

## Article

# Strategies and Governance for Implementing Deep Decarbonization Plans at the Local Level

Samantha Linton <sup>1</sup>, Amelia Clarke <sup>1,\*</sup> and Laura Tozer <sup>2</sup>

<sup>1</sup> School of Environment, Enterprise & Development, University of Waterloo, Waterloo, ON N2L 3G1, Canada; shlinton@uwaterloo.ca

<sup>2</sup> Department of Physical and Environmental Sciences, University of Toronto Scarborough, Toronto, ON M1C 1A4, Canada; laura.tozer@utoronto.ca

\* Correspondence: amelia.clarke@uwaterloo.ca

**Abstract:** This study qualitatively explores eight cases of best practice cities that are leading the way towards deep decarbonization. Local governments and stakeholders are developing short-term strategies and long-term pathways towards deep decarbonization at the local level but are struggling to determine effective actions. In this article, we examine cities pursuing deep decarbonization to provide insights into the strategies and governance structures that eight leading local governments are using to develop and implement deep decarbonization plans. The cases are in Canada (Bridgewater, Guelph, Vancouver and Toronto), the USA (Park City and New York City), Finland (Lahti), and Norway (Oslo) and range from very small (8.4 thousand people) to very large (9.6 million people). For each city, their implementation strategies are detailed under four categories: engagement; green economy; policy tools; and financial tools. Governance mechanisms and modes are explained regarding coordination; oversight and reporting; communication; multi-level integration; cross-sector collaboration; funding, and mode. While a number of these approaches and tools have been identified in previous research and grey literature, the findings show that leading local government plans continue to develop innovative strategies on their own and also share their successes with other communities through transnational networks. The cases examined in this study are moving beyond the incremental approach to mitigating greenhouse gases and are innovating to find applied methods for achieving transformative change. The findings from this study are useful for practitioners and academics working on climate mitigation, strategy implementation, cross-sector partnerships, and sustainable cities.

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## 1. Introduction

Recognizing the need for urgent climate action, local governments and stakeholders are developing short-term strategies and long-term pathways towards deep decarbonization at the local level [1], which are documented in community climate action plans [2]. Cities are crucial to effective climate action since urban areas are the largest place-based source of greenhouse gas emissions (71–76% of global emissions) and local governments have control of over 52% of emissions that occur within their municipalities [3–6]. Local governments face many challenges as they work to implement their strategies for decarbonizing urban systems [1]. Effective decarbonization action requires rethinking institutional structures, operational plans, and budgets, including the way in which local governments work with the community and business sectors [1].

While enabling factors for local climate governance have been identified, it is challenging to understand outcomes because there is no single measurement or indicator that best captures them [7–9]. The consensus in the urban climate governance literature is

that these enabling factors work in conjunction to create trajectories and pathways that can lead to effective urban climate governance, but they are not sufficient alone [9]. There is still a gap in knowledge pertaining to the strategies and governance structures that are best for implementing climate action plans at the local level.

Our objective in this paper is to examine best practice examples of the strategies and governance structures that eight local governments are using to develop and implement deep decarbonization plans. This paper highlights good practices and lessons learned from the cases in order to share insights with researchers and practitioners. The eight chosen cities have all committed to ambitious climate mitigation of 80% to 100% reduction in greenhouse gas emissions (GHGs) by 2050 or earlier. We compare the strategies and governance structures recommended for local climate mitigation action in academic and grey literature to those described in the deep decarbonization plans of leading local governments in order to identify innovative implementation strategies and governance approaches for urban deep decarbonization. By examining these case studies, this paper highlights key strategies that can be further developed and implemented in a wider variety of communities.

It is important to note that deep decarbonization by definition involves a systematic transformation of society. Transformation here means having net-zero GHGs from urban systems while also considering broader sustainability goals such as climate adaptation and social equity [10,11]. Much of the current literature on climate action at the local level takes an incremental approach to GHG mitigation. This study looks at case studies of cities attempting transformational shifts to eliminate fossil fuels and compares their climate change mitigation strategies to those recommended in the literature.

This paper begins by summarizing the current knowledge on deep decarbonization strategies and governance mechanisms at the local level, followed by the methodology for the data collection and analysis. The results from the data collection are presented next, followed by a detailed discussion of the analysis, and lastly, the conclusions and future research.

## 2. Literature Review of Deep Decarbonization Strategies and Governance

Decarbonization means overcoming carbon lock-in to eliminate fossil fuel use and reduce greenhouse gas emissions to zero [12,13]. It is a complete transformation of the systems and technologies that rely on fossil fuels and requires a rethinking of institutional structures [10,14]. It can use a polycentric approach to tackling climate change, where mitigation activities are undertaken by many actors at many levels [15,16]. For the purposes of this article, local deep decarbonization is defined as pursuing 80–100% reduction in greenhouse gas emissions and integrating net-zero carbon into urban systems. Cities must not only develop technical pathways to decarbonize the main emitting sectors, but they must also develop strategies to implement actions that will embed it in institutional frameworks and steer the local economy towards a low-carbon one [1]. We review academic and grey literature to identify key categories in the institutionalization and implementation of deep decarbonization plans. We have grouped these categories into two main areas—strategies and governance.

### 2.1. Strategies for Local Climate Action

The first key category in local deep decarbonization strategies is engagement, which helps to strengthen and sustain local political will for long-term systemic transformation [1,17,18]. Meaningful engagement involves getting input from a wide variety of stakeholders, maintaining constant and meaningful communication, promoting education campaigns, being transparent, as well as encouraging and celebrating stakeholders' actions during both the development and implementation phases [18,19]. Inclusive stakeholder engagement can generate a sense of ownership, encourage cross-sectoral collaboration, spark complementary action, increase awareness, and build capacity [17,18]. It can also enable partners to help with implementing a community-wide

strategy [20]. Another form of engagement is advocacy, where 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 [1,21,22]. Participation in regional, national, and international networks of cities that promote climate action can help cities in their decarbonization processes [1,18,23].

Economic development tied with sustainability and the notion of a “green economy” has emerged at the center of climate action planning [24]. Green economy is therefore a key category in local deep decarbonization strategies and is defined as “[an economy] that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities [25]. In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive” [26]. Although there has been a lack of functional synergies between mitigation efforts and local development priorities in the past [27], cities can use strategies to achieve green economies, such as supporting clean technology development, developing circular economies, integrating climate considerations into the city’s economic plan, and other climate action initiatives [24]. 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 [24]. Local governments can also support market transformation and help to 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 [18].

Financial tools refer to the tools that local governments can use to encourage citizens to choose low-carbon options and lower community-wide GHG emissions [28]. 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-emission options [29,30]. 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 [29,31]. Local governments can also use direct investments in equipment and infrastructure that lead to a reduction in carbon emissions as a financial tool [1,30].

Policy tools are key strategies that can be implemented by all levels of government. These tools can be used to directly or indirectly reduce GHG emissions [32]. They can set limits on emissions or emission intensities, create price signals to incorporate externality costs, and influence purchasing decisions [33]. 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 [32–34]. Policy tools must be flexible, transparent, and collaborative in order to yield legitimate social acceptability and deepened trust among parties [22,34]. Not all policy tools are accessible to local governments and actors because of the limited jurisdiction of municipal governments [1]. Local governments can lead by example by setting policies and regulations for corporate-owned assets and local government operations. Through self regulation, local governments can model the actions and behaviour for their residents [1].

## 2.2. Governance of Local Climate Action

Within the local context, the 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” [35]. Given our focus on local government deep decarbonization

planning, here, we consider key categories related to governance structures within local government and cross-sector collaboration. A governance structure or framework refers to how power and decision-making is distributed within an organization [36]. Nguyen, Davidson, and Gleeson (2018) conducted a study that suggests that a local government's governance structure influences the way it in which undertakes climate actions and the potential efficacy of those actions [37]. Emerging frameworks for urban climate governance also address the importance of a multi-actor approach and vertical and horizontal coordination [38].

A key category is the coordination structure within the local government. Grey literature recommends that local governments clearly locate the authority of climate planning in a way that commands attention across local government departments and is in close contact with the elected leadership [1]. Two approaches exist for the creation and implementation of climate action plans: first, a dedicated unit that is in charge of climate change policy can be established within each climate-relevant department [39]. This approach means having climate-related capacities built in to each local government division or department. The second approach relies on a form of climate policy steering group, or an overarching unit to mainstream climate change policy within local government planning. Given the limited availability of staff in many municipalities, this second approach appears to be more promising [27,39]. 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 [18,39]. Centralized climate change teams can help to ensure that all key departments can provide input into the plan and create a sense of co-ownership over the final product [18]. An overarching climate change team can help to support other departments to integrate climate action objectives into their own plans and help to pave the way for innovative and constructive partnerships during implementation [18]. It is critical that sustainability or climate change agencies have the competencies to implement comprehensive concepts or they risk coordination and implementation problems [39]. Aylett (2014) found that in 63% of the cities that 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. Globally, there was a general dominance of integrative and collaborative mitigation planning processes over more isolated and siloed approaches [27]. Building internal networks between departments is the most effective strategy for encouraging inter-departmental engagement with climate change [27].

Oversight and reporting is a crucial part of climate action planning and implementation [40]. 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 contact with the elected leadership [1]. Climate action plans should include a monitoring and evaluation framework, along with key performance indicators for measuring progress that lead to updates for the actions [1,18,23,40,41]. Effective monitoring includes the tracking of progress towards targets, as well as outcomes [18]. Regularly monitoring progress and updating plans can help local governments to reflect the latest climate science, technological developments, financial situations, and development capacities [18]. Robinson and Gore (2015) found that municipalities in Canada are implementing more emission-reducing activities than formal monitoring revealed [41]. With the rapid increase in popularity for data-driven climate policy, it is important to note that this approach can enhance accountability but also risks a focus on satisfying metrics instead of transformation to achieve decarbonization [42].

Clear, open, and continuous communication throughout the governance structure is vital [43]. As local governments must coordinate and collaborate with multiple actors, formalized communication structures are important in the climate action planning process [1]. Building sustainable and resilient cities and communities also depends on strong leadership and clear and open communication [43].

Multi-level integration has been highlighted as one of the key attributes of urban climate governance [44,45]. Multi-level integration implies whether the climate action strategies of local governments are integrated with the different activities and/or strategies at the national or sub-national levels of government [44,45]. 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 [41]. Hammer et al. 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 [45]. This has drawn attention to the multi-level governance systems and networks in which cities are integrated. In order to pursue mitigation actions effectively and efficiently, cities need the support of other levels of government [46]. Working in a multi-level governance framework with 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 [46].

Cross-sector collaboration has also been identified as a key attribute of urban climate governance. Cities that take a collaborative approach to the governance of their climate action plans deliver twice as many actions as those that implement through an approach not based on partnerships [47]. The idea of using collaborative strategies to tackle issues such as these has gained momentum as demand for climate action increases [48,49]. Local governments are often more successful in delivering climate action when they coordinate with other actors from the private sector and civil society [47,50]. 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 [47,51]. Numerous cross-sector partners and voluntary actions are needed to implement a local climate action plan [20]. Cross-sector partnerships and collaborative governance structures are very important in the implementation of climate action plans [52]. Collaboration between sectors and in governance arrangements has been proven to result in more actions taken and higher rates of success in terms of reaching long-term targets [47]. The core idea behind collaborative governance is non-governmental and private sector stakeholders working with governments and/or across sectors for collective action and collaborative planning [53]. 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 [54].

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 [1]. Local governments can apply traditional methods of funding for their climate action plans and/or develop new funding mechanisms in order to raise the money required for plan implementation [1]. Traditional funding mechanisms include using tax revenue/local government budgets and partner/sponsor grants. Innovative funding sources include carbon tax/cap and trade systems, green bonds, insurance, and financing pricing [1,55].

A key category related to local climate action governance relates to the modes of governance, which 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 [56]. The modes of governance reflect the approaches 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 [39]. 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 [39]. 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, and projects to encourage and support action are most important for this mode of governing [18,39]. Governing by provision refers to the delivery of services and resources. This is accomplished through infrastructure and financial means [39]. 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) [18]. 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 [18,39]. These modes of governing may overlap and individual measures are often based on a combination of several modes [39].

### 3. Methods

Case study selection was based on the ambitiousness of community-wide climate targets in terms of % of GHG emissions to be mitigated by 2050 or earlier. In order to select the cases, the Carbon Disclosure Project (CDP) Cities 2019 database was used. This database provides a global platform for cities to report and disclose information on climate action plans and achievements to date [57]. CDP collaborates with the Global Covenant of Mayors for Climate and Energy, C40, ICLEI—Local Governments for Sustainability and other organizations working towards climate action at the local level—for a total of over 800 cities being represented. The database includes information from a voluntary questionnaire that city representatives fill out annually. This database provides streamlined and comparable information and presents a unified platform for reporting [57].

Eight case studies were chosen for this study, four Canadian cities and four international cities. This study was co-designed with ICLEI Canada—Local Governments for Sustainability. Given this partnership, an emphasis was placed on the Canadian context. Of the 17 Canadian cities that reported to the CDP in 2019, four were selected as case studies. International cases were then selected based on criteria such as comparable population sizes, ambitiousness of GHG mitigation targets, and economic development. Four different population categories were determined (small, medium, large, and very large), with one Canadian case and one international case fitting in each population size category.

The following table summarizes the eight cases that were chosen, along with their population sizes and the overall GHG reduction goal (percentage and date). Table 1 summarizes the cases selected for this study as well as their long term GHG reduction targets.

**Table 1.** Case study selection.

<b>Canadian Cases:</b>		
Bridgewater, Nova Scotia	8532	80% reduction by 2050
Guelph, Ontario	131,794	100% reduction by 2050
Vancouver, British Columbia	642,868	100% reduction by 2050
Toronto, Ontario	2,929,886	80% reduction by 2050
<b>International Cases:</b>		
Park City, Utah, United States	8376	100% reduction by 2030
Lahti, Finland	120,028	80% reduction by 2025
Oslo, Norway	673,469	95% reduction by 2030
New York City, New York, United States	8,622,700	80% reduction by 2050

The data collection and analysis began with document content analysis and was followed up with semi-structured interviews with representatives from the case cities. Information from publicly available sources such as online documents, reports, and

articles were collected and analyzed for information pertaining to the strategies and governance mechanisms and were used to develop the background for each case study. Other documents such as peer-reviewed journal articles, newspaper articles, third party-reports, and studies were also considered [58]. The CDP 2019 Cities database was also a key source of information for the data collection as all of the case studies voluntarily provided a set of standardized data in the form of answers to a questionnaire.

Interviews were conducted with representatives from five of the case cities in order to gather information that was not available from public sources. For three of the cases, it was determined that there was enough publicly available information and they did not warrant an interview.

Key representatives from the five cases were identified during the document analysis phase and were initially contacted by email. The recruitment emails contained a recruitment letter and an information letter. Once a willingness to participate in the research study was established, an interview guide was developed specifically for each case study based on information that was unavailable in public documents. The interview guides were sent to the participants prior to the interview. Interviews were recorded and transcribed and then coded for content related to strategies and governance mechanisms. Each case was considered separately for each strategy and governance mechanism; then, a cross-case comparison was completed to see trends and consider city size.

#### 4. Results

In this section, we examine best practice examples of the strategies and governance structures that eight local governments are using to develop and implement climate action plans. Our literature review identified eleven categories that are recommended by grey and academic literature as key strategies and governance approaches for local climate change mitigation action. We categorize the content of the deep decarbonization plans according to these eleven categories. These strategies and governance approaches can be further developed and implemented in a wider variety of communities.

Below are key examples of the actions and strategies that are outlined in the climate action plan documents and/or discussed during the interviews with representatives from the case study cities.

##### 4.1. Strategies

###### 4.1.1. Engagement

**Bridgewater:** Community-wide engagement for plan development was completed over an 18-month period including input from an advisory committee composed of community stakeholders. Community-wide educational activities are led by the Bridgewater Energy Partnership. The town works with higher levels of government to advocate for more climate action initiatives and challenges local businesses to adopt actions outlined in their plan, entitled Community Energy Investment Plan (CEIP). Bridgewater is also a member of ICLEI Canada's Partners for Climate Protection program, a network of Canadian municipalities taking action against climate change.

**Park City:** The city conducted a community-wide, three-phase visioning process during stakeholder meetings. The city organizes monthly talks and events to educate residents about climate action and the climate action plan. Through their leading role in developing the Community Renewable Energy Act, the City uses advocacy actions to engage the State government of Utah in community climate action. Park City has partnered with and is a member of several transnational city networks: Global Covenant of Mayors (GCoM), ICLEI USA, and The Climate Reality Project.

**Guelph:** The Community Energy Initiative update was written by Our Energy Guelph (OEG), a community group composed of many stakeholders. OEG consulted with the community for the plan creation. OEG is largely responsible for plan implementation; the community group engages stakeholders at all levels for implementation of actions.

OEG advocated to the local government, the provincial government, as well as community stakeholders to adopt more climate actions. Guelph is a member of ICLEI Canada's PCP program.

**Lahti:** For stakeholder input and plan development, the City of Lahti uses a mobile application called the Porukka app, which is used to gather ideas and feedback from residents in a manner that is cost, energy, and time efficient. Lahti is a member of the EU Covenant of Mayors initiative.

**Vancouver:** Community-wide engagement was done for plan development; over 46,000 people were included in the process. The city has many community-wide engagement programs for resident education, including programs for students. The city uses social media, newsletters, and courses offered at community centers. The city has also created an Award of Excellence for individuals and organizations that make achievements towards reaching Vancouver's targets. The city is also part of several transnational city networks, including C40 and the Carbon Neutral Cities Alliance (CNCA).

**Oslo:** Oslo's Climate and Energy Strategy was developed in dialogue with the involvement of the business community and state-owned enterprises in five sector groups (transport, energy, buildings, resource utilization, and cross-sector energy issues). The city leads information and educational campaigns about climate change, particularly for children in schools, with their online education portal called "Climate School". The city works with Climate House, which is a physical place where residents can go to learn about climate change and what they can do. Oslo participates in multiple transnational city networks, including C40 and CNCA.

**Toronto:** 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. Live Green Toronto Outreach Program participated in over 400 events between 2017 and 2018 and uses social media for public awareness. Toronto participates in transnational city networks including C40 and CNCA.

**New York:** For the plan development, 17 focus group meetings were held with more than 100 technical and policy experts. 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 to meet its ambitious sustainability goals. The program includes a multitude of engagement activities and resources for New Yorkers to get involved with climate action in the city and uses mass social media to engage with residents. New York City participates in multiple transnational networks such as C40 and CNCA.

#### 4.1.2. Green Economy

**Bridgewater:** The CEIP is an economic development strategy with sustainability goals embedded into it. The town is working to develop more sustainable purchasing practices.

**Park City:** The city is changing its procurement policy in order to reach climate action targets.

**Guelph:** OEG works with local businesses through the Guelph Energy Managers programs, helping and encouraging innovation and "greening" of business practices.

**Lahti:** The city is changing the Public Procurement Policy to reflect the targets of the Sustainable Energy and Climate Action Plan (SECAP). There is heavy focus on the circular economy in the City Master Plan and the city is developing actions such as developing a circular economy map for the city, borrowing programs for residents, and improving construction standards and waste recovery programs.

**Vancouver:** Vancouver has a specific green economy target in the Greenest City Action Plan. The goal is to double the number of green jobs and businesses by 2020. The



city will also launch a clean tech accelerator, partner with educational institutions, and support trades training to develop a workforce that will expand the green economy.

**Oslo:** The Climate and Energy Fund helps to encourage innovation in the green tech sector by providing funding for projects. The city will intensify efforts to promote fossil-fuel-free and zero-emission construction practices among developers in the public and private sectors. The city has also increased its procurement guidelines to be more environmentally friendly.

**Toronto:** 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. 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.

**New York:** The city works closely with the private sector and unions to increase the development of a green workforce. They provide programs for industry on energy efficiency technologies and strategies.

#### 4.1.3. Policy Tools

**Bridgewater:** The town is looking to review its Municipal Planning Strategy and include policies identified in the CEIP.

**Park City:** There is a net-zero performance standard for city-owned buildings and there is also a city-wide ban on plastic bags.

**Guelph:** OEG makes policy change recommendations to City Council to achieve the Community Energy Initiative (CEI) targets. Guelph City Council has committed to the climate targets and will be shaping local policies in accordance with the targets set out by the CEI.

**Lahti:** Policies are being implemented at the local government level, such as energy efficiency regulations for municipal buildings.

**Vancouver:** Vancouver has introduced an energy bylaw for existing buildings (the first in Canada) and a stretch code for all new buildings. By 2030, all new buildings will be zero-emission and embodied emissions will be reduced by 40%.

**Oslo:** The Carbon Budget is a key regulatory and governance tool that ensures that all Oslo's agencies assume responsibility for climate initiative, though the majority of regulations are set at the national level.

**Toronto:** 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 Zero Emissions Buildings (ZEB) by 2030.

**New York:** The Climate Mobilization Act, enacted in 2019, uses legislation for climate action. It includes a slate of laws designed to dramatically cut GHG emissions in the city. Laws include green roofs, building energy efficiency grade, Property Assessed Clean Energy (PACE) program, buildings mandate, 80 x50 target, long-term energy plan, and a climate action executive order [59].

#### 4.1.4. Financial Tools

**Bridgewater:** The town has implemented a PACE Program and is looking to develop a local clean energy investment system.

**Park City:** The city has started a PACE program for commercial buildings and has also waived fees for permits associated with energy efficient construction. The city provides free public transit as well as free charging for electric vehicles.

**Guelph:** The local government is investing in climate-friendly infrastructure such as bike lanes, electric buses, and electric vehicle (EV) charging infrastructure. OEG is looking into 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 Retirement Saving Plan (RSP) eligible, so residents can invest part of their retirement savings in local climate initiatives.

**Lahti:** The local government along with its partners (City Group) have made large infrastructure investments, including a EUR 180 million bioenergy plant. The local government is utilizing financial tools offered by the national government rather than creating their own. In partnership with the local technical university, the city has developed a personal cap-and-trade system for transportation. The CitiCAP Program allows residents to record their daily transportation habits, and they are rewarded for using low-carbon transportation such as walking/biking and using public transportation.

**Vancouver:** The city is investing heavily in climate-friendly infrastructure. For residents, Greenest City Grants are offered for projects that take action towards meeting the GCAP goals. The city also offers energy retrofit incentives for windows and building envelopes.

**Oslo:** Oslo is making large infrastructure investments such as active transit routes, carbon capture and storage systems, and electric vehicles for fleet and transit. The city provides subsidies through the Climate and Energy Fund that will facilitate the implementation of measures by private individuals and businesses to help to reduce GHG emissions and use energy more efficiently. Oslo has an extensive road user payment system where most of the revenue is reinvested in public transit systems. The city is divesting from fossil fuels in the pension fund.

**Toronto:** The city is investing heavily in climate-friendly infrastructure such as public and active transit. The city provides many grants and financial incentives for residents and organizations to take on green projects. 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.

**New York:** The city is investing over USD 20 billion in infrastructure such as better public transit, bike lanes, safe pedestrian infrastructure, and better buildings. The city will be introducing congestion pricing to reduce traffic and generate funds for the improvement of public transit systems.

Table 2 summarizes the commonly used strategies being employed and which case cities are using them.

**Table 2.** Strategies.

Category	Actions	Cities
Engagement	Stakeholder Engagement—Plan Development	All
	Stakeholder Engagement—Plan Implementation	Guelph
	Engaging Technical Experts	All
	Participating in Transnational/City Networks	All
Green Economy	Greening Public Procurement	All
	Targeting Green Jobs	Vancouver
	Green Jobs as a Co-Benefit	Bridgewater, Vancouver, Oslo, Toronto, NYC
	Targeting Green Businesses	Guelph, Vancouver
	Workforce Training	Vancouver, NYC
Policy Tools	Self-Regulation	All
	Command and Control Regulations	Vancouver, NYC
	Voluntary Actions	Bridgewater, Park City, Guelph, Lahti, Toronto
Financial Tools	Market Based Instruments	Park City, Lahti, Oslo, NYC
	Infrastructure Investments	All
	Financial Incentives	Bridgewater, Park City, Guelph, Vancouver, Oslo, Toronto, NYC,
	Divesting Pension Funds	Oslo, NYC

## 4.2. Governance

### 4.2.1. Coordination

**Bridgewater:** Climate action implementation is distributed across relevant city departments.

**Park City:** A two-person sustainability team plays a leading role in climate action planning. They collaborate with other departments to implement climate actions.

**Guelph:** A collaborative governance structure where the city and OEG work together to develop and implement the plan. Guelph City Council has adopted the plan and will shape policy and strategies to reflect it.

**Lahti:** 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. Plan creation and coordination is done through the Sustainable Development Department. This department is also responsible for recruiting other departments for actions directly related to the SECAP.

**Vancouver:** The Greenest City Action Plan (GCAP) embeds responsibility for meeting the defined targets within city departments where the specific expertise lies. Each of the 10 goals for the GCAP have both internal and external committees for the implementation of actions related to that goal. For internal collaboration, there is 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.

**Oslo:** 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 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; it provides a sense of cross-municipal ownership of climate action.

**Toronto:** The Environment and Energy Division is responsible for the coordination and the preparation of the TransformTO plan. All relevant city departments (Transportation, Waste Management, Planning, Fleet Services) have their own strategies that align with the targets and each of these departments plays a leading role on their own actions

**New York:** The NYC Mayor's Office of Climate Policy and Programs (CPP) leads New York City's fight against climate change and manages OneNYC 2050; the 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 80 x 50 pathway and the OneNYC plan.

### 4.2.2. Oversight and Reporting

**Bridgewater:** The plan is overseen by the Town Council, with GHG inventories taken every 2 years and updates to the CEIP done every five years.

**Park City:** A municipal carbon footprint is calculated annually.

**Guelph:** The board of directors of OEG oversees the progress of the CEI and they report to Guelph City Council quarterly. GHG inventories are taken annually and the overall plan is updated every five years.

**Lahti:** The City Board (Council) oversees progress on actions. GHG inventories taken every four years and biannual Environmental Balance Sheet is done including a progress report and strategy follow-up.

**Vancouver:** The City Manager and City Council are the main overseers and the Sustainably Department is in charge of monitoring and reporting. GHG inventories are calculated annually in the buildings, transportation, and waste sectors and the GCAP is updated every five years.

**Oslo:** The City Council has overall responsibility for monitoring and implementing the climate measures. The city has developed a “Climate Barometer”, a monitoring and oversight tool that helps to keep all actors and actions on track. It has 14 indicators that are updated quarterly on the progress of the Climate Budget, identifying the need for increased action in specific sectors. New Climate Budgets and GHG inventories are published annually.

**Toronto:** The City Council oversees progress on TransformTO. Every four years, a report including a GHG inventory, co-benefits of actions, public engagement levels, amount of financial and other resources mobilized, progress on the actions, and any revisions and additions to the actions is submitted to City Council.

**New York:** The City Council is the legislative body of local government that oversees the implementation of local laws. There are annual GHG inventories and progress reports submitted to the Mayor’s office and the OneNYC plan is updated every four years.

#### 4.2.3. Communication

**Bridgewater:** Communication is facilitated by the town’s Chief Administrative Officer. There are regular meetings held between city departments, though communication can at times be informal.

**Park City:** The sustainability team facilitates communication with other city departments, through meetings, emails, and reports to the Council.

**Guelph:** OEG board meets every six weeks; subcommittees for each of the actions report to the board.

**Lahti:** The Sustainable Development Department facilitates communication with other city departments. Communication occurs through an internal city website, email, regular meetings, and other informal communication.

**Vancouver:** The City of Vancouver has a cross-department team to share information on progress and challenges regarding plan implementation that meets quarterly. The city has an internal website dedicated to green operations; it also provides a online course for city staff, and there is also an internal newsletter that discusses sustainability actions and topics. Dissemination of information to the public is through GCAP and Climate Emergency Plan progress reports, website, education, and engagement programs.

**Oslo:** The annual climate budget and the climate barometer are documents that communicate the progress of every indicator. The Oslo Agency for Climate coordinates and facilitates climate work in the city; the agency works to coordinate the city departments/agencies and facilitates communication internally.

**Toronto:** Communication to the public via progress reports and documents as well as community-wide engagement and education campaigns and social media. The Energy Division coordinates with other departments and facilitates communication on TransformTO progress.

**New York:** OneNYC website and open data portal are available to the public for transparency and to keep NYC residents involved in the actions.

#### 4.2.4. Multi-Level Integration

**Bridgewater:** There is provincial legislation that makes Municipal Climate Change Action Plans mandatory in Nova Scotia, though Bridgewater’s plan exceeds provincial standards.

**Park City:** Park City has taken a bottom-up approach to the integration of climate policies, through their work on the Community Renewable Energy Act. This bill will support other municipalities in Utah who want to integrate more renewable energy.

**Guelph:** 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 such as Guelph and the provincial agenda.

**Lahti:** The Finnish national government has set ambitious climate action targets and many national policies support local climate action as well.

**Vancouver:** City strategies are aligned with others at the regional (Metro Vancouver) and provincial levels. The provincial carbon tax is a good example of multi-level 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.

**Oslo:** The national government and the Oslo municipal government work together on integrating policies; many of them are introduced at the national level.

**Toronto:** 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.

**New York:** The State and the City work together closely and the city plays a large role in advocacy to the state for climate action; the federal government plays a small role in imposing climate regulations since it announced that it would back out of the Paris Agreement.

#### 4.2.5. Cross-Sector Collaboration

**Bridgewater:** Collaboration is practiced through the Energize Bridgewater entity, which includes over 50 partners from various sectors. Bridgewater is in the process of creating an Energize Bridgewater Advisory Committee, which will be a forum for the town to engage with and support the energy poverty reduction program and the CEIP.

**Park City:** The local government partners with local businesses and NGOs to implement specific actions.

**Guelph:** There is extensive collaboration between many diverse community groups, businesses, and city government for the CEI and the 2050 Pathway. OEG has created task forces for each of the actions composed of diverse stakeholders with expertise in the field.

**Lahti:** The city collaborates with City Group, which is a group of companies (including district heating, waste management, and utilities) that are partially or wholly owned by the city for the implementation of climate actions.

**Vancouver:** Internal and external advisor groups for each of the ten goals in the plan coordinate the actions and provide expertise.

**Oslo:** The Oslo Agency for Climate coordinates and facilitates collaboration between all the local government agencies and external actors for the Climate Budget and implementation actions.

**Toronto:** Partnerships have been developed with external actors working in separate sectors—each sector partnership has a different agreement model to work on various projects. Partnerships are separated by sectors and/or specific actions.

**New York:** There is city-wide collaboration for implementation of actions. Partnerships are developed surrounding a specific sector.

#### 4.2.6. Funding

**Bridgewater:** The local government will raise over CAD 400 million to implement the plan. The town will use tax revenue and funding from provincial and federal governments.

**Park City:** Through the public private partnership with Rocky Mountain Power, the city receives funding for renewable energy projects. The city allocates funding from tax revenue and has created open space bonds to protect 8000 acres of land.

**Guelph:** The local government provides funding for climate initiatives and operation funding for OEG. OEG is looking into a community-funding model “local climate bank” for the majority of capital. Higher levels of government also provide funding through various programs.

**Lahti:** Funding for projects comes from various sources such as the EU, the National Government, partner organizations (City Group), and the City of Lahti.

**Vancouver:** The majority of funding comes from Vancouver's tax revenue. Municipalities in British Columbia pay the province's carbon tax but are refunded the money if they fulfil certain environmental requirements. This refund provides an extra 1 to 1.5 million dollars annually for climate action in the city.

**Oslo:** Funding for the actions outlined in the climate budgets comes from the national government, City Council, and through public/private partnerships.

**Toronto:** The City Council in February 2018 fully funded the implementation of the TransformTO 2017–2020 short-term strategies. A CAD 300 million green bond program was established in 2018 to fund climate actions in the city. The city also receives external funding from the provincial and federal governments.

**New York:** Capital for each of the actions comes from one or several of the following entities: city agencies, state agencies, federal government, private sector. The city has committed USD 4 billion in city pension fund investments for projects in renewable energy, energy efficiency, and other climate change solutions. Several green bonds have been issued in different sectors (including a sustainable neighbourhood bond and several climate certified bonds from the Metropolitan Transit Authority (MTA) for low-carbon transportation). The City of New York has filed lawsuits against polluters—namely Volkswagen 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 VW case was successful, though the case against the five large oil companies was rejected. The city will continue to look for settlement funding in this manner.

#### 4.2.7. Modes of Governance

**Bridgewater, Park City, Guelph, Lahti, and Oslo:** The local government uses self-governing, governing through enabling, and governing through provisioning to implement climate actions.

**Vancouver, Toronto, and New York:** The local government uses self-governing, governing through enabling, governing through provisioning, and governing through authority to implement climate actions.

Table 3 summarizes the categories for governance arrangements and which cases are developing governance mechanisms for each of the categories.

**Table 3.** Governance.

Category	Actions	Cities
Coordination	Centralized Sustainability Department	All
	Internal (Cross-Department) Collaboration	All
	Climate Lens in all Departments	Bridgewater, Vancouver, Oslo, Toronto, NYC
	Multi-Stakeholder Entity Co-Leads Coordination with City	Guelph
Oversight & Reporting	Overseeing Board/Council	All
	Regular Interval Reporting System	All
Communication	Internal Communication Structures	All
	Communication with Public	All
Cross-Sector Collaboration	City Engages Partners	All
	City Engages a Multi-Stakeholder Entity/Committee	Bridgewater, Guelph, Lahti, Vancouver, Toronto, NYC
Multi-Level Integration	Two-Way Integration	Bridgewater, Guelph, Lahti, Vancouver, Oslo, Toronto
	Bottom-Up Approach	Park City, NYC

Funding	Tax Revenue	All
	Higher Levels of Government	All
	Partnerships/Private Sector Investment	Park City, Lahti, Vancouver, Toronto, NYC
	Innovative Funding Mechanisms	Park City, Vancouver, Oslo, Toronto, NYC
	Self-Governing	All
Modes of Governance	Enabling	All
	Provisioning	All
	Authority	Vancouver, NYC

## 5. Discussion

The eight case studies employ many of the strategies and governance structures recommended by the academic and grey literature to govern deep decarbonization. Our analysis also reveals that these leading local governments are pursuing innovative strategies and governance approaches for deep decarbonization

### 5.1. Strategies

Strategies are being used to help to implement climate action plans and local government are finding innovative ways to improve upon the strategies described by previous research. Table 2 provides a summary of the strategies section of the results, while the following section will discuss the details of the results.

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 and 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 of 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. In addition, 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.

Furthermore, 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. 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—Local Governments for Sustainability's program is for small to medium-sized 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 towards its own needs.

When it comes to fostering a green economy, cities are leading by example though 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

as a co-benefit. 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 such as 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.

In terms of enforcing regulation and creating policy at the local level, 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 to regulate corporate emissions (self-regulate) in the sectors that they control directly [1]. Local governments can develop strategies to model the behaviour that they envision for the community as a whole [1]. 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 include command and control regulations, removing barriers, and voluntary approaches [29]. This study found examples of 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.

Cities are providing financial incentives and using market-based instruments to encourage residents to decrease their personal carbon footprints, especially in the sectors in which the city has the least authority (for example, the transportation and building sectors). Financial tools can be market-based (for example, taxes or removing perverse incentives) [29] and non market-based (for example, investing in low-carbon infrastructure) [1]. For the transportation sector, Oslo and New York have implemented road pricing (NY's congestion pricing strategy is still under review and will potentially come into effect as early as 2021). Park City has implemented free public transit, free EV charging, and is increasing parking prices. Lahti offers free public transit to school children along with the CitiCAP program that incentivizes residents to use active or public transit. 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-emission 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.



## 5.2. Governance

The case study cities are developing a variety of governance structures. Local governments are increasing their internal capacity for action and collaborating both internally and externally. Their experiences validate the notion that collaboration is key. Table 3 summarizes the governance structures and mechanisms from the results section; the following section will discuss those results.

In terms of coordination efforts within local governments, the results demonstrate that all of the cities have a sustainability/climate action 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 climate actions 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.

Other city departments have not consistently been involved in climate action planning processes. Bassett and Shandas (2010) found that plans were generally spearheaded by public works, environmental services, and/or sustainability bureaus. External consultants, including ICLEI—Local Governments for Sustainability, played roles. However, planners and other city departments/workers appear to have been called in to participate in task forces and to contribute their traditional expertise [19]. While this seems to be the case for the smaller municipalities in this study, cases such as Vancouver have distributed ownership of climate actions across the local government departments and integrate climate considerations to their day-to-day activities.

While roles in urban climate action are distributed vertically and horizontally, local governments do not necessarily formally recognize the 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 exemplify the importance of cross-sectoral action and show that quite a large portion of the action that needs to take place to achieve the techno-economic pathways are actions that need to be taken by non-state actors. The only formal governance structure with decision-making power for non-state actors is Our Energy Guelph, which is the only community-led governance structure among the case studies and has a multi-stakeholder board of directors. For each sector in the plan, the organization OEG assembles a task force, accumulating specific expertise for each of the goals.

The results demonstrate that all of the case cities have oversight and reporting structures 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, as with 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 emission trends. Other cases have annual or bi-annual reporting structures, which, as the City of Oslo points out, may result in slower reaction times and thus failing actions and or less accountability for the local government to reach the targets it has set.

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 was 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 mechanisms.

Cities that engage in cross-sector collaboration across the public, private, and third sectors typically have better results and outcomes [47,52]. 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 and also the importance of engaging relevant stakeholders in implementation. 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.

Multi-level integration leads to success in urban climate action, as it brings policies from different levels of government together to avoid policy gaps [44,45]. 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-up 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 in which 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.

The results demonstrate that cities are mainly using traditional forms of funding, using tax revenue, funding from higher levels of governments, or funding arranged through partnerships. The results show that several cases are encouraging private investments as a means of funding through public-private partnerships (e.g., 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, such as

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 innovative 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. Our Energy Guelph is investigating the feasibility of a community funding model called a local climate bank, where residents can make RSP (Retirements Savings Plan) eligible investments in local climate initiatives. New York City notes in the OneNYC plan that financial support from the national level has decreased substantially over time, resulting in a need to create 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. For example, 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 city continues in this legal battle by appealing a court decision to dismiss the case in 2019.

Corroborating findings from previous research, we also found that cities use a combination of different modes of governance throughout the planning process [39]. Local governments 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 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.

## 6. Conclusions and Future Research

We examined best practice examples of cities pursuing deep decarbonization to provide insights into the strategies and governance structures that eight leading local governments are using to develop and implement deep decarbonization plans. This study highlights that best practice cases of urban deep decarbonization are using the key strategies of engaging stakeholders, fostering a green economy, creating policy, and providing financial incentives. Moreover, these best practice cases have governance structures for coordinating within the local government, providing oversight and reporting, collaborating across sectors, pursuing multi-level integration, obtaining funding, and they are using a combination of different modes of governance. While a number of these approaches and tools have been identified in previous research and grey literature, the findings show that leading local governments and stakeholders continue to develop innovative strategies and also share their successes with other communities through transnational networks. For example, local governments are working to expand their green economies and the capacity of their workforces to meet the future demand for skilled workers, especially in the buildings and construction sectors. The cases examined in this study are moving beyond the incremental approach to GHG mitigation that much of the pre-existing literature has examined, which means that they are innovating to try to find applied methods for achieving deep decarbonization. As more cities recognize the necessity for deep decarbonization and transformative change to address the climate crisis, the key strategies and governance approaches discussed in this paper can be further developed and implemented in a wide variety of communities.

The study improves our understanding of strategies and governance structures for local governments of various population sizes to address deep decarbonization

specifically and plan implementation more generally. This study also contributes to practical knowledge for developing and implementing deep decarbonization plans at the local level. Further research is needed for strategies and governance mechanisms at the local level. This study examines the progress of eight leading and ambitious cities. Larger studies that examine a wider sample size would better highlight the current state of local deep decarbonization planning. Further study on small and mid-sized cities, and their capacity and jurisdictional challenges, would also further our understanding of the potential for all cities to deeply decarbonize. Studies of cities in developing countries would provide a more global perspective. In addition, deeper research into cross-sector collaboration structures, including engagement of partners in implementation, shared decision-making options, and communication systems, would allow a study on which design features lead to greater collective action and more GHG reduction in cities. Finally, in light of the 2020 global pandemic, the impacts of COVID-19 on climate action planning and implementation at all levels require further study.

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