Green bond, private sector
	Resident engagement program mass social media, surveys, events, workshops			
	Local Business Network, Advocate to higher governments, partnerships, transnational city networks			
New York	Technical experts	Short Term Strategy + Long Term Pathway – sustainability embedded in other city planning	Technical scenario modeling, geo-spatial analysis, engaged technical experts	Local government funds (tax revenue), higher government, green bond, private sector
	Resident engagement program, mass social media, events, programs, workshops			
	Local Business Network, Advocate to higher governments, transnational city networks			

Table 40: Institutionalization Strategies Cross Comparison (Part 2)

	Green Economy	Regulatory/ Policy	Financial/ Investment
Bridgewater	Green economic development plan, green job creation, local business network, green procurement policy	Self regulating, Policy Document, building standard	PACE, clean energy investment system – Infrastructure investments
Park City	Developing green procurement policies, local business network	Self regulating, voluntary stretch code, local bylaws	C-PACE, financial incentives, community fund, open space bonds, Infrastructure investments
Guelph	Local business network / acceleration program- greening business practices	Policy change recommendations to city council Policy document, self regulating, building standard	PACE, Infrastructure Investments, (potential) community funding program
Lahti	Green procurement policies, circular economy road map, circular economy programs for residents, local business network	Self regulating, Policy document, building standards	Infrastructure investments
Vancouver	Double # of green jobs, Double # businesses greening operations, business accelerator, green business platform, workforce development, green	Self regulating, policy documents, building code, by-laws	Grants, infrastructure investments, financial incentives

	procurement policy		
Oslo	Funding for innovation and green tech, green job creation, workforce development, green procurement policy	Self regulating, by-laws, building standards, building regulations	Subsidies, financial incentives, MBIs, infrastructure investments, fossil fuel divestment
Toronto	Green market acceleration program, workforce development, green job creation, green procurement policy	Self regulating, by-laws, building standards	Grants, low interest loans, financial incentives, infrastructure investments
New York	Workforce development, green job creation, green procurement policy	Self regulating, by-laws, standards, regulations, building mandate	PACE, MBIs, Infrastructure investments, Fossil fuel divestment

Table 41: Governance Cross Comparison

	Decision-Making Structure	Oversight & Accountability	Leadership	Communication	Vertical Integration	Collaboration / Partnership Structure	Governance Mode
Bridgewater	Sustainability department & embedded climate lens	City Council & Chief Administrator's Office GHG Inventory - 2 years, Plan Update - 5 years, Progress report - 1 year Reports made public	City	CAO facilitates communication, regular meetings, online communication, informal meetings	Two- way	Collaborative partnership of stakeholders – cross sector	Self Governing, Enabling, Provision
Park City	Sustainability department,	City Council - City manager Plan in progress, Corporate inventory - 1 year, developing monthly reporting system	City	Website, community events, regular meetings, informal meetings	Bottom up	Public – private partnership for implementation	Self Governing, Enabling, Provision
Guelph	Collaborative governance structure – sustainability group,	City Council - OEG Board of Directors GHG inventory -1 year,	Community Group	Board meetings every 6 weeks, Website	Two-way	Collaborative partnership of stakeholders – partnerships and task forces	Self governing, Enabling, Provision, Community

	embedded climate lens	progress report 4/year, plan update - 5 years				by sector	led actions
Lahti	Sustainability department	City Council GHG inventory - 4 years, progress report - 2 years, plan update - 4 years, reports made public	City	Internal website, email, formal and informal meetings	Two way	Public - private partnerships for implementation – partnerships by sector	Self Governing, Enabling, Provision
Vancouver	Sustainability department & embedded climate lens	City Council GHG inventory – 1 year, progress reports - 1 year, plan update - 5 years, reports made public	City	Internal website, newsletters, staff training, formal and informal meetings	Two way	Collaborative partnerships for implementation – by sector	Self governing, enabling, provision & authority
Oslo	Sustainability department & embedded climate lens	City Council GHG inventory - 1 year, progress reports - 3/year, plan update - 1 year, reports made public	City	-	Two way	Collaborative partnerships for implementation – by sector	Self governing, enabling, provision & authority
Toronto	Sustainability department & embedded climate lens	City Council GHG inventory - 4 years, progress report - 2 years, Plan update - 4 years, Reports made public	City	-	Two way	Public - private partnerships for implementation	Self governing, enabling, provision & authority
New York	Sustainability department & embedded climate lens	City Council GHG inventory - 1 year, progress report - 1 year, plan update - 4 years, open data portal, reports are public	City	-	Two way	Public - private partnerships for implementation	Self governing, enabling, provision & authority

Table 42: Key Actors and Roles Cross Comparison

	Internal Actors	External Actors
Bridgewater	Local government – all relevant departments,	Local stakeholders, local businesses, higher levels of

	cross sector partnership (EB)	government
	Decision making, implementation, leadership, enabling, coordinating, facilitating, funding	Enabling, consulting, implementation, facilitating and funding
Park City	Local government – sustainability department, utility company	Community stakeholders, NGOs, Local Business
	Decision making, implementation, convener, leadership, enabling, coordinating, facilitating, regulating, funding	Consultation, implementation partners, enabling
Guelph	Community Group, local government, task forces	Local stakeholders, local businesses, education institutions, higher levels of government
	Decision making, implementation, enabling, facilitating, funding, convening	Consultation, implementation, enabling, funding
Lahti	Local government – sustainability department and other relevant departments, publically owned companies	Local stakeholders, local businesses, education institutions, national government
	Decision making, implementation, funding, enabling, coordinating, facilitating	Consultation, implementation, enabling, funding
Vancouver	Local government – all relevant departments, internal task forces	External working groups, local stakeholders, local businesses, education institutions, provincial government
	Decision making, regulating, funding, implementation, enabling, coordinating, facilitating	Consultation, implementation, enabling, funding
Oslo	Local government – all relevant departments	Local stakeholders, local businesses, community groups, educational institutions, national government
	Decision making, regulating, funding, implementation, enabling, coordinating, facilitating	Regulating (NG), consultation, implementation, enabling, funding
Toronto	Local government – all relevant departments, cross sector partnerships	Local stakeholders, local businesses, community groups, educational institutions, higher levels of government
	Decision making, regulating, funding, implementation, enabling, coordinating, facilitating	Consultation, implementation, enabling, funding
New York	Local government – all relevant departments, cross sector partnerships	Local stakeholders, local businesses, community groups, educational institutions
	Decision making, regulating, funding, implementation, enabling, coordinating, facilitating	Consultation, implementation, enabling

Chapter 5: Discussion

This chapter synthesizes and discusses the empirical results from the research in relation to the literature review to answer the research questions posed in this study. This chapter aims to situate the thesis within the larger field of research and explore the findings in the context of the literature and existing knowledge on the subject.

5.1 Research Question 1: Pathways

- What are the GHG reduction pathways that are being developed for the implementation of deep decarbonization plans?

The technical pathways focus on GHG emissions reduction actions in the priority sectors that the city has identified. The results show that cities have included actions that are meant to support GHG reductions and institutionalize climate action-

The pathways developed by the case cities generally resemble each other, having targets/goals, actions and indicators to measure progress. The technical pathways include but are not limited to the four priority sectors (energy, buildings, transportation and waste) (Carbon Neutral Cities Alliance, 2015; Deep Decarbonization Pathways Project, 2015; IPCC, 2018; USDN, 2018). Several cities have added additional sectors depending on the depth of their projects and the specific needs of that city. For example, Oslo has begun to focus heavily on decarbonizing the construction sector, Vancouver is aiming to expand its local green economy and Park City and Lahti are increasing the capacity of local carbon sinks to offset emissions. Each city has a unique circumstance and priorities, though not all cities prioritize their highest emitting sectors for decarbonization, in some cases the most accessible GHG reductions are in the “low hanging fruit” (IPCC, 2018).

Table 43: Technical Pathways Discussion

Pathways	Empirical	Literature	Comments
Energy	All cases have made renewable energy a top priority.	Removing fossil fuels entirely from electricity grid – cities can utilize building scale and district energy solutions if they do not have full control over energy	Validate / Extend – Small cities tend to prioritize increasing renewable energy capacity

		sector.	
Existing Buildings	All cases address the need to retrofit existing buildings and improve efficiency.	Retrofits are necessary to improve energy efficiency and heating/cooling systems must be converted to zero emissions systems.	Validate
New Buildings	All cases address the need for new low or zero emission buildings	Low or zero carbon emissions standards for new buildings	Validate
Transportation Mode Shift	All cases are implementing actions to encourage transportation mode shift	Mode shift can be influenced through active transportation and public transit infrastructure investments and MBIs	Validate
Transportation Fuel Shift	Local governments are investing in low carbon fleets, electric public transit and EV charging infrastructure	Local governments have little control other than the vehicles directly owned by the City. They can create incentives and use MBIs to influence residents to use zero emissions vehicles	Validate
Waste	Not all cities have direct control over waste management. Those that do are increasing diversion rates and installing gas capture and W2E systems.	Cities can reduce emissions in this sector by diverting waste from landfills or incineration by providing better services and/or enabling activities. Waste to energy infrastructure and landfill gas capture systems can also be built to limit emissions from this sector	Validate
Carbon Sinks	Not all cities are considering carbon sinks or offsets	Increasing capacity of natural carbon sinks, or purchasing offsets	Validate/ Extend – Local governments are developing new strategies for increasing local carbon sink capacity

5.1.1 Technical Pathways Discussion

Energy

The decarbonization literature says that elimination of fossil fuels from the entire energy sector is needed to address ambitious climate goals in cities, in other words, energy must be derived from 100% renewable sources (Ballentine et al., 2019; Brozynski & Leibowicz, 2018; C40 & ARUP,

2016; De Chalendar et al., 2019; Rogelj et al., 2015). The consensus in the literature is that the pathway to decarbonization begins with the energy sector, followed by efficiency gains and electrification in other sectors (Ballentine et al., 2019). The literature also notes that in many cases, municipal governments do not have direct control over their sources of energy (C40 & ARUP, 2016; Koben et al., 2017). In this case, cities can focus on deploying building-scale and district clean energy solutions to decarbonize their energy sector (C40 & ARUP, 2016). The empirical results validate the literature; all of the case cities have targets to significantly increase the capacity of renewable energy. Park City, Lahti, Guelph, Vancouver, Oslo and New York have targets to derive 100% of their energy from renewable sources by or before 2050.

The cities are using a variety of strategies (including scaling up district energy systems, building scale renewable energy, partnerships and advocacy actions) that validate the literature. Park City and Lahti (the cities with the most ambitious renewable energy targets) have both leveraged public/private partnerships in order to build large-scale renewable energy generation facilities. By partnering with their local utility companies, they have managed to rapidly decarbonize their energy grids as well as heating systems.

Park City has been a leader in advocating to the Utah State Government through its role in the creation of The Community Renewable Energy Act, which sets a framework to regulate procurement and pricing of large-scale renewables for communities in Utah that aim to have 100% renewable energy. Guelph, Toronto, and New York also use advocacy as a tool to express their demands to higher levels of governments for more renewable energy.

Existing Buildings

The literature says that retrofits of existing buildings are critical in the decarbonization of cities. Existing buildings must be energy efficient and have heating and cooling systems that do not rely on fossil fuels (Billimoria et al., 2018; Salon et al., 2010). Retrofits can result in lower energy costs (Hoicka & Das, 2020; Lucon et al., 2014), though the results show that this is dependent on location and energy prices (Carbon Neutral Cities Alliance, 2015). Municipal governments can prioritize GHG reductions in existing buildings through updates to efficiency

standards and provide incentives for retrofits, they can also lead by example as an owner/investor of a substantial portfolio of buildings (Becque et al., 2019).

The empirical results show that cities acknowledge that retrofits are a key aspect of decarbonization. Many of them have set retrofit targets and efficiency improvement targets. Cities such as Toronto, Vancouver, New York, Guelph, and Oslo are leading by example with retrofits to their own building stock.

The results show that providing tools and incentives for residents and businesses/organizations to take action is a popular strategy. Financial tools and incentives such as the PACE program (Bridgewater, Park City, Guelph and New York), low interest loans (Toronto), discounts and rebates (Lahti, Vancouver), and efficiency tool kits (Park City) are all being used in order to influence building owners to retrofit.

Vancouver and New York City have taken on a much more ambitious strategy through the development of their own building regulations. These two cities have the legal authority under their city charters to develop their own building codes, which have been extended to apply to existing buildings. They have also created networks to help to connect building owners with technical experts and to help educate and engage them.

New Buildings

To limit emissions from new buildings, cities that have the legal jurisdiction to do so, can implement building codes and standards for new developments (Billimoria et al., 2018). Cities can also lead by example by building their own developments to be zero emissions (Becque et al., 2019).

The empirical results validate the literature. All of the case cities have opted to lead by example and set strict regulations for efficient or net zero buildings that are city-owned. All of the cities have also developed building standards or codes (voluntary or mandatory) for new developments.

There are few examples of cities implementing their own mandatory building codes because of the limited legal jurisdiction of cities. Vancouver is the only city in Canada that has enacted its own building code, because it is one of the only charter cities in the country that has the power to do so. Toronto has developed the Toronto Green Standard (under the City of Toronto Act 2006) a tiered system, tier one being mandatory and tiers two to four being voluntary. The City of Toronto offers financial incentives for builders to adhere to the voluntary tiers.

The majority of Canadian cities and towns, including Bridgewater and Guelph have to follow their provincial building codes. In the United States, building codes are set at the state level. Park City does not have the jurisdiction to make its own building regulations therefore the city must follow Utah's code. New York City is the only city in the State of New York that is permitted to retain its own building code. The city has taken advantage of this and has implemented efficiency regulations for various building types.

Both Lahti and Oslo are following their national building requirements. On top of complying with the national ban on fossil fuel heating, Oslo has been piloting fossil-free construction sites, which are now a requirement for city owned buildings and developments. The city is looking into implementing regulations for eliminating emissions from construction by 2030.

Cities can influence efficiency and energy behaviour for buildings, they can also act as a regulator, convener, facilitator, as well as a strategic partner (Becque et al., 2019; Salon et al., 2010). The empirical evidence shows that cities are developing and managing networks to influence building performance for example; BEex program (NY), BBP (Toronto), the Zero Emissions Buildings Center of Excellence (Vancouver). The purpose of these programs is to educate and build capacity for building owners and developers.

Vancouver and New York have been developing and supporting programs to help increase the capacity for green construction and Zero Emissions Buildings construction. Through training and enabling and enable the workforce and private sector stakeholders involved in this sector.

Mode shift

Transportation mode shift can be influenced through the promotion and increase in the use of zero emissions modes of transportation (e.g., walking, biking, public transit) (C40 & ARUP, 2016; Carbon Neutral Cities Alliance, 2015; UNECE, 2011). Cities provide transportation infrastructure giving them an opportunity to invest in the types of infrastructure, such as pedestrian walkways, bike lanes, and public transit, that support their climate action targets (C40 & ARUP, 2016; Carbon Neutral Cities Alliance, 2015; Lah, 2017; Transport Decarbonisation Alliance, 2017). Cities can also manage how streets are used through rules, regulations and pricing (Carbon Neutral Cities Alliance, 2015).

The results validate the literature. All of the cases are targeting increases in walking, biking and public transit trips and are investing in pedestrian, bike and public transit infrastructure to reach their targets. By improving accessibility and safety of active and public transit, the case cities are anticipating that their citizens will opt to walk, bike or take public transit.

Some cities are going further, providing incentives to choose active or low carbon forms of transport and dis-incentivising single passenger vehicles by using market based instruments. These incentives or MBIs include: paid parking (Park City), toll rings (Oslo), congestion pricing (NYC), free public transit (Park City), active transportation rewards (Lahti and Guelph).

Oslo, Toronto, New York and Guelph are considering or have gone ahead with car free or restricted vehicle access zones as well as removing or limiting parking spaces in key areas as a way to remove perverse incentives that may influence residents to use other forms of transportation.

Fuel Shifting

The literature indicates that the scope for local policies that affect vehicle emissions is limited outside of fleet-based operations (Salon et al., 2010). However, cities can develop creative ways to impact the vehicle choices of their residents by providing prime parking spots for fuel-

efficient vehicles and raising road prices for larger vehicles. Local governments could also mount social marketing campaigns in support of climate-friendly vehicles (Salon et al., 2010).

The empirical results validate the literature; all of the cities have a target in place for the decarbonization/ fuel shift in their own fleet and/or transit operations. Cities are also building EV infrastructure in the hopes that it will incentivise residents to purchase and drive more electric vehicles. Vancouver has included in its building code that for multi-family and commercial buildings, wiring for EV charging stations must be built into parking stalls. Oslo and Park City have implemented financial incentives for electric vehicles. Oslo's toll ring system charges lower prices for zero emissions vehicles and Park City provides free charging for EVs in the city.

Though cities are helping to enable transitions towards zero emissions vehicles, they are mostly relying on higher levels of government and the automotive industry to push a shift. Due to the lack of regulatory control in this sector, local governments make use of enabling and provisioning governance tools.

Waste

The literature concludes that the main emissions reductions in the waste sector are associated with reducing the amount solid waste going to landfills (Sandulescu, 2004; Zaman & Lehmann, 2011, 2013). Cities can divert waste that would previously go to landfills through several processes. Public education initiatives on waste reduction, changing procurement to support circular economies and zero waste, increasing recycling and composting services can all help to limit waste that goes to landfill. Non-recyclable materials can also be converted into usable energy (heat, electricity or fuel) through a variety of waste to energy processes (Moya et al., 2017). Emissions from existing landfills can also be minimized through the installation of landfill gas capture systems (Moya et al., 2017).

Municipal governments can implement education and advocacy programs in order to influence behaviour changes to reduce and eliminate waste (Zaman & Lehmann, 2011). The empirical results validate this as 6/8 cities have their own solid waste plan with targets to reduce waste

sent to landfills. The waste management plans outline the enabling activities that the cities are co-ordinating for overall waste reduction. The small towns do not have the same capacity as the larger centers in terms of waste management. Bridgewater and Park City both share waste management systems with other municipalities in the region. In this case, they focus on education or enabling actions to encourage their citizens to reduce their solid waste output.

Increasing the waste management service that the city provides is another way to limit waste. Park City is looking into more composting, New York has expanded its composting pick up services, other cities (Toronto, Oslo, Lahti) make bio fuel from their organic waste so that the trucks that pick up waste can run on it, creating a closed loop system. Lahti practically runs on waste, the new bio fuel plant that uses agricultural waste and sewage to power the city.

Lahti, Vancouver, Oslo, Toronto and New York have built gas capture systems in existing landfills to reduce methane emissions over time. The cases are also using waste as a form of energy through different W2E processes – for heating and bio fuel for transportation.

Park City and New York have banned certain products (plastic bags) in order to influence upstream purchasing that results in less waste creation.

Current literature notes that cities should not only be diverting waste from landfills, but also from high temperature destruction (incinerators) (Carbon Neutral Cities Alliance, 2015; Koben et al., 2017). Counter to this, the Klemstrudd plant in Oslo is a waste incineration plant that provides district heating. A project was initiated to develop a full-scale carbon capture and storage system for the incinerator to be completed by 2020. This pilot project came to be through a public/private partnership and was the first of its kind. Not only does this W2E system provide district heating for the city, with the CCaS system in place Oslo's community wide emissions will decrease by 12-15% alone. Oslo is hoping to use this as an example and share its experience and technology so that other cities may be able to use this type of system for both waste disposal and energy.

Carbon Sinks and Offsets

Carbon offsets and sinks can be used to further GHG mitigation strategies after they have reached a threshold where all other means of mitigation have been exhausted (Barreto et al., 2018). Not all of the cases consider carbon sinks or offsets as a part of their emissions reduction plans. Park City, Guelph, Lahti, Vancouver and New York all do.

Vancouver is investing in forest restoration, though the city will not count the GHG reductions as offsets. New York and Guelph are taking the approach that the literature recommends (Barreto et al., 2018), by focusing first on eliminating sources of emissions and then making up the remaining difference with purchasing carbon offsets.

Park City and Lahti will rely heavily on increasing capacity of local carbon sinks to reach their GHG emissions targets, rather than decreasing emissions from all the sectors. They plan to capture and store enough emissions in local sinks in order to reach net zero emissions. Protecting local land, restorative agriculture, wooden building structures and tree planting are examples of actions that will be used in order to increase local carbon sink capacity.

5.2 Research Question 2: Institutionalization Strategies

What planning and implementation strategies are outlined in the local deep decarbonization plans and/or are being utilized in order to implement the plans?

Table 44: Institutionalization Strategies Discussion

Institutionalization Actions	Empirical	Literature	Comments
Engagement	Present in all cases	Local governments must build effective relationships with the many stakeholder groups through valuing stakeholder input, communication, and education for plan development and implementation Local governments can work	Validate

		with other governments and sectors, encouraging them to support zero emissions outcomes through advocacy	
Long Term Endeavours	Present in all cases	Cities must ensure that climate action planning is long term and results are monitored over long periods of time.	Validate
Technical capacity	Present	Cities need to develop technical capacity and make decisions based off of data through increasing internal technical capacity, outsourcing or through partnerships.	Validate
Funding	Present	Cities must apply traditional methods of funding public programs to their climate action plans as well as new innovative funding mechanisms.	Validate
Green Economy	Local governments are beginning to take action to develop a local green economy by supporting/encouraging businesses to go green, circular economies, and integrating sustainability in economic and city planning.	Cities can help develop a green economy by supporting clean technology development, developing circular economies, integrating sustainability into the city's economic plan and other climate action initiatives.	Validate / Extend – Local governments are addressing the importance of developing a workforce that is equipped to meet the demands of decarbonization strategies
Regulatory and Policy Tools	Dependent on power of the city and the support from higher levels of governments. Local governments use policy tools to regulate local government operations. Broader, community-wide regulations are limited in certain sectors and vary between cities.	Creating and using city regulations to support low carbon initiatives and coordinating with higher levels of government to implement policies for climate action.	Validate
Behaviour Influencing Financial Tools	Present in all cases	Investing directly in equipment and infrastructure that are	Validate / Extend - Some cases are developing innovative

		low carbon or, providing financial incentives to choose low carbon options.	strategies for project funding
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5.2.1 Institutionalization Strategies Discussion

Engagement

The literature shows that governments have to develop relationships with the public and the broad array of stakeholders in order to be successful in meeting their targets. They have to consider their input when it comes to decision-making, have good communication streams, help to educate and make the case for the plan and for climate change in general. It also helps to highlight the actions that stakeholders are doing and celebrate the people taking action (Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015; Clarke, 2011).

The empirical results validate the literature; all cities are engaging stakeholders for both the plan development phase and the implementation. For plan development, all of the cases showed evidence of consultation processes with stakeholders. Through engagement activities such as surveys, workshops, town halls and community events, the cases that were studied all demonstrated their efforts in collecting community-wide input for the plan development phase. The cases also engaged technical experts in GHG reduction pathways.

The case cities have engagement programs that link the stakeholders and city residents to local climate initiatives. These engagement programs are used to organize events and activities, promote awareness. Many of these are promoted through social media. Lahti is notable for having its Porukka app, a fast, informal but effective communication tool for connecting with a wide variety stakeholders. It allows for quick communication and decision-making and constant input from stakeholders. Both Park City and Oslo have a physical place that they can associate with climate action. Oslo’s Climate House and the Public Library in Park City are places where residents and stakeholders can go to be engaged with climate action in the city.

Cities are gearing education and engagement towards youth and students to get them involved in climate actions. Many are partnering with schools and post-secondary education institutions for youth engagement.

The literature shows that cities can use advocacy and partnership tools to engage stakeholders and higher levels of government (Carbon Neutral Cities Alliance, 2015; Clarke & Crane, 2018; Vancouver City Council, 2019). This can help to gain support for the plans, build capacity and help to influence other actors to increase their commitments towards climate action. The results validate the literature as all of the case cities are advocating for climate action to higher levels of government for policy change to support low carbon initiatives as well as other stakeholders for support and participation.

City networks for sustainability like, CNCA, ICLEI, C40 and GCoM, can be key partners for all types of cities in climate action. Transnational city networks foster engagement, education and advocacy for climate action, they give cities a forum to learn and to share their own experiences (Aylett, 2014). All of the cities participate in one or more city networks. There are different networks that are tailored towards different needs. C40 and CNCA are targeted towards large cities, ICLEI's PCP program is for small to medium sized Canadian municipalities, and Mountain Towns 2030 is a cohort of small towns in the American Rockies committed to reducing environmental impacts. Each case study has opted to join at least one city network that is geared to its own needs.

Long Term Endeavours

The literature states that climate action planning must be done for both the short term and long term and that buy-in from leaders can depend on a sense of ownership and long-term measured results (C40, 2020; Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015).

The results validate the literature; all of the cases all have developed long term commitments along with short-term actions. The cities are also including sustainability targets in their city planning as a whole, providing multi departmental ownership of climate actions within the local governments.

Building Technical Capacity

Cities must use data driven decision-making and technical analysis for climate action planning (Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015). Building technical capacity is essential for effective decision-making and implementation. Cities can build their technical capacity by engaging outside specialists and experts, develop partnerships/working relationships with research and educational organizations and/ or build internal technical capacity through adding staff or training staff (Carbon Neutral Cities Alliance, 2015).

The results show that all of the cities are conducting technical analysis for plan creating and decision making through emissions modeling, scenario building and other more advanced methods of analysis. The cities are both engaging outside specialists (technical experts, consultants) and increasing internal capacity through new hires or staff trainings. Three out of the four Canadian cities (Bridgewater, Guelph and Toronto) have hired the consulting firm Sustainability Solutions Group (SSG) for technical analysis and reports. Vancouver, Lahti and Bridgewater are engaging educational institutions for research purposes and are connecting student projects to the climate goals of the plans. For example Vancouver's City Studio Program and Lahti's CitiCAP project both students research to the climate action initiatives

Funding

Climate action plans require substantial funds for implementation. Municipal governments have the task of funding or finding funding for the projects. They can use traditional methods such as allocate funds from tax revenue, create funding partnerships, locate sponsors funds and/ or find funding government programs. They can also use more innovative funding schemes such as green bonds, carbon tax or cap and trade systems (Carbon Neutral Cities Alliance, 2015).

The results demonstrate that cities are mainly using traditional forms of funding, using tax revenue, funding from higher levels of governments or through partnerships. The results show that several cases are encouraging private investments as a means of funding through public-private partnerships (Park City with Rocky Mountain Power). The results also show that local

governments are trying to catalyze private sector investments through engagement and support programs, like the Better Building Partnership (Toronto), Building Energy Exchange (New York) and the Zero Emissions Buildings Center of Excellence (Vancouver).

Some of the cases supplement the traditional funding sources with innovating methods such as green bonds (Toronto, New York), open space bonds (Park City), and green funds (Park City, Oslo, Vancouver). Oslo and New York re-invest the funds collected from road pricing back into improving public transit infrastructure. New York City notes in the OneNYC plan that financial support from the national level has decreased substantially over time, resulting in innovative funding strategies. The city is divesting 5 billion dollars from fossil fuels in the pension fund, and will re-invest 4 billion dollars into projects that support local decarbonization. New York City has also been filing lawsuits and allocating the settlement funds towards climate action. The VW settlement money will go towards supporting fuel shifts in commercial vehicles. New York also filed a lawsuit against five of the largest emitting oil companies, claiming that the city should be compensated for the costs of mitigating climate changes that the oil industry has caused. The case was dismissed in 2019, but NYC continues to seek compensation.

The Green Economy

Local governments can support market transformation and help open up new areas of economic activity. Approaches may include public/private provision of climate friendly infrastructure, and the development of broader green economic development strategies (UN Habitat, 2015). Cities can accelerate innovation and the green economy by helping to create a wider innovation ecosystem within the city (C40, n.d.).

The results indicated that cities are leading by example through greening procurement policies, engaging local businesses as well as fostering innovation in the local economy. Vancouver is the only city to include a green economy goal in the climate action plan. The city has specified targets for both the number of green jobs and the number of businesses in the city.-Bridgewater, Vancouver, Oslo, Toronto and New York state in their plans that many of the climate actions will result in green job creation.

New York City and Vancouver both go beyond the prescription of the literature and acknowledge the importance of developing a workforce that will be able to support a transition to decarbonization in sectors like green buildings. They say that their ZEB policies will result in an increase in the demand for workers who are trained in green building practices. The NYC Green Jobs Corps has partnered with the Building Construction Trades Council to develop programs that will train new workers in green construction practices and other skills for the emerging green economy in order to prepare the workforce for future demand.

Regulatory and Policy Tools

The literature indicates that cities can either create new regulations that will support low carbon initiatives and/or they can coordinate with higher levels of government to implement policies (Deep Decarbonization Pathways Project, 2015).

It is important to note that municipalities do not have jurisdiction over many of the sectors that they are trying to decarbonize. The easiest thing for cities to do is regulate corporate emissions (self regulate) in the sectors that they control directly (Carbon Neutral Cities Alliance, 2015). Local governments can develop strategies to model the behavior that they envision for the community as a whole (Carbon Neutral Cities Alliance, 2015). The results show that all of the cases use self-regulating policy for local climate action planning by developing corporate emissions targets and self-regulating policies.

Community-wide policies and regulations that cities can implement are market-based (for example; taxes or removing perverse incentives) and non market-based (command and control regulations, removing barriers and voluntary approaches) (Görlach, 2013). This study found examples of removing perverse incentives (free parking in Park City), command and control regulations (building regulations in Vancouver and New York and the banning certain products in Park City and New York) and voluntary actions (building standards in Bridgewater, Park City, Guelph, Toronto).

Climate action plans are policy documents aimed at the wider community and outline the vision and targets for the community as a whole. These documents are meant to guide local government policymaking. Seven of the eight cities have such a document; the eighth's (Park City) is on its way.

Behaviour Influencing Financial Tools

Cities can use financial tools to support their climate action planning, by investing directly in infrastructure that will support low carbon initiatives and/or providing financial incentives that influence residents to choose low carbon options (City of Edmonton, 2018; Vancouver City Council, 2019). The results validate the literature; all of the cities that were studied are investing in new infrastructure that will help support the plans. Infrastructure investments are predominantly for renewable energy or to promote a mode shift in the transportation sector, and infrastructure for electric vehicle charging.

Cities are providing financial incentives and using market-based instruments to encourage residents to decrease their personal carbon footprints, especially in the sectors that the city has the least authority. For example the transportation and building sectors. For the transportation sector, Oslo and New York have implemented road pricing (NY's congestion pricing will go into effect later this year), Park City has implemented free public transit, free EV charging, and is increasing parking prices. Lahti offers free public transit to school children. For existing buildings, Bridgewater, Park City, Guelph and New York have a PACE program and Toronto provides low interest loans for building retrofits. Oslo and Vancouver both provide financial incentives for building retrofits and for installations of zero emissions heating systems (Vancouver does not have the legal authority for a PACE).

Oslo and New York have committed to divesting their pension funds from fossil fuel investments. Vancouver and Toronto have implemented responsible or "green" investment strategies for the city. These investment actions may not necessarily count as investments towards the implementation of the deep decarbonization actions, but it is a financial tool or signal that cities are using to demonstrate their commitment towards low carbon futures.

5.3 Research Question 3: Governance

What forms of governance are being utilized in the planning and implementation of local deep decarbonization plans?

Reportedly there are a variety of governance structures, validating that collaboration is key, and cities are increasing their internal capacity for action and collaborating both internally and externally.

Table 45: Governance Discussion

Governance	Empirical	Literature	Comments
Decision-Making Structure	Local governments have a combination of an overarching sustainability department and a built in sustainability capacity or climate “lens” within other departments. All decision-making is under the City Council.	Within local governments, they can have an overarching sustainability department or have capacity built into the relevant agencies/ departments	Validate
Oversight, Monitoring & Reporting	Present in all the cases	Governance structure must clearly declare an oversight authority and keep decision makers informed through continual monitoring and reporting.	Validate
Collaboration	Present	Collaborative plans have better success using internal collaboration and with external actors.	Validate
Leadership	Local governments are generally leaders, though community groups can take a bottom up approach.	Climate action plans need a clear leader.	Validate
Communication	Cities highlight the importance of clear communication. Results from interviews highlight that communication is an area in need of improvement in some cases.	Ongoing, clear communication is essential.	Validate/Extend – internal communication has been highlighted by some cases as an area for improvement
Vertical Integration	Local governments are integrating policies with those at higher levels of government; in some	Vertical integration of plans is important to avoid policy gaps.	Validate/Extend – through advocacy and lobbying, cities can try to integrate with a

	cases taking a bottom up approach.		bottom up approach.
Governance Mode	Local governments use a combination of the modes of governance.	Depending on capacity, cities use a combination of governing modes.	Validate

5.3.1 Governance Discussion

Decision-Making Structure:

The decision-making structure for climate action plans refers to how power and decision-making are distributed. Climate governance needs to be adaptive and resilient (Fröhlich & Knieling, 2013) and frameworks that have collaboration and partnerships often work best (C40, 2015). For climate action planning within a local government there are two approaches highlighted by Kern & Alber (2009); an overarching sustainability team, or sustainability expertise embedded within all relevant city departments.

The results demonstrate that all of the cities have a sustainability team that is overarching and responsible for plan creation and all of the cities are making attempts to embed a “climate lens” within all local government decision-making in other relevant departments and agencies.

Park City and Lahti both have small sustainability teams who have the responsibility and ownership of climate action planning, the results show that the sustainability teams work to recruit other departments and coordinate horizontally. It is one of their tasks to get other departments thinking about sustainability in their own fields.

The larger cities have added more capacity to their internal sustainability teams over the years and have recruited other city departments to use a “climate lens” in all of their work, distributing ownership of plan goals across the city organization.

Multi-level governance redistributes the political authority of climate action vertically upward to transnational networks, downward to communities and horizontally to non-state actors (Betsill & Bulkeley, 2006). It goes beyond state actors, where the roles of governmental and nongovernmental actors are recognized at all levels.

The results show that this is an area where the lines are blurred, cities are somewhere on a continuum of multi-level governance, meaning that the multi-level frameworks are not defined and formalized. While roles in urban climate action are distributed vertically and horizontally, local governments do not necessarily formally recognize decision-making power of non-state actors, though the importance of non-state actor engagement in decision-making is acknowledged. As shown in the results, the extensive consultation processes and engagement strategies that the cases have exemplified recognize the importance of multi-level action and that quite a large portion of the actions that needs to take place to achieve the technical pathways are actions that need to be taken by non-state actors.

Our Energy Guelph, (the only community led governance structure) there is the board of directors similar to the overarching sustainability team. For each sector in the plan the organization will assemble a task force, accumulating specific expertise for each of the relevant sectors. Our Energy Guelph and the City of Guelph is the only example that was studied of a collaborative governance framework, where the six essentials for collaborative governance described by Ansell and Gash (2008) are met.

Leadership

The literature specifies a need for clear leadership in climate action planning to provide direction (Callaghan & Colton, 2008). The results validate the literature, local governments often take on the leadership role, but the example shown by Our Energy Guelph in Guelph shows that community groups can lead climate action initiatives.

Oversight, Monitoring & Reporting

An overseeing body is essential to hold all actors accountable for their roles in climate action planning and implementation (Baret et al., 2013; Carbon Neutral Cities Alliance, 2015; UN Habitat, 2015). The results show that city councils, which are the legislative bodies of local governments that approve the climate action plans, are the oversight body for all city planning. City councils oversee the implementation through monitoring and reporting processes.

Decision makers must be kept informed on the progress of the plans through continual monitoring and reporting (Carbon Neutral Cities Alliance, 2015). The results show that all of the case cities have monitoring and reporting mechanisms in place to keep track of progress and report to decision makers and overseers. While all of the cases have defined monitoring and reporting structures, they do not all look the same. Cases such as Oslo and Guelph have developed much more frequent reporting structures compared to the other cases. Oslo has developed a “climate barometer” which is a monitoring and reporting tool that tracks a set of (14) indicators. Reporting on the climate barometer is done quarterly, just like the city’s financial budget, for fast reactions and decision-making. This is a reporting mechanism that allows for adaptive governance and decision-making. Our Energy Guelph also reports to the Guelph City Council quarterly, three of the reports are qualitative progress reports while one report per year is quantitative showing actual emissions trends. Other cases have annual or bi-annual reporting structures, which as the City of Oslo points out, may result in slower reaction times so failing actions and or less accountability for the local government to reach the targets it has set.

Communication

The literature states the need for constant, open communication in governance structures (Callaghan & Colton, 2008). The climate action plans in the cases all acknowledge the importance of clear communication between internal actors and external stakeholders, but information on the actual streams of internal communication were not directly available. In some of the interviews conducted with representatives from the case cities, it was found that communication structures are not always clear or formalized, and in some cases communication structures were highlighted as areas that need improvement and formalization. From the interviews, it was found that internal governance structures use a variety of formal and informal communication tools, including online forums such as Google docs and polls, emails, city websites and newsletters, non-scheduled face-to-face meetings in the office and scheduled periodic meetings. In the cities where no interview was conducted, there was no publicly available information on communication measures.

Collaboration / Partnership Structure

Cities that use a collaborative approach towards climate action typically have better results and outcomes (C40, 2015). The literature stresses the importance of collaboration within the city structure (Clarke, 2012; Mazzara, Sangiorgi, & Siboni, 2010) as well as with external stakeholders (Clarke & Erfan, 2007). The case cities are taking collaborative approaches towards plan development and implementation. All of the cities collaborate with external stakeholders through engagement processes for plan creation and implementation and acknowledge the importance of working with external stakeholders. The results show that the local governments do not necessarily share decision-making power with external stakeholders, but they do recognize the importance of input and consultation with relevant stakeholders. Within the local government structures, collaboration is occurring between departments whether the local government departments take ownership of certain actions at the behest of the City Council, or the departments are recruited to coordinate by the sustainability team. Generally, sustainability teams do not work alone; they act as the leaders and conveners as they recruit other departments to foster the work.

Vertical Integration

Vertical integration leads to better success in urban climate action, as it brings policies from different levels of government together to avoid policy gaps (Gleeson et al., 2004; Hammer et al., 2011). Vertical integration includes a two-way flow of information from the grassroots to policy-makers, and a counter-flow of political and financial support to actors at the grassroots that helps integrate plans and actions making them coherent (Leipzig, 2007).

The empirical results show that the varying level of support of higher levels of governments can either be a great support or create a barrier for cities in implementing climate action plans. The American cities in this study have been found to be working in a bottom up approach towards addressing the lack of climate action at the national and state levels. Park City has been using advocacy actions to lobby the state of Utah for access to renewable energy. Park City representatives coordinated with other municipalities in Utah to write legislation that would allow for communities in the state to source 100% of their electricity from renewable sources. They are taking a bottom approach to integrating their own climate agenda within policies at

the state level. New York City has been advocating to the State of New York for stronger climate policies and support.

On the other hand, Oslo and Vancouver both have strong support from higher levels of government. In the case of Oslo, the Norwegian national government is a leader in climate policy and is responsible for some of the key actions that set Oslo apart from other cities. For Vancouver, the provincial government of British Columbia has been a leader in Canadian climate action. Provincial policies have allowed Vancouver to have opportunities that many other Canadian cities have not had.

Ontario cities provide an interesting case of where a change in political will at the provincial level has resulted in the cancellation of climate related policies. Toronto and Guelph were left with a policy gap when the provincial government loosened environmental protection and removed climate related policies. The two cities have had to make up the policy gap by strengthening their own climate action initiatives, and finding other sources of support.

Governance Mode

Cities can use a combination of governance modes (Kern & Alber, 2009) and the results of this study validate the literature; cities use a combination of modes of governance throughout the planning process. Cities lean more towards certain modes, depending on their level of power/authority. All of the cases use self-governing as a mode to regulate local government operations. Governing through enabling and governing through provisioning are also commonly used in order to implement some of the actions in their plans as well as help to influence the behaviour of residents to choose low carbon options. Governing through authority is used in the cases that have adopted regulations for GHG reductions. As mentioned in the regulation and policy tools section, the results show that local governments can use their authority to impose policy or regulation to further their low carbon agendas, but only if they have the legal authority to do so.

5.4 Research Question 4: Actors

Who are the actors involved in local deep decarbonization strategies?

Table 46: Actors Discussion

Actors	Empirical	Literature	Comments
Internal Actors	Multiple city departments are involved in the planning and implementation processes.	Municipalities generally are the leaders in climate action planning. Different departments and agencies must be involved and coordinate.	Validate
External Actors	Present in all cases.	A wide variety of actors/stakeholders have to be involved in the process.	Validate

5.4.1 Actors Discussion

Internal Actors

Local governments are generally the leaders and within the local governments, multiple relevant departments and agencies should be inclusively engaged to create a sense of cross ownership (UN Habitat, 2015).

The empirical results show that cities are making efforts to include all relevant city departments by distributing responsibilities and ownership of actions to include a wider scope of capabilities and expertise as well as create a sense of ownership for the city as a whole.

Our Energy Guelph is the only non-municipal government “internal” actor or decision maker. Our Energy Guelph is developing specific task forces for each of the sectors/ main targets, including a mix of specialists in the sector, local government representatives and other local stakeholders thereby creating a sense of cross sector or community-wide ownership.

External Actors

Collaboration is important between internal and external actors (Carbon Neutral Cities Alliance, 2015). The results demonstrate that all the case cities actively include a multitude of external actors from various sectors.

5.4.2 Research Question 4.1

What roles do they play?

Table 47: Roles Discussion

Actors	Empirical	Literature	Comments
Internal	Internal Actors play many key roles including; decision-making, leadership, implementation, coordination and funding roles.	Types of roles depend on the “power” that the city has.	Validate
External	External actors generally play less leadership and decision making roles. They have enabling, consulting and implementation roles.	External actors can ensure widespread support and help with enabling, coordinating and facilitating.	Validate

5.4.2.1 Roles Discussion

Internal Roles

As leaders and decision makers, the roles that the local governments play in climate action planning are generally the same in the cases studied. Local governments have many roles to play, from enabling and coordinating to funding and regulating. Not all cities have strong regulatory powers. In each city, the City Council acts as the legislative body, the different internal departments can suggest policy changes, but ultimately City Council holds the power to act as a regulator.

Some cities opt to leave the regulatory roles to higher levels of government and simply act as enablers, coordinators and facilitators in climate action planning. The City of Guelph has opted to share the leadership role with Our Energy Guelph with the city acting as the financier, and ultimate policy maker while Our Energy Guelph shares in the decision making and acts as an enabler, coordinator and facilitator for actions.

As it becomes more apparent that multi sector coordination/collaboration is important, local governments have adopted the role of managing networks of actors (Clarke, 2012; Mazzara et al., 2010). The results validate this observation. Examples of cross sector partnerships like the Energize Bridgewater, BBP (Toronto), the BEex and Solar Partnership (NYC) show that cities convene and coordinate networks of actors to ultimately aid the local government in reaching climate action targets. Local governments coordinate stakeholder engagement and manage networks of partners, meaning that cities engage external actors in a manner that the government controls.

External Roles

As shown in the results, cities engage a multitude of external actors in the planning and implementation phases of climate action planning. Decision-making roles in these case studies are not shared with external actors. Decision makers (local governments) have engagement processes where external stakeholders are consulted and have an opportunity to provide input before the internal actors finalize the plans.

The external partners can play a wide variety of supporting roles from consultation and enabling activities to funding and capacity building. The results show that in most cases the internal actors take it upon themselves to coordinate and convene the external actors.

5.5 Overall Discussion

This study highlights six areas where the results have extended the current literature on pathways to deep decarbonization in cities. The first observation is that small cities tend to prioritize transitions to renewable energy. Due to lack of power and capacity in some cases, small cities have been formulating partnerships with utility companies in order to reach their targets.

A second extension of the literature highlights the movement towards increasing the capacity of local carbon sinks in order to offset community wide emissions. Rather than solely purchasing carbon offsets, local governments are beginning to explore alternative methods of increasing local carbon sink capacities.

The third finding reflects the development of targets and implementation actions to expand local green economies. The results highlighted the programs that leading cities are developing for training the local workforce in skills that will be crucial for the types of development that the cities are aiming for. Green jobs are projected to increase in demand as a result of climate action plans and policies and some cities are beginning to prepare the workforce for this development.

As a fourth finding, this study has highlighted that communication within governance structures can be fluid and informal. This type of informal communication can be useful and effective for day-to-day activities, though several of the cases have highlighted a need for more formalized communication structures.

In certain regions and countries, support for climate action initiatives has recently decreased. As a fifth finding, this study shows that several cities taking a bottom up approach to vertical integration of climate policy. Through advocacy actions, cities, even very small ones, have been found to be able to influence higher levels of government in supporting their climate action pathways.

The last contribution highlighted that as financial support from higher levels of governments decreases, cities are becoming more creative with funding mechanisms. Cities with large investment portfolios have committed to divesting from fossil fuels and using the divested funds to reinvest in climate action projects, and though so far unsuccessful, the concept of making those responsible for climate change pay for climate action initiatives in cities that will be affected has been explored.

It is important to note that some practices are only possible in certain communities, meaning that they are inherently limited to particular legal contexts, or cities that own their electric utilities. Though these may not have broad relevance, these findings could have a deep impact where enabled. An equally important note is that, during the research process, it was found that much of the literature on deep decarbonization at the local level is written by and for

practitioners and/or transnational networks of cities such as CNCA, C40 and ICLIE. Academic research and sources are lacking in several of the key variables that this study has highlighted.

As the climate emergency worsens, cities are taking leadership roles, and the eight case cities have been found to take strong actions towards leading by example through purchasing or generating renewable energy for their municipal operations, adding electric vehicles to their municipal fleets and public transit, retrofitting, and building new zero emissions buildings. These practices may not create community-wide impact in GHG mitigation, but they help to foster leadership and demonstrate commitment towards climate action.

Lastly, as all of the cities that were studied have both short term and long term plans and targets, it is important to note that several of the cities are near the end of one of their short term strategies and are either currently or will soon be updating their plans.

Chapter 6. Conclusion

6.1 Objectives of Study

The objective of this study is to examine some of the best practice examples of cities transitioning to deep decarbonization and to provide insights on the pathways, strategies, governance and actors that leading cities are using. Through identifying the key variables in the urban climate action literature, this study aimed to see which of these were being addressed in climate action plans, and if cities were going beyond what the literature prescribed. The key research questions related to which sectors were the focus of emissions reduction strategies, how the plans were organized and governed, what key actors were involved and what policy, financial and advocacy tools were used.

6.2 Theoretical Impact and Contribution of Research

This study made several contributions to theory and the larger literature on decarbonization pathways and urban climate governance. The first contribution addressed the theoretical gap in knowledge for climate governance and the actions of small cities and towns. By studying the plans and processes of two small towns, this study was able to contribute findings on the levels of capacity, the barriers to overcome and the strategies that small towns use in order to reach their GHG mitigation targets.

This study made contributions to the literature on decarbonization frameworks in six key areas by extending the literature to include new initiatives that leading cities are developing. The areas that this study contributes to are: decarbonizing the energy sector in small cities, increasing capacity of local carbon sinks, developing green economy targets and workforce development, formalizing communication structures, bottom up vertical integration tactics, and creating funding mechanisms. In these eight areas, the literature of deep decarbonization can be extended to show the emerging best practice examples.

6.3 Practical Implications

This study examines and breaks down the deep decarbonization pathways of eight best practice examples of municipalities implementing deep decarbonization. The results of this study can be useful to municipalities who are in the midst of developing deep decarbonization planning

frameworks. The results of this study demonstrate that cities are learning from each other through transnational networks of cities. This study can be of use to cities that are looking for direction and who may not be members of wider learning peer sharing networks. While not all cities will have the same capacities or level of political will as those in this study, the general pattern in the pathways, the governance, the actors and the tools being used can be adopted by municipalities and community groups of varying capacity.

The investigation also contributes practical knowledge to city networks like C40, ICLEI and CNCA. The results validate the key role that transnational networks play in global information dissemination and in enabling deep decarbonization action in cities. The findings can also be of practical use to transnational networks as the research explores cities of varying sizes. As more cities and municipalities join the movement to deep decarbonization, practical knowledge pertaining to the different sizes and capabilities of cities will be useful for these networks. This thesis offers eight best practice stories to share, going beyond current pathways to detail key strategies, governance mechanisms and actors involved in deep decarbonization processes. It is important that local governments consider all of these things when planning for climate action at the local lever, as they are all intertwined.

6.4 Limitations and Future Research

This study examined eight best practice examples. These cases exemplify some of the leading and innovative actions that are being implemented for deep decarbonization. Future research will benefit from studying examples of cities that have struggled with their planning or implementation processes. This could help to identify the barriers that some cities face and provide insight on how to overcome them. It would also be useful to gather a larger sample size of cities in each of the population categories. A similar study with a larger sample size would better highlight any potential emerging patterns.

A second limitation of this study is that the cases are all located in the global north, in wealthy and developed countries. For the purpose of this study the similarities in climate and economy

made the cities comparable to each other. It is unknown whether the learning from this study can be transferable to cities in developing countries. Future research may benefit from studying cities with varying levels of development and economic growth.

A third limitation of this study is that it solely took a qualitative method approach. As greenhouse gas emissions trends are quantitative in nature, future research in this field would benefit from using a quantitative or mixed methods methodology perspective. Quantified outcomes relating to deep decarbonization plan implementation and other factors including the local economy and the four priority sectors would be a next step towards understanding the actions and pathways of best practice cities.

In summary, this qualitative and exploratory study, which examined the technical pathways, the institutionalization strategies, the governance, and the actors that best practice cities are using for deep decarbonization implementation was fruitful. In addition to showing what the areas cities focus on for their decarbonization plan, this study highlighted the innovative strategies that are being developed. In addition to contributing to the literature on urban climate governance, it contributes to practical knowledge for developing and implementing deep decarbonization plans at the local level. Overall this study continues the conversation around climate action in cities.

References

- Acuto, M., & Rayner S. (2016). City Networks: Breaking Gridlocks of Forging (New) Lock-Ins? *International Affairs*, 95(5), 1147–1166.
- Ahmad, F. M. (2019, April 23). Keeping up the Pace: State, City and Private Sector Transport Decarbonization. Retrieved September 11, 2019, from <https://link.gale.com/apps/doc/A583957887/AONE?u=uniwater&sid=AONE&xid=9cddbca9>. Accessed 9 Sept. 2019
- Ansell, C., & Gash, A. (2008). Collaborative Governance in Theory and Practice. *Journal of Public Administration Research and Theory*, 18(4), 543–571.
<https://doi.org/10.1093/jopart/mum032>
- Association, I. A. (2018). Decarbonization: A Briefing for Actuaries. Retrieved September 6, 2019, from www.actuaries.org
- Aylett, A. (2014). *Progress and Challenges in the Urban Governance of Climate Change*. Cambridge, MA: MIT.
- Bager, S., & Mundaca, L. (2017). Making “Smart Meters” Smarter? Insights from a Behavioural Economics Pilot Field Experiment in Copenhagen, Denmark. *Energy Research & Social Science*, 28, 316–330.
- Ballentine, R., Connaughton, J., & Grossman, D. (2019). *Decarbonizing the Electricity Sector & Beyond*. Washington D.C.: The Aspen Institute.
- Baret, S., Hida, E., Hatfield, S., Sandford, N., & Vazirani, J. (2013). *Developing an Effective Governance Operating Model A Guide for Financial Services Boards and Management Teams*. Deloitte.
- Barreto, V., Gonzalez, A., Mate, R., & Zuk, E. (2018). A Study of Carbon Offsets and RECs to Meet Boston’s Mandate for Carbon Neutrality by 2050. Boston: BU Institute for Sustainable Energy.
- Becque, R., Weyl, D., Stewart, E., Mackers, E., Jin, L., & Shen, X. (2019). Accelerating Building Decarbonization: Eight Attainable Policy Pathways to Net Zero Carbon Buildings for All. Washington D.C.: World Resources Institute.
- Bernauer, T. (2013). Climate Change Politics. *Annual Review of Political Science*, 16, 421–448. <https://doi.org/10.1146/annurev-polisci-062011-154926>
- Bernstein, S., & Hoffmann, M. (2018). The Politics of Decarbonization and the Catalytic

- Impact of Subnational Climate Experiments. *Policy Sciences*, 51(2), 189–211.
<https://doi.org/10.1007/s11077-018-9314-8>
- Betsill, M. M., & Bulkeley, H. (2006). Cities and the Multilevel Governance of Global Climate Change. *Global Governance*, 12(2), 141–159.
- Bhatia, P., Ranganathan, J., & WBCSD. (2004). The Greenhouse Gas Protocol. Washington: World Resources Institute. <https://doi.org/1-56973-568-9>
- Billimoria, S., Guccione, L., Henchen, M., & Louis-Prescott, L. (2018). *The Economics of Electrifying Buildings: How Electric Space and Water Heating Supports Decarbonization of Residential Buildings*. Rocky Mountain Institute.
- Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal*, 9(2), 27–40. <https://doi.org/10.3316/QRJ0902027>
- Brozynski, M. T., & Leibowicz, B. D. (2018). Decarbonizing Power and Transportation at the Urban Scale: An Analysis of the Austin, Texas Community Climate Plan. *Sustainable Cities and Society*, 43, 41–54. <https://doi.org/10.1016/j.scs.2018.08.005>
- Bulkeley, H., & Betsill, M. (2005). Rethinking Sustainable Cities: Multilevel Governance and the “Urban” Politics of Climate Change. *Environmental Politics*, 14(1), 42–63. <https://doi.org/10.1080/0964401042000310178>
- Bulkeley, H., & Betsill, M. M. (2013). Revisiting the Urban Politics of Climate Change. *Environmental Politics*, 22(1), 136–154. <https://doi.org/10.1080/09644016.2013.755797>
- Bulkeley, H., & Kern, K. (2006). Local Government and the Governing of Climate Change in Germany and the UK. *Urban Studies*, 43(12), 2237–2259. <https://doi.org/10.1080/00420980600936491>
- Burch, S. (2018). Pursuing Deep Decarbonization in Canada: Advice from Canadian Scholars (Policy Brief No. 126).
- C40. (n.d.). Green Economy & Innovation Forum. Retrieved May 7, 2020, from <https://www.c40.org/programmes/green-economy-innovation-forum>
- C40. (2015). *Powering Climate Action: Cities as Global Change Makers*. London: C40 Cities.
- C40. (2020). *Climate Action Planning Framework*. C40 Cities.
- C40, & ARUP. (2016). *Deadline 2020*. C40 Cities.

- Cadman, T., Maguire, R., & Sampford, E. (2015). *Governing the Climate Change Regime; Institutional Integrity and Integrity Systems*. Abingdon: Routledge.
- Callaghan, E. G., & Colton, J. (2008). Building Sustainable & Resilient Communities: A Balancing of Community Capital. *Environment, Development and Sustainability*, 10(6), 931–942. <https://doi.org/10.1007/s10668-007-9093-4>
- Canadian Home Builders' Association. (n.d.). Building Codes. Retrieved May 29, 2020, from http://www.chba.ca/CHBA/Housing_in_Canada/Building_Codes.aspx
- Carbon Neutral Cities Alliance. (2015). *Framework for Long-Term Deep Carbon Reduction Planning*. CNCA.
- Castan Broto, V. (2017). Urban Governance and the Politics of Climate Change. *World Development*, 93(1), 1–15.
- Castan Broto, V. C., & Bulkeley, H. (2013). A survey of urban climate change experiments in 100 cities. *Global Environmental Change*, 23(1), 92–102. <https://doi.org/10.1016/J.GLOENVCHA.2012.07.005>
- CDP. (2019). Guidance for Cities - CDP. Retrieved November 15, 2019, from [https://www.cdp.net/en/guidance/guidance-for-cities#:~:targetText=CDP Cities provides a global, and mitigation and adaptation strategies](https://www.cdp.net/en/guidance/guidance-for-cities#:~:targetText=CDP%20Cities%20provides%20a%20global,adaptation%20and%20mitigation%20strategies).
- Chan, S., Falkner, R., Goldberg, M., & van Asselt, H. (2018). Effective and geographically balanced? An output-based assessment of non-state climate actions. *Climate Policy*, 18(1), 24–35. <https://doi.org/10.1080/14693062.2016.1248343>
- Chu, E., Anguelovski, I., & Carmin, J. (2016). Inclusive Approaches to Urban Climate Adaptation Planning and Implementation in the Global South. *Climate Policy*, 16(3), 372–392.
- City of Edmonton. (2018). *Municipal Tools Review*. Edmonton: City of Edmonton.
- City of Emeryville. (2016). *The City of Emeryville Climate Action Plan 2.0 2016*. City of Emeryville.
- Clarke, A. (2011). Key Structural Features for Collaborative Strategy Implementation : A Study of Sustainable Development/Local Agenda 21 Collaborations. *Management & Avenir*, 50(10), 153. <https://doi.org/10.3917/mav.050.0153>
- Clarke, A. (2012). Implementing Agenda 21s Through Local Agenda 21s: An International Study to Improve Collaborative Governance Structures and Green

- Economy Outcomes. *Annual Review of Social Partnerships*, 7, 12.
- Clarke, A. (2014). Designing Social Partnerships for Local Sustainability Strategy Implementation. In M. Seitanidi & A. Crane (Eds.), *Social Partnerships and Responsible Business A Research Handbook* (pp. 79–102). London, UK: Taylor & Francis.
- Clarke, A., & Crane, A. (2018). Cross-Sector Partnerships for Systemic Change: Systematized Literature Review and Agenda for Further Research. *Journal of Business Ethics*, 150(2), 303–313. <https://doi.org/10.1007/s10551-018-3922-2>
- Clarke, A., & Erfan, A. (2007). Regional Sustainability Strategies: A Comparison of Eight Canadian Approaches. *Plan Canada*, 47(3), 15–18.
- Clarke, A., & Fuller, M. (2010). Collaborative Strategic Management: Strategy Formulation and Implementation by Multi-Organizational Cross-Sector Social Partnerships. *Journal of Business Ethics*, 94(S1), 85–101. <https://doi.org/10.1007/s10551-011-0781-5>
- 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*.
- Clarke, S. (2017). Local Place-Based Collaborative Governance: Comparing State-Centric and Society-Centered Models. *Urban Affairs Review*, 53(3), 578–602. <https://doi.org/10.1177/1078087416637126>
- CNCA. (2016). *New Financial and Delivery Models for Retrofitting Buildings*.
- Coaffee, J., & Lee, P. (2016). *Planning for Risk, Crisis and Uncertainty*. New York: Palgrave Macmillan.
- Corfee-Morlot, J., Kamal-Chaoui, L., Donovan, M. G., Cochran, I., Robert, A., Teasdale, P. J., ... Teasdale, P.-J. (2009). *Cities, Climate Change and Multilevel Governance* (No. 14). OECD Publishing.
- Creswell, J. W. (1998). *Qualitative inquiry and research design : choosing among five traditions*. Thousand Oaks: Sage Publications.
- Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and mixed methods approaches*. Thousand Oaks: Sage Publications.
- Cundill, G., & Fabricius, C. (2010). Monitoring the Governance Dimension of Natural

- Resource Comanagement. *Ecology and Society*, 15(1).
- Dale, A., Ling, C., & Newman, L. (2010). Community Vitality: The Role of Community-Level Resilience Adaptation and Innovation in Sustainable Development. *Sustainability*, 2(1), 215–231. <https://doi.org/10.3390/su2010215>
- Davies, Z. G., Edmondson, J. L., Heinemeyer, A., Leake, J. R., & Gaston, K. J. (2011). Mapping an Urban Ecosystem Service: Quantifying Above-Ground Carbon Storage at a City-Wide Scale. *Journal of Applied Ecology*, 48(5), 1125–1134. [https://doi.org/10.1111/J.1365-2664.2011.02021.X@10.1111/\(ISSN\)1365-2664.CLIMATE_JPE](https://doi.org/10.1111/J.1365-2664.2011.02021.X@10.1111/(ISSN)1365-2664.CLIMATE_JPE)
- Day, T., Gonzales-Zuñiga, S., Höhne, N., Fekete, H., Sterl, S., Hans, F., ... Van, P. (2018). *Opportunity 2030: Benefits of Climate Action Quantifying the benefits of city-level measures in buildings, transport and energy supply*. C40 Cities.
- De Chalendar, J. A., Glynn, P. W., & Benson, S. M. (2019). City scale decarbonization experiments with integrated energy systems. *Energy & Environmental Science*, 12, 1695–1707. <https://doi.org/10.1039/c8ee03706j>
- Deep Decarbonization Pathways Project. (2015). *Pathways to Deep Decarbonization 2015 Report*. SDSN-IDDRI: DDPP.
- Driscoll, P. A. (2014). Breaking Carbon Lock-In: Path Dependencies in Large-Scale Transportation Infrastructure Projects. *Planning Practice & Research*, 29(3), 317–330. <https://doi.org/10.1080/02697459.2014.929847>
- Eberhard, J., & Madlener, R. (2003). *The Forgotten Benefits of Climate Change Mitigation: Innovation, Technological Leapfrogging, Employment, and Sustainable Development*. Paris: OCED.
- Echeverri, L. G. (2018). Investing for Rapid Decarbonization in Cities. *Current Opinion in Environmental Sustainability*, 30(1), 42–51. <https://doi.org/https://doi.org/10.1016/j.cosust.2018.02.010>
- Edwards, G. A. S., & Bulkeley, H. (2017). Urban Political Ecologies of Housing and Climate Change: The ‘Coolest Block’ Contest in Philadelphia. *Urban Studies*, 54(5), 1126–1141. <https://doi.org/10.1177/0042098015617907>
- Enterprises pour L’Environment, & World Resources Institute. (2013). *Protocol for the quantification of greenhouse gas emissions from waste management activities*.

- Ewall, M. (n.d.). Environmental Hierarchy of Waste Management; Energy Production Methods / Fuels / Technology. Retrieved October 4, 2019, from <http://www.energyjustice.net/files/technologies.pdf>
- Eyre, N. (1997). Barriers to energy efficiency: more than just market failure. *Energy & Environment*, 8(1), 25–43.
- FCM. (2018). Case study: Helping Bridgewater, NS, take the lead on sustainability | Federation of Canadian Municipalities. Retrieved November 15, 2019, from <https://fcm.ca/en/resources/pcp/case-study-helping-bridgewater-ns-take-the-lead-sustainability>
- FCM, & EnviroEconomics. (2009). Act Locally The Municipal Role in Fighting Climate Change. Retrieved May 19, 2020, from www.fcm.ca
- FCM, & ICLEI. (2015). *Climate Protection National Measures Report 2015*. FCM.
- FCM, & ICLEI. (2018). Partners for Climate Protection: National Measures Report 2018. Retrieved April 24, 2019, from <https://fcm.ca/Documents/reports/PCP/2018/pcp-nationalmeasures-report-2018-en.pdf> Government of Canada. (2018).
- Fedriago-Fazio, D., Ten Brink, P., Bassi, S., Emond, J., & Lucas, T. (2012). *Green Economy - What Do We Mean by a Green Economy ?* UNEP.
- Floater, G., Heeckt, C., Ulterino, M., Mackie, L., Rode, P., Bhardwaj, A., ... Huxley, R. (2016). *Co-benefits of urban climate action: A framework for cities*.
- Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, 12(2), 219–245. <https://doi.org/10.1177/1077800405284363>
- Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive Governance of Social-Ecological Systems. *Annual Review of Environment and Resources*, 30(1), 441–473. <https://doi.org/10.1146/annurev.energy.30.050504.144511>
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. (2012). *How to Design and Evaluate Research in Education* (Eighth). New York: McGraw-Hill.
- Fredriks, E., Stenner, K., & Hobman, E. (2015). Household Energy Use: Applying Behavioural Economics to Understand Consumer Decision-Making and Behaviour. *Renewable and Sustainable Energy Reviews*, 41, 1385–1394.
- Fröhlich, J., & Knieling, J. (2013). Conceptualising Climate Change Governance. In *Climate Change Governance*. Berlin: Springer. <https://doi.org/10.1007/978-3-642->

- Fuhr, H., Hickmann, T., & Kern, K. (2018). The Role of Cities in Multi-Level Climate Governance: Local Climate Policies and the 1.5_C Target. *Current Opinion in Environmental Sustainability*, 30, 1–6. <https://doi.org/10.1016/j.cosust.2017.10.006>
- Geels, F. W., Sovacool, B. K., Schwanen, T., & Sorrell, S. (2017). Sociotechnical Transitions for Deep Decarbonization. *Science*, 357(6357), 1242–1244. <https://doi.org/10.1126/science.aao3760>
- Gleeson, B., Darbas, T., & Lawson, S. (2004). Governance, Sustainability and Recent Australian Metropolitan Strategies: A Socio-Theoretic Analysis. *Urban Policy and Research*, 22(4), 345–366.
- Gonzales-Zuñiga, S., Nascimento, L., Höhne, N., Fekete, H., Sterl, S., Hans, F., ... Van Breevoort, P. (2018). *Climate Opportunity: More Jobs; Better Health; Livable Cities Quantifying The Benefits Of Climate Change Mitigation Measures in Buildings, Transport and Energy Supply*.
- Görlach, B. (2013). *What Constitutes an Optimal Climate Policy Mix?* Berlin: Ecologic Institute.
- Government of British Columbia. (n.d.). Community-Wide Climate Action Planning | BC Climate Action Toolkit. Retrieved May 19, 2020, from <https://www.toolkit.bc.ca/Community-Wide-Climate-Action-Planning>
- Gray, B., & Stites, J. P. (2013). *Sustainability Through Partnerships: Capitalizing on Collaboration*. Network for Business Sustainability.
- 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>
- Hammer, S., Kamal-Chaoui, L., Robert, A., & Plouin, M. (2011). *Cities and Green Growth: A Conceptual Framework*. OECD Regional Development Working Papers. OCED. <https://doi.org/10.1787/5kg0tflmzx34-en>
- Haus, M., & Klausen, J. E. (2011). Urban leadership and community involvement: Ingredients for good governance? *Urban Affairs Review*, 47(2), 256–279. <https://doi.org/10.1177/1078087410388867>
- Hein, C., & Pelliter, P. (2006). *Cities, Autonomy and Decentralization in Japan*. London:

Routledge.

- Hoicka, C. E., & Das, R. (2020). Ambitious Deep Energy Retrofits of Buildings to Accelerate the 1.5° C Energy Transition in Canada. *Canadian Geographer*.
- Hughes, S. (2017). The Politics of Urban Climate Change Policy; Toward a Research Agenda. *Urban Aff. Review*, 53(2), 362–380.
- Hughes, S., Chu, E., & Mason, S. (2018). *Climate Change in Cities: Innovations in Multi-Level Governance*. Cham: Springer.
- ICLEI - Canada. (n.d.). About ICLEI Canada. Retrieved August 2, 2019, from http://www.icleicanada.org/files/About_ICLEI_website.pdf
- 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*. Geneva, Switzerland: IPCC.
- IPCC. (2018). *Global warming of 1.5°C [IPCC Special Report]*. In Press.
- Johnson, C. (2018). *The Power of Cities in Global Climate Politics : Saviours, Suppliants or Agents of Change?* London: Palgrave Macmillan.
- Johnson, Craig, Toly, Noah, Schroeder, & Heike. (2015). *The Urban Climate Challenge*. Abingdon: Routledge.
- Jordan, A., & Turnpenny, J. (2015). *The Tools of Polity Formation: Actors, Capacities, Venues and Effects*. Cheltenham: Edward Elgar.
- 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>
- Kates, R. W., Travis, W. R., & Wilbanks, T. J. (2012). Transformational Adaptation When Incremental Adaptations to Climate Change are Insufficient. *National Academy of Sciences*, 109(19), 7156–7161. <https://doi.org/10.1073/pnas.1115521109>
- Keping, Y. (2017). Governance and Good Governance: A New Framework for Political Analysis. *Fudan Journal of the Humanities and Social Sciences*, 11, 1–8. <https://doi.org/10.1007/s40647-017-0197-4>
- Kern, K., & Alber, G. (2009). Governing Climate Change in Cities: Modes of Urban Climate Governance in Multi-Level Systems. In *International Conference on*

- Competitive Cities and Climate Change* (pp. 171–196). Paris: OCED.
- Kirchner, M., Schmidt, J., & Wehrle, S. (2019). Exploiting Synergy of Carbon Pricing and other Policy Instruments for Deep Decarbonization. *Joule*, 3(4), 891–893.
<https://doi.org/0.1016/j.joule.2019.03.006>
- Knieling, J. (2016). *Climate Adaptation Governance in Cities and Regions: Theoretical Fundamentals and Practical Evidence*. Oxford: Wiley Blackwell.
- Koben, C., Jacob, C., Jon, C., Matt, J., James, M., O’Grady, E., & Bronski, P. (2017). The Carbon-Free City Handbook. Retrieved from rmi.org/carbonfreecities
- Kramer, R., & Gray, B. (1990). Collaborating: Finding Common Ground for Multiparty Problems. *The Academy of Management Review*, 15(3), 545.
<https://doi.org/10.2307/258026>
- Kwon, M., Jang, H. S., & Feiock, R. C. (2014). Climate Protection and Energy Sustainability Policy in California Cities: What Have We Learned? *Journal of Urban Affairs*, 36(5), 905–924. <https://doi.org/10.1111/juaf.12094>
- Lah, O. (2015). The Barriers to Low-Carbon Land-Transport and Policies to Overcome Them. *European Transport Research Review*, 7(1), 5.
<https://doi.org/10.1007/s12544-014-0151-3>
- Lah, O. (2017). Decarbonizing the Transportation Sector: Policy Options, Synergies, and Institutions to Deliver on a Low-Carbon Stabilization Pathway. *Wiley Interdisciplinary Reviews: Energy and Environment*, 6(6), e257.
<https://doi.org/10.1002/wene.257>
- Lambert, V. A., & Lambert, C. E. (2012). Qualitative Descriptive Research: An Acceptable Approach. *Pacific Rim International Journal of Nursing Research*, 16(4), 255–256.
- Lawson, A., & Ahmad, F. M. (2018). *Decarbonizing U.S. Transportation*.
- Le Penneç, M., & Raufflet, E. (2018). Value Creation in Inter-Organizational Collaboration: An Empirical Study. *Journal of Business Ethics*, 148(4), 817–834.
<https://doi.org/10.1007/s10551-015-3012-7>
- Lebel, L., Anderies, J. M., Campbell, B., Folke, C., & Hatfield-Dodds, S. (2006). Governance and the Capacity to Manage Resilience in Regional Social-Ecological Systems. *Ecology and Society*, 11(1).

- Leipzig. (2007). The Leipzig Charter on Sustainable European Cities.
- Löffler, K., Hainsch, K., Burandt, T., Oei, P.-Y., Kemfert, C., & von Hirschhausen, C. (2017). Designing a Model for the Global Energy System—GENeSYS-MOD: An Application of the Open-Source Energy Modeling System (OSeMOSYS). *Energies*, *10*(10), 1468. <https://doi.org/10.3390/en10101468>
- Lovell, H. (2007). Exploring the role of materials in policy change: innovation in low energy housing in the UK. *Environment and Planning*, *39*(10), 2500–2517. <https://doi.org/10.1068/a38408>
- Lucon, O., Ürge-Vorsatz, A., Zain Ahmed, H., Akbari, P., Bertoldi, L. F., Cabeza, N., ... Vilariño. (2014). Buildings. In S. Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum & T. Z. and J. C. M. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow (Eds.), *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
- Luque-Ayala, A., Marvin, S., & Bulkeley, H. (2018). *Rethinking Urban Transitions: Politics in the Low Carbon City*. Taylor & Francis Group. <https://doi.org/https://doi.org/10.4324/9781315164779>
- MacDonald, A., Clarke, A., & Huang, L. (2018). Multi-Stakeholder Partnerships for Sustainability: Designing Decision Making Processes for Partnership Capacity. *Journal of Business Ethics*. <https://doi.org/10.1007/s10551-018-3885-3>
- Marshall, C., & Rossman, G. (1989). *Designing Qualitative Research*. Newbury Park, CA: Sage.
- Maxwell, J. A. (1992). Understanding and Validity in Qualitative Research. *Harvard Educational Review*, *62*(3), 279–301.
- Mazzara, L., Sangiorgi, D., & Siboni, B. (2010). Public Strategic Plans in Italian Local Governments. *Public Management Review*, *12*(4), 493–509. <https://doi.org/http://doi.org/10.1080/14719037.2010.496264>
- Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education* (2nd ed.). San Francisco: Jossey-Bass.

- Monni, S., & Raes, F. (2008). Multilevel Climate Policy: The Case of the European Union, Finland and Helsinki. *Environmental Science and Policy*, 11(8), 743–755. <https://doi.org/10.1016/j.envsci.2008.08.001>
- Morvaj, B., Evins, R., & Carmeliet, J. (2017). Decarbonizing the Electricity Grid: The Impact on Urban Energy Systems, Distribution Grids and District Heating Potential. *Applied Energy*, 191, 125–140. <https://doi.org/10.1016/J.APENERGY.2017.01.058>
- Moya, D., Aldás, C., Jaramillo, D., Játiva, E., & Kaparaju, P. (2017). Waste-To-Energy Technologies: An Opportunity of Energy Recovery from Municipal Solid Waste, Using Quito - Ecuador as Case Study. In *Energy Procedia* (Vol. 134, pp. 327–336). Elsevier Ltd. <https://doi.org/10.1016/j.egypro.2017.09.537>
- Mundaca, L., Ürge-Vorsatz, D., & Wilson, C. (2019). Demand-Side Approaches for Limiting Global Warming to 1.5 °C. *Energy Efficiency*, 12(2), 343–362. <https://doi.org/10.1007/s12053-018-9722-9>
- Nguyen, T. M. P., Davidson, K., & Gleeson, B. (2018). Metropolitan Strategies and Climate Governance: Towards New Evaluative Approaches. *International Journal of Urban and Regional Research*, 42(5), 934–951. <https://doi.org/10.1111/1468-2427.12662>
- 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>
- Ostrom, E. (2010). Beyond Markets and States: Polycentric Governance of Complex Economic Systems. *The American Economic Review*, 100(3), 641–672. <https://doi.org/10.2307/27871226>
- Park City. (2019). Sustainability | Park City, UT. Retrieved November 15, 2019, from <https://www.parkcity.org/departments/sustainability>
- Parkhe, A. (1993). “Messy” Research Methodological Predispositions, and Theory Development in International Joint Ventures. *Academy of Management Review*, 18(2), 227–268.
- Patterson, J., Schulz, K., Vervoort, J., Adler, C., Hurlbert, M., van der Hel, S., ... Widerberg, O. (2015). “Transformations towards sustainability” *Emerging approaches, critical reflections, and a research agenda*. Lund and Amsterdam.

- Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., ...
 Barau, A. (2017). Exploring the Governance and Politics of Transformations
 Towards Sustainability. *Environmental Innovation and Societal Transitions*, 24, 1–
 16. <https://doi.org/10.1016/j.eist.2016.09.001>
- Pierre, J. (2011). *Politics of Urban Governance*. Houndsmills: Palgrave MacMillan.
- Prieur-Richard, A.-H., Walsh, B., Craig, M., Melamed, M. L., Colbert, L., Pathak, M., ...
 Ürge-Vorsatz, D. (2018). *Extended version: Global Research and Action Agenda on
 Cities and Climate Change Science*. Edmonton: WCRP.
- Robinson, & Gore. (2015). Municipal Climate Reporting: Gaps in Monitoring and
 Implications for Governance and Action. *Environment and Planning C: Government
 and Policy*, 33, 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*, 14(1 SUPPL.), 102–120.
- Robiou du Pont, Y., Jeffery, M. L., Gütschow, J., Rogelj, J., Christoff, P., &
 Meinshausen, M. (2017). Equitable Mitigation to Achieve the Paris Agreement
 Goals. *Nature Climate Change*, 7(1), 38–43. <https://doi.org/10.1038/nclimate3186>
- 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>
- Rosenbloom, D., & Meadowcroft, J. (2014). The Journey Towards Decarbonization:
 Exploring Socio-Technical Transitions in the Electricity Sector in the Province of
 Ontario (1885-2013) and Potential Low-Carbon pathways. *Energy Policy*, 65, 670–
 679. <https://doi.org/10.1016/j.enpol.2013.09.039>
- Rosenweig, C., Solecki, W., Romeor-Lanko, P., Mehrota, S., Dhakal, S., & Ali Ibrahim,
 S. (2018). *Climate Change and Cities: Second Assessment Report of the Urban
 Climate Change Research Network*. Cambridge: Cambridge University Press.
- Sachs, J. D. (2015). What's The Path to Deep Decarbonization? Retrieved September 3,
 2019, from <https://www.weforum.org/agenda/2015/12/whats-the-path-to-deep-decarbonization/>
- Sachs, J. D., Schmidt-Traub, G., & Williams, J. (2015). From Good Intentions to Deep

Decarbonization. <https://doi.org/1762500357>

- Salon, D., Sperling, D., Meier, A., Murphy, S., Gorham, R., & Barrett, J. (2010). City carbon budgets: A proposal to align incentives for climate-friendly communities. *Energy Policy*, 38(4), 2032–2041. <https://doi.org/10.1016/j.enpol.2009.12.005>
- Sanchez-Rodriguez, R. (2009). Learning to Adapt to Climate Change in Urban Areas. A Review of Recent Contributions. *Current Opinion in Environmental Sustainability*, 1(1), 201–206.
- Sandulescu, E. (2004). The Contribution of Waste Management to the Reduction of Greenhouse Gas Emissions with Applications in the City of Bucharest. *Waste Management Resources*, 22, 413–426. <https://doi.org/10.1177/0734242X04048519>
- Schroeder, H., & Bulkeley, H. (2009). Global Cities and the Governance of Climate Change; What is the Role of Law in Cities? *Fordham Urban Law Review*, 36(1), 313–359.
- Selin, S., & Chevez, D. (1995). Developing a collaborative model for environmental planning and management. *Environmental Management*, 19(2), 189–195. <https://doi.org/10.1007/BF02471990>
- Selsky, J., & Parker, B. (2005). Cross-Sector Partnerships to Address Social Issues: Challenges to Theory and Practice. *Journal of Management*, 31(6), 849–873. <https://doi.org/10.1177/0149206305279601>
- Sennet, R., Burdett, R., & Sassen, S. (2018). *The Quito Papers and the New Urban Agenda*. London: Routledge. <https://doi.org/10.4324/9781351216067>
- Shank, M. (2018). Adopting a Zero-Emissions Standard for New Buildings – CNCA. Retrieved May 27, 2020, from https://carbonneutralcities.org/adopting-a-zero-emissions-standard-for-new-buildings/?utm_source=FINAL+CNCA++E-News++November+2018&utm_campaign=Nov+2018+CNCA+Monthly+Update&utm_medium=email
- Smith, J. B., Schneider, S. H., Oppenheimer, M., Yohe, G. W., Hare, W., Mastrandrea, M. D., ... Van Ypersele, J.-P. (2009). Assessing Dangerous Climate Change Through an Update of the Intergovernmental Panel on Climate Change (IPCC) “Reasons for Concern.” *Proc. Nat. Acad. Sci. USA*, 106, 4133–4137.
- Sovacool, B. K., Noel, L., Kester, J., & De Rubens, G. Z. (2018). Reviewing Nordic

- Transport Challenges and Climate Policy Priorities: Expert Perceptions of Decarbonisation in Denmark, Finland, Iceland, Norway, Sweden. *Energy*, 165, 532–542. <https://doi.org/10.1016/J.ENERGY.2018.09.110>
- 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>
- Sun, X., Clarke, A., & MacDonald, A. (2020). Implementing Community Sustainability Plans Through Partnerships: An Examination of the Relationship between Partnership Structural Fractures and Climate Change Mitigation Plan Outcomes. *Sustainability*, 12(15), 6172. <https://doi.org/10.3390/su12156172>
- Tozer, L. (2013). Community Energy Plans in Canadian Cities: Success and Barriers in Implementation. *Local Environment*, 18(1), 20–35.
- Tozer, L. (2018). *Urban Decarbonization: Politics and Practices of Carbon Neutrality*. University of Toronto.
- Tozer, L. (2019a). Deep Decarbonization in Practice: Solutions and Challenges for Low-Carbon Building Retrofits. *Canadian Journal of Urban Research*, 28(2).
- Tozer, L. (2019b). The Urban Material Politics of Decarbonization in Stockholm, London and San Francisco. *Geoforum*, 102, 106–115. <https://doi.org/10.1016/J.GEOFORUM.2019.03.020>
- Tozer, L., & Klenk, N. (2019). Urban Configurations of Carbon Neutrality: Insights from the Carbon Neutral Cities Alliance. *Politics and Space*, 37(3), 539–557. <https://doi.org/10.1177/2399654418784949>
- Transport Decarbonisation Alliance. (2017). Development of the Transport Decarbonisation Alliance. Retrieved September 12, 2019, from <http://tda-mobility.org/wp-content/uploads/2018/08/TDA-Concept-Note.pdf>
- Tucker, P., & Speirs, D. (2003). Attitudes and Behavioural Change in Household Waste Management Behaviours. *Journal of Environmental Planning and Management*, 46(2), 289–307. <https://doi.org/10.1080/0964056032000070927>
- UN Habitat. (2015). *Guiding Principles for City Climate Action Planning Guiding Principles for Climate City Planning Action Guiding Principles for City Climate Action Planning*. UN Habitat.
- UNECE. (2011). *Climate Neutral Cities; How to Make Cities less Energy and Carbon*

- Intensive and More Resilient to Climatic Challenges*. Geneva: UNECE.
- United Nations-Department of Economic and Social Affairs-Population Division. (2018). *The World 's Cities in 2018 - Data Booklet*. UN DESA.
- Ürge-Vorsatz, D., Herrero, S. T., Dubash, N. K., & Lecocq, F. (2014). Measuring the Co-Benefits of Climate Change Mitigation. *Annual Review of Environment and Resources*, 39(1), 549–582. <https://doi.org/10.1146/annurev-environ-031312-125456>
- USDN. (2018). *Catalyzing Sustainability Impact*. USDN.
- Van der Heijden, J. (2019). Studying Urban Climate Governance: Where to Begin, What to Look For, and How to Make a Meaningful Contribution to Scholarship and Practice. *Earth System Governance*, 1, 100005. <https://doi.org/10.1016/j.esg.2019.100005>
- Vancouver City Council. (2019). Climate Emergency Responce. Retrieved October 3, 2019, from <https://council.vancouver.ca/20190424/documents/cfsc1.pdf>
- Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, Adaptability and Transformability in Social–ecological Systems. *Ecology and Society*, 9(2).
- Wondolleck, J. M., & Yaffee, S. L. (2000). *Making Collaboration Work: Lessons From Innovation in Natural Resource Management*. Washington, D.C.: Island Press.
- 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. von Schnurbein (Ed.), *Transitions to Strong Partnerships for the Sustainable Development Goals*. Basel, Switzerland: SDG Book Series.
- World Population Review. (2019). Population of Cities in Canada (2019). Retrieved November 15, 2019, from <http://worldpopulationreview.com/countries/canada-population/cities/>
- Yan, X., Lin, H., & Clarke, A. (2018). Cross-Sector Social Partnerships for Social Change: The Roles of Non-Governmental Organizations. *Sustainability*, 10(2), 558. <https://doi.org/10.3390/su10020558>
- Yedla, S., Shrestha, R. M., & Anandarajah, G. (2005). Environmentally Sustainable

Urban Transportation—Comparative Analysis of Local Emission Mitigation Strategies Vis-à-Vis GHG Mitigation Strategies. *Transport Policy*, 12(3), 245–254. <https://doi.org/10.1016/J.TRANPOL.2005.02.003>

Yin, R. K. (2011). *Applications of Case Study Research* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Yin, R. K. (2014). *Case Study Research: Design and Methods* (Fifth). Thousand Oaks, CA: Sage.

Zaman, A. U., & Lehmann, S. (2011). Challenges and Opportunities in Transforming a City into a “Zero Waste City.” *Challenges*, 2, 73–93. <https://doi.org/10.3390/challe2040073>

Zaman, A. U., & Lehmann, S. (2013). The Zero Waste Index: A Performance Measurement Tool for Waste Management Systems in a ‘Zero Waste City.’ *Journal of Cleaner Production*, 50, 123–132. <https://doi.org/10.1016/j.jclepro.2012.11.041>

Zero Waste International Alliance. (2018). Zero Waste Hierarchy of Highest and Best Use. Retrieved October 4, 2019, from <http://zwia.org/zwh/>

Appendices

Appendix 1: Key Questions from CDP Cities 2019 Questionnaire

City-wide GHG Emissions Data

4.0 Does your city have a city-wide emissions inventory to report?

By selecting Yes below, you are indicating that you have fuel and/or greenhouse gas (GHG) emissions data from the entire city area over which the city government can exercise a degree of influence through the policies and regulations they implement (sometimes referred to as 'geographic' or 'community' emissions) to report at this time.

Response Options

Select one of the following options:

- Yes
- In progress
- Intending to undertake in the next 2 years
- Not intending to undertake

Mitigation Target setting

5.0 Do you have a GHG emissions reduction target in place at the city-wide level?

Response Options

Select all that apply:

- Base year emissions (absolute) target
- Fixed level target
- Base year intensity target
- Baseline scenario (business as usual) target
- No target

5.0a Please provide details of your total city-wide base year emissions reduction (absolute) target. In addition, you may add rows to provide details of your sector-specific targets, by providing the base year emissions specific to that target.

Response Options

Please complete the following table. You are able to add rows by using the "Add Row" button at the bottom of the table.

Sector	Where sources differ from the inventory, identify and explain these additions / exclusions	Boundary of target relative to city boundary (reported in 0.1)	Base year	Year of target implementation	Base year emissions (metric tonnes CO2e)	Percentage reduction target
Select from: • All emissions sources included in city inventory • Energy • Transport • Waste • Other	Text field	Select from: • Same - covers entire city and nothing else • Smaller - covers only part of the city • Larger - covers the whole city and adjoining areas • Partial - Covers part of the city and adjoining areas	Numerical field	Numerical field	Numerical field	Numerical field

Target year	Target year absolute emissions (metric tonnes CO2e)	Percentage of target achieved so far	Does this target align with the global 1.5 - 2°C pathway set out in the Paris Agreement?	Please indicate to which sector(s) the target applies	Does this target align to a requirement from a higher level of sub-national government?	Please describe your target. If your country has an NDC and your city's target is less ambitious than the NDC, please explain why.
Numerical field	Numerical field	Numerical field	Select from: • Yes - 1.5 c • Yes - 2°C • No • Do not know	Select from: • Energy industry • Heating and cooling supply • Commercial buildings • Residential buildings • Public facility • Industrial facilities • Transport • Water • Other	Select from: • Yes • Yes, but it exceeds its scale or requirement • No • Do not know	Text field

5.5 Does your city have a climate change mitigation or energy access plan for reducing city-wide GHG emissions?

Response Options

Select one of the following options:

- Yes
- In progress
- Intending to undertake in the next 2 years
- Not intending to undertake
- Do not know

Appendix 2: Cities with Climate Action Plan, % Reduction Targets, GHG Inventory and Decreasing / Same Emissions

Cities with Plan, Targets, Inventory & Decreased/Same Emissions
Ajuntament de Barcelona
Ajuntament de Valencia
Alcaldia de MonterÃa
Alcaldia de Pasto
Auckland Council
Ayuntamiento de Murcia
Ayuntamiento de Vitoria-Gasteiz
BÃrum Kommune
Bangkok Metropolitan Administration
BogotÃ; Distrito Capital
Boulder County
Byron Shire Council
Canberra
City of Adelaide
City of Amsterdam
City of Ann Arbor
City of Austin
City of Baltimore
City of Basel-Stadt
City of Berlin
City of Boston
City of Boulder
City of Brisbane, CA
City of Brussels
City of Burlington
City of Chicago
City of Chula Vista
City of Cincinnati
City of Cleveland
City of Cupertino
City of Denver
City of Dubuque
City of Emeryville, CA
City of Espoo
City of Evanston, IL
City of Fort Collins
City of Fremont
City of Guelph
City of Hamilton
City of Helsingborg
City of Helsinki
City of Hvidovre
City of Indianapolis
City of Knoxville
City of Lahti
City of Lakewood
City of Leicester
City of London, ON

City of Los Angeles
City of Manhattan Beach, CA
City of Medford
City of Minneapolis
City of North Vancouver
City of Oakland
City of Orlando
City of Oslo
City of Ottawa
City of Palo Alto
City of Paris
City of Park City, UT
City of Philadelphia
City of Pittsburgh
City of Reykjavík
City of San Diego
City of San Francisco
City of San José
City of Santa Barbara, CA
City of Santa Monica
City of Seattle
City of St Louis
City of Stockholm
City of Sydney
City of Toronto
City of Turku
City of Vancouver
City of Victoria
City of West Palm Beach
City of Yokohama
City of Zaragoza
Commune de Cocody
Comune di Genova
Comune di Milano
Comune di Parma
Comune di Ravenna
Comune di Torino
Comune di Venezia
Coventry City Council
Cuyahoga County
District of Columbia
Egedal Municipality
Falköping Kommun
Fredensborg Kommune
Gemeente Rotterdam
Gislaveds Kommun
Gladsaxe Kommune
Greater London Authority
Greater Manchester
Greifswald

HÅ_rsholm Kommune
HelsingÅ_r Kommune / Elsinore Municipality
Jakarta City Government
Kansas City
Kaohsiung City Government
Khon Kaen City
Kristianstad
Metropolitan Government of Nashville and Davidson County
Middelfart Kommune
MunÃcipio de Sintra
MunicÃpio de GuimarÃes
MunicÃpio de Torres Vedras
Municipalidad de BelÃ©n
Municipality of Belo Horizonte
Municipality of Karlskrona
Municipality of Uppsala
New York City
Roskilde
Shah Alam City Council
Sigtuna Municipality
Stadt Heidelberg
Stadt ZÃ¼rich
Taipei City Government
Taoyuan City Government
The Hague
Town of Blacksburg
VÃ¸stervik
Ville de Monaco
Ville de Montreal
Wellington City Council
Yilan County Government
Town of Lexington, MA

Appendix 3: 80x50 Cities Shortlist

	Reduction target	Year	Population	Category
Town of Lexington, MA	100	2050	31394	small
Fredensborg Kommune	100	2050	40112	small
City of North Vancouver	100	2050	52898	medium
City of Medford	100	2050	57797	medium
City of Cupertino	83	2050	60170	medium
Helsingør Kommune / Elsinore Municipality	100	2045	62567	medium
City of Palo Alto	80	2030	67082	medium
City of Evanston, IL	100	2050	75603	medium
Kristianstad	85	2045	84908	medium
City of Växjö	100	2030	91060	medium
City of Victoria	80	2050	92000	medium
City of Santa Monica	80	2030	92478	medium
City of Boulder	80	2050	108507	medium
City of West Palm Beach	100	2050	112906	medium
City of Lahti	80	2025	120028	medium
City of Ann Arbor	90	2050	121890	medium
City of Guelph	100	2050	131794	medium
City of Helsingborg	100	2035	145415	medium
Stadt Heidelberg	95	2050	147437	medium
City of Fort Collins	100	2050	170100	medium
City of Turku	80	2029	191000	medium
Trondheim Municipality	80	2030	196000	medium
Wellington City Council	80	2050	213847	medium
Municipality of Uppsala	100	2050	225164	medium
City of Fremont	100	2045	234962	medium
City of Espoo	-1*	2030	283632	medium
City of Pittsburgh	80	2050	301048	medium
City of Cincinnati	84	2050	301301	medium
City of St Louis	80	2050	302838	medium
Boulder County	90	2050	322226	medium
City of London, ON	80	2050	378000	medium
City of Cleveland	80	2050	385428	medium
City of Minneapolis	80	2050	422331	medium
Stadt Zürich	82	2050	428737	medium
City of Hamilton	100	2050	558397	large
City of Vancouver	100	2050	642686	large
City of Helsinki	80	2035	650033	large
City of Oslo	95	2030	673469	large
City of Boston	100	2050	683015	large

District of Columbia	100	2050	702455	large
City of Denver	80	2050	704621	large
City of Seattle	100	2050	730400	large
City of Amsterdam	95	2050	863000	large
City of Indianapolis	100	2015	872680	large
City of Stockholm	100	2040	949161	large
City of Ottawa	80	2050	979173	large
City of San JosÃ©	88	2050	1046079	very large
City of Austin	90	2050	1227000	very large
Cuyahoga County	100	2050	1248371	very large
Comune di Milano	100	2050	1395274	very large
City of Philadelphia	80	2050	1555072	very large
Auckland Council	-1*	2050	1614400	very large
City of Paris	80	2050	2249975	very large
Greater Manchester	97.3	2038	2812569	very large
City of Toronto	80	2050	2929886	very large
City of Berlin	95	2050	3644998	very large
New York City	80	2050	8622700	very large
Greater London Authority	100	2050	8883800	very large

*-1 implies negative emissions (the city offsets more emissions than it produces)

Appendix 4: CDP Small Cities Short List

City	% Reduction Target	Target Year	Population	Size
Bridgewater	81	2050	8532	small
Emeryville, CA	80	2050	11885	small
Park City, UT	100	2030	8376	small

Appendix 5: Final Case Selection

City	Size	Population	% Reduction Target	Target Year
Toronto	Very Large	2929886	80	2050
New York	Very Large	8622700	80	2050
Vancouver	Large	642686	100	2050
Oslo	Large	673469	95	2030
Guelph	Medium	131794	100	2050
Lahti	Medium	120028	80	2025
Bridgewater	Small	8532	80	2050
Park City	Small	8376	100	2030

Appendix 6: Recruitment Letter

Dear (name of potential participant)

My name is Samantha Linton and I am a Masters student working under the supervision of Dr. Amelia Clarke in the School of Environment, Enterprise and Development at the University of Waterloo. I am writing to you about our current study, which is being done in partnership with ICLEI Canada. The research project is entitled “Pathways to Deep Decarbonization in Cities: Mechanisms, Tools and Governance Structures for Transformative Climate Action”. The purpose of this research is to collect information about the current pathways that cities are developing towards deep decarbonization and compare case studies.

I am contacting you as the [City] is an excellent fit to be a case study for the research project, based off of the data disclosed in the CDP Cities 2019 database. I would like to seek your participation, which entails a 30-60 minute interview over the phone at a time convenient for you. You will be asked only factual questions about the deep decarbonization pathways, strategies and governance structures in your city. For more information about the study please see the attached information letter.

Please reply to this email (shlinton@uwaterloo.ca) to confirm your participation and indicate any times you are available for an interview within the next weeks.

Thank you for taking time to read this email and for your consideration.

Sincerely,

Samantha Linton
Masters of Environmental Studies Candidate
School of Environment, Enterprise and Development
Faculty of Environment, University of Waterloo, Canada
E-mail: shlinton@uwaterloo.ca
<https://uwaterloo.ca/implementing-sustainable-community-plans/current-students-studies/samantha-linton>

Appendix 7: Information Letter

This letter is an invitation to consider participating in a study I am conducting as part of my Master's degree in the School of Environment, Enterprise and Development (Faculty of Environment) at the University of Waterloo in partnership with ICLEI Canada. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part. Please take time to read the following information pertaining to the research project and discuss with involved parties regarding your city's participation.

Deep decarbonization at the citywide level requires transformative action. The aim of this study is to identify the current pathways that leading "best practice" cities in Canada and internationally are developing in order to reach ambitious GHG reductions.

Through examining the governance structures, key actors involved as well as the particular tools and strategies being used for the implementation of climate action/deep decarbonization plans, this study will gain an understanding of the current best practices in cities. For this, we are seeking information on the current practices occurring within your city for the creation and implementation of your climate action plan.

An analysis of your city's current climate action plan will be conducted prior to the interview. The purpose of the interview will be to clarify any gaps in information after the document analysis. For the interview questions, there is no preparation required, but for your early reference, you will also be sent the list of interview questions prior. The city will be listed as a case city and highlighted within the research study.

The interview will be conducted over the phone or via Skype, and will be approximately 30 minutes - 1 hour in length. You may decline to answer any of the interview questions if you wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. With your permission, the interview will be audio recorded to facilitate collection of information, and later transcribed for facilitation of analysis. Participation in this study is voluntary. If you are willing to participate in this interview, please contact Samantha Linton at shlinton@uwaterloo.ca or (819) 328-3376. In your reply, please indicate a time when you will be available.

I very much look forward to speaking with you and thank you in advance for your assistance in this project.

Sincerely,

Samantha Linton
Masters of Environmental Studies Candidate
School of Environment, Enterprise and Development
Faculty of Environment
University of Waterloo
E-mail: shlinton@uwaterloo.ca

<https://uwaterloo.ca/implementing-sustainable-community-plans/current-students-studies/samantha-linton>

Under the supervision of

Dr. Amelia Clarke

School of Environment, Enterprise and Development

University of Waterloo

Email: amelia.clarke@uwaterloo.ca

<https://uwaterloo.ca/implementing-sustainable-community-plans/>

Appendix 8: Interview Guide

And I am looking to see what factors stand out across countries and population sizes

I have already conducted some online research of the publically available documents and this interview is meant to fill in some of the gaps that I have not been able to find online

This study aims to **collect factual information on cities' climate action plans and no personal opinions.**

This is completely voluntary and you may say no if you do not want this information used in the study.

With your consent, this interview will be recorded and transcribed. Direct quotes may be used, you will be sent a copy of the transcribed interview in order to redact or clarify anything said in the interview.

Do you still agree to participate in this interview?

To start can you state your name, your current role and how long you have been in that role

Planning:

1. How were stakeholders engaged for the creation of the climate action plan?
2. How is monitoring and reporting done on the progress of the plan and actions?
3. How often is the plan updated?
4. Can you tell me about the planning process ?

Pathways:

5. What sectors does the climate action plan focus on?
6. What actions is your city taking in each sector?
7. Does the plan consider carbon sinks and or carbon offsets?
 - If so, how is your city going about this?

Governance:

8. Describe the governance structure used to implement the climate action plan
9. Is there an overseeing body that actors and partners report to and holds them accountable
10. Describe the means of communication used between the actors and partners
11. How is the local government collaborating with other sectors such as businesses, NGOs, higher levels of government etc?
12. How many external partners/actors are involved in the climate action plan?
 - What are their roles? (Do they determine their own contribution, do they take part in decision making, do they play a consultative role?)
13. What internal city departments are involved in the climate action plan?

- What are their roles?

Tools:

14. Have any new policies been created that are specifically intended to reduce GHG emissions?
15. Is the city using any financial tools to help reduce GHG emissions for example: financial incentives for residents to choose low carbon alternatives
16. Is the local government making any large infrastructure investments that will result in GHG reduction?
17. (How) does the city do public education on climate change issues and/or GHG reduction?
18. How is the local government coordinating with higher levels of government to implement policies for climate action?
19. Where does the funding come from?

Before we finish is there anything else you would like to add or mention?

Do you have any questions for me?

Thank you so much for your time and participation. I really appreciate it.

A copy of the transcribed interview will be sent to you within the next few weeks if you would like to clarify or redact anything you said you are more than welcome to do so

Thanks, have a great day

Appendix 9: Deductive and Inductive Key Words for Cross Case Comparison

Technical Pathways

Energy	Existing Buildings	New Buildings	Transport Mode Shift	Transport Fuel Shift	Waste	Sinks
Target	Target	Target	Target	Target	Target	Target
No target - supporting actions	No target - supporting actions	No target - supporting actions	No target - supporting actions	No target - supporting actions	No target - supporting actions	No target - supporting actions
No target - no action	No target - no action	No target - no action	No target - no action	No target - no action	No target - no action	No target - no action
Installing RE systems	PACE / financial tools (incentives)	Regulation (building code/ Mandate)	Infrastructure Investment	Transit + fleet actions	Waste to energy (bio fuel)	Increase local carbon sink capacity
Building Scale Energy	Regulation	Voluntary standards	Financial incentive/ tools (MBI?)	EV infrastructure	Landfill gas capture	Purchase Offsets
District Energy System	Enabling actions			Financial tools	CCaS system	
			Regulations (car free zone, parking limitations, taxi laws)	Regulations (EV infrastructure in buildings, taxi regulations)	Enabling Actions	

***Enabling actions for waste** – things like education campaigns, increasing services like composting ...

* **Enabling for buildings** – education, advocacy, convening actors, financial tools – incentives, MBIs, Low interest loans, PACE program
Supporting actions for carbon sinks – increasing green spaces

Institutionalization Strategies

Engagement	Long Term Endeavours	Technical capacity & innovation	Funding	Green Economy	Policy Tools	Financial Tools	Governance Mode
Youth Programs	Long term pathway	Technical Scenario Modeling	Higher Government (s)	Business innovation network / accelerator	Policy document	PACE/low interest loan	Self Governing
Climate Change center (a physical place that residents can go to be	Short term strategies	Geo-spatial data	Local Government (tax revenue)	Workforce development / training	Stretch code	Infrastructure investments	Governing Through Enabling

engaged / educated)							
Partner with Education Institutions	Sustainability embedded in other city planning	Technical Report	Private Sector	Green local businesses network	Legislation	Financial incentives	Governing Through Provision
Organized resident engagement program		External consultants	Green Bond/ Local Climate Bank / Investment scheme	Procurement policy	Self regulating*	Grants	Governing Through Authority
Meetings/workshops / events/surveys		Partner with educational institutions	Pension fund investments			MBI	Community Led Actions
Online engagement/ communication application		Increasing internal technical capacity	Lawsuit settlement			Fossil fuel divestment and re-investment	
Community-wide Engagement process for plan development							
Technical experts engagement for plan development							
Higher governments							
Local business network							
Transnational city network							

Governance

Governance Structure	Oversight & Accountability	Collaboration / Partnership Structure	Leadership	Communication	Vertical Integration
Hierarchy/ traditional	City Council	Public-private partnership (action based)	City / City department	Website/Online	Two way
Collaborative	Other		Community Group	Public reports	Top down
Multi Level	GHG inventory - frequency	Cross sector partnerships	Other	Formal meetings	Bottom up
Sustainability department	Progress reports - frequency	Partnerships by sector		Email	

Internal experts	Plan update - frequency			Informal meetings	
	Information made public				

Actors

Actors	Roles
Municipal government	Enabling
Businesses / private sector	Coordinating
NGOs	Facilitating
Local stakeholders and community groups	Regulating
Education institutions	Decision maker
	Implementation partner
	Funding